Best Available Techniques (BAT) for the textile industry

Reducing emissions of some micro-pollutants via wastewater

Brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH)

Final report

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The data in this study are up to date until May 2010.

BACKGROUND

On the initiative of the Flemish Government, a centre for Best Available Techniques was established at the Flemish Institute for Technological Research (VITO) in 1995. The objective of this BAT centre is to distribute information about environment-friendly techniques available to companies. The target groups for this information are environmental officials in companies and the Government. The publication of this book is part of the assignment in question. The BAT centre is, together with its sister project EMIS (http://www.emis.vito.be), run by a steering committee with representatives from the Flemish ministry for Environment, Energy, Nature and Public Works, the department for Environment, Nature and Energy (LNE), the department for Economics, Science and Innovation and the agencies IWT, OVAM, VEA, VLM, VMM and Health & Welfare.

Environment-friendly techniques are aimed at reducing potential environmental damage caused by companies. These techniques could be for purifying wastewater and flue gases, waste processing or soil pollution remediation. However, these measures are often preventive measures that prevent emissions of polluting substances and reduce the consumption of energy and raw materials. If, in comparison with all comparable techniques, such techniques achieve the best scores for environmental aspects and if they are also affordable, they will be referred to as Best Available Techniques or BAT.

The environmental regulations imposed on companies are, to a great degree, based on the BAT. Thus, sectoral emission limit values in VLAREM II often reflect the level of environmental protection that can be realised with the BAT. Therefore, the determination of BAT is not only useful as a source of information for companies, but is also a reference that the Government can use to establish new environmental regulations. In certain cases, the Flemish Government also issues subsidies to companies that invest in BAT.

The BAT centre prepares BAT studies per business sector or per group of similar activities. These studies describe the BAT and provide background information. The background information gives environmental officials a better insight into daily business practices and informs business managers about the scientific basis for various environmental regulations. The BAT are evaluated against the environmental permit conditions and against environmental investement support (ecologiepremie) applicable in Flanders. Suggestions are sometimes made to fine-tune these emission limit values and regulations. Experience demonstrates that the Flemish Government often implements the suggested modifications in new VLAREM legislation and in the environmental investment support. However, while awaiting this implementation, these suggestions must be regarded as non-binding.

BAT studies are the result of intensive literature searches, visits to companies, collaboration with sector experts, supplier questionnaires, extensive contact with business managers and officials, etc. Naturally, the outlined BAT are only a reflection of the current state of affairs and not all BAT – existing and future – can be included in this overview.

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Chapter 1   Introduction
explains the term "Best Available Techniques" (BAT) and its use in Flanders, and then outlines the general framework for this BAT study.

Chapter 2   Socio-economic and environmental legislation in the sector
provides a socio-economic investigation of the textile industry. This chapter outlines the importance of the sector, using the number and size of companies, the level of employment and various financial statistics. This allows us to evaluate the economic health and the resilienceof the sector. Further, the main legislative provisions (that could be) applicable to the textile industry are also identified.

Chapter 3   Process description
describes the processes in the textile industry and the accompanying environmental impact, with specific attention to textile companies that apply finishing processes and thus use brominated flame retardants (Deca-BDE, HBCD), antimony trioxide (Sb_2O_3), perfluorinated tensides (PFOS and PFOA), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH).

Chapter 4   Available environment-friendly techniques
outlines the various measures that are used, or can be used, to prevent or limit environmental damage. This paragraph primarily addresses the specific environment-friendly techniques that can be implemented to limit the environmental impact of Deca-BDE, HBCD, Sb_2O_3, PFOS, PFOA, NP, NPE and PAH via wastewater.

Chapter 5   Selection of the Best Available Techniques
evaluates the environment-friendly measures described in chapter 4 in terms of their impact on the environment, their technical feasibility and their economical feasibility. The subsequently selected techniques are regarded as BAT for the textile industry as a whole or for textile companies with specific activities (possibly with boundary conditions).

Chapter 6   Recommendations based on the Best Available Techniques
makes suggestions to confirm and/or supplement existing environmental legislation. This chapter also examines which of the environment-friendly techniques are qualified for investment support under the environmental investment support (ecologiepremie) applicable in Flanders. Finally, this chapter provides recommendations for further research and technological development.

Appendices
reveals the members of the steering committee and the visited companies. Further, the appendices provide background information about the reference measurement methods for BFR, antimony, PFT, NP, NPE and PAH, background information about the method used to obtain BAT-associated emission levels (BAT-AELs) for textile companies and final comments about the proposed final report for the textile industry.

CONTENTS

SUMMARY

The Centre for Best Available Techniques (BAT) is founded by the Flemish Government, and is hosted by VITO. The BAT centre collects, evaluates and distributes information on environmentally friendly techniques. Moreover, it advises the Flemish authorities on how to translate this information into its environmental policy. Central in this translation is the concept "BAT" (Best Available Techniques). BAT corresponds to the techniques with the best environmental performance that can be introduced at a reasonable cost.

This report discusses the BAT for the textile industry in Flanders. In particular, the report focuses on the brominated flame retardants Deca-BDE and HBCD, diantimony trioxide (Sb_2O_3), perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH). This report completes the Flemish BAT study for the textile finishing industry (Jacobs A. et al., 1998).
NPNPE
The first aim of the study is to select the BAT for preventing and/or minimizing the emissions of the above mentioned pollutants via textile wastewater. In this study more than 20 techniques are selected as BAT for the textile industry. The BAT selection in this study was based on a technical and socio-economic analysis of the textile industry, discussions with industry experts and authorities, plant visits and a comparison with other related studies, for example the BREF for the Textiles Industry (EIPPCB, 2003a).

Most of the BAT for preventing and/or minimizing the emissions of the above mentioned pollutants via textile wastewater are preventative and process integrated measures. Examples of BAT are: make arrangements with suppliers of purchased fibres and yarns, concerning the implemented chemicals; use environment-friendly alternative chemicals for finishing activities; collect exhausted process baths with Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA and dispose via a qualified processing company. Wastewater that contains Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA must thus be diverted away from the AWZI wherever possible.If preventive or process-integrated measures are insufficient in helping to realise concentration levels that are acceptable for discharge, then the BAT is to appropriately treat the wastewater (possibly partial flows) by implementing a combination of suitable wastewater purification techniques.

PAH are (partly) removed from the wastewater of textile companies by implementing biological (main) purification. However, when this wastewater purification technique is implemented, Deca-BDE, HBCD, Sb_2O_3, NP and/or NPE are not removed from the wastewater. Depending on the to-be-removed micro-pollutants and the specific situation (e.g. discharge situation, load of the wastewater, to be treated volume), the following wastewater purification techniques can, for example, be implemented additionally: adsorption (active carbon filtration, incl. Deca-BDE, HBCD, NP and NPE), sand filtration (incl. Deca-BDE, HBCD, Sb_2O_3 and PAH) or chemical precipitation (coagulation-flocculation, incl. Deca-BDE, HBCD, Sb_2O_3 and PAH).

Further, it is also the aim of the BAT study to determine BAT associated emission levels (BAT-AELs) for discharging wastewater in the textile industry and to propose

wastewater emission limit values for the textile industry. Table 1 provides an overview of the recommendations for environmental legislation.

Table 1: Summary of BAT associated emission levels (BAT-AELs), proposals for sectoral wastewater emission limit values and other recommendations for environmental legislation)

Parameter / parameter group	BAT-AELs		Proposal - sectoral wastewater emission limit values		Recommendation - special wastewater emission limit values		Recommendation - need for additional measurement data	
	OW	RIO	OW	RIO	OW	RIO	OW	RIO
Deca-BDE (used by the textile company)	<20 µg/l	-[1]	20 µg/l	-[2]	-	+[3]	-	-
Deca-BDE (not used by the textile company)	<10 µg/l	<10 µg/l	10 µg/l	10 µg/l	-	-	-	-
HBCD (used by the textile company)	<10 µg/l	<10 µg/l	10 µg/l	10 µg/l	-	-	-	-
HBCD (not used by the textile company)	<2 µg/l	<2 µg/l	2 µg/l	2 µg/l	-	-	-	-
Sb_2O_3	<1 mg/l	<1 mg/l	1 mg/l	1 mg/l	-	-	-	-
PFOS/PFOA	-	-	-	-	-	-	+	+
NP/NPE	-	-	-	-	+	+	+	+
PAH	-[4]	-[5]	0,001 mg/l excl. naphthalene (= existing sectoral permit conditions)	+ (delete existing sectoral permit conditions)	-	+	-	-

Legend:
- -: No recommendation made
- +: Recommendations made
- OW: Discharge into surface water
- RIO: Discharge into sewer

[1] due to insufficient data

[2] due to insufficient data

[3] see comments in chapter 6, paragraph 6.1.2.3 (page 184-185)

[4] emission levels were derived

[5] emission levels were derived

Finally, the BAT study will be used as input when reviewing the European BAT study for the Textiles Industry (EIPPCB, 2003a). This review is likely to start in 2010.

CHAPTER 1 INTRODUCTION

This chapter explains the term 'Best Available Techniques', or BAT for short, its meaning in Flanders, as well as the general framework of the BAT study for the textile industry – Reducing emissions of brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH) via wastewater.

1.1 Best Available Techniques in Flanders

1.1.1 Definition

The term "Best Available Techniques", abbreviated to BAT, is defined in VLAREM I[6], article 1 29°, as:

" the most efficient and advanced stage of development of the activities and operation methods, whereby the practical usability of special techniques to form in principle the starting-point for the emission limit values is demonstrated, with the aim of preventing emissions and effects on the environment in their entirety, or when this does not appear to be possible, to limit them in general;

a. *"technologies": the applied techniques and the way in which the installation is designed, constructed, maintained, operated and dismantled;*
b. *"available": developed on such a scale that the techniques, costs and benefits considered can be applied in an economical and technically feasible manner within the industrial context, irrespective of whether these techniques are or are not applied or produced on the territory of the Flemish Region, provided they are accessible to the operator at reasonable conditions;*
c. *"best": the most efficient means of achieving a high general level of protection of the environment in its entirety.*

This definition forms the starting point for firmly establishing the term BAT for reducing emissions of bromine-based flame retardants (BFR), antimony trioxide (Sb_2O_3)[7], perfluorinated tensides (PFT), nonylphenols (NP) and nonylphenol ethoxylates (NPE) via wastewater from the textile industry in Flanders.

[6] VLAREM I: Order of the Flemish Government of 6 February 1991 concerning Environmental Licences, repetitively modified.

[7] Antimony, in the form of antimony trioxide (Sb_2O_3), is used in the textile industry as a synergist in combination with BFR (see paragraph 3.2.3).

1.1.2 Best Available Techniques as a term in Flemish environmental policy

a. Background

Almost all human activity (e.g. home-construction, industrial activity, recreation, agriculture, etc) affects the environment in one way or another. Often it is not possible to estimate how harmful this impact is. Because of this uncertainty, it is deemed that all activities must be carried out with utmost care to burden the environment as little as possible. This corresponds to the prevention principle.

In its industrial environmental policy, the Flemish Government has translated this prevention principle into a request to implement the "Best Available Techniques". This request has thus been included in the general conditions in VLAREM II[8] (art. 4.1.2.1). Implementation of the BAT means that every operator must do everything technically and economically possible to prevent environmental damage. Furthermore, compliance with permit conditions is regarded as fulfilling the obligation to implement BAT.

The BAT principle can also be found in the environmental policy of most industrialised countries, albeit with a different emphasis. Similar terms include: BATNEEC (Best Available Techniques Not Entailing Excessive Costs), the German 'Stand der Technik', the ALARA principle (As Low as Reasonably Achievable) and 'Beste Uitvoerbare Technieken' in the Netherlands.

Within Flemish environmental policy, the term BAT is primarily used as a basis for establishing environmental permit conditions. Such conditions, which are imposed on institutions in Flanders, are supported by two facets:
- implementation of the BAT;
- remaining environmental effects must not breach predetermined environmental quality standards.

The European "IPPC" Guideline (2008/1/EC) requires member countries to use these two facets as a basis when determining environmental permit conditions.

b. Defining the term

In order to firmly establish the definition for the term BAT, one first needs to further clarify the general definition of VLAREM I. The BAT centre uses the following definitions for the three elements.
"Best" means "best for the environment as a whole", whereby the effect of the technique in question on the various environment compartments (air, water, soil, waste, …) is assessed;
"Available" places the emphasis on something that is available on the market and is accompanied by a reasonable cost price. Therefore, these techniques are no longer in an experimental phase, but have actually proven their worth in the industrial sector. The cost price is deemed reasonable if it can be met by an 'average' company in the concerned sector and is not disproportionate to the realised environmental benefit;

[8] VLAREM II: Ruling by the Flemish Government concerning general and sector determinations on environmental hygiene, of 1 June 1995, repetitively modified.

"Techniques" are technologies and organisational measures. They include process modifications, the use of less polluted raw materials, end-of-pipe measures, as well as good business practices.

It is thus clear that what one company regards as a BAT, is not necessarily regarded in the same manner by another company. However, experience in Flanders and other regions/countries has demonstrated that it is possible to set general BAT guidelines for groups of companies that use the same processes and/or manufacture similar products. Such sector or business branch BAT enable the Government to establish *sectoral permit conditions*. Thus, the Government will not impose the BAT, but will regard the environmental performance achievable with that BAT to be emission limit values.

The definition of BAT for particular sectors is also a useful reference point when assistance is awarded by the Flemish Government for environment-friendly investments. The environmental investment support regulation states that companies making environmental efforts that exceed the legal requirements, qualify for an investment subsidy.

1.1.3 The Flemish centre for Best Available Techniques

To help the Government to collect and distribute information about BAT and to advise it about BAT associated emission levels, VITO (Flemish Institute for Technological Research) has, on the initiative of the Flemish Government, established a centre for Best Available Techniques. This BAT centre inventories information about available environment-friendly techniques, selects the best available techniques from these techniques and translates them into conditions for permits and environmental investment support. The results are distributed in an active manner, to the Government as well as the industrial sector, via sector reports, information sessions and the internet (http://www.emis.vito.be).

The BAT centre is financed by the Flemish Region and is run by a steering committee with representatives from the Flemish Ministry for Environment, Energy, Nature and Public Works, the department for Environment, Nature and Energy (LNE), the department for Economics, Science and Innovation (EWI) and the agencies IWT, OVAM, VEA, VLM, VMM and Health & Welfare.

1.2 BAT study for the textile industry – reducing emissions of brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH)

1.2.1 Aims of the study

The study supplements the existing Flemish BAT study for textile processing (Jacobs A. et al., 1998).

The general aim of the study is:

- to examine emissions of brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH) via wastewater from the textile industry;
- to pinpoint and evaluate potential environmental measures (process / AWZI) to restrict emissions of BFR, diantimony trioxide (Sb_2O_3), PFT, NP, NPE and PAH via wastewater from the textile industry;
- to select BAT to limit emissions of BFR, diantimony trioxide (Sb_2O_3), PFT, NP, NPE and PAH via wastewater from the textile industry
- propose BAT associated emission levels and if possible sectoral emission limit values for the textile industry.

Further, the BAT study will be used as input when reviewing the European BAT study for the Textiles Industry (EIPPCB, 2003a). This review is likely to start in 2010.

1.2.2 Scope of the study

The study is aimed at textile companies that implement finishing activities and thus use brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and/or polycyclic aromatic hydrocarbons (PAH). Wherever relevant, a link will be made with activities that are:

- Up-stream: Producers of chemicals and formulators (integrated into the textile company in some cases);
- Down-stream: Qualified waste processing companies (e.g. paper bags, concentrated process baths) and drum cleaners (e.g. Intermediate Bulk Containers or IBCs for short).

The study primarily focuses of the environmental compartment ‘wastewater'. If there are direct or indirect links, (diffuse) emissions into air and waste (silt, packaging material) will also be studied.

The first group of parameters to be examined in the study is brominated flame retardants (BFR). The most relevant BFRs in the textile industry in Flanders are: decabromodiphenyl ether (Deca-BDE) and hexabromocyclododecane (HBCD). Further, the parameter diantimony trioxide (Sb_2O_3), which is used as synergist for e.g. Deca-BDE, is also studied (also see paragraph 3.2).

Perfluorinated tensides (PFT) are next to be addressed in the study. The PFTs primarily implemented in the Flemish textile industry are: Perfluorinated octanoic acid (PFOA) and perfluorooctanoic sulphonate (PFOS) (also see paragraph 3.3).

Further, a third variety of substances used in the Flemish textile industry is also examined, namely nonylphenols (NP) and nonylphenol ethoxylates (NPE) (also see paragraph 3.4).

Finally, polycyclic aromatic hydrocarbons (PAH), more specifically the 16 of EPA, are also addressed (also see paragraph 3.5).

1.2.3 Content of the study

The starting point for the research into Best Available Techniques (BAT) for the textile industry is the status of the sector (chapter 2), with specific focus on brominated flame retardants (BFR), diantimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH) via wastewater, in terms of both socio-economics and environmental legislation.

Chapter 3 briefly describes the processes implemented in the textile industry. The aim of this description is to paint a general picture of the implemented process steps and the impact on the environment of BFR, Sb_2O_3, PFT, NP/NPE and PAH via wastewater from the textile industry.

Chapter 4 addresses the various measures that can be implemented in the textile industry to prevent or limit environmental damage. The main focus has been placed on measures that prevent and/or limit emissions of Deca-BDE, HBCD, Sb_2O_3, PFOS, PFOA, NP/NPE and PAH via textile wastewater into the environment.

Chapter 5 evaluates the environment-friendly techniques addressed in chapter 4, in terms of their technical feasibility, environmental impact and economical feasibility, and states whether the mentioned environment-friendly techniques can be regarded as BAT for the textile industry. The BAT selected in this chapter are deemed BAT for the textile industry that can be implemented by an average company. However, this does not mean that every company in the sector will be able to automatically implement any technique regarded as a BAT. Company-specific circumstances must also be taken into consideration.

Chapter 6 presents a number of concrete recommendations and suggestions, based on the BAT analysis (chapter 5). The first recommendations relate to environmental permit conditions, which are aimed at reinforcing and/or supplementing existing environmental legislation. Chapter 6 also contains recommendations for environmental investment support. The final recommendations relate to further research and technological development.

1.2.4 Management and methodology

A steering committee, containing representatives from the industrial sector and the Government, was set up to handle scientific management. This committee gathered on 4 occasions to manage the study content (14/11/08, 06/03/09, 23/06/09, 19/11/09). The names of committee members and external experts who collaborated with this study, have been included in appendix 1.

Wherever possible, the BAT centre has taken comments from steering committee members into account. The content of this report has not been compromised and merely reflects what the BAT centre regards as up-to-date techniques. All recommendations have been made on this basis.

CHAPTER 2 SOCIO-ECONOMIC AND ENVIRONMENTAL LEGISLATION IN THE SECTOR

This chapter places the textile industry in its context, with specific attention being paid to emissions of bromine-based flame retardants (BFR), antimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH), in terms of both socio-economics and environmental legislation.

We will first try to describe the sector and the study subject as precisely as possible. Thereafter, we will provide a brief socio-economic update of the situation in the sector. Finally, we will take a close look at the main factors concerning environmental legislation for BFR, Sb_2O_3, PFT, NP, NP and PAH in the textile industry.

2.1 Description and scope of the sector

2.1.1 Scope and layout of the sector

a. Scope of the sector

The study is aimed at textile companies that implement finishing activities and thus use bromine-based flame retardants (BFR), antimony trioxide (Sb_2O_3), perfluorinated tensides (PFT), nonylphenols (NP) and/or nonylphenol ethoxylates (NPE). Wherever relevant, a link will be made with activities that are:

- Up-stream: Producers of chemicals and formulators (integrated into the textile company in some cases);
- Down-stream: Qualified waste processing companies (e.g. paper bags, concentrated process baths) and drum cleaners (e.g. Intermediate Bulk Containers or IBCs for short).

b. NACE-BEL division

The NACE-BEL nomenclature[9] is a way of dividing the sector on the basis of economic activity. Official statistics, like data from the Social Security Department (RSZ) or the National Institute for Statistics (NIS), normally use the NACE-BEL division.

The textile companies examined in the study during the economic analysis, are those that are part of NACE-BEL 2008 categories:

13 textile;
13.300 textile processing;

[9] NACE: Nomenclature générale des activités économiques dans les Comunautés Européennes, in 1970 by the European Community Office of Statistics, compiled to regulate industrial activities in a logical manner. A new issue - NACE Rev. 2 – was established by Ordinance (EC) no. 1893/2006 of the European Parliament and the Council of 20 December 2006 (Publication by the European Union on 30 December 2006). NACE-BEL 2008 is the most up-to-date Belgian version of the NACE nomenclature, in accordance with NACE Rev. 2.

13.930 manufacture of rugs and carpets;
20.600 manufacture of synthetic and artificial fibres;

The remaining items are regarded as the textile industry as a whole, so long as the activities/implemented processes are relevant to the scope of this study.

2.1.2 The industrial scale

Activities in the textile industry concern industrial processing of natural or other textiles during the various phases of the conversion process, or the production of all fibres and yarns, other than natural, for textile purposes.

The next upstream activities for the textile industry are those of raw materials and product manufacturing. Here are a few examples: producers of chemicals and formulators (integrated into the textile company in some cases). Downstream activities include textile products that enter the trade sector. Waste processing (e.g. paper bags, concentrated process baths) and drum cleaners (e.g. Intermediate Bulk Containers or IBCs for short) are examples of downstream activities.

The place of the textile industry in the industrial scale has been displayed in Figure 1.

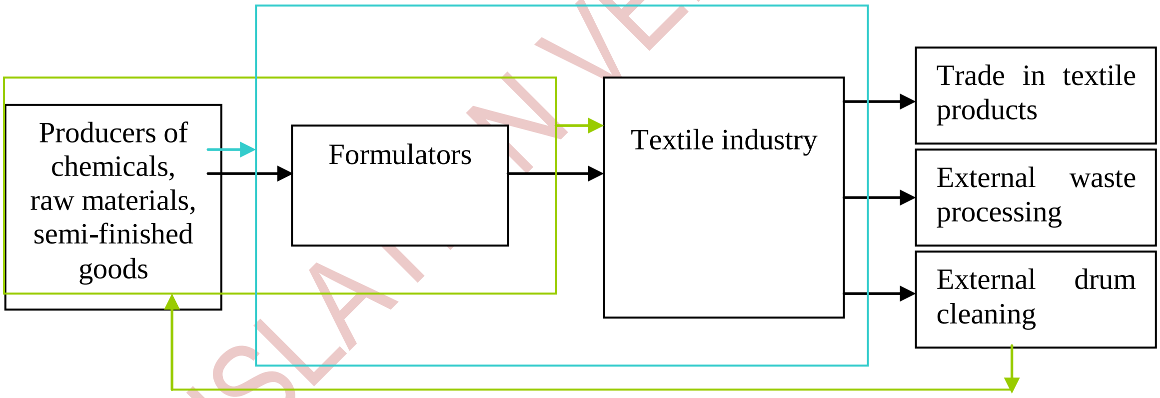

Figure 1: Place of textile industry in the industrial scale

2.2 Socio-economic characteristics of the sector

This paragraph uses a few socio-economic indicators to outline the current status of the textile industry. These indicators sketch a general picture of the sector structure and form the basis for evaluating the financial health of the sector in the following paragraph.

2.2.1 Number and size of companies

The Bel-First database[10] contains the non-consolidated annual accounts[11] of companies active in Belgium. Table 3 provides an overview of textile companies active in Belgium per Region, which are part of the new NACE-BEL code 13 (textile), 13.300 (textile processing), 13.930 (manufacture of rugs and carpets) and 20.600 (manufacture of synthetic and artificial fibres). The figures in brackets indicate the number of companies that indicated the concerned NACE-BEL code as their main activity.

comment
The most relevant NACE-BEL codes, as far as the substances examined in the BAT study, are13 (textile), 13.300 (textile processing) and 20.600 (manufacture of synthetic and artificial fibres). Companies that are part of NACE-BEL code 13.930 (manufacture of rugs and carpets), have also been included when evaluating the socio-economic characteristics of the sector, because many textile companies – for whom discharge data is available (incl. via VMM) - state that their main activity falls under this code.

Table 3: Number of active companies per region in Belgium (2007)

NACE code	Number of companies active in Belgium	Number of companies active in Flanders	Number of companies active in Brussels	Number of companies active in Wallonia
13	1 596 (1 080)	1 251 (852)	112 (65)	233 (163)
13.300	233 (142)	167 (100)	19 (12)	47 (30)
13.930	220 (135)	200 (123)	7 (4)	13 (8)
20.600	50 (34)	36 (24)	0	14 (10)

SOURCE: Bel-First

Another way of dividing the sector is to use product groups, as done by Fedustria and Centexbel. This involves making a distinction between interior textiles, technical textiles, clothing textiles, finishing and spinning. Figure 2 show the distribution of these product groups, based on their added value in Belgium. It is noticeable that interior textiles, with 42%, and technical textiles, with 33%, are by far the most important activities in the Belgian textile sector. This is in contrast with the overall picture in the EU, where clothing textiles represent more than 40% of the added value[12]. Interior textiles and technical textiles are also the main product groups where numerous chemicals are used, like fire-resistant, antibacterial and water-proof products. This indicates that the potential impact on the environment of these pollutants in greater in the Belgium – and thus also Flanders – textile sector than in the rest of Europe. In addition, Centexbel (in TIS-Reflex 2010 Roadmap Technical Textiles) has also indicated that the technical textiles sub-sector is currently experiencing large-scale expansion.

[10] The Bel-First database contains annual accounts and other financial information about all Belgian companies with a history longer than 10 years – this information is supplied by the Belgian National Bank.

[11] A consolidated annual account consists of a balance and results account, which includes financial information for the parent company and all subsidiaries for which the company directly or indirectly possesses more than 50% of the shares capital.

[12] Eurostat Structural Business Statistics, 2006

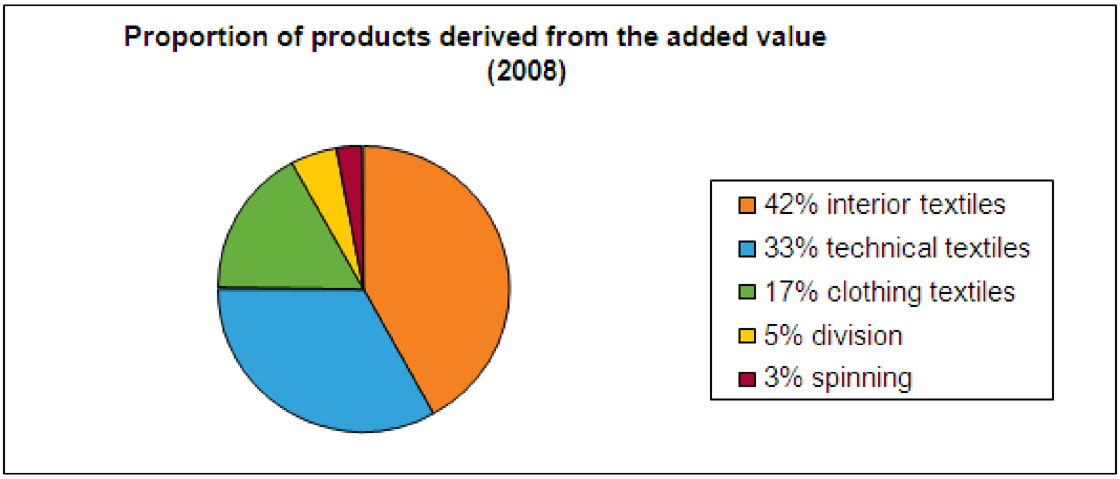

Figure 2: Share of the product groups based on their added value in 2008 (Source: Fedustria Annual Report 2008-2009)

The Bel-First company list for Flanders is used for selecting the textile companies surveyed by Centexbel and for selecting textile companies for whom discharge data is collected (see appendix 3).

For further analysis, we will focus on Flemish companies who have an annual account in Bel-First for financial year 2007. We hereby split the sub-sectors based on size. The Register of Companies deems a company to be 'large' if its average workforce per year amounts to over 100, or if it exceeds one of the following thresholds:
- average annual workforce: 50
– annual turnover (excluding VAT): € 7 300 000
- balance total € 3 650 000

Small companies are companies that had an abbreviate annual account in 2007. *Large companies* are companies that had a full annual account in 2007. Companies that are not required to submit annual accounts have not been included in this analysis[13].

[13] Incl. natural persons in the capacity of traders, small companies with partners who have unlimited liability, partnerships, normal limited partnership, cooperatives with unlimited liability, and large companies with partners that have unlimited liability if none of the partners is a legal person.

Table 4: Number of companies in Flanders in the examined (sub)sectors, for whom an annual account for 2007 is available (Source: Bel-First)

NACE code	Small company	Large company
13	950 (624)	212 (154)
13.300	124 (74)	26 (14)
13.930	136 (80)	55 (37)
20.600	14 (10)	22 (14)

Textile industry (code 13), textile processing (code 13.300) and carpet production (code 13.930) primarily comprise of small companies, which confirms the sector's typical SME characteristic. The production of synthetic and artificial fibres (code 20.600), on the other hand, involves a larger number of large companies.

2.2.2 Other socio-economic characteristics

a. Turnover

Turnover is defined as follows: "The amount realised from the sale of goods and the delivery of services to third parties, within the framework of normal business operations[14]. The evolution of turnover in the textile industry and the examined sub-sectors is displayed in Figure 3. Table 5 provides an overview of the level and distribution of turnover. Turnover has only been displayed for large companies because small companies are not obligated to report turnover figures.

In the period 2001-2007, there was a slight drop in turnover figures in the textile industry (code 13). Textile processing (code 13.300) has followed this evolution, while turnover from the production of synthetic fibres (code 20.600) between 2001 and 2005 was subject to a relatively sharp drop, and recovered in 2006 and 2007. Manufacturers of carpets (code 13.930) witnessed a rise in turnover in the period 2001-2007.

Fedustria issued a press release[15] stating that the current economic crisis in the export-sensitive textile industry had caused a 14% drop in turnover in 2008. Interior textiles were particularly hard hit by the housing crisis in the British and American markets.

[14] Trade discounts on the retail price are deducted, though tax on added value or any other direct tax related to turnover is not. Contributions by the government, as compensation for lower income, are included in the turnover.

[15] Press release Fedustria 28 April 2009: 'Difficult 2008, surviving in 2009, but with confidence in the future'

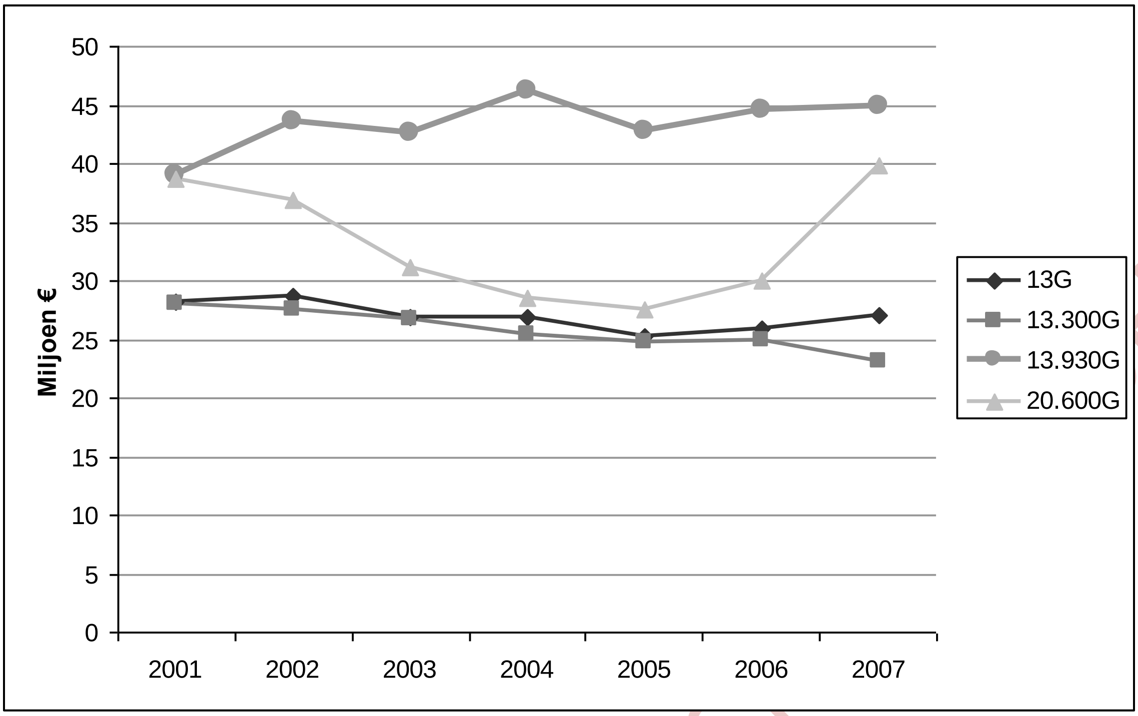

Figure 3: Evolution of average turnover among large companies in Flanders (Source: Bel-First)

The distribution of turnover (Table 5) indicates that manufacturers of carpets (code 13.930) and synthetic fibres (code 20.600) generally have a higher turnover than companies in the textile industry (code 13) and textile processing (code 13.300). The median for each of the sub-sectors is less than the average, which indicates that a few large companies push up the average figure.

Table 5: Distribution of turnover among large companies in Flanders in 2007 (Source: Bel-First)

€ 1 000	**NACE**			
	13	**13.300**	**13.930**	**20.600**
20th percentile	3.991	4.148	7.022	6.583
median	11.129	10.032	15.216	15.906
80th percentile	33.286	35.329	65.716	68.633
average	28.365	24.049	46.641	41.648

b. Added Value

The added value (AV) is calculated as the difference between the value of produced and sold goods and services (output) and the value of purchased and consumed goods and services (input)[16].

[16] A company can be defined as an organisation where production factors (personnel, equipment, sources of finance, etc.) jointly provide an added value, which is used to pay for each of these factors. The accumulated added value of all companies in an entity (region, country, …) forms the Gross National Product of the entity in question (Ooghe and Van Wymeersch, 2003).

The evolution of added value in the textile industry and the examined sub-sectors is displayed in Figure 4. Table 6 provides an overview of the level and distribution of the added value.

The added value generally fell among the small companies in the textile industry. In the period 2001-2007, manufacturers of synthetic fibres were alone in realising an increase in added value.

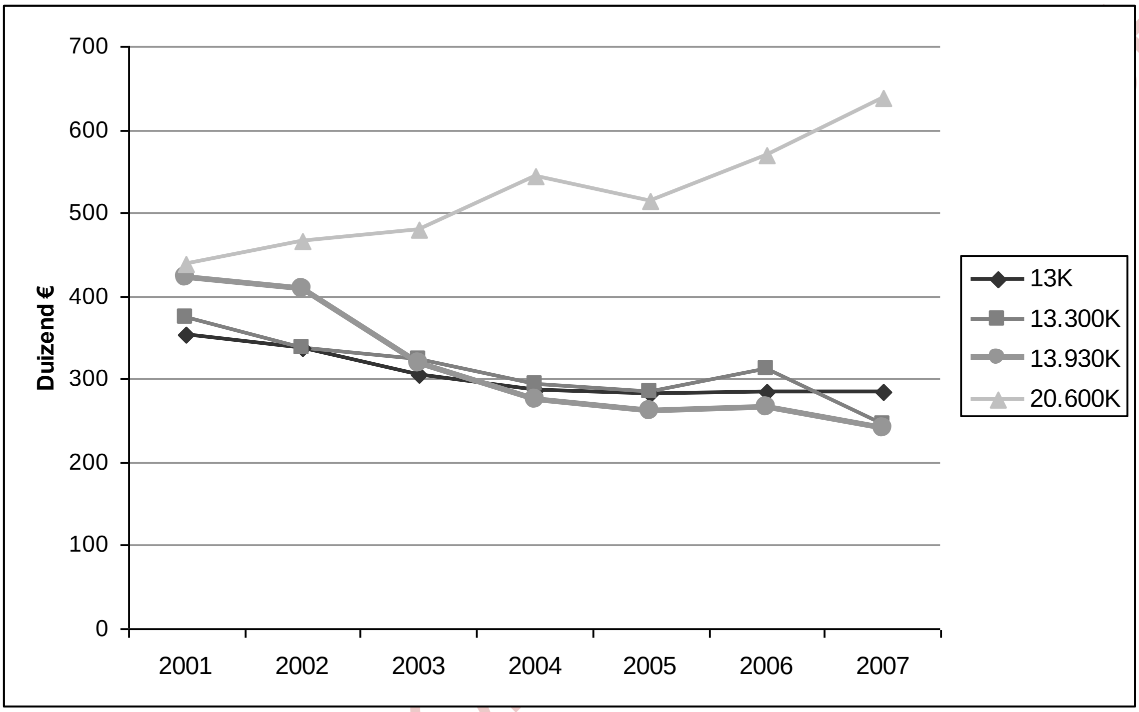

Figure 4: Evolution of average added value among small companies in Flanders (Source: Bel-First)

The distribution of added value (Table 6) indicates that manufacturers of synthetic fibres (code 20.600) generally have a higher added value than companies in the textile industry (code 13). Although manufacturers of carpets (code 13.930) generally had a relatively high turnover, the same cannot be said for added value. The median for each of the sub-sectors is less than the average, which indicates that a few large companies push up the average figure.

Table 6: Distribution of added value among small companies in Flanders in 2007 (Source: Bel-First)

€ 1 000	**NACE**			
	13	**13.300**	**13.930**	**20.600**
20th percentile	13	5	13	12
median	91	56	88	403
80th percentile	425	370	401	710
average	285	247	243	638

The evolution of added value for large companies in the textile industry and the examined sub-sectors is displayed in Figure 5. Table 7 provides an overview of the level and distribution of the added value among large companies.

The added value generally fell among the large companies in the textile industry. In the period 2001-2007, manufacturers of carpets were alone in realising an increase in added value.

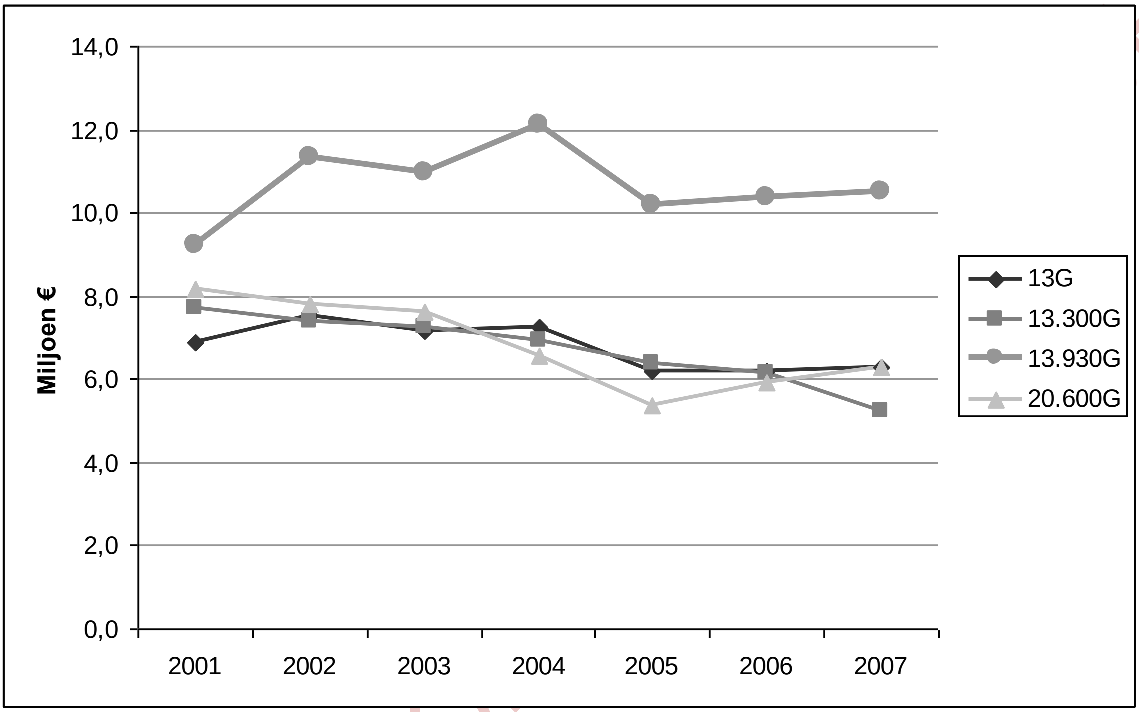

Figure 5: Evolution of average added value among large companies in Flanders (Source: Bel-First)

The distribution of added value among large companies (Table 7) indicates that the added value of large companies in the various sub-sectors are generally at the same level. The median for each of the sub-sectors is less than the average, which indicates that a few large companies push up the average figure.

Table 7: Distribution of added value among large companies in Flanders in 2007 (Source: Bel-First)

	NACE			
€ 1 000	**13**	**13.300**	**13.930**	**20.600**
20th percentile	934	1.725	1.191	1.046
median	2.801	3.087	3.723	4.062
80th percentile	7.382	5.379	15.750	10.940
average	6.275	5.230	10.515	6.306

c. *Operating results*

The operating results are calculated by subtracting the operating costs from the operating income. This is thus the result before financial costs and incomes, exceptional costs and incomes and taxes. The average operating result indicates the profitability of operating activities.

The evolution of the operating results among small companies in the textile industry and the examined sub-sectors is displayed in Figure 6. Table 8 provides an overview of the level and distribution of the operating results of small companies.

Operating results for the textile sector (code 13) fell in the period 2001-2007, with the exception of synthetic fibre manufacturers (code 20.600). Textile finishing (code 13.300), in particular, was subject to a relatively sharp fall in operating results. The operating results of small manufacturers of carpets were always negative in the period 2003-2007.

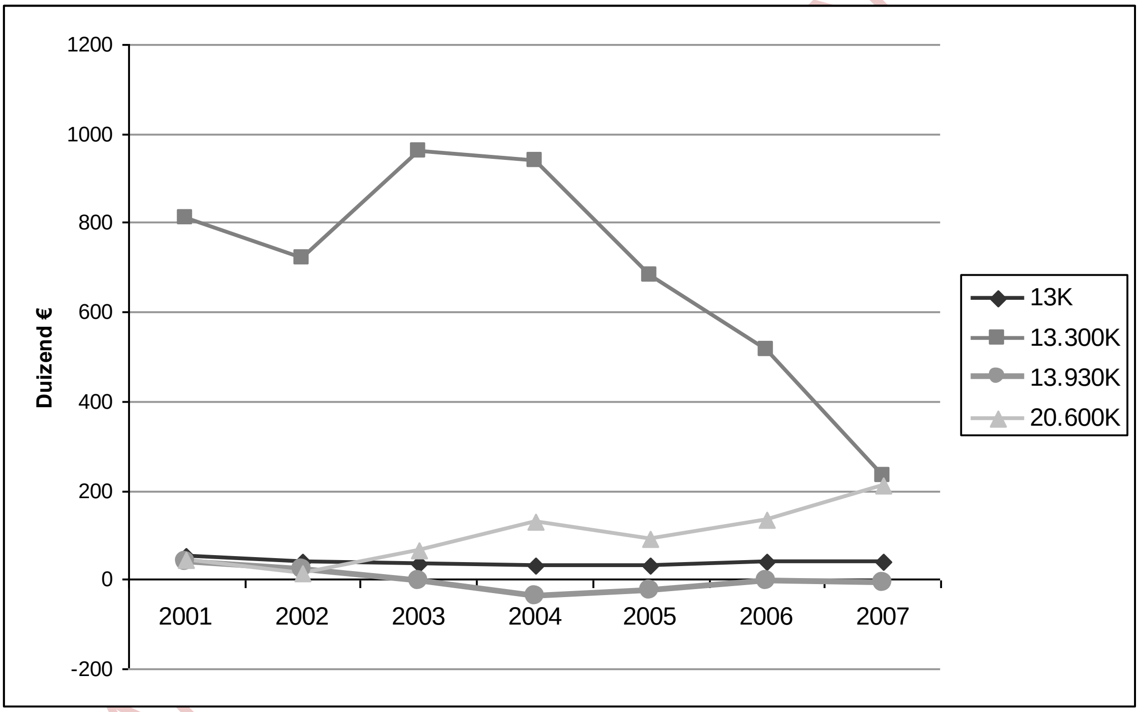

Figure 6: Evolution of average operating results among small companies in Flanders (Source: Bel-First)

The distribution of operating results (Table 8) indicates that small manufacturers of carpets and synthetic fibres (code 20.600) generally had higher operating results than small companies in the textile industry (code 13). For most sub-sectors, with the exception of carpet manufacturers (code 13.930), the median is lower than the average; this indicates that a few large companies push up the average figures.

Table 8: Distribution of operating results among small companies in Flanders in 2007 (Source: Bel-First)

€ 1 000	NACE			
	13	13.300	13.930	20.600
20th percentile	-14	-14	-28	5
median	12	5	4	69
80th percentile	78	37	48	223
average	40	29	-8	212

The evolution of operating results among large companies in the textile industry and the examined sub-sectors is displayed in Figure 7. Table 9 provides an overview of the level and distribution of the operating results of large companies.

The operating results of large companies in the textile sector are more volatile in nature. In the textile industry (code 13), after a few ups and downs, operating results returned to the same level as 2001 in 2007. Textile processing (code 13.300) and the manufacture of synthetic fibres (code 20.600) show a fall in operating results while the operating results of carpet manufacturers (code 13.930) fluctuate greatly.

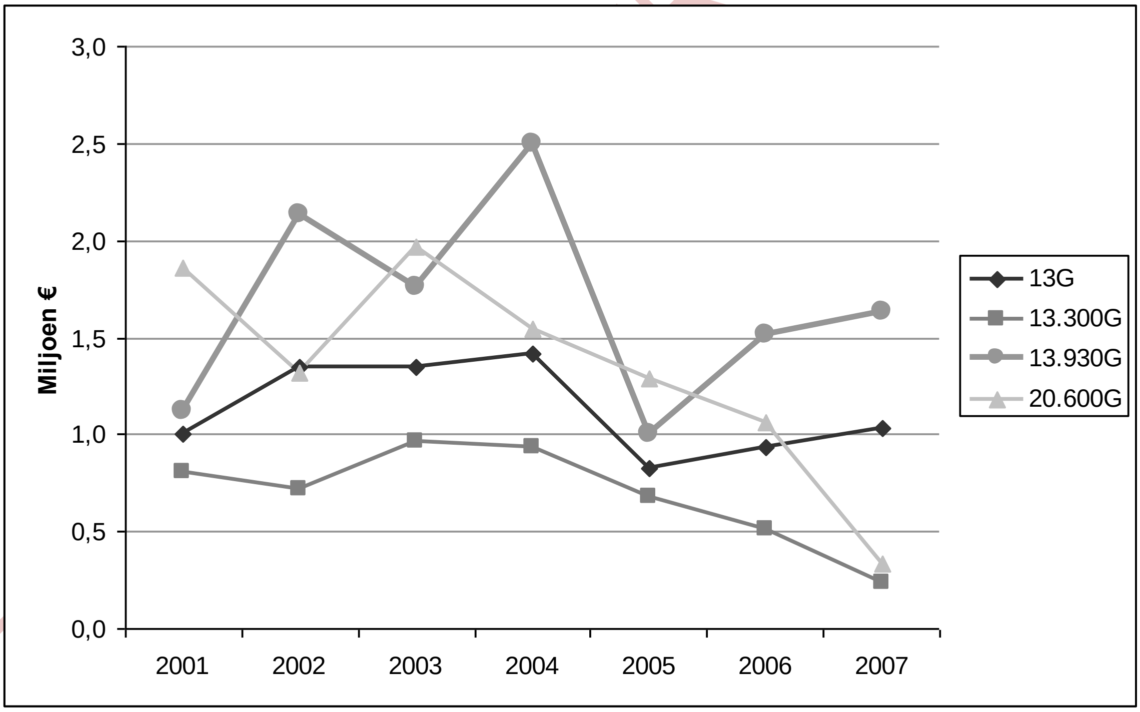

Figure 7: Evolution of average operating results among large companies in Flanders (Source: Bel-First)

The distribution of operating results (Table 9) indicates that the operating results of large companies in the various sub-sectors are the same in terms of size. The median for the textile industry (code 13) and the production of carpets (code 13.930) is lower than the average, which indicates that a few large companies push up the average figures. In the case of synthetic fibre manufacture, the average is lower because a few companies have severely negative or low operating results.

Table 9: Distribution of operating results among large companies in Flanders in 2007 (Source: Bel-First)

€ 1 000	**NACE**			
	13	**13.300**	**13.930**	**20.600**
20th percentile	-31	-124	-6	-131
median	319	269	359	806
80th percentile	1.293	1.043	1.312	1.679
average	1.032	234	1.632	339

d. Investment

Investment is calculated based on purchases of fixed material assets (including produced fixed assets) mentioned in the annual account information provided by companies.

The evolution of investment among small companies in the textile industry and the examined sub-sectors is displayed in Figure 8. Table 10 provides an overview of the level and distribution of investment.

One generally notices a downward trend, although the textile industry (code 13), textile processing (13.300) and the manufacture of carpets (code 19.930) experienced an increase in 2007. The high peak for the manufacture of carpets in 2004 can be attributed to major investments by a few companies. The annual report by Fedustria (2008-2009)[17] indicates a 9.3% reduction in investment in 2008. This drop can primarily be attributed to the low occupancy rate in production capacity due to unfavourable economic conditions (occupancy rate of 58.7 % in January 2009 compared to 73.7 % in 2008 and 78.4 % in 2007) and reduced access to bank credit.

17 http://www.fedustria.be/DocShare/docs/1/GHIPPBBCCFPLPPDAPKKEKKDMFL19GRVG3CPDBG4EO3PD/Fedustria/docs/DLS/FEDUSTRIA_2009_NL-2009-00201-v01-N.pdf

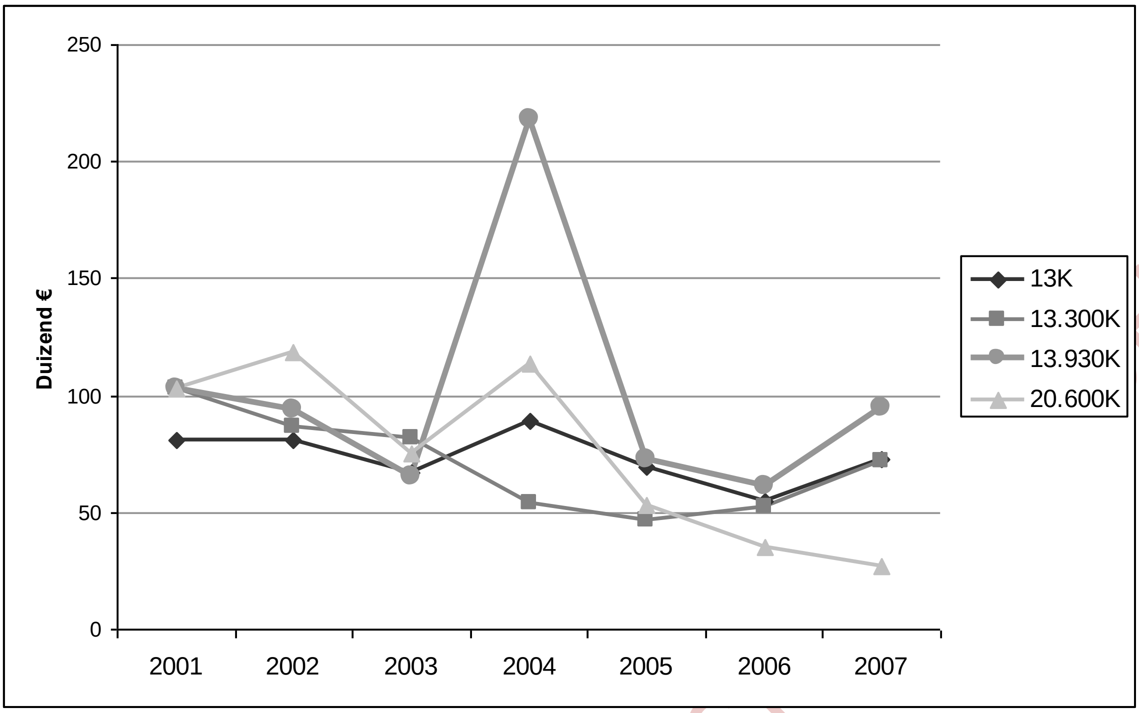

Figure 8: Evolution of average investments in fixed material assets among small companies in Flanders (Source: Bel-First)

The distribution of investment (Table 10) shows that small manufacturers of synthetic fibres generally made fewer investments in 2007. The median for each of the sub-sectors is less than the average, which indicates that a few large companies push up the average figure.

Table 10: Distribution of investment among small companies in Flanders in 2007 (Source: Bel-First)

€ 1 000	**NACE**			
	13	**13.300**	**13.930**	**20.600**
20th percentile	3	3	2	1
median	23	25	21	16
80th percentile	117	174	130	53
average	104	108	129	31

Investments among large companies (Figure 9) stayed, with the exception of a few peaks, relatively constant in the period 2001-2008. However, the annual report of Fedustria (2008-2009)[18] indicates a 9.3% reduction in investment in 2008 (see above).

18 http://www.fedustria.be/DocShare/docs/1/GHIPPBBCCFPLPPDAPKKEKKDMFL19GRVG3CPDBG4EO3PD/Fedustria/docs/DLS/FEDUSTRIA_2009_NL-2009-00201-v01-N.pdf

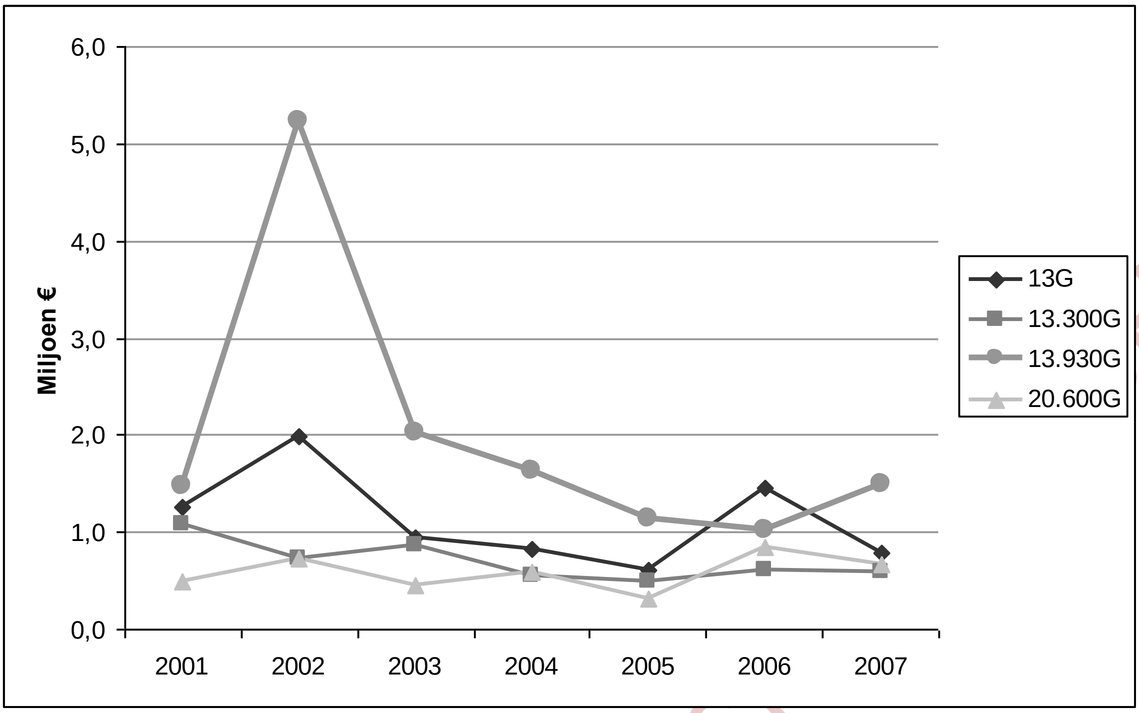

Figure 9: Evolution of average investments in fixed material assets among large companies in Flanders (Source: Bel-First)

The distribution of investment (Table 11) shows a clear difference between the various sub-sectors. The median for each of the sub-sectors is less than the average, which indicates that a few large companies push up the average figure. However, this is less pronounced for manufacturers of synthetic fibres.

Table 11: Distribution of investment among large companies in 2007 (Source: Bel-First)

€ 1 000	NACE			
	13	**13.300**	**13.930**	**20.600**
20th percentile	57	135	135	296
median	323	440	974	1.037
80th percentile	1.936	1.273	4.062	2.082
average	1.392	967	2.277	1.234

2.3 Resilience of the sector

Textile processing Flanders has a clear SME character. These SMEs are an important, though also vulnerable, group within the export-oriented textile industry. An evaluation of the economic statistics shows that the sector has recently (2008-2009) been hit by sharp drops in turnover and a low occupancy rate due to the current economic climate. In such circumstances, major additional environmental costs could, in the short term, cause competitiveness within the sector to fall even further. Therefore, when implementing further major environmental investment, it would be advisable to take a transitional period into account.

2.4 Environmental juridical aspects

The paragraphs below outline the study's environmental legislation framework. The main focus is legislation in Flanders. Further, relevant European legislation has also been addressed.

2.4.1 Environmental permit conditions

a. VLAREM I

In VLAREM I[19], with regards to the environmental permit in Flanders, a distinction is made between three classes of harmful set-ups. Class 1 and Class 2 set-ups must possess an environmental permit. Class 3 set-ups only have a reporting obligation. An environmental permit for a class 1 set-up must be requested from the provincial committee of the province where exploitation will take place. A class 2 or class 3 set-up is subject to the municipal council of the municipality where exploitation will take place.

The class to which a set-up belongs is determined by the encountered topics, as stated in appendix 1 of VLAREM I 'List of set-ups regarded as harmful'. If multiple set-ups are encountered in a single company, the permit procedure for the highest class must be followed.

In the list of harmful set-ups, textile companies are found under Section 41: Textile (fibres, yarns, wool, tissue, knitting work, braid work, textile goods, plastics and similar products). This section is further divided into the following sub-sections:

- 41.1. mechanical treatment of textiles
- 41.2. Fibres, knitting work, brain work, textile goods
- 41.3. wool degreasing factories, wool laundries, combing and carbonisation
- 41.4. chemical cleaning and treatment, textile processing
- 41.5. storage warehouse, more than 10 tonnes
- 41.6. manufacture of carpets
- 41.7. application of artificial under-layer on carpets
- 41.8. retting of flax, hemp and fibre pulp
- 41.9. production of viscose
- 41.10. pre-treatment or dying of fibres and textiles
- 41.11. production and processing of pulp

The parameters (BFR, Sb_2O_3, PFT, NP/NPE and PAH) examined in the study are implemented by textile companies that implement enriching processes. Specific attention has also been given to companies that fall under sub-section 41.4 (chemical cleaning and treatment, textile processing).

[19] VLAREM I: Ruling by the Flemish government on 6 February 1991 concerning Flemish regulations for the environmental permit, repetitively modified.

Section	Description and subsections			Class	Comments	Coordi- nator	Audit	Annual report	Vlarebo
41.4.	Installations for the chemical cleaning, pre-treatment and treatment of textiles, as well as textile finishing (with the exception of the installations referred to in Sections 41.9 and 46), with a total installed power of:								
	1°	a)	5 kW to 200 kW inclusive when the installation lies entirely within an industrial area	3					B
		b)	5 kW to 100 kW inclusive when the installation lies entirely or partially within an area other than an industrial area	3					B
	2°	a)	over 200 kW to 1,000 kW inclusive when the installation lies entirely within an industrial area	2	A,M				B
		b)	over 100 kW to 500 kW inclusive when the installation lies entirely or partially within an area other than an industrial area	2	A,M				B
	3°	a)	over 1,000 kW when the installation lies entirely within an industrial area	1	M	B	P	J	B
		b)	over 500 kW when the installation lies entirely or partially within an area other than an industrial area	1	M	B	P	J	B

comment
For an explanation of the symbols used in the table above, please refer to the introductory paragraphs in appendix 1 (list of systems regarded as harmful) of VLAREM 1.

Further information about further dividing the other sub-section in section 41 into classes, can be found via the environmental legislation navigator on the EMIS website www.emis.vito.be (environment, legislation, Environment, Nature and Energy navigator).

VLAREM I, appendix 2C contains a list of harmful substances for discharging into an aquatic environment. These lists contain the following substances:

- substances that are proven to be carcinogenic in or via water (list I);
- antimony (list II);
- brominated diphenyl ethers (only pentabromobiphenyl ether) (list III);
- 4-(para)-nonylphenol (list III);
- anthracene (list III);
- fluoranthene (as indicator for other more dangerous PAH) (list III);
- naphthalene (list III);
- benzo(a)pyrene (list III);;
- benzo(b)fluoranthene (list III);
- benzo(ghi)perylene (list III);
- benzo(k)fluoranthene (list III);
- indeno(1,2,3-cd)pyrene (list III).

Comments

- Appendix X of Priority Substances Co-guidelines (Guidelines 2008/105/EC), which is part of the Water Framework Guidelines (2000/60/EC), states which harmful substances are regarded as priority harmful substances (also see paragraph 2.4.3.g).
  Comments
  - List 2C of VLAREM I does not yet comply with appendix X of guidelines 2008/105/EC.
    - Antimony is not mentioned in appendix X of guidelines 2008/105/EC. VLAREM I does not distinguish between environmental classification of antimony compounds in general (namely R51/53: poisonous for organisms living in water; can have a harmful impact on aquatic environment in the long-term) and those of Sb_2O_3, which indicates that there is no environmental classification for Sb_2O_3 (i2a, 2009b and 2010).
    - The ruling for new environmental quality standards(provisionally approved by the Flemish Government on 04/12/09) contains an up-to-date version of List 2C, which mentions 4 –(para)-nonylphenol as a priority harmful substance (VMM, 2009f).
  - VLAREM I, article 1, 14° defines high priority substances as follows:
    Substances of which the list is established in accordance with EC directive 2000/60/EC in list III of appendix 2C to this order; this

comprises high priority hazardous substances in the field of water policy' for which measures must be taken;
.
 - Further information about the identification of these substances as priority/harmful priority substances, and an accompanying MKN, can be found in the Priority Substances Co-guidelines (2008/105/EC, also see paragraph 2.4.3.g), which are part of the Water Framework Guidelines (2000/60/EC, also see paragraph 2.4.3.f).

- VLAREM II, article 2.3.6.1 contains the following determinations:
  In accordance with Directive 76/464/EEC a licence for the discharging of industrial sewage that contains one or more hazardous substances can only be granted when complying with the following conditions:
  1° the pollution of the waters by the hazardous substances as referred to in list I of appendix 2C must be ended in accordance with the provisions of this order;
  2° the pollution of the waters by the hazardous substances as referred to in list II of appendix 2C must be reduced in accordance with the provisions of this order;
  ...
- The Dangerous Substances Reduction Programme (also see paragraph 2.4.2.b) mentions the following determinations:
  - Further, the benchmark for all dangerous substances is remediation at the source, progressive reduction and realisation of the MKN;
  - Further, the benchmark for most dangerous substances is, bearing in mind the toxicity, persistence and bio-accumulation, to <u>prevent</u> and/or <u>end</u> the pollution.

In addition to actual textile activities, other harmful systems will also normally be encountered in textile companies, whereby other VLAREM I sections may also be applicable. This may include:

- section 2 waste
- section 3 wastewater and cooling water
- section 12 electricity
- section 15 garages, car parks and repair workshops for
- section 16 gases
- section 17 dangerous substances
- section 24 laboratories
- section 29 metals
- section 31 engines with internal combustion
- section 39 steam equipment and hot water equipment
- section 43 incineration systems
- section 53 recuperation of groundwater

b. VLAREM II

VLAREM II[20] contains general and sectoral environmental permit conditions, which must be adhered to by companies in Flanders that require a permit or have a reporting obligation. The general environmental conditions apply to all harmful systems. The sectoral environmental regulations specifically apply to particular harmful systems, and take priority over the general conditions. In addition, VLAREM II also makes it possible to impose special award conditions in the environmental permit. Please refer to the paragraph c for further details.

The general and sectoral permit conditions below are some of the conditions that apply to the textile industry:

General environmental permit conditions
VLAREM II, section 4.1.11 mentions the following determinations:

Art. 4.1.11.1.
Pursuant to Article 67 of Regulation (EC) no. 1907/2006, a substance may not be manufactured or used as such, or in a preparation or object to which a restriction in Appendix XVII of Regulation (EC) no. 1907/2006 applies, unless the conditions of this restriction are satisfied. This does not apply to the manufacture and use of a substance for scientific research or scientific development. Appendix XVII specifies when the restriction does not apply to research and development carried out on products and processes, and specifies the maximum quantity exempted.

Art. 4.1.11.2.
Pursuant to Article 56 of Regulation (EC) no. 1907/2006, a manufacturer, importer or downstream user may not use a substance listed in Appendix XIV of Regulation (EC) no. 1907/2006 for a particular use, unless the provisions of Article 56 of this Regulation are satisfied.

The general environmental permit conditions for managing surface water pollution have been included in VLAREM II, chapter 4.2. Section 4.2.3 contains the general environmental permit conditions for companies that discharge industrial wastewater containing one or more dangerous substances (also see Table 13). Article 4.2.3.1.3° mentions the following determinations:

> *"From the hazardous substances referred to in appendix 2C, only those substances may be discharged in concentrations higher than the environmental quality standards applicable for the ultimately receiving watercourse, for which emission limit values have been laid down in the environmental licence in accordance with that specified in art. 2.3.6.1."*

The basic environmental quality standardsfor surface water can be found in appendix 2.3.1 of VLAREM II (also see Table 13).

[20] VLAREM II: Ruling by the Flemish Government concerning general and sector determinations on environmental hygiene, of 1 June 1995, repetitively modified.

Sub-section 4.2.5.3 of VLAREM II contains determinations for the self-monitoring programme for the discharge of industrial wastewater that contains one or more dangerous substances.

Other general environmental regulations for partitioned systems (part 4 of VLAREM II) that apply to the textile industry, include:
- General regulations (Hfdst 4.1);
- Managing soil and groundwater pollution (Hfdst. 4.3);
- Managing air pollution (Hfdst. 4.4);
- Managing noise problems (Hfdst. 4.5);
- Energy planning (Hfdst. 4.9).

Further information about the general environmental permit conditions that apply to the textile industry can be found via the environmental legislation navigator on the EMIS website www.emis.vito.be (environment, legislation, Environment, Nature and Energy navigator).

The terms detection limit, determination level, reporting limit, precision, accuracy and reference measurement method have been defined in VLAREM II, part I (general determinations), chapter 1.1 (legal basis and definitions), article 1.1.2 (also see Table 3). Background information about the reference measurement methods for BFR, antimony, PFT, NP/ NPE and PAH can be found in appendix 2.

Sectoral environmental permit conditions
Sectoral environmental permit conditions for the textile industry can be found in VLAREM II chapter 5.41 (textile).

> *Art 5.41.1.5.*
> *§1 The use of substances that are harmful to the environment must be limited and if possible avoided. Fully biodegradable and/or bio eliminable substances are preferably used with low human and ecological toxicity and low emission and odour levels.*
>
> *If replacement is not possible, the necessary measures must be taken to keep the risk to the population and the environment as low as possible.*
>
> *Substances are regarded as fully biodegradable if they meet the following conditions:*
>
> *1° ≥ 70% dissolved organic carbon (DOC) degradation in 28 days based on tests measuring degradation by the reduction in dissolved C (e.g., ECD tests 301A, 301E);*
> *2° ≥ 60% degradation in 28 days based on tests measuring degradation by O_2 consumption or CO_2 production (e.g., OECD test 301B).*
>
> *Substances are regarded as bio eliminable if they meet the following conditions:*
> *1° ≥ 70% dissolved organic carbon (DOC) degradation in 28 days according to OECD 302B;*

2° ≥ 80% dissolved organic carbon (DOC) degradation in 7 days according to OECD 302B with an adapted inoculum.

§2 The substances/groups of substances below must be replaced to the maximum extent:

1° alkylphenol ethoxylates.
2° PAH-containing mineral oils.
3° sodium hypochlorite for bleaching applications, except with high whiteness requirements and sensitive fabrics (acrylic).
4° cadmium-containing pigments.
5° chlorinated carriers : e.g., 1,2 dichlorobenzene; 1,2,4 trichlorobenzene; dichlorotoluene.

§3 The following substances may not be used:

1° carcinogenic azo dyes and azo dyes, which under reductive conditions, cleave carcinogenic aromatic amines.
2° dyes containing pentachlorophenol
3° Cr VI for the oxidation of sulphur and vat dyes.
4° arsenic, pentachlorophenol and organotin compounds for rot-resistant, moth-resistant and anti-mite treatments.
5° ethylene diamine tetra acetic acid (EDTA)n and diethylenetriamine pentaacetic acid (DTPA) for the softening of process water.
6° distearyl dimethyl ammonium chloride (DSDMAC), di (hardened tallow) dimethyl ammonium chloride (DHTDMAC) and bis (hydrogenated tallow alkyl) dimethyl ammonium chloride (DTDMAC).

§4. Process vats with bromine-containing flame retarders or antimony may not be discharged.”

Sectoral discharge standards for the systems referred to in sub-section 41.4 of the division list can be found in VLAREM II, appendix 5.3.2.44° (also see Table 13).

Further information about other sectoral permit conditions for textile companies that fall under the other sub-sections in section 41, can be found via the environmental legislation navigator on the EMIS website www.emis.vito.be (environment, legislation, Environment, Nature and Energy navigator).

c. *Special environmental permit conditions*

In accordance with Art. 3.3.0.1 of VLAREM II, the permit issuing authority can impose special environmental permit conditions in the environmental permit. Special environmental permit conditions supplement general and/or sectoral environmental permit conditions, or set additional requirements. They are imposed with the aim of protecting humans and the environment, and with the aim of realising environmental quality standards.

The Dangerous Substances Reduction Programme (see paragraph 2.4.2.c) is one of the considerations when determining special environmental permit conditions for wastewater from textile companies. However, Flemish textile companies are currently (2010) not known to be subject to additional emission limit values imposed by special environmental permit conditions for e.g.. Deca-BDE, HBCD, NP and NPE.

Here are a few concrete examples:

- In Flanders, no companies are known to have had emission limit values for Deca-BDE and HBCD imposed on them via special environmental permit conditions.
  comment
  Deca-BDE and HBCD, for which no emission limit values have been established in the environmental permit, cannot be discharged (also see VLAREM II, article 4.2.3.1.3°, paragraph 2.4.1.b).
- In Flanders, a few textile companies have had an emission limit value imposed on them for antimony via special environmental permit conditions. These emission limit values go up to maximum 1 mg/l (also see Table 13).
- As of 01/03/2009, the textile industry apply sectoral emission limit values for PFOA, PFOS and some PFT (excl. PFAO and PFOS) (also see Table 13). According to the sector, there are no indications that it will not be possible for Flemish textile companies to realise these emission limit values.
- In Flanders, no companies are known to have had emission limit values for NP or NPE imposed on them via special environmental permit conditions.
  Comments
  - A Flemish chemicals manufacturer must, in addition to implementing source-oriented measures, comply with the following emission limit values for alkylphenol ethoxylates: annual average 0.5 ppm with a maximum of 1 ppm (imposed by special environmental permit conditions).
  - NP (e.g. 4-(para)-nonylphenol) and/or NPE (e.g. nonylphenol ethoxylates), for which no emission limit values have been established in the environmental permit, cannot be discharged (also see VLAREM II, article 4.2.3.1.3°, paragraph 2.4.1.b).
  - The sector is of the opinion that an indirect emission limit value does apply to textile companies that discharge NP and NPE into surface water, namely the emission limit value for non-ionic detergents (also see Table 13):
    - 10 mg/l (sectoral emission limit value applicable up to and including 31/12/2009);
    - 3 mg/l (general emission limit value applicable from01/01/2010).
  - VMM emphasises that, according to the Dangerous Substances Reduction Programme (also see paragraph 2.4.2.b), a separate permit must be issued for the most dangerous substances (substances that have been identified as priority dangerous substances in appendix X of Priority Substances Co-guidelines, 2008/105/EC, also see paragraph 2.4.3.g), such as nonylphenols (VMM, 2009c).
  - VLAREM I, appendix 2C contains a list of harmful substances for discharging into an aquatic environment. 4-(para)-nonylphenol is included in list III but is not identified as a priority dangerous substance (Centexbel, 2009b).
  - List 2C of VLAREM I does not yet comply with appendix X of guidelines 2008/105/EC (VMM, 2009d).
- Currently (year 2010), two Flemish textile companies are known to have had special environmental permit conditions imposed on them in their environmental permit for a number of PAH. An overview has been provided in Table 12.

However, as of 01/01/2010, all textile companies must comply with the emission limit value for PAH that is part of the sectoral wastewater discharge standards (1 µg/l for the 16 of EPA with the exception of naphthalene). The special environmental permit conditions may never exceed the sectoral emission limit values (VMM, 2009f).

Comments

- The PAH, which have been imposed via special environmental permit conditions on textile companies, are based on concrete analysis results (e.g. via self-monitoring programmes).
- According to the sector, the implemented measurement method, as well as the sampling and sample preparation, could possibly influence the analysis results of individual PAH.

Table 12: PAH emission limit values [µg/l] imposed on 2 Flemish textile companies via special environmental permit conditions

	company 1		company 2
PAH	emission limit value - instant sample [µg/l]	emission limit value - daily average [µg/l]	emission limit value [µg/l]
naphthalene	10,00		2,10
acenaphtylene	4,13		0,09
acenaphthene	0,60		0,60
fluorene	2,12		1,60
benzo(a)pyrene	0,20		0,04
phenanthrene	2,85	1,00	1,00
anthracene	0,63		0,15
fluoranthene	4,00		0,21
pyrene	0,60	0,40	0,34
benzo(a)anthracene	0,30		0,15
chrysene	1,43		0,15
benzo(b)fluoranthene	1,00		0,10
benzo(k)fluoranthene	0,036		0,0036
benzo(ghi)perylene	0,016		0,07
indeno(1,2,3-cd)pyrene	0,035		0,0008
dibenzo(a,h)anthracene	0,50		0,07

d. *Summary of textile industry emission limit values*

Table 13 provides an overview of the emission limit values (general, sectoral and special environmental permit conditions) for a number of parameters for Flemish textile companies that discharge their wastewater in surface water or the sewer. It also shows the proposed BMKN[21] values. Available information about the demonstrability level, the

[21] Basic quality norms; the proposed act for BEQN was provisionally approved by the Flemish government on 04/12/09

determination level, the reporting level, the accuracy, the precision and the reference measurement methods are also included in Table 13.

- The detection limit is the smallest quantity of substance or lowest concentration of a component in a sample, for which the presence can still be established.
- The determination limit is the smallest quantity of substance or lowest concentration of a component in a sample, which can be quantified with an analysis method.

  comment

  Determination limits are partly determined by the sample intake, the volume of end extract, device sensitivity and the blank sample, and can thus differ from lab to lab.
- The reporting limit is the value below which a component is reported as non-quantifiable ('<') this amounts to at least the determination level.

  comment

  The reporting levels for a number of parameters have been included in VLAREM II, appendix 4.2.5.2, article 4 §1 (also see Table 13).
- Precision is the amount of spread in the analysis results.

  comment

  The precision for a number of parameters has been included in VLAREM II, appendix 4.2.5.2, article 4 §1 (also see Table 13).
- Accuracy is the level of consistency between the average value that is obtained from a (large) number of observations, and the actual value.

  comment

  The accuracy for a number of parameters has been included in VLAREM II, appendix 4.2.5.2, article 4 §1 (also see Table 13).
- The reference measurement method entails: methodology that must be implemented in order to determine a particular parameter; reference measurement methods include European (EN) international (ISO) or other normative methods or methods that are validated by the reference lab of the Flemish Institute for Technological Research (VITO) under assignment from the Flemish Government. These measurement methods have been described in the Compendium for Analysing Water (WAC) (also see www.emis.vito.be).

  Comments

  - The reference measurement methods for a number of parameters have been included in VLAREM II, appendix 4.2.5.2, article 4 §1 (also see Table 13).
  - The Ministerial Decree of 15 April 2009 concerning the compendium for analysing water [2009/202141] established WAC methods for a number of parameters (B.S. 20/05/09). The WAC methods included in the contents of the most recent MD must be used, 10 days after publication of the MD in the Belgian Book of Statutes, when exercising article 1.1.2, definition of "reference measurement method", in version II of VLAREM. WAC methods that have not (yet) been established via the MD of 15/04/09 are regarded as recommended methods.
  - In addition to the measurement methods in the compendium, other measurement methods can also be used that have been declared as equivalent methods by the qualified authorities. If the laboratory wants to use other analysis methods than those in the compendium, it must be able to demonstrate equivalence. The results of the equivalence investigation must

be submitted to the qualified authorities and VITO. The qualified authority will decide, after advice from VITO, whether the analysis method is actually equivalent and will inform the laboratory of the decision via registered letter.

If a source has not been mentioned in Table 13, then the information originates from VLAREM, or the location of the information has been mentioned.

Table 13: Emission limit values and additional information for Flemish textile companies that discharge into surface water and sewers

parameter (group)	**parameter**	**emission limit values**			**BMKN (proposed annual average value[22])**	**BMKN (proposed maximum value[23])**	**Demonstrability limit[24]**	**Determination limit[25]**	**Reporting limit**	**Precision**	**Accuracy**	**Reference measurement method[26]**
		Gen. EPC	Sect. EPC	Spec. EPC								
BFRs	Deca-BDE (BDE-209)	-	-	3 µg/l[27]	-	-	gg	0,5 µg/l [28]	1 µg/l	25%	25%	WAC/IV/A/030
	HBCD	-	-	-	-	-	gg	0,02 µg/l[29] - 0,5 µg/l[30]	0.1 µg/l	25%	25%	WAC/IV/A/030
Synergist BFR	antimony	-	-	0,6 mg/l[31]	100 µg/l[32]	-	0,7 µg/l [33]	gg	20 µg/l	20%	10%	WAC/III/B

[22] The bill with the new BMKN has been provisionally approved by the Flemish government on 14/12/09

[23] The bill with the new BMKN has been provisionally approved by the Flemish government on 14/12/09

[24] 3x standard deviation; compendium for sampling and analysis (CMA) in executing the waste materials decree and the soil purification decree: CMA/6/A/performance characteristics, December 2007, as mentioned at www.emis.vito.be

[25] 3x standard deviation; compendium for sampling and analysis (CMA) in executing the waste materials decree and the soil purification decree: CMA/6/A/performance characteristics, December 2007, as mentioned in www.emis.vito.be; the blank sample plays an important role when establishing the determination limit; this can vary from lab to lab.

[26] Compendium for Analysing Water (WAC) (also see www.emis.vito.be).

[27] Currently (2010), a norm for NFn/NPE is only known to have been imposed on one textile company via special permit conditions, namely 0.33µg/l (based on the PNEC)

[28] VITO, 2009a

[29] VITO, 2009a

[30] EBFRIP, 2009a; Experience in the bromine sector shows that the reliability of lower HBCD concentrations cannot be guaranteed.

[31] CENTEXBEL, 2009b and company visits

[32] CENTEXBEL, 2009b (from new BEQN proposal for Flanders)

[33] In the implementation of ICP-EOS (Inductively coupled plasma optical emission spectroscopy) (i2a, 2009a)

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
				max 1 mg/l			- 10 µg/l[34]		[35]			
PFT	PFOS	-	0,05 mg/l	-	-[36]	-	gg	0,0001 mg/l[37]	gg	gg	gg	WAC/IV/A/025*
	PFOA	-	0,01 mg/l	-	-[38]	-	gg	0,0001 mg/l[39]	gg	gg	gg	WAC/IV/A/025*
	sum excl. PFOS and PFOA	-	0,2 mg/l	-	-	-	gg		gg	gg	gg	WAC/IV/A/025*
NP	nonylphenol	-	-	0,33 µg/l[40]	0,3 µg/l[41]	2 µg/l[42]	gg	<100 ng/l[43]	100 ng/l[44]	25%	25%	WAC/IV/A/003**

[34] i2a (2009)

[35] (=0,02 mg/l)

[36] No proposed BMKN available, PNEC-value=25 µg/l (Callebaut K., *et al.*, 2007)

[37] VITO, 2009a

[38] No proposed BMKN available, PNEC-value=250 µg/l (Callebaut K., *et al.*, 2007)

[39] VITO, 2009a

[40] VMM, 2009f (1 textile company was subject to a norm for NFn/NPE in its permit, as a special permit condition, based on the PNEC). Members of the technical work group of BREF Textile Processing (EIPPCB, 2003a) were asked about the applicable norms for NFn/NPE. Questions were also asked about the background of these norms, and potential norm modifications in the concerned member countries. 4 of the 12 requested member countries supplied information (situation 22/01/2010). Currently (2010), sector norms for the textile industry are not available in Portugal, Ireland, United Kingdom and the Czech Republic. In Portugal, the BEQN (annual average value) is the same as in Flanders (0.3 µg/l). An emission limit of 0.6 µg/l has been established in the Czech Republic (VITO, 2010b).

[41] Average annual value for 4-nonylphenol (Guideline 2008/105/EG)

[42] CENTEXBEL, 2009b

[43] VITO, 2008c

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
Non-ionogenic surface-active substances[45]		3 mg/l[46]	10 mg/l[47]	-	Mt ≤ 1000 µg/l	-	gg	gg	gg	gg	gg	gg
NPE	Nonylphenol ethoxylates	-	-	0.5 ppm aver. (1 ppm max)[48]	-[49]	-[50]	gg	5[51]-10[52] µg/l	5-10[53] and 20[54] µg/l	25%	25%	WAC/IV/A/021 ***
PAH	16 of EPA	-	0,001 mg/l[55]	-	Mt ≤ 100 ng/l	-	gg	10 ng/l[56];	gg	gg	gg	gg

44 (=0,1 µg/l)

45 For example Alcohol ethoxylates (AE) and alkylphenol ethoxylates (APE)

46 Applicable from 01/01/2010

47 Applicable up to and including 31/12/2009

48 For alkylphenol ethoxylates (CENTEXBEL, 2009a)

49 proposed BEQN not available; ratio NFn/NPE amounts to 1.198, 1.396 and 2.189 respectively, depending on whether it concerns mono-NPE, di-NPE or poly-NPE (also see paragraph 3.4.3.c).

50 No proposed BMKN available, see previous footnote

51 for nonylphenol monoethoxylates and nonylphenol diethoxylates (VITO, 2009b)

52 for nonylphenol polyethoxylates (VITO, 2009b)

53 for nonylphenol monoethoxylates and nonylphenol diethoxylates (VITO, 2009b)

54 for nonylphenol polyethoxylates (VITO, 2009b)

55 Applicable from 01/01/2010 (=1 000 ng/l)

56 CENTEXBEL, 2009b (HPLC)

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
			excl naphthalene					20-100 ng/l[57]				
	acenaphthene	-	-	0,6 µg/l[58]	0,06 µg/l[59]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	acenaphtylene	-	-	0,09-4,13 µg/l[60]	4 µg/l[61]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	anthracene	-	-	0,15-0,63 µg/l[62]	0,1 µg/l[63]	0,4 µg/l[64]	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	benzo(a)anthracene	-	-	0,15-0,30 µg/l[65]	0,3 Ag/l[66]	-	gag	gag	100 eng/l	25%	25%	WAC/IV/A/002
	benzo(b)fluoranthene	-	-	0,10-1,00	Σ 0,03 µg/l[68]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002

[57] CENTEXBEL, 2009b (GC/MS)

[58] CENTEXBEL, 2009b and company visits

[59] EURAS-VITO, 2004; VMM, 2009d

[60] CENTEXBEL, 2009b and company visits

[61] VMM, 2009d

[62] CENTEXBEL, 2009b and company visits

[63] Guideline 2008/105/EG

[64] VMM, 2009d

[65] CENTEXBEL, 2009b and company visits

[66] VMM, 2009d

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
				µg/l[67]								
	benzo(k)fluoranthene	-	-	0,0036-0,036 µg/l[69]			gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	benzo(a)pyrene	-	-	0,04-0,20 µg/l[70]	0,05 µg/l[71]	0,1[72]	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	benzo(ghi)perylene	-	-	0,016-0,07 µg/l[73]	Σ 0,002 µg/l[74]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	indeno(1,2,3-cd)pyrene	-	-	0,0008-0,035 µg/l[75]			gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	chrysene	-	-	0,15-1,43 µg/l[76]	1 µg/l[77]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002

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[68] Annual average for sum of benzo(b)fluoranthene and benzo(k)fluoranthene (Guidelines 2008/105/EC)

[67] CENTEXBEL, 2009b and company visits

[69] CENTEXBEL, 2009b and company visits

[70] CENTEXBEL, 2009b and company visits

[71] Guideline 2008/105/EG

[72] VMM, 2009d

[73] CENTEXBEL, 2009b and company visits

[74] Annual average for sum of benzo(ghi)perylene and indeno(1,2,3-cd)pyrene (Guidelines 2008/105/EC)

[75] CENTEXBEL, 2009b and company visits

[76] CENTEXBEL, 2009b and company visits

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
	Dibenzo(a,h)anthracene;	-	-	0,07-0,50 µg/l[78]	0,5 µg/l[79]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	phenanthrene	-	-	1,00-2,85 µg/l[80]	0,1 µg/l[81]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	fluoranthene	-	-	0,21-4,00 µg/l[82]	0,1 µg/l[83]	1 µg/l[84]	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	fluorene	-	-	1,60-2,12 µg/l[85]	2 µg/l[86]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002
	naphthalene	-	0,04 mg/l[87]	2,10-10,00 µg/l[88]	2,4 µg/l[89]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002 en WAC/IV/A/016[90]

[77] VMM, 2009d
[78] CENTEXBEL, 2009b and company visits
[79] VMM, 2009d
[80] CENTEXBEL, 2009b and company visits
[81] EURAS-VITO, 2004; VMM, 2009d
[82] CENTEXBEL, 2009b and company visits
[83] Guideline 2008/105/EG
[84] VMM, 2009d
[85] CENTEXBEL, 2009b and company visits
[86] VMM, 2009d
[87] Applicable from 01/01/2010

parameter (group)	parameter	emission limit values			BMKN (proposed annual average value[22])	BMKN (proposed maximum value[23])	Demonstrability limit[24]	Determination limit[25]	Reporting limit	Precision	Accuracy	Reference measurement method[26]
		Gen. EPC	Sect. EPC	Spec. EPC								
	pyrene	-	-	0,34-0,60 µg/l[91]	0,04 µg/l[92]	-	gg	gg	100 ng/l	25%	25%	WAC/IV/A/002

Legend:
- Gen. EPC: General environmental permit conditions
- Sect. EPC: Sectoral environmental permit conditions
- Spec. EPC: Special environmental permit conditions
- BMKN: Basic environmental quality standards
- Mt: Median Total
- * being compiled (also see appendix 2)
- ** method not yet thoroughly validated for nonylphenol (also see appendix 2)
- *** ethoxylates are determined via fluid chromatography (also see appendix 2)
- - no emission limit values available
- gg no data

[88] CENTEXBEL, 2009b and company visits, switch to sector norm from 01/012010 (0.04 µg/l)

[89] VMM, 2009d

[90] provisional (from proposed change to Vlarem, April 2009)

[91] CENTEXBEL, 2009b and company visits

[92] VMM, 2009d

2.4.2 Other Flemish legislation

The paragraph below contains a (non-limitative) list of other Flemish environmental legislation that is relevant to the textile industry.

a. LNW Circular 2005/01 and the accompanying executive ruling

Flanders has textile companies that discharge their wastewater in surface water as well as the sewer system.

The LNW Circular 2005/01[93] and the executive ruling[94] state that the processability of industrial wastewater in public purification systems must be evaluated based on the company category, namely 'small companies', 'companies with little impact' and 'other companies'.

- Small companies are all companies that fall below the N thresholds for industrial wastewater (N1 < 600, N2 < 200 and N3 < 400), who discharge large quantities of diluted wastewater (no more than 200 m^3/day with an average BOD < 100 mg/l) and discharge no other substances in quantities that could disrupt the workings of the WWTP. Industrial wastewater from small companies can be remediated within the WWTP basic purification capacity.
- Companies with a little impact are companies that exceed the N thresholds, but comply with other criteria for a 'small company', as well as with a discharge load of less than 15% of the design load of the WWTP for BOD and less than 5% of the design load of the WWTP for total nitrogen, total phosphorous, total COD and total SM and less than 5% of the hydraulic capacity of the WWTP (based on design 1DWA). Industrial wastewater from these companies can normally be processed at the WWTP.
- Other companies are subject to an 'ad hoc' approach.
  When evaluating the impact of a company, the smooth operation – adherence to VLAREM emission limit values – at the WWTP and other purification systems is essential. If the operation of the purification infrastructure is not compromised, there is no reason to not connect these companies to the WWTP. If the operation of public purification infrastructure is insufficient, or threatens to become insufficient in the future, to realise the imposed emission limit values, the connectability of every company in this category must be examined in purification policy.
  Transport of industrial waste from these companies must not have a demonstrably negative impact on the quality of surface water due to multiple over-discharging of large quantities of unpurified wastewater.
  The aspects below must be investigated to determine the impact of joint processing, and to evaluate the potential connectivity of the companies to the public purification infrastructure:
  - Can the supplied wastewaters be effectively processed in the public sewer-water purification system? The composition of the wastewater and the capacity of the WWTP are important when addressing this question.

[93] LNW Circular 2005/01: Ministerial circular dated 23 September 2005 concerning the processing of industrial wastewater via public purification systems (BS 14/11/2005).

[94] Ruling by the Flemish Government on 21 October 2005 concerning regulations for purifying industrial wastewater in a public sewer water purification system (BS 05/12/2005).

Comments:

- The wastewater can generally be effectively processed at the WWTP if the wastewater (on average) complies with the following ratios:
  - COD/BOD < 4;
  - BOD/N > 4;
  - BOD/P > 25;
- Valorisable wastewater is industrial wastewater with a concentration and composition that permits it to be directly used as a raw material in the WWTP purification process (e.g. for denitrification or dephosphatation).
- Complementary industrial wastewater has a composition which makes it have a positive effect on the workings of the WWTP, e.g. via a favourable impact on the ratios of COD/BOD, BOD/N or BOD/P. This means the wastewater can be remedied in the WWTP basic purification capacity; in other words, it does not occupy extra capacity at the WWTP. Companies with such wastewater can remain connected to the WWTP.

- What hydraulic impact do discharged wastewaters have on the sewer-water purification system?
- Does the wastewater contain large quantities of dangerous substances? In this case, further evaluation is recommended, for which one can refer to VLAREM, BAT and the Dangerous Substances Reduction Programme.
- Are there possible alternatives for connecting to the sewer system?

The programme decree of 24 December 2004 provided a legal basis for a contractual link between the companies and NV Aquafin. The aim is to correctly define a costs breakdown for the purification of industrial wastewater. If the to-be-treated wastewaters give cause for additional interventions, and thus higher costs, the maximum use will be made of the polluter-pays principle. The regulations for this contractual remediation of industrial wastewater have been included in the above mentioned executive decree.

Industrial wastewater from textile companies could contain potentially dangerous substances (also see paragraph 2.4.2.b). Article 2.4.3 of LNW Circular 2005/01 states that a WWTP is not designed for the remediation of dangerous substances and that discharge into sewer is only possible once the dangerous substances have been removed from the source.

Comment

It is estimated that 20-25% of Flemish textile companies who discharge into sewer, are small companies (according to the determinations of the circular in question). Around 30% of the textile companies in Flanders that discharge into sewer, are medium-sized. The rest of the textile companies that discharge into sewer are large companies (ad hoc situation).

b. Dangerous Substances Reduction Programme 2005

The Dangerous Substances Reduction Programme is a ruling from the minister of Environment, dated 23 October 2005, in accordance with art. 2.3.6.1., § 3 of VLAREM II. The Reduction programme is a Flemish-level framework for the various elements of policy concerning dangerous substances in surface water. It indicates which (existing) principles and instruments must be expanded or implemented and how this should be done. The Reduction programme is an obligatory method and user manual for all Flemish Government departments and administrations involved with the matter.

According to the Dangerous Substances Reduction Programme (also see paragraph 2.4.2.b), the following acts as a general framework for discharging dangerous substances via industrial wastewater:

- The Best Available Techniques always form the minimum framework in which the environmental permit conditions must be established. The general and sectoral environmental permit conditions in VLAREM are necessary, but are not necessarily sufficient conditions (see Art. 4.1.2.1 and 4.2.3.1 in VLAREM II).
- The benchmark for all substances is remediation at the source.
- The benchmark for all substances, and dangerous substances in particular, is to realise the environmental quality standards[95] for the receiving surface water (see Art. 3.3.0.1 in VLAREM II).
- Further, progressive reduction is the benchmark for all dangerous substances (see Art. 2.3.6.1 in VLAREM II).
- For dangerous substances that are bio-accumulable, persistent and toxic (the most dangerous substances), the benchmark is to prevent and/or end the pollution (see Art. 2.3.6.1 in VLAREM II).
- For priority dangerous substances (PDS) / polluted substances (PS) that are discharged by sewer dischargers via a WWTP - and where these substances are removed at the WWTP in the same way that surface-water dischargers remove them in their own water purification systems - a dilution factor can be implemented when determining emission limit values (VMM, 2010).

  comment

  In practice, the above approach can be used for, for example, the parameter PAH.
- In the interest of realising environmental quality standards for not the most dangerous substances, one can, if concrete volume data is not available, assume a ten-fold dilution of wastewater after discharge (e.g. rule of thumb, 10x basic environmental quality standards). However, one must bear in mind that this is a very general and maximum approach – the emission limit values for non-dangerous parameters like BOD, COD, SM, …always imply a lower level of dilution (e.g. BOD = 25 mg/l versus basic environmental quality standard = 6 mg/l). If additional volume information is available, one can modify the 10x basic environmental quality standard. The rule of thumb of 10x basic environmental quality standardscan also be modified depending on the quality of the receiving surface water.
- If a specific environmental quality standardhas not yet been established in VLAREM II, the available data and the standard method (TGD Technical Guidance Document on risk assessment, Water Framework Guidelines, appendix 5.1.2.6) should be used to estimate an emission limit value as evaluation basis. In other cases, one also uses the 10x measurability threshold.

[95] Environment quality norm is defined in VLAREM II (part I, chapter 1.1, article 1.1.2) as all requirements in a particular environment compartment or particular part of it, which must be adhered to at a given moment in time in accordance with this ruling.

Comment

According to VMM, one can use group parameters for complex wastewaters (e.g. AOX) as a substitute for individual dangerous substances. In such cases, emission limilt values still need to be established individually for the most dangerous substances if they are discharged in concentrations that exceed the MKM (VMM, 2009c).

Table 14 summarises the properties of Deca-BDE and HBCD, antimony trioxide (Sb_2O_3), PFOS, PFOA, NP, NPE and the 16 PAH of EPA with regards to their bio-accumulability, persistence and toxicity.

A substance is bio-accumulable if it is able to store itself in living organisms or the environment. A persistent substance is a substance that cannot be broken down, or only be broken down very slowly, in the environment A toxic substance has a negative impact on the biological systems of living organisms.

Table 14: Properties for bio-accumulability, persistence and toxicity for Deca-BDE and HBCD, Sb_2O_3, PFOS and PFOA, NP and NPE and the 16 PAH of EPA

Parameter group	**parameter**	**Bio-accumulability**	**persistent**	**toxic**
BFRs	Deca-BDE	?[96]	+	?[97]
	HBCD	+	+	+
Synergist BFR	antimony trioxide (Sb_2O_3)[98]	+/-	+	-[99]
PFT	PFOS	+	+	+[100]
	PFOA	+	+	+/-[101]
NP		+[102]	+[103]	+[104]
NPE		-	+	-[105]

96 Despite numerous studies about possible risks, there is still uncertainty about the toxic nature of Deca-BDE. Risk Assessment studies for Deca-BDE (incl. EU_SCHER, 2004) indicate that further research is needed to classify Deca-BDE in terms of its bio-accumulability.

97 Despite numerous studies about possible risks, there is still uncertainty about the toxic nature of Deca-BDE. Additional research is being carried out in this area.

Comments

-Literature (EU-JRC, 2003a) shows that there is uncertainty about evaluating the risk of toxicity (e.g. for higher organisms) (EBFRIP, 2009b).

-EBFRIP (2009b) states that no R-phrases are applicable to Deca-BDE. R-phrases (danger phrases, warning phrases) relate to the intrinsic dangers of chemical substances. An intrinsic danger only becomes a risk in case of exposure above a particular dose or concentration.

98 i2a (2009) states that PBT (persistence, bio-accumulability and toxicity) criteria cannot be implemented for metals and refers to Annex XIII of REACH (1907/2006/EC) and EU-RAR ATO (SCA, 2008). Similar criteria for metals (United World Model) are currently being compiled (Eurometaux).

99 The following risk indicator applies to Sb_2O_3: R40-carcinogenic effects are excluded. However, Sb_2O_3 is categorised as being toxic (e.g. R50-R51) or harmful to organisms that live in water (e.g. R52) (i2a, 2009a).

100 Poisonous, but probably not carcinogenic or hormone-disruptive

101 Probably not carcinogenic or hormone-disruptive

102 nonylphenols

103 nonylphenols

104 Primarily hormone-disruptive

Parameter group	parameter	Bio-accumulability	persistent	toxic
PAH	16 of EPA	+	+[106]	+[107]
	acenaphtylene	?	+	-[108]
	acenaphthene	?	+	+/-[109]
	anthracene	+	+	+[110]
	benzo(a)anthracene	?	+	+[111]
	benzo(b)fluoranthene	+	+	+[112]
	benzo(k)fluoranthene	+	+	+[113]
	benzo(a)pyrene	+	+	+[114]
	benzo(ghi)perylene	+	+	+[115]

[105] NPE breaks down in water by gradually splitting from the ethoxy group, whereby toxic NF is released.

[106] The higher the molecular weight of the PAH, the higher the persistence (Connell D.W., 1997)

[107] PAH are not toxic in their own right, but are converted in the body into reactive metabolites that could affect hereditary material

[108] Probably not carcinogenic or hormone-disruptive

[109] Cannot be excluded that exposure to this substance is carcinogenic and hormone-disruptive.

[110] Hormone-disruptive; cannot be excluded that exposure to this substance has carcinogenic consequences.

[111] carcinogenic and possibly hormone-disruptive

[112] Toxic, carcinogenic and possibly hormone-disruptive

[113] Toxic, potentially carcinogenic and potentially hormone-disruptive

[114] Testing (RIVM, 2008) has shown that benzo(a)pyrene is one of the most carcinogenic and mutagenic PAH; carcinogenic and possibly hormone-disruptive; exposure to this substance may also cause genetic damage, reduce fertility or harm unborn children

[115] Very toxic and possibly hormone-disruptive

	indeno(1,2,3-cd)pyrene	?	+	+[116]
	chrysene	+	+	+[117]
	dibenzo(a,h)anthracene	+	+	+[118]
	phenanthrene	?	+	+[119]
	fluoranthene	+	+	+[120]
	fluorene	?	+	+/-[121]
	naphthalene	+	+	+[122]
	pyrene	+	+	+[123]

Legend: +: Property applicable
+/-: Property with average to little applicability
-: Property not applicable
? Insufficient data available to pass judgement
gg no data

SOURCES: EU-SCHER, 2004; BSEF, 2007, 2008a and 2008b; Callebaut K. et al., 2007 ; De Bont R. et al., 2004; EBFRIP-VECAP, 2008b, 2009b and c; ECB, 2007; ECHA, 2008a and b; EIPPCB, 2003a; EU-JRC, 2002a, 2003a, 2007 and 2008; i2a, 2008b and 2009; RDC, 2001; RIVM, 2007a and 2008; RIZA, 2004SCA, 2008; SIAM, 2008; VMM, 2007a, 2007b, 2008 and 2009c

c. Environmental impact and safety report

The underlying principle of environment-effect reporting is that potentially dangerous effects for humans and the environment must be identified in the planning and decision-making phase of particular activities, along with those of existing alternatives for the activities. The rule is derived from the principle of preventive care[124] and the principle of preventive action[125] (also referred to as the prevention principle).

The same applies to safety reporting that is aimed at identifying the risks of severe accidents, preventing severe accidents from happening and at reducing the consequences to humans and the environment.

[116] Potentially carcinogenic and hormone-disruptive

[117] Poisonous, carcinogenic and hormone-disruptive

[118] Poisonous, potentially carcinogenic and hormone-disruptive

[119] Cannot be excluded that exposure to this substance has carcinogenic consequences; potentially hormone-disruptive

[120] Cannot be excluded that exposure to this substance has carcinogenic consequences; potentially hormone-disruptive

[121] Cannot be excluded that exposure to this substance has carcinogenic consequences.

[122] Potentially carcinogenic and potentially hormone-disruptive

[123] Cannot be excluded that exposure to this substance has carcinogenic consequences; potentially hormone-disruptive.

[124] The underlying idea is that measures can be taken when there are indications that a particular activity is accompanied by serious risks for people and the environment, and one need not wait for a consensus on the matter in scientific circles.

[125] The underlying idea is that it is better to prevent environmental pollution than to address the damage at a later point.

According to the ruling by the Flemish Government dated 10 December 2004 concerning the determination of categories for projects subject to environmental reporting, installations that pre-treat (like washing, bleaching, mercerising) or dye fibres or textiles, and have a production capacity of 30,000 tonnes per year or more, are obligated to provide environment-effect reports. However, the subject is entitled to request the environment-effect reporting obligation to be lifted by making a well-founded request to the qualified authority.

There are no known companies with an environment-effect reporting obligation, or a safety report obligation, in Flanders (January 2009).

For further information about environment-effect reporting, please refer to:
http://www.mervlaanderen.be
For further information about safety reporting, please refer to:
http://www.lne.be/themas/veiligheidsrapportage

2.4.3 European legislation

The paragraph below contains a (non-limitative) list of European environmental legislation that is relevant to the textile industry.

a. Directive 2008/1/EC[126] (IPPC Directive)

The aim of the IPPC Directive is to realise integrated prevention and alleviation of pollutants caused by industrial activities with major polluting potential (as listed in appendix I of the IPPC Directive), and to protect all facets of the environment. The Directive has been in effect since 1999 on new installations and existing installations where potential modifications could have major negative consequences for public health or the environment. As of 30 October 2007, all existing installations are required to fully comply with these Directive. In other words, companies must possess a permit based on BAT and accompanying (emission) limit values.

Article 2, point 6, of the IPPC Directive includes the following determination. When determining the emission limit values of the installation for indirect discharges into water, one can take into account the effect if a purification station, under the condition that an equivalent level of environmental protection is generally safeguarded and that this does not additionally burden the environment with pollutants, without prejudicing the determinations in Directive 2006/11/EC and the Directives adopted to implement them.

The European BAT study for the textile industry is the reference document for Best Available Techniques (BREF document) in the textile industry and has been published within the framework of the IPPC Directive. This study relates to the industrial activities mentioned in paragraph 6.2 of appendix I of the IPPC Directive, namely

[126] Guidelines 2008/1/EC of the European Parliament and the Council of 15 January 2008 concerning the prevention and alleviation of pollution (corded version, *p*ublication No. L 024 of 29/01/2008, pag. 0008 – 0029).

"Installations for pre-treating (washing, bleaching, mercerising) or dying fibres or textiles with a processing capacity of more than 10 tonnes per day".

b. *European Pollutant Emission Register (EPER)*

EPER was established after EC decision on 17/07/2000 (2000/479/EC) within the framework of IPPC Directive (96/31/EC). The first member-state report for EPER took place 2001. The second reporting year was 2004. For the third reporting year (2007), EPER will be replaced by the European PRTR (Pollutant Release and Transfer Register). Within the framework of EPER, around 50 substances are accompanied by a reporting obligation. This includes, for example (EC, 2006a):

- Polybrominated diphenyl ethers (PBDE) (from a discharge of 1 kg/year);
- Fluoranthene;
- benzo(g,h,i)perylene;
- Other PAH (incl. benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene).

c. *Regulation 1907/2006[127] (REACH)*

REACH (Regulation 1907/2006) is the EU Act for chemical substances and their safe use. This Regulation concerns the **r**egistration, **e**valuation, **a**uthorisation and limitation of **ch**emical substances. This Regulation is used to set a number of requirements for organisations that produce, import or use chemicals. The requirements have a bearing on matters such as: information gathering, risk evaluation and measures for reducing risks associated with chemicals (EC, 2006b). REACH not only concerns substances like metals and basic chemicals, it also concerns substances in preparates (cement, paint, glue and ink) and substances in objects. A few examples relevant to the textile industry include flame retardants in utensils and colorants in clothing.

The REACH Regulation is accompanied by a number of appendices. Appendices XIV and XVII are particularly relevant to the scope of this BAT study. These appendices are briefly explained in the paragraphs below.

Appendix XIV in REACH will, in time, contain a list of substances that require authorisation. With will include persistent, bio-accumulable and toxic substances or substances with endocrine-disrupting properties. In the future these substances will need to be replaced by less toxic alternatives (phasing out in time).
A proposed list of candidates for very disturbing substances (SVHC[128]), for inclusion in appendix XIV of REACH, will be available in 2010 (www.echa.eu). This list includes substances such as HBCD and anthracene (one of the 16 PAH of EPA). At this moment in time (January 2010), HBCD and anthracene are substances that do not require

[127] Ordinance (EG) nr. 1907/2006 of the European Parliament and the Board of 18 December 2006 concerning the registration and evaluation, and the authorisation and limitations, of chemical substances (REACH), to establish a European Agency for the chemical substances, containing modifications to Guidelines 1999/45/EG and containing withdrawal of Ordinance (EEG) no. 793/93 of the Board and the Guidelines 91/155/EEG, 93/67/EEG, 93/105/EG and 2000/21/EG of the Commission (publication no. L 396 of 30.12.2006, p. 1-848).

[128] Substances of Very High Concern

authorisation. However, there are reporting obligations for presence in objects, for concentrations >0.1% (g/g).

> *comment*
> Deca-BDE, antimony trioxide, PFOS, PFOA, NP, NPE and most of the 16 PAH of EPA have not been included in the SVHC list of candidates for inclusion in appendix XIV of REACH.

Appendix XVII of REACH (Regulation 552/2009[129]) contains determinations concerning limitations for the production, trade and use of particular dangerous substances, mixes and objects. This appendix includes the following determinations:

44. *Diphenyl ether, pentabromo derivate ($C_{12}H_5Br_5O$)*
1. Shall not be placed on the market, or used,
— as a substance,
— in mixtures in concentrations greater than 0,1 % by weight.
2. Articles shall not be placed on the market if they, or flame-retarded parts thereof, contain this substance in concentrations greater than 0,1 % by weight.

45. *Diphenyl ether, octabromo derivate ($C_{12}H_2Br_8O$)*
1. Shall not be placed on the market, or used:
— as a substance,
— as a constituent of other substances, or in mixtures, in concentrations greater than 0,1 % by weight.
2. Articles shall not be placed on the market if they, or flame-retardant parts thereof, contain this substance in concentrations greater than 0,1 % by weight.

> *comment*
> A ban on the use of penta-BDE and octa-BDE has been in effect since 2003 in accordance with Directive 2003/11/EC of 6 February 2003, which modified Directive 76/769/EEC (in the meantime, these Directive have been replaced by REACH).

46. *a) Nonylphenol ($C_6H_4(OH)C_9H_{19}$)*
b) Nonylphenol ethoxylate ($(C_2H_4O)nC_{15}H_{24}O$)
Shall not be placed on the market, or used, as substances or in mixtures in concentrations equal to or greater than 0,1 % by weight for the following purposes:

…

[129] Ordinance (EG) no. 552/2009 by the Commission on 22 June 2009 to modify appendix XVII by Ordinance (EG) no. 1907/2006 by the European Parliament and the Council concerning the registration and evaluation of, and the authorisation and limitation of chemical substances (REACH).

3. textiles and leather processing except:
— processing with no release into waste water,
— systems with special treatment where the process water is pretreated to remove the organic fraction completely prior to biological waste water treatment (degreasing of sheepskin);;

…

53. *Perfluorooctane sulphonates (PFOS) ($C_8F_{17}SO_2X$) (X=OH, metal salt (O-M+), halide, amide and other derivates including polymers)*

1. Shall not be placed on the market, or used, as substances or in mixtures in concentrations equal to or greater than 50 mg/kg (0,005 % by weight).

2. Shall not be placed on the market in semi-finished products or articles, or parts thereof, if the concentration of PFOS is equal to or greater than 0,1 % by weight calculated with reference to the mass of structurally or microstructurally distinct parts that contain PFOS or, for textiles or other coated materials, if the amount of PFOS is equal to or greater than 1 μg/ m 2 of the coated material.

…

7. As soon as new information on details of uses and safer alternative substances or technologies for the uses becomes available, the Commission shall review each of the derogations in paragraph 3(a) to (d) so that:
(a) the uses of PFOS will be phased out as soon as the use of safer alternatives are technically and economically feasible;
(b) a derogation can only be continued for essential uses for which safer alternatives do not exist and where the efforts undertaken to find safer alternatives have been reported on;
(c) releases of PFOS into the environment have been minimised, by applying best available techniques.

8. The Commission shall keep under review the ongoing risk assessment activities and the availability of safer alternative substances or technologies related to the uses of perfluorooctanoic acid (PFOA) and related substances and propose all necessary measures to reduce identified risks, including restrictions on marketing and use, in particular when safer alternative substances or technologies, that are technically and economically feasible, are available.

Comments

- These determinations can also be found in Directive 2003/53/EC of 18 June 2003, which modified Directive 76/769/EEC concerning use and market restrictions (in the meantime, these Directeve has been replaced by REACH). These determinations have been translated into Belgian Law via the RD of 15 July 2004, which modified the RD of 25 February

1996 concerning limitations to using and bringing particular dangerous substances and preparates on to the market.
- A number of substitutes (also see paragraph 4.2.1) for nonylphenol ethoxylates can be found in the Recommendation by the European Economic and Social Committee concerning the proposal of Directive 2002/0206 to modify Directive 76/769/EEC (in the meantime, these Directive has been replaced by REACH).

Comments

- The determinations in REACH concerning PAH do not relate to the textile industry, but to process oils for rubber processing and the following parameters in particular:
    - benzo(a)pyrene;
    - benzo(e)pyrene;
    - benzo(a)anthracene;
    - Chrysene;
    - benzo(b)fluoranthene;
    - benzo(j)fluoranthene;
    - benzo(k)fluoranthene;
    - dibenzo[a, h]anthracene.

d. OSPAR (1992)[130]

The OSPAR treaty incorporates the earlier treaties of Paris (PARCOM) and OSLO (OSCOM) and is aimed at protecting the marine environment in the North-East section of the Atlantic Ocean.

The aim of the OSPAR strategy for Dangerous Substances (in which Belgium is also involved) is to realise zero emissions of dangerous substances by 2020. The OSPAR list of substances contains polluting substances for which the aim is to stop discharge, emission and loss into the environment by 2020 at the latest. The final objective is to prevent the synthetic substances on the list from entering the sea. For substances on the list that are derived from nature, the aim is to prevent the concentration in the sea from exceeding the natural background level. The OSPAR list contains substances like HBCD, PFOS, NP and NPE (OSPAR, 2007).

e. Directive 2006/122/EC (PFOS guidelines)

This Directive from the European Parliament and the Council of 12 December 2006 for the thirtieth modification of Directive 76/769/EEC by the Council, concerns modifications to the legal and administrational determinations of member states concerning limitations for the use and bringing on to the market of particular dangerous substances and preparates (perfluorooctane sulphonates). According to this Directive, PFOS cannot be brought on to the market or used as a substance or component of preparates in a concentration of 0.005 mass percentage or more. Thus PFOS may also not be released on the market as semi-finished products or objects, or components of them, if the PFOS concentration is 0.1 mass percentage or more – calculated based on the mass of structural or micro-structural individual parts that contain PFOS - or as

[130] Treaty for protecting the marine environment in the north-east section of the Atlantic Ocean. The treaty was agreed at the ministerial gathering in Paris on 22 September 1992. After ratification by the undersigning states, the treaty came into effect on 25 March 1998.

textiles or other coated materials if the quantity of PFOS is equal to or exceeds 1 $\mu g/m^2$ of the coated material.
These determinations can also be found in VLAREM II, article 4.1.11.8.

Further, this Directive states that:

- once new information becomes available with further specifics about the use of, and safer alternative substances and technologies for, various applications, the Commission will proceed to review the respective exceptions….so that:
  a) the use of PFOS is gradually phased out so that the use of safer alternatives becomes technically and economically viable;
  b) an exception can only remain in effect for essential applications for which there are no safer alternatives, and if a report has been compiled to document efforts made to find safer alternatives;
  c) the release of PFOS into the environment is kept to a minimum, by implementing the best available techniques.
- Perfluorooctane acid (PFOA) and its salts potentially has a similar risk profile as PFOS
- The Commission is keeping abreast of the ongoing risk evaluation activities and the availability of safer substances and technologies relating to the use of perfluorooctane acid (PFOA and other related substances, and it is taking all necessary measures to reduce known risks, including reducing the introduction on to the market and use of substances, namely when safer alternative substances or technologies are available, which are technically and economically viable.

Comments

- PFOA is not part of Directive 2006/122/EG (PFOS Directive) (FOD, 2009). The determinations of this Directive have been included under point 53 of Regulation 552/2009[131].
- The production all products based on PFOS has been halted in Flanders since 2002.

f. Directive 2000/60/EC[132] (Water Framework Directive, KRLW)

The Water Framework Directive has been in effect since 22/12/2000 and is aimed at safeguarding water stocks and the quality of catchment areas in Europe in the long-term. This Directive uses concrete objectives for the quality of surface water and groundwater. The objectives have been set via catchment area management plans and programmes of measures.

The KRLW has been translated at Flemish level into the decree concerning Integral Water Policy (IWB) of 18 July 2003 (B.S. 14/11/03).

[131] Ordinance (EG) no. 552/2009 by the Commission on 22 June 2009 to modify appendix XVII of Ordinance (EC) no. 1907/2006 by the European Parliament and the Council concerning the registration and evaluation of, and the authorisation and limitation of chemical substances (REACH) (Publication No. L 164 of 26/06/2009 p. 0007-0031)

[132] Guidelines 2000/60/EC of the European Parliament and the Council of 23 October 2000 to determine a framework for community measures concerning water policy (publication No.L 327 of 22.12.2000, p. 1-73).

Appendix V (part 1.2.6) of the KRLW indicates the procedure for determining environmental quality standards. This procedure is based on data concerning eco-toxicity, bio-accumulation and persistence.

Appendix VIII of the KRLW contains the following substances:

> *Indicative list of the main polluting substances*
>
> *…*
>
> *4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment.*
>
> *…*
>
> *7. Metals and their compounds.*
>
> *…*

Appendix X of the KRLW (modifications of 22 May 2007, PB. 24/04/2008) contains the following priority substances in the framework of water policy:

- bromodiphenyl ethers (only pentabromodiphenyl ether);
- nonylphenols (4-(para)-nonylphenol);
- Anthracene;
- Naphthalene;
- fluoranthene (fluoranthene has been included in the list as an indicator for other more dangerous polyaromatic hydrocarbons);
- Benzo(a)pyrene;
- Benzo(b)fluoranthene;
- benzo(g,h,i)perylene;
- Benzo(k)fluoranthene;
- indeno(1,2,3-cd)pyrene;

In time, the aim will be to realise zero discharges for the substances on this list, by way of stopping use or gradually phasing it out.

Comments

- Further information about the identification of these substances as priority/harmful priority substances, and an accompanying MKN, can be found in the Priority Substances Directive (2008/105/EC, also see paragraph 2.4.3.g), which are part of the Water Framework Directive (2000/60/EC).
- List 2C of VLAREM I does not yet comply with appendix X of guidelines 2008/105/EC.

g. Guidelines 2008/105/EG (Priority Substances Directive)

Directive 2008/105/EC of the European Parliament and the Council of 16 December 2008 concerning environmental quality standards for water policy, to modify and then withdraw Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC and 86/280/EEC of the Council, and to modify Directive 2000/60/EC (24/11/2008). Appendix 1 of this Directive, which are part of the Water Framework Directive (also see paragraph 2.4.3.f), indicates the environmental quality standards for priority substances and other particular polluting substances (also see Table 13). Appendix X

contains a list of priority substances in the field of water policy. A number of these substances have been identified as priority dangerous substances.
Table 15 summarises the priority substances that are relevant to this study and indicates which of these substances have been identified as priority dangerous substances.

Table 15: List of a number of priority substances in the field of water policy and indication whether they are identified as priority dangerous substances.

Parameter group	Name of priority substance	Identified as priority dangerous substance
BFRs	Brominated diphenyl ethers[133]	x[134]
	Pentabromodiphenyl ether (congeners 28, 47, 99, 100, 153 and 154)	
NP	Nonylphenols	x
	(4-nonylphenol)	x
PAH	anthracene	x
	fluoranthene[135]	
	naphthalene	
	benzo(a)pyrene	x
	benzo(b)fluoranthene	x
	benzo(g,h,i)perylene	x
	benzo(k)fluoranthene	x
	indeno(1,2,3-cd)pyrene	x

SOURCE: Directive 2008/105/EC, appendix X

h. Directive 76/464/EEC[136] (Dangerous Substances Directive, RGS)

The aim of Directive 76/464 is to prevent and reduce further aquatic pollution of the Community. Member states must take all necessary measures to stop the pollution of surface waters, territorial waters and coastal waters by substances on List I (black list) and to reduce pollution caused by substances on List II (grey list).

The substances on List I and II have also been included in the IPPC Directive (also see paragraph 2.4.3.a).

The aim and obligations of Directive 76/464/EEG will remain in effect until 2013. The RGS is replaced by the Priority Substance Lists Directive 2008/105/EC[137] as part of the KRLW (also see paragraph 2.4.3.f and g).

[133] Normally includes a large number of different compounds. Adequate indicative parameters cannot be mentioned. Deca-BDE and HBCD are not mentioned specifically.

[134] Only pentabromodiphenyl ether

[135] has been included in the list as dangerous PAH

[136] Guidelines 76/464/EEC of the Council of 4 May 1976 concerning the pollution caused by certain dangerous substances that are discharged in the aquatic environment within the Community (Publication No. PBL 129 of 18.5.1976, p. 23-29).

[137] Guidelines 2008/105/EC of the European Parliament and the Council of 16 December 2008 concerning environment quality norms for water policy.

The appendix of the RGS contains the following substances:

List I of families and groups of substances
List I contains certain individual substances which belong to the following families and group of substances, selected mainly on the basis of their toxicity, persistence and bioaccumulation, with the exception of those which are biologically harmless or which are rapidly converted into substances which are biologically harmless.
...
4. substances in respect of which it has been proved that they possess carcinogenic in or via the aquatic environment (I);
…

List II of families and groups of substances
List II contains:
•substances belonging to the families and groups of substances in list I for which the limit values referred to in Article 6 of the Directive have not been determined
(N.B. only 18 substances have been regulated under the specific Directives. Consequently, all the groups of substances under list I and the other substances on the 'candidate-list I' are part of list II);
•certain individual substances and categories of substances belonging to the families and group of substances listed below, which have a deleterious effect on the aquatic environment, which can, however, be confined to a given area and which depend on the characteristics and location of the water into which they are discharged
Families and groups of substances as referred to in the second point above.
1 . The following metaloids and metals andtheir compounds:
...
8 . antimony
...
(1) If some substance in list II are carcinogenic, they have been included in category 4 of that list.

i. Directive 2006/11/EC

Directive 2006/11/EC of the European Parliament and the Council of 15 February 2006 concerning pollution caused by particular dangerous substances that are discharged in the aquatic environment of the Community (04/03/2006), is a coded version of Directive 76/464/EEC.

In order to implement Directive 2006/11/EC, Flanders must possess environmental quality standards for environmentally harmful substance in surface water. In Flanders, this has been established in the determinations of article 2.3.6.1 in VLAREM II.

Appendix 2.3.1 of Title II in VLAREM includes basic environmental quality standardsfor surface water, for a number of dangerous substances. This was insufficient according to Europe, and resulted in the first condemnation on 21 September 1999 due to incomplete implementation of Directive 2006/11/EC. In response to the Reduction Programme 2000 being compiled, (updated via the ministerial decree of 23 October 2005), on 4 July 2002 the European Commission decided that the Flemish Region was in compliance with Directive 2006/11/EC, under the condition that the programme actually be implemented, namely by further establishing environmental quality standardsfor surface water. In order to avoid a procedure for breaching Directive 2006/11/EC, these environmental quality standardsfor dangerous substances must be approved at Flemish level.

This Directive have also been replaced by the Priority Substances Directive (2008/105/EC[138]) as part of the KRLW (also see paragraph 2.4.3.f and g).

2.5 Reduction programmes

In addition to legal determinations, there are a number of programmes in the chemicals sector where companies make mutual agreements about reducing the production and/or use of particular chemical substances in the future. The paragraphs below discuss the programmes that have a bearing on the textile industry.

a. VECAP

VECAP stands for Voluntary Emissions Control Action Program and is a voluntary initiative by EBFRIP (European Brominated Flame Retardant Industry Panel), together with the sector's worldwide organisation, the BSEF (Bromine Science and Environmental Forum). The origins of VECAP lie in the TFA (UK Textile Finishers Association), which establish a Code of Good Practice in 2004. Implementation of this code then resulted in agreements about reducing emissions of Deca-BDA.
Further information about VECAP can be found via: www.vecap.info

b. PFOA Stewardship Program

At this moment in time, there are no legal limitations for the use of PFOA in Europe.

> *comment*
> However, Norway did propose to ban PFOA and individual salts and ethers of PFOA from consumer products.

In America and Canada, agreements have been made concerning the use of PFOA. The PFOA Stewardship Program has been running since January 2006 within the EPA (U.S. Environmental Protection Agency). 8 major producers of PFOA have committed themselves to voluntarily reduce the production and/or use of PFOA. The objectives are:

- Reduction of 95% (compared to 2000) by 2010;
- Fully phased out by 2015.

Further information about the PFOA Stewardship Programme can be found via:
http://www.epa.gov/opptintr/pfoa/pubs/stewardship/index.html

[138] Guidelines 2008/105/EC of the European Parliament and the Council of 16 December 2008 concerning environment quality norms for water policy.

CHAPTER 3 PROCESS DESCRIPTION

This chapter briefly describes the processes implemented in the textile industry. Specific attention has been given to the use of BFR, Sb_2O_3, PFT, NP/NPE and PAH in finishing processes in textile companies, as well as the accompanying environmental impact.

The aim of this description is to paint a general picture of the implemented process steps and the impact on the environment of BFR, Sb_2O_3, PFT, NP/NPE and PAH. This is the background for chapter 4 describing the environment-friendly techniques that the sector is able to implement to reduce the environmental impact.

Details of the processes and the order of the implemented processes can vary in practice from company to company. This chapter does not describe all possible variations in processes. Processes can also be more complicated in practice than the description provided in this chapter.

Under no circumstances is this chapter aimed at passing judgement about particular process steps being, or not being, BAT. The fact that a process has, or has not, been mentioned in this chapter in no way means that the process is, or is not, a BAT.

3.1 Processes in the textile industry

3.1.1 Introduction

Various processes are implemented in the textile industry, depending on factors such as the raw material and the desired end product. The following activities can be carried out in a textile company:

- Cleaning and/or washing raw materials like wool, cotton and flax;
- Washing yarns and tissues;
- Production of raw materials and/or finished products like spinning, cloth production and clothing;
- Conditioning fibres in spinning or weaving;
- Chemical or thermal stabilisation of yarns or tissues;
- Preparation and/or pre-treatment associated with colouring;
- Dying or whitening using pigments, paints, printing;
- Post-treatments and/or finishing;
- Trimming and/or stripping (carpets);
- Manufacture of end products (clothing).

For further background information about processes that are used in the textile industry, please refer to the BAT study for the textile industry (Jacobs A. et al., 1998) and the European BAT study for the textile industry (EIPPCB, 2003a).

3.1.2 Textile finishing

One of the activities in the textile industry are finishing processes. These processes may take place in various phases of the production process. The raw materials used for finishing could include fibres, yarns or cloths.

The aim of textile finishing is to give the textile a number of desired properties. Brominated flame retardants (BFR), together with antimony trioxide (Sb_2O_3), are used in the textile sector (in process baths) to reduce the inflammability of flammable materials (also see paragraph 3.2). Perfluorotensides (PFT) are used (possibly in process baths) to improve the water-resistance and polluting nature of textile (also see paragraph 3.3). NPE are present in detergents used in the textile sector. In a watery environment, NPE are broken down to NP and enter the wastewater of textile companies (also see paragraph 3.4). PAH are not implemented in the textile industry as such. Textile raw materials are a major source of PAH due to the mineral oils (also see paragraph 3.5).

Textile enrichers purchase textile-enriching chemicals in various forms, e.g. ready-to-use solution, a mix of active substances (e.g. Deca-BDE and Sb_2O_3), powder, watery dispersion[139] or a viscous paste. Textile companies make their own chemical mixes or formulations, buy the chemicals from chemical manufactures.

Packaging types for textile finishing chemicals include, for example, intermediary bulk containers (IBC), big bags, 25 kg metal buckets (paste), containers (1000l), metal recipients (50 kg), plastic or paper bags (up to 25 kg).

Textile finishing chemicals are placed on the textile in the form of a covering layer (using a lick-roller, squeegee or spray) or via impregnation. The watery carrier will vaporise when heated in an oven, and the finishing product will bond with the textile.

Wastewater or liquid waste flows in the textile sector are released in the production process, during cleaning activities and in the company laboratory. Here are a few examples:

- Washing-water from tissues and yarns when preparing dying processes;
- Rinse water from washed, painted and/or printed textile materials;
- Residues of (concentrated) process baths (e.g. residual fleets and residual pastes in the dying/printing/filling workshops, responsible for e.g. 1-2% of the total wastewater volume);
- Exhausted process baths in discontinuous process (dying);
- Rinse water from process baths (e.g. rinse water from paint baths, responsible for e.g. 1-2% of the total wastewater volume);
- Rinse water after processes (e.g. residues of support aids and chemicals used in the process);
- Rinse water from chemical packaging;
- Rinse water (cleansing water / cleaning water) from machines, tools and pipes;
- Spray from the steam boiler;
- Condensation water (from drying processes for textile yarns);

[139] Solid or liquid substances, in very small particles, spread throughout the liquid

- Wastewater from water treatment techniques (e.g. water softening using ion exchange);
- Sanitary water.

  Comments
  - As indicated in paragraph 2.1.1.a, the creation of formulations either takes place externally upstream or is integrated into the textile company itself. In principle, no wastewater directly linked to this activity is released when formulators (preparate producers) implement drying processes. However, indirect emissions into water are a possibility, via air emissions of dust-sensitive particles.
  - Of the 52 textile companies surveyed by Centexbel, 2 companies indicated that they make their own formulations. 1 textile company indicated that formulations are purchased via an external party (Centexbel, 2009a).

Here are a few examples of solid waste flows that are released in the textiles sector:
- Cloths or other absorbent materials which are used for dry-removing solid residues;
- Packaging material:
  - Inter-bulk containers or IBCs for short;
  - Big bags;
  - Metal containers;
  - Plastic bags;
  - Paper bags;

3.1.3 references

The following sources were referenced when compiling paragraph 3.1:

Jacobs *et al.*, 1998;
Centexbel, 2009b;
EBFRIP-VECAP, 2007b and 2008b.
EIPPCB, 2003a;
Fedustria, 2009;
Land C.A., 2008;
LNE-AMI, 2006;
LNE-AMV, 2009;

3.2 Use of brominated flame retardants (BFR) and antimony trioxide (Sb_2O_3) in the textile industry

3.2.1 Introduction

Brominated Flame Retardants (BFRs) are bromine-based organic compounds that have a restrictive effect on the inflammability and flame-propagation of flammable materials. They are primarily used in the production of electronic equipment (e.g. computers). Further, BFR can also be used in the textiles industry for finishing processes in the production of e.g. clothing, carpets and curtains. Concrete examples of processes in Flemish textile companies where flame retardants are used, include:

- Post-treatment in piece-dying;
- Coating of textiles for mattresses;
- Coating of velours and flat furniture fabric;
- Back-coating of carpets.

comment

- Not all Flemish textile companies implement BFR for making textile fire-resistant. Today (2010), particular companies use organic phosphorous compounds as fire retardants. Certain companies also use aluminium trihydroxide as a fire retardant when back-coating carpets.

There are around 75 variants of BFR, each with specific properties and application possibilities. The most commonly used brominated flame retardant in the Flemish textile sector today (2010), is decabromodiphenyl ether (Deca-BDE), in combination with antimony, in the form of antimony trioxide (Sb_2O_3), as synergist. The substances are implemented in process baths used during finishing processes.
The second brominated flame retardant used by Flemish textile companies is hexabromocyclododecane (HBCD).
A few BFR cannot and are no longer implemented in the textiles industry, namely penta-BDE and octa-BDE (also see paragraph 2.4.3.c).

BFRs, namely Deca-BDE and HBCD, and Sb_2O_3, enter a textile company as pure chemicals or as components in formulations (preparates). Further, BFRs and Sb_2O_3 can also work its way into a textile company via purchased tissues and yarns, intermediary products and water intake.
No information is known to be available about the quantity of BFR and Sb_2O_3 in purchased tissues, yarns and intermediary products. However, information about the quantity of these substances in water is available. The paragraphs below contain a few examples.

example 1 (Centexbel, 2009b)

- This example concerns a Flemish textile enricher who primarily uses surface water, which is recuperated at a partner company and transported via a discharge pipe, as a water source.
- In the period 2008-2009, analyses were carried out at various times into the concentrations of Deca-BDE, antimony and HBCD in the received water:
  - Deca-BDE: 0.2 – 6.2 µg/l (4 measurements)
  - HBCD: <0.1 - <1.0µg/l (4 measurements)
  - Antimony: <20 µg/l (1 measurement)

example 2 (Centexbel, 2009b)

- This example concerns a Flemish textile enricher using surface water as a water source.
- An analysis into concentrations of Deca-BDE in the received water was carried out at the start of 2008. This amounted to: 3 µg/l (1 measurement).

example 3 (Centexbel, 2009b)

- The Sb_2O_3 concentration (2007, 2008) in the water received by a Flemish textile company amounted to < 0.02 mg/l (2 measurements). The analysis was carried out on pre-treated surface water, which, in addition to groundwater and tap water, was used as a water source in the production process.

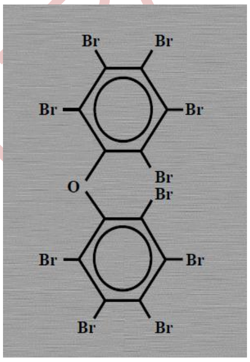
example 4 (Centexbel, 2009b)

- This example concerns a Flemish textile company that uses (treated) surface water, among other waters, as a water source.
- In 2008 analyses were carried out at three different times into the concentrations of Deca-BDE and HBCD in the received water:
  - Deca-BDE: 1.6-8.5 µg/l
  - HBCD: <0.1 - <0.2 µg/l

3.2.2 Decabromodiphenyl ether (Deca-BDE)

a. Introduction

Deca-BDE belongs to the group of polybrominated diphenyl ethers (PBDE) and is represented as follows:



SOURCE: EU-JRC, 2002b

Deca-BDE is not produced in Europe. Deca-BDE is imported from e.g. Israel, USA and the Far East.

In 2008 an estimated 417 tonnes of Deca-BDE-based formulations used in the textile industry in Belgium. The solids content in such formulations amounts to 53.9% on average, but can vary greatly depending on the specific situation. In addition to Deca-BDE, these formulations also contain antimony trioxide (Sb_2O_3), control substances (e.g. talc powder and latex) and water. The use of Deca-BDE as pure chemical by the textile industry in Belgium was estimated at 400 tonnes in 2008 (compared to 8,100 tonnes used by the entire industry in Europe). Because it is fairly difficult to pinpoint the exact quantity of used Deca-BDE, the above mentioned figures must be interpreted with a certain level of caution (Centexbel, 2009a, b and d; EBFRIP-VECAP, 2009a and b and 2010a).

comment
Other examples of PBDE include: penta-BDE and octa-BDE. As already mentioned in paragraph 3.2, these BFRs cannot, and are no longer, used today (2010) in the textile industry.

b. Application and underlying principle
Deca-BDE is the most commonly used brominated flame retardant in the textile sector in Flanders (also see paragraph 3.2). Here are a few concrete examples of how Deca-BDE is used in the textile sector: carpets, car seats, furniture, tents and safety clothing for the military.

Comments
- Deca-BDE is implemented as a substitute product for HBCD (also see paragraph 3.2.3).
- England is a major used of Deca-BDE, namely for furniture because of the fire safety standards (BS5258) that apply there.
- In addition to England, formulations with Deca-BDE got to countries like Turkey and other low-wage countries, where back-coating activities are actually carried out.
- Particular textile brands (e.g. Oekotex, edition 01/01/2010) has stipulated that Deca-BDE must not be used (www.oeko-tex.com). There are no known analysis results concerning the presence of Deca-BDE in textiles.

Deca-BDE is applied to the back of the textile material. In case of fire, bromine radicals (Br°) are released from Deca-BDE from a certain temperature. These react with the present oxygen. Fire is avoided/restricted because oxygen is no longer available.

c. Environmental impact
Deca-BDE can be released from the textile industry into the environment in various ways. The first way is direct emission of Deca-BDE into water. Further, there is an indirect impact on the water via emission into the air (e.g. when empty packages of dust-sensitive products like Deca-BDE and Sb_2O_3 are handled).) Finally, Deca-BDE can also enter the environment via waste (e.g. silt from the AWZI and empty packaging).

A risk analysis study has indicated that Deca-BDE is persistent. Deca-BDE is currently not catalogued as toxic and is probably not bio-accumulable (also see paragraph 2.4.2.b, Table 14).

Deca-BDE is not soluble in water, and probably precipitates on e.g. suspended matter in wastewater.

An estimate can be made for emissions of Deca-BDE into water by Flemish textile companies, based on measured and available discharge data (2006-2009). Table 16 provides an overview of the findings.

Table 16: Summary of measured and available data [µg/l] for discharge of Deca-BDE by Flemish textile companies (2006-2009)

	Discharge situation		
	OW	RIO	An.*
	Individual discharge data		
Number of companies	14	9	?
number of measurements	185	81	92
Average value [µg/l]	27,24	274,77	24,95
minimum [µg/l]	0,07	0,08	<1
maximum [µg/l]	1 153,00	6 600,00	490,00
median[140] [µg/l]	0,24	2,40	1,15
5^{th} percentile [µg/l]	0,08	0,09	<1
10^{th} percentile [µg/l]	0,09	0,09	<1
25^{th} percentile [µg/l]	0,10	0,10	<1
50^{th} percentile [µg/l]	0,24	2,40	1,15
75^{th} percentile[141] [µg/l]	6,00	130,00	11,25
80^{th} percentile [µg/l]	8,64	210,00	14,00
90^{th} percentile [µg/l]	39,00	490,00	37,30
95^{th} percentile [µg/l]	148,00	742,00	133,50

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
*: Discharge data from 2008 and 2009

SOURCE: Centexbel, 2009a and c, Fedustria-Centexbel, 2010, LNE-AMI, 2009, VMM, 2009a and e and own calculations

Comments accompanying Table 16

- Chapter 3 highlights all measured and available discharge data (2006-2009), irrespective of the activities and techniques implemented by the textile companies.
- 1 of the 14 textile companies that discharge into surface water and 2 of the 9 that discharge into sewer have halted their activities (situation September 2009).

[140] Median: The central value in a series of values ranked by size; if there is an even number of values, the average of the two central values is used.

[141] Percentile: Each of the points that split a numerical collection into a hundred equal parts. For example: 75^{th} percentile =x indicates that 75% of the discharge norm is less than x.

- No information is available concerning the use of Deca-BDEF for 2 of the 14 textile companies that discharge into surface water. The same applied to 3 of the 9 textile companies that discharge into sewer.
- 8 of the 14 textile companies that discharge into surface water and 2 of the 9 textile companies that discharge into sewer indicate that they do not use Deca-BDE.
- 3 of the 14 textile companies that discharge into surface water and 2 of the 9 companies that discharge into sewer definitely use Deca-BDE for their finishing activities.

  Comments
  - According to i2a (2009b), there are currently (2010) 29 textile companies in Europe who, as clients of the antimony industry, purchase Sb_2O_3 to use as a synergist in combination with BFR. Most of these companies are thought to be located in England and Belgium (8 textile companies). Thus there could be more textile companies in Flanders that implement Deca-BDE, but have failed to mention this.
  - Currently (2010) 1 of the 2 textile companies that discharge into sewer, is thought ton o longer use Deca-BDE (VMM, 2010).

Since 2006, a number of companies have stopped sending wastewater that contains Deca-BDE, HBCD and Sb_2O_3, (process baths and rinse water from process baths) to the AWZI. That said, substances like Deca-BDE, HBCD and Sb_2O_3 are still being measured in the effluents of these companies (major variations, periods with peak discharges), despite great efforts to clean up the AWZI (e.g. cleansing buffer basis and pipes, replacement of pumps). These companies are experiencing the after-effects of e.g. Deca-BDE, HBCD and Sb_2O_3, due to these substances precipitating in silt and residues, and gradually releasing back into the wastewater flow. Table 17 summarises the results of a Flemish company's self-monitoring programme, with regards to the Sb_2O_3 concentration in influent and effluent. The wastewater purification installation consists of a buffer basin, main biological purification (one-phase system) and a sand filter. The Sb_2O_3 concentration in the effluent is compared with the initial concentration caused by leaching. Possible sources of leaching include: buffer basin, storage cellar, pump system and pipes.

Table 17: Summarised results of discharge data [mg/l] from self-monitoring programme (2007) run by a Flemish textile company, for the parameter antimony

	minimum	maximum	average	number of measurements
influent [mg/l]	0,1	0,1	0,1	1
effluent [mg/l]	0,2	0,8	0,4	22

SOURCE: Centexbel, 2009c

3.2.3 Antimony trioxide (Sb_2O_3)

a. Introduction

Antimony belongs to the metals group. Antimony, in the form of antimony trioxide (Sb_2O_3), is used in the textile industry as a synergist in combination with substances like Deca-BDE. Sb_2O_3 is represented as follows:

```
    Sb = O
     |
     O
     |
O =  Sb
```

SOURCE: Own diagram based on SCA, 2008 and SIAM, 2008

In 2006, antimony trioxide was produced at four locations in Europe. The produced quantity in 2005 amounted to 24,250 tonnes in the EU and an estimated 120,000 tonnes worldwide (SCA, 2008).

b. Application and underlying principle

Antimony, in the form of antimony trioxide (Sb_2O_3), is used as a synergist in combination with substances like Deca-BDE. Sb_2O_3 as such is not a flame retardant, but it does stimulate the effectiveness of Deca-BDE. Antimony tribromide ($SbBr_3$) is formed in the presence of Sb_2O_3 and bromine compounds. This compound hinders the forming and preservation of the flames

If Sb_2O_3 is added (approximately 1 gram per 2.5-3 grams Deca-BDE), less Deca-BDE is needed to create the desired fire retarding properties in the textile.

In 2005, the textile industry was the 4th biggest sector in the EU where Sb_2O_3 was used as a synergist for brominated flame retardants (SCA, 2008). The production of plastic (38%), PVC (36%) and rubber (9%) are the main activities where Sb_2O_3 is used for such applications.

In 2006 an estimated 24,715 tonnes of Sb_2O_3 was used in the industrial sector in Europe. Of this total, 1757 tonnes could be attributed to the European textile industry. According to i2a (2009b), there are currently (2010) 29 textile companies in Europe who, as clients of the antimony industry, purchase Sb_2O_3 to use as a synergist in combination with BFR. Most of these companies are thought to be located in England and Belgium (8 textile companies).

As a general rule of thumb, for every 3 grams of Deca-BDE, approximately 1 gram of Sb_2O_3 is used when implementing as a synergist.

Besides implementing Sb_2O_3 as a synergist in combination with substances like Deca-BDE, antimony can also be found in raw materials like, for example, colorants and pigments that are used in the textile industry. Further, antimony is also used for the production of polyester and can be released again when polyester is processed (paints incl. HT paints).

Antimony trioxide (Sb_2O_3) used as a synergist in combination with BFR represents approximately 7% of the total quantity. Approximately 4% of the total quantity of Sb_2O_3 can be attributed to use as a catalyst in the polyester industry (polyester fibre and PET bottles) (i2a, 2009b and www.antimony.be). Although the use of Sb_2O_3 as a catalyst in polyester is said to be associated with ppm's, it only concerns a few percent of the antimony trioxide used for flame retarding purposes. Furthermore, Sb_2O_3 is also used in the production of pigments.

There are product standards for textiles (e.g. Oekotex, edition 01/01/2010). For all production groups, the product standards for Sb amounts to 30 mg/kg.

c. Environmental impact

In water, antimony compounds bond with e.g. floating matter and silt. A risk analysis shows that antimony is persistent and fairly bio-accumulable, but is not toxic (also see paragraph 2.4.2.b, Table 14).

There is a minimal amount of antimony migration from polyester, because the antimony is encapsulated in the polyester matrix. Drinking water standards and Oekotex standards help to guarantee a minimum amount of antimony migration from polyester (i2a, 2009b).

An estimate can be made for emissions of antimony into water by Flemish textile companies, based on measured individual discharge data (2006-2009). Table 18 provides an overview of the findings.

Table 18: Summary of measured and available discharge data [mg/l] for antimony (2006-2009)

	Discharge situation		
	OW	RIO	An.*
	Individual discharge data		
Number of companies	24	21	?
number of measurements	629	582	69
Average value [mg/l]	0,820	0,776	0,82
minimum [mg/l]	0,003	0,003	0,02
maximum [mg/l]	32,340	19,810	14,20
median [mg/l]	0,035	0,184	0,02
5th percentile [mg/l]	0,003	0,003	0,02
10th percentile [mg/l]	0,003	0,003	0,02
25th percentile [mg/l]	0,007	0,009	0,02
50th percentile [mg/l]	0,035	0,184	0,02
75th percentile [mg/l]	0,275	0,498	0,42
80th percentile [mg/l]	0,393	0,657	0,53
90th percentile [mg/l]	1,508	1,369	2,53
95th percentile [mg/l]	4,904	3,314	4,94

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
* Discharge data from 2006 and 2007

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

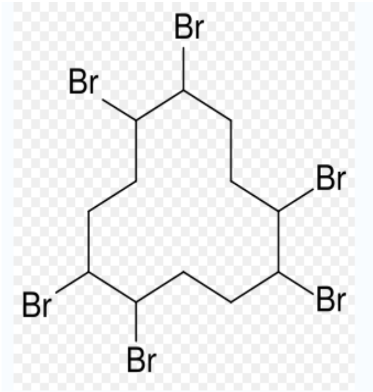
Comments accompanying Table 18

- Chapter 3 highlights all measured and available discharge data (2006-2009), irrespective of the activities and techniques implemented by the textile companies.
- 3 of the 24 companies that discharge into surface water indicate that they use antimony trioxide in combination with BFR. The average antimony concentration amounts to 0.731 mg/l with a spread of <0.02 mg/l (reporting limit) to 23.360 mg/l (95 measurements). 2 of the 21 textile companies that discharge into sewer definitely implement antimony trioxide in combination with BFR. The average antimony concentration amounts to 3.163 mg/l with a spread of 0.263-19.810 mg/l (99 measurements) (also see appendix 3).
  comment
  There could also be other textile companies in Flanders who implement Sb_2O_3 as a synergist in combination with BFR, but have failed to mention this (i2a, 2009b).
- 11 of the 24 companies that discharge into surface water indicate that they <u>do not use BFR</u>. Though these companies do perform paint-related activities (PA paints and PES paints). The average antimony concentration amounts to 1.654 mg/l with a spread of <0.02 mg/l (reporting limit) to 32.340 mg/l (251 measurements). The median value is <0.02 mg/l. High antimony concentrations are found in a limited number (2) of companies. Further, this measurement data dates back to before 2009. 8 of the 21 textile companies that discharge into sewer do not use BFR. However, antimony is present in wastewater and paint-related activities. The average antimony concentration amounts to 0.383 mg/l with a spread of <0.02 mg/l (reporting limit) to 13.130 mg/l (226 measurements). The median value amounts to 0.06 mg/l. High antimony concentrations are only encountered in 1 company. Though this measurement data dates back to before 2009.
- <u>No information</u> is available about the origin of antimony in the wastewater for 3 of the 21 textile companies that discharge into surface water and 3 of the 21 textile companies that discharge into sewer.
- 5 of the 24 textile companies that discharge into surface water and 8 of the 21 textile companies that discharge into sewer have <u>halted</u> their activities (situation September 2009).

3.2.4 Hexabromocyclododecane (HBCD)

a. Introduction

HBCD is represented as follows:



SOURCE: www.wikipedia.org

There is only 1 production location for HBCD in Europe, namely in the Netherlands. However, HBCD that is produced in Europe is no longer supplied to Flemish companies. That said, HBCD is imported into Flanders from outside Europe (e.g. from China). Conversely, a substantial share of the formulation are also exported (from the Netherlands) to, for example, Turkey.

In 2008 an estimated 49 tonnes of HBCD-based formulations was used in the textile industry in Belgium. The solids content in formulations amounts to 53.9% on average, but can vary greatly depending on the specific situation. The use of HBCD as pure chemical by the textile industry in Belgium was estimated at <20 tonnes in 2008 (compared to 14,000 tonnes used by the entire industry in Europe). Because it is fairly difficult to pinpoint the exact quantity of used HBCD, the above mentioned figures must be interpreted with a certain level of caution (Centexbel, 2009a, b and d; EBFRIP-VECAP, 2009a and b and 2010a).

b. Application and underlying principle

HBCD that is imported from outside Europe is still primarily used in the textile industry in Flanders (also see paragraph 3.2) for very specific applications, e.g. soft and transparent substances (e.g. glass curtains) and upholstered furniture destined for public buildings and hotels. There is no VECAP data available for the use of HBCD by Flemish textile companies.

The underlying principle is similar to that of Deca-BDE (also see paragraph 3.2.1.b). However, HBCD reacts at a slight lower temperature, whereby it becomes effective faster than Deca-BDE. In practice, HBCD and Deca-BDE are also used in combination with each other.

Comments

- Compared to Deca-BDE, HBCD is approximately 2.5 times more expensive.
- The use of HBCD will be (further) restricted in time because HBCD has been included in the REACH list of very harmful substances (SVHC). In mid-2009, a number of companies and formulators confirmed that they intend to quickly reduce the use of HBCD (Fedustria, 2009).
- Based on surveys among a number of formulators, Fedustria (2009) indicates that antimony is never used as a synergist in combination with HBCD. However, in certain cases, Deca-BDE is added to HBCD preparates. In this case, the added combination is Deca-BDE and antimony trioxide.
- Particular textile brands (e.g. Oekotex, edition 01/01/2010) has stipulated that HBCD must not be used (www.oeko-tex.com). There are no known analysis results concerning the presence of HBCD in textiles.

c. Environmental impact

Wastewater, air and waste are the main environmental compartments impacted by HBCD from the textile industry. For the water environmental compartment, there are primarily direct emissions of HBCD into water. Further, there is an indirect impact on the water via emission into the air (e.g. when empty packages of dust-sensitive products).) Finally, HBCD can also enter the environment via waste (e.g. silt from the AWZI and empty packaging).

The risk analysis for HBCD was finalised in 2008. This study shows that HBCD is bio-accumulable, persistent and toxic (also see paragraph 4.2.4.b, Table 14). HBCD is a PBT substance or a “substance of very high concern” (also see paragraph 2.4.3.c concerning REACH). This means that a separate application must be made for this substance in the permit and a separate permit must be issued (PNEC value HBCD: 0.31 µg/l).

HBCD is not soluble in water, and probably precipitates on e.g. suspended matter in wastewater.

An estimate can be made for emissions of HBCD into water by Flemish textile companies, based on measured and available discharge data (2006-2009). Table 19 provides an overview of the findings.

Table 19: Summary of measured and available data [µg/l] for discharge of HBCD by Flemish textile companies (2006-2009)

	Discharge situation		
	OW	RIO	An.*
	Individual discharge data		
Number of companies	14	9	?
number of measurements	127	52	44
Average value [µg/l]	1,62	1,68	6,50
minimum [µg/l]	0,01	0,10	0,02
maximum [µg/l]	85,00	34,00	130,00
median [µg/l]	0,13	0,15	0,93
5^{th} percentile [µg/l]	0,10	0,10	0,10

10th percentile [µg/l]	0,10	0,10	0,10
25th percentile [µg/l]	0,11	0,11	0,10
50th percentile [µg/l]	0,13	0,15	0,93
75th percentile [µg/l]	0,62	0,71	3,55
80th percentile [µg/l]	1,18	0,85	4,30
90th percentile [µg/l]	2,64	3,73	8,97
95th percentile [µg/l]	5,42	7,95	24,10

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
* Discharge data from 2006 and 2007

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

Comments accompanying Table 19

- Chapter 3 highlights all measured and available discharge data (2006-2009), irrespective of the activities and techniques implemented by the textile companies.
- 1 of the 14 textile companies that discharge into surface water and 2 of the 9 textile companies that discharge into sewer have halted their activities (situation September 2009).
- No information is available concerning the use of HBCD for 2 of the 14 textile companies that discharge into surface water. This is also the case for 3 of the 9 textile companies that discharge into sewer.
- 8 of the 14 textile companies that discharge into surface water and 2 of the 9 textile companies that discharge into sewer indicate that they do not use HBCD.
- 3 of the 14 textile companies that discharge into surface water and 2 of the 9 companies that discharge into sewer use BFR (incl. HBCD) for their finishing activities.

  comment

  According to i2a (2009b), there are currently (2010) 29 textile companies in Europe who, as clients of the antimony industry, purchase Sb_2O_3 to use as a synergist in combination with BFR. Most of these companies are thought to be located in England and Belgium (8 textile companies). Thus there could be more textile companies in Flanders that implement Deca-BDE, but have failed to mention this.

3.2.5 References

The following sources were referenced when compiling paragraph 3.2:

Company visits;
Company information;
BSEF, 2007 and 2008;
Callebaut K. *et al.*, 2007;
Centexbel, 2009a, b and c;
DEPA, 1999;
ECB, 2006;
EFRA, 2007;

EIPPCB, 2003a;
EU-JRC, 2002b;
Fedustria, 2009;
i2a, 2008a, 2008b, 2009b;
Jacobs *et al.*, 1998;
Jansen B. and Vanermen G., 2006;
Land C.A., 2008;
LNE-AMI, 2009;
LNE-AMV, 2009;
RIVM, 2007a and b;
SCA, 2008;
VITO en LNE, 2008;
EBFRIP-VECAP, 2008b and 2009c;
VMM, 2007 and 2009a and e;
VROM, 2002;
http://www.antimony.be
http://www.chemblink.com/products/1309-64-4.htm
www.oeko-tex.com
http://www.sica-chauny.com/content/eng/world_eu.html

3.3 Use of perfluorinated tensides (PFT) in the textile industry

3.3.1 Introduction

Perfluorinated tensides (PFT) are persistent organofluorinated compounds with surface-active properties. PFT is defined as perfluorinated molecules with a chain length of 8 carbons (C8) or longer. These substances are implemented in various sectors, including the textile industry.
For many applications in the textile industry (e.g. carpets with an effect on one side), PFTs are applied via spraying, as a foam or via a squeegee technique. In these cases, fewer PFTs enter the wastewater. If the effect is needed on both sides of the textile, process baths with PFT and a binding product are used. PFTs are rarely used as a concentrated bath liquid.

Concrete examples of processes in Flemish textile companies where PFTs are used, include:

- Post-treatment in piece-dying;
- Coating of textiles for mattresses.

PFTs are used to increase water-resistance and anti-dirt properties in the production of carpets, fabrics, upholstery and car interiors.

A PFT that was used in the Flemish textile industry, primarily in the past, for finishing activities was perfluorooctane sulphonic acid (PFOS, C8 compounds).

Comments

- Over the past few years, the production and use of PFT in e.g. the EU, US, Canada and Australia is said to be falling due to legislation dictating the need to phase out PFOS (also see paragraph 2.4.3.e).
- The production all products based on PFOS has been halted in Flanders since 2002.

Another example of a PFT that is used in the Flemish textile industry is perfluorooctane acid (PFOA, C8 compound).

Comments

- There are no legal limitations for the use of PFOA in Europe.
- However, a few countries (incl. America and Canada) have reached agreements to limit the use of PFOA and to ban it in time (PFOA Stewardship Program, also see paragraph 2.4.4.b).

Alternative compounds that can be used to substitute e.g. PFOS include, for example, PFBS (perfluoro butanesulphonate, C4 compound) and PFHA (perfluorohexane acid, C6 compound).

comment

Perfluorinated molecules with a chain length of 4 or 6 carbons cannot strictly be seen as PFT

PFTs are produced in Europe (e.g. Belgium, France and Germany) and other regions. There is only 1 known producer of PFT alternatives (e.g. PFBS to replace PFOS) in Flanders.

No quantitative information is known to be available concerning the used quantities of PFT in the Flemish textile sector.

An estimate can be made for emissions of PFT into water by the textile industry, based on measured and available discharge data from Flemish companies (2006-2009). Table 20 provides and overview of the discharge data for PFT by Flemish textile companies in 2007 (Centexbel, 2009a). Individual discharge data for PFOA, PFOS and PFT totals in 2006 can be found in Table 21 (LNE-AMI, 2009).

Table 20: PFT discharge data [µg/l] for Flemish textile companies (2007)

parameter	concentration [µg/l]			number of measurements
	minimum	maximum	average	
PFBS	**0.3**	**50.5**	**23.0**	**5**
PFHA	**0.2**	**15**	**2.1**	**9**
PFOA	**0.3**	**11.6**	**3,8**	**21**
PFNA	0	5.6	2.2	17
PFHpA	0	4.3	0.8	10
PFuDA	0	3.4	0.7	6
PFOS	**0**	**3**	**0,7**	**6**
PFDA	0	2.8	0.9	13
PFC5A	0.2	0.8	0.4	3
PFC14A	0.2	0.6	0.4	2

PFDoA	0	0.6	0.2	3
PFHS	0.3	0.3	0.3	2
FOSA	0	0.3	0.2	1
PFBA	0.1	0.2	0.2	3

SOURCE: Centexbel, 2009a

Comments accompanying Table 20

- Chapter 3 highlights all measured and available discharge data, irrespective of the activities and techniques implemented by the textile companies.
- The intention was to have a measurement campaign carried out by VMM during the course of 2009, with regards to PFT in the wastewater of textile companies. However, based on the first screening, VMM decided not to deem PFT (incl. PFOS and PFOA) as a relevant parameter for the textile industry during their measurement campaign in 2009 (VMM, 2009e).
- A limited amount of measurement data(2008) for the parameters PFOS and PFOA is available (Centexbel, 2009c). This shows that the concerned parameters fall within the ranges indicated in Table 20.
- Today (2010), PFOS is replaced by e.g. PFBS in many cases.
- During the production of e.g. PFBS, PFOS is created as by-product. This means, despite switching to e.g. PFBS, one continues to find small quantities of PFOS in the wastewater of textile companies. According to a manufacturer of PFT alternatives, these are low concentrations (ppb level) which, after refinement and purification, result in a maximum concentration of <20 ppb (detection limit) in commercial formulations.
- According to Centexbel, PFBS (C4 compounds) and PFHA (C6 compounds) are substitute products for PFOS and PFOA. Today (2010), these alternative PFT compounds are being tested in a number of Flemish textile companies.

Table 21: Measured and available discharge data (anonymous) [µg/l] for PFOA, PFOS, PFBS and some PFT for Flemish textile companies (2006)

	parameter				
	PFOA	PFOS	PFBS	PFHA	sum PFTs
	Individual discharge data				
Number of companies	?	?	?	?	?
number of measurements	45	45	45	45	45
Average value [µg/l]	1,86	0,19	9,58	0,25	3,90
minimum [µg/l]	0,10	0,10	0,10	0,10	0,00
maximum [µg/l]	11,60	3,00	20,09	4,78	24,20[142]
median [µg/l]	0,10	0,10	10,00	0,10	0,00
5th percentile [µg/l]	0,10	0,10	2,80	0,10	0,00
10th percentile [µg/l]	0,10	0,10	10,00	0,10	0,00
25th percentile [µg/l]	0,10	0,10	10,00	0,10	0,00

[142] A limited amount of individual discharge data (2006-2008) is available for two textile companies (CENTEXBEL, 2009c). The individual measurement data for PFOS and PFOA is within the indicated range (see Table 21). This is also the case for PFT measurement data, with the exception of 1 measurement value from 2006 (namely 39 µg/l)

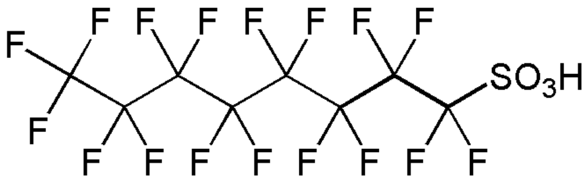
50th percentile [µg/l]	0,10	0,10	10,00	0,10	0,00
75th percentile [µg/l]	2,90	0,10	10,00	0,10	7,61
80th percentile [µg/l]	3,42	0,10	10,00	0,10	8,29
90th percentile [µg/l]	5,69	0,10	10,00	0,19	12,74
95th percentile [µg/l]	8,34	0,28	10,00	0,81	15,03

SOURCE: LNE-AMI, 2009 and own calculations

3.3.2 Perfluorooctane sulphonic acid (PFOS)

a. Introduction

PFOS ($C_8HF_{17}O_3S$) is a synthetic chemical product, which consists of 8 carbon atoms, and is represented as follows:



SOURCE: www.wikipedia.org

b. Application and underlying principle

PFOS is used in the textile industry as a protective layer in the production of e.g. sofas.

Comments

- PFOS-based products are, for example, used as extinguishing foam when combating e.g. solvent fires[143].
- As far as the textile industry is concerned, PFOS alternatives are said to be currently (2010) in testing/use, namely C4 and/or C6 compounds (also see paragraph 4.2.1).
- There are product standards for textile (Oekotex, edition 01/01/2010). For PFOS, this product standards amounts to 1 µg/m² for all product groups.
- There are still no Centexbel analysis results available for textile materials. The analysis method for determining PFOS on textile items is currently (2010) being refined.

c. Environmental impact

PFOS are released from the textile industry into the environment during their production and use. Wastewater and air are the main environmental compartments to be impacted by PFOS.

PFOS is bio-accumulable, persistent and toxic (also see paragraph 2.4.2.b, Table 14). PFOS is very difficult to break down, in both aerobic and anaerobic conditions.

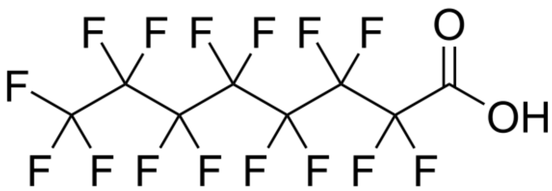
[143] This application is not regulated under Guidelines 2006/122/EC (derogation 6/20011) and is beyond the scope of the BAT study.

Measured and available discharge data (2006 and 2007) for PFOS among Flemish textile companies can be found in Table 20 and Table 21.

3.3.3 Perfluorooctane acid (PFOA)

a. Introduction

PFOA ($C_8HF_{15}O_2$) is a synthetic chemical product, which consists of 8 carbon atoms, and is represented as follows:



SOURCE: www.wikipedia.org

b. Application and underlying principle

PFOA is used in the production of fluoropolymers. Fluoropolymers have functional characteristics like e.g. oil, fat and water repellence. They are used as protective layers in the production of textiles.

Comments

- There are product standards for textile (Oekotex, edition 01/01/2010). The product standard for PFOA varies between 0.10 and 0.25 mg/kg depending on the product group.
- There are still no Centexbel analysis results available for textile materials. The analysis method for determining PFOA on textile items is currently (2010) being refined.

c. Environmental impact

PFOA are released from the textile industry into the environment during their production and use. Wastewater and air are the main environmental compartments to be impacted by PFOA.

PFOA is bio-accumulable, persistent and toxic (also see paragraph 4.2.4.b, Table 14). PFOA is very difficult to break down, in both aerobic and anaerobic conditions.

Measured and available discharge data (2006 and 2007) for PFOA among Flemish textile companies can be found in Table 20 and Table 21).

3.3.4 References

The following sources were referenced when compiling paragraph 3.3:
3M, 2009a and b;
Company visits;
Centexbel, 2009a, b and c;

De Bont R. *et al.*, 2004;
EIPPCB, 2003a;
LNE-AMI, 2009;
Jacobs *et al.*, 1998;
Land C.A., 2008;
RIVM, 2007a and c;
SCA, 2006;
VITO and LNE, 2008;
VITO, 2008a;
VMM, 2005;
www.3M.com/pfos-pfoa
http://www.epa.gov/opptintr/pfoa/pubs/stewardship/index.html

3.4 Use of nonylphenols (NP) and nonylphenol ethoxylates (NPE) in the textile industry

3.4.1 Introduction

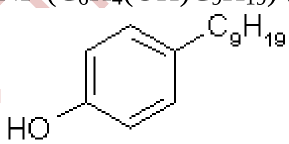
Nonylphenols (NP) are organic compounds (non-ionic surface-active substances) from the alkylphenols family. NP are primarily used as intermediary products in the preparation of nonylphenol ethoxylates (NPE). In turn, NPE is used as surface-active substance in e.g. the textiles sector.

3.4.2 Nonylphenols (NP)

a. Introduction

Nonylphenols are not natural substances, but are the result of a synthesis process. Nonylphenol is the name of a cluster of isomers that are formed during the alkylation process of phenols. Nonylphenols have a hydrocarbon chain of nine carbon atoms connected to the phenol ring at para position. Nonylphenols produced for commercial purposes primarily consist of 4-nonymphenol, with an aliphatic chain that is branched in various ways to a non-defined extent.

NP ($C_6H_4(OH)C_9H_{19}$) (example: para-nonylphenol) is represented as follows:



SOURCE: www.wikipedia.org

NP is not known to be produced in Flanders.

Comments

- There are various types of nonylphenols. 4nNyFol (para-nonylphenol) is a very common type of NP in the textiles industry.
- Octylphenols and octylphenol ethoxylates are also relevant to the textile industry because they are currently (2010) being used as alternative for NP and NPE.

b. Application and underlying principle

Nonylphenols (NP) are primarily used as intermediary products in the production of nonylphenol ethoxylates (NPENPE, also see paragraph 3.4.3.b), in the chemicals industry for example, and are not implemented in the textile industry as such).

> *comment*
> With regards to product standards (e.g. Oekotex, edition 01/01/2010 or GUT) there are no limitations regarding the presence of NP in textiles. Thus far, no analyses are known to have been performed concerning NP on tissues or yarns. Thus, no data is available on the matter.

c. Environmental impact

NP in the wastewater of textile companies can primarily be attributed to the breakdown of NPE (also see paragraph 3.4.3.c). NP is water soluble and is not bio-degradable. NP are not removed when wastewater is purified biologically.

A risk analysis study shows that NP is bio-accumulable, persistent and toxic (also see paragraph 4.2.4.b, Table 14).

An estimate can be made for emissions of NP into water by Flemish textile companies, based on measured and available discharge data from Flemish textile companies (2006-2008). Table 22 provides an overview of the initial findings.

Table 22: Summary of measured and available data [µg/l] for discharge of NP by Flemish textile companies (2006-2009)

	OW		RIO	
	4nNyFol[144]	NyFol[145]	4nNyFol[146]	NyFol
Number of companies	11	11	8	8
number of measurements	255	161	142	74
Average value [µg/l]	0,23	1,31	0,03	15,29
minimum [µg/l]	0,02	0,05	0,02	0,05
maximum [µg/l]	50,00	100,00	0,34	155,00
median [µg/l]	0,02	0,23	0,02	2,15
5th percentile [µg/l]	0,02	0,05	0,02	0,10

[144] 4n nonylphenol, 4 measurements equal to or in excess of 0.1 µg/l (reporting limit)

[145] The sum of isomers for nonylphenol is determined using GC-MS. 4nNyFol, as well as 4nOyFol (4n octylphenol) and 4tOyFol (4ter octylphenol) are found in another location in the chromatogram and are determined and reported separately (Debbaudt A., 2009).

[146] Only 1 measurement is over the reporting limit(0.1 µg/l)

10^{th} percentile [µg/l]	0,02	0,10	0,02	0,10
25^{th} percentile [µg/l]	0,02	0,10	0,02	0,62
50^{th} percentile [µg/l]	0,02	0,23	0,02	2,15
75^{th} percentile [µg/l]	0,02	0,67	0,02	10,20
80^{th} percentile [µg/l]	0,02	0,85	0,02	13,08
90^{th} percentile [µg/l]	0,02	1,60	0,02	51,20
95^{th} percentile [µg/l]	0,05	3,00	0,02	95,90

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
SOURCE: VMM, 2009a, b and e, and own calculations

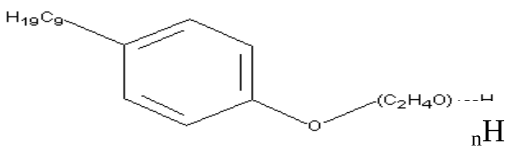
Comments accompanying Table 22

- Chapter 3 highlights all measured and available discharge data, irrespective of the activities and techniques implemented by the textile companies.
- 3 of the 11 surface water dischargers and 4 of the 8 sewer dischargers have stopped their activities (situation September 2009).
- For 5 of the 11 textile companies that discharge into surface water and 2 of the 8 sewer dischargers, no concrete background information accompanies the measurement data.
- Information is available about the implemented wastewater purification techniques for 3 of the 11 textile companies that discharge into surface water and 2 of the 8 companies that discharge into sewer, but insufficient information is available about the origin of the NP in the effluent.

3.4.3 Nonylphenol ethoxylates (NPE)

a. *Introduction*

Alkylphenol ethoylates (APE) belong to the group of non-ionic surface-active substances. Nonylphenol ethoxylates (NPE) are the main substances in this group and are represented as follows:



SOURCE: http://www.irz.cz/repository/nonylphenol_a_nonylphenol_ethoxylaty1.gif

If 1 (C_2H_4O) group is present, it will be mono-NPE. Di-NPE contains 2 (C_2H_4O) groups. If multiple (C_2H_4O) groups are present, this is known as poly-NPE.

NPE $((C_2H_4O)nC_{15}H_{24}O)$ are synthetisised from e.g.. NP (also see paragraph 3.4.1).

There is thought to be 1 producer of NPE in Flanders, albeit in very small quantities. No quantitative information is known to be available. It is also unclear how much NPE is used by the textile industry in Flanders.

b. Application and underlying principle

NPE are not used as pure substances in the textile industry However, NPE are supplied as surface-active substances in preparates (e.g. detergents, dispergators, wetting agents) by product suppliers. Such preparates are used, for example, in paint baths in finishing processes.

Purchased tissues and yarns could possibly be (partly) responsible for the presence of NP in the wastewater of Flemish textile companies. According to the sector, to date (2010) a targeted investigation has not been carried out into the compositions and quantities of NPE in purchased tissues and yarns.

Comments

- Centexbel (2009b) states that the textile industry primarily purchases preparates for textile applications within the EU.
- VMM (2009f) indicates that product suppliers within the EU could possibly create mixes with NPE/NP > 0.1% (g/g). Textile enrichers are also allowed to use products (EU or non-EU) that contain more than 0.1% (g/g) NPE/NP, under the condition that they do not discharge these products in wastewater. Today (2010), insufficient checks are carried out for the presence of NP/NPE in the wastewater of textile companies. There is no fixed guideline (= emission limit value).
- With regards to product standards (e.g. Oekotex, edition 01/01/2010 or GUT) there are no known limitations regarding the presence of NPE in textiles.
- Tissues and yarns purchased outside the European Union can also contain NPE. To date (2010) Centexbel has not, and nor have any other textile institutions, performed an analysis into NPE on tissues and yarns. Thus, no data is available on the matter.
- Other chemical compounds in the alkylphenol ethoxylates group include octylphenol ethoxylates (OFE) and decylphenol ethoxylates (DFO). Octylphenol ethoxylates are deemed to be relevant to the sector because they can be implemented as alternative chemicals (also see elsewhere[147]).

c. Environmental impact

NPE from the textile industry primarily have an impact on the environmental compartment ‘water’. NPE will break down once again in water, into e.g. NP (also see paragraph 3.4.2.c), due to one[148] or multiple[149] (C_2H_4O) groups splitting off..

example

If mono-NPE[150] breaks down to NP[151], then the NPE/NP ratio will be 1.198. This ratio is 1.396 for di-NPE[152]. For poly-NPE (e.g.. with 6 C_2H_4O groups)[153] this ratio is 2.189.

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147 Candidate BAT: Use alternative chemicals for enrichment activities wherever possible

148 for mono-NPE

149 for e.g. di-NPE or poly-NPE

150 molecular weight = 222 grams per mole

151 molecular weight = 266 grams per mole

152 molecular weight = 310 grams per mole

(SOURCE: Own calculations based on VITO, 2009b)

NPE is water soluble and is not bio-degradable. NPE are not removed when wastewater is purified biologically.

A risk analysis shows that NPE is persistent (also see paragraph 4.2.4.b, Table 14). NPE are not known to be bio-accumulable or toxic.

An estimate for NPE concentrations in raw wastewater can be made based on the theoretical example below (Centexbel, 2009). If one assumes that the NPE content in preparates, which are intended for textile applications, is limited to maximum 0.1% g/g (also if it is purchased from outside the UE), then the following values can be estimate for raw wastewater in a discontinuous process:

- Maximum 0.1 % g/g (cf. REACH) when 2-4% is used in a bath as detergent:
  - 2% = 2 g per100 g bath; converted to per litre bath: 20,000 mg x 0.1% = 20 mg per l bath;
  - 4% = 4 g per100 g bath; converted to per litre bath: 40,000 mg x 0.1% = 40 mg per l bath;
  - For a total of e.g. 4 processes (wetting and bleaching, rinsing, dying and rinsing), this will be 5-10 mg of NPE per litre of released wastewater (specific partial flows at the 4 processes). Further dilution will take place if these partial flows enter the general wastewater flow. However, for some companies, NPE-based wastewater flows represent a large share of all wastewater flows.

An estimate can be made for emissions of NPE into water by Flemish textile companies, based on measured and available discharge data (2007-2009). Table 23 provides an overview of the findings.

comment
NPE break down into NP is watery environments. A limited sample from Flemish textile companies indicates that more NPE (scale [mg/l]) is present in the effluent than NP (scale [µg/l]). NPE is fully converted into NP, though complete metabolisation has not yet taken place in the effluent. Thus, for the main part, the conversion of NPE into NP occurs once industrial wastewater has been discharged. Therefore, in addition to NP, it is also important for NPE to be measured in the wastewater of textile companies.

Table 23: Summary of measured and available discharge data for NPE (nonylphenolpolyethoxylates) in Flemish textile companies (2007) expressed in mg/l

	Discharge situation	
	OW	RIO
	Annual averages	
Number of companies	14	6
number of measurements	16	8
Average value [mg/l]	0,054	0,422
minimum [mg/l]	0,011	0,041

[153] molecular weight = 486 grams per mole

maximum [mg/l]	0,180	1,270
median [mg/l]	0,019	0,220
5th percentile [mg/l]	0,011	0,062
10th percentile [mg/l]	0,011	0,082
25th percentile [mg/l]	0,014	0,115
50th percentile [mg/l]	0,019	0,220
75th percentile [mg/l]	0,068	0,595
80th percentile [mg/l]	0,100	0,706
90th percentile [mg/l]	0,170	0,976
95th percentile [mg/l]	0,175	1,123

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
SOURCE: VMM, 2009a and own calculations

Comments

- Chapter 3 highlights all measured and available discharge data, irrespective of the techniques (candidate BAT, also see chapter 4) implemented by the textile companies.
- I concrete measurement is available from 1 Flemish company (volume proportionate sample, 2007), namely <0.5 µg/l (Centexbel, 2009c). This value is lower than the reporting limit (5-10 µg/l mono and dipolyethoxylates, and 20µg/l for polyethoxylates).
- For 6 of the 14 textile companies that discharge into surface water and 3 of the 6 sewer dischargers, no information is available for the implemented wastewater purification techniques.
- 2 of the 14 textile companies that discharge into surface water and 1 textile company that discharges into sewer have halted their activities (situation September 2009).

Further, annual averages (2007) are also available for octylphenol ethoxylates (OFE) (see Table 24).

Table 24: Summary of annual average discharge data for OFE (octylphenol polyethoxylates) in Flemish textile companies (2007) expressed in mg/l

	Discharge situation	
	OW	RIO
	Annual averages	
Number of companies	14	6
number of measurements	16	8
Average value [mg/l]	0,223	2,362
minimum [mg/l]	0,011	0,024
maximum [mg/l]	0,980	12,000
median [mg/l]	0,062	0,320
5th percentile [mg/l]	0,012	0,053
10th percentile [mg/l]	0,013	0,082
25th percentile [mg/l]	0,020	0,120
50th percentile [mg/l]	0,062	0,320
75th percentile [mg/l]	0,235	1,975

80th percentile [mg/l]	0,274	2,710
90th percentile [mg/l]	0,572	6,720
95th percentile [mg/l]	0,776	9,360

Legend: OW: Discharged into surface water
RIO: Discharged into sewer
SOURCE: VMM, 2009a and own calculations

3.4.4 References

The following sources were referenced when compiling paragraph 3.4:
Centexbel, 2009a, b and c;
EIPPCB, 2003a;
Fedustria, 2009;
RDC, 2001;
RIVM, 2007a and d;
VMM, 2008a and 2009;
http://www.allesovercosmetica.nl/was_en_reinigingsmiddelen/pages/dictionary.php?page_id=11&dictionary_id=7
www.oeko-tex.com
http://www.irz.cz/repository/nonylphenol_a_nonylphenol_ethoxylaty1.gif

3.5 Use of polycyclic aromatic hydrocarbons (PAH) in the textile industry

3.5.1 Introduction

Polycyclic aromatic hydrocarbons, or PAH for short, are a group of organic substances consisting on two or more benzene rings. The higher the number of benzene rings, the higher the molecular weight and the less ‘volatile’ and hydrophobic the properties of the PAH.

> *comment*
> Naphthalene, anthracene, phenanthrene, fluoranthene and pyrene are regarded as ‘volatile’ PAH. Benzo(a)pyrene is an example of a ‘non-volatile’ PAH.

The PAH group contains hundreds of organic substances. Based on their toxicity, PAH are classified by various organisations into different classification lists.

3.5.2 16 PAH of EPA

a. introduction

The PAH examined in the BAT study are the 16 PAH of EPA (Environmental Protection Agency in the United States). In concrete terms, they are:

- acenaphtylene ($C_{12}H_8$);
- acenaphthene ($C_{12}H_{10}$);

- anthracene ($C_{14}H_{10}$);
- benzo(a)anthracene ($C_{18}H_{12}$);
- benzo(b)fluoranthene ($C_{20}H_{12}$);
- benzo(k)fluoranthene ($C_{20}H_{12}$);
- benzo(a)pyrene ($C_{20}H_{12}$);
- benzo(ghi)perylene ($C_{22}H_{12}$);
- indeno(1,2,3 cd)pyrene ($C_{22}H_{12}$);
- chrysene ($C_{18}H_{12}$);
- dibenzo(a,h)anthracene ($C_{22}H_{14}$);
- phenanthrene ($C_{14}H_{10}$);
- fluoranthene ($C_{16}H_{10}$);
- fluorene ($C_{13}H_{10}$);
- naphthalene (C_{10}H8);
- pyrene ($C_{16}H_{10}$).

b. Application and underlying principle

The sector indicates that there are no, or very few, known processes where PAH are used in the textiles industry. A study about the PAH problems of a Flemish textile company (Centexbel, 2009b) indicates that textile raw materials are a major and constant source of discharged PAH (phenanthrene and pyrene in particular). The BREF (EIPPCB, 2003a) shows that mineral oils are the main source of PAH in the textile industry. Minerals oils are found, together with detergents, on yarns and tissues and are washed out prior to dying.

Naphthalene is no longer used as anti-moth treatment in Flanders. Though naphthalene can still be present in purchased tissues and yarns.

PAH in the wastewater of textile companies could possible originate from:
- Raw materials (via pollutants in spinning oils, used for lubricating needles on looms, present on natural fibres like e.g. cotton, viscose, flax and bamboo; e.g. phenanthrene and pyrene);
- Pollutants in colorants and dyes: e.g. naphthalene as component of particular colorants;
- Optical whiteners;
- Support products for dying polyester: carriers (= support products (e.g. o-phenylphenol, biphenyl, 1-methylnaphthalene) to be able to e.g. dye polyester at a lower temperature; carriers acts as accelerators for the transport of dye in the fibre);
- Reaction products produced during e.g. thermal process for mineral oils (used as spinning oils);
- Oil leaks in machines (e.g. phenanthrene and pyrene);
- Rain water (via roof coverings featuring e.g. bitumen);
- groundwater.

Comments

- The Flemish BAT study for the textile industry (Jacobs A. *et al.*, 1998) states, with regards to VOS emissions into the air, that some process chemical are adsorbed by the textile material and only become volatile at a later time when they dry. Naphthalene is an example of a chemical compound that behaves in this manner.

- The European BAT study for the textile industry (EIPPCB, 2003a) mentions naphthalene-based components in colorants and dyes, as well as PAH-based spinning oils, knitting oils and support products.
- The BAT study for laundries and linen lessors (Van den Abeele, L. et al., 2010) examined the link between washing particular types of textile and the presence of particular pollutants in laundry wastewater. This showed that PAH are primarily present in the wastewater of laundries that wash mats.

Purchased tissues and yarns are a possible source of PAH (an mineral oils) in the wastewater of Flemish textile companies. According to the sector, to date (2010) a targeted investigation has not been carried out into the compositions and quantities of e.g. PAH (and mineral oils) in purchased tissues and yarns. An analysis method has been established to determine PAH in yarns and tissues – namely the GCMS measurement method. HPLC could also be a useful technique. With regards to product standards (e.g. Oekotex, edition 01/01/2010 or GUT) determinations have been included regarding the presence of PAH in textiles. The following threshold values are imposed for PAH in the 4 product classes:

- 10 mg/kg for the 16 specified substances;
- 1 mg/kg for benzo [a] pyrene.

The determinations have been in effect since 01/04/2010. Currently, it is not possible to estimate the quantities of these substances used in the textile industry.

c. Environmental impact

PAH are formed after incomplete burning or carbonisation of various carbon-based materials (e.g. fossil fuels, foods and wood). PAH are present in the gas phase of flue gases and air, and are attached to particles. The deposit and accumulation of PAH via the food chain could result in the pollution of forests, soils, rivers and seas.

PAH are bio-accumulable and persistent. PAH are not toxic in their own right, but are converted in the body into reactive metabolites that could affect hereditary material. Properties concerning toxicity, carcinogenic and hormone-disruptive properties and bio-accumulability and persistence for the 16 PAH of EPA, have been summarised in Table 14 (also see paragraph 2.4.2.b).

PAH are found in the wastewater of textile companies. A significant different has been established between dischargers into sewers (higher concentrations) and dischargers into surface water (lower concentrations) (also see appendix 3). In this case, the difference can be attributed to the use of biological wastewater techniques in the textile companies. The fact that PAH are removed in biological wastewater purification installations is confirmed by the analysis of PAH measurements in wastewater from WWTP, which was carried out while reviewing the BAT study for laundries and linen lessors (Van den Abeele L. *et al.*, 2010).

PAH are characterised by low water solubility, and their propensity to bond with e.g. suspended matter or silt in the water. This is primarily the case with heavier PAH. The lighter PAH (e.g. naphthalene) in wastewater volatalise or break down.

PAH like e.g. acenaphthene, acenaphtylene, naphthalene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, phenanthrene, fluoranthene, fluorene, indeno(1, 2, 3-cd)pyrene and naphthalene are bio-degradable. Anthracene and chrysene, on the other hand, are only broken down to a limited extent by biological processes.

Benzo[g,h,i]perylene and indeno[1,2,3-cd]pyrene are the most environmentally harmful PAH (identified as priority dangerous substances in appendix X of DPR (also see paragraph 2.4.3.g).

> *comment*
> The European BAT study for the textile industry (EIPPCB, 2003a) states that mineral oils are difficult to break down biologically and that adsorption techniques are needed to remove them from wastewater (also see elsewhere [154]).

An estimate can be made for emissions of PAH (16 PAH of EPA) into water by Flemish textile companies, based on measured and available discharge data (2006-2008). Table 25 provides an overview of the findings for textile companies that discharge into surface water.

[154] Candidate BAT: Use alternative chemicals for enrichment activities wherever possible

Table 25: Summary of measured and available discharge data for PAH (16 of EPA) [ng/l] in Flemish textile companies that discharge into surface water (2006-2009)

parameter	acenaphtylene	acenaphthene	anthracene	benzo(a)anthracene	benzo(b)fluoranthene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(ghi)perylene	indeno(1,2,3-cd)pyrene	chrysene	dibenzo(a,h)anthracene	phenanthrene	fluoranthene	fluorene	naphthalene	pyrene	PAH (16 of EPA)
Number of companies	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26
number of measurements	334	335	337	339	338	334	337	333	338	339	334	337	337	338	335	339	315
Average value [ng/l]	23,13	32,69	45,11	16,89	13,86	11,53	13,25	11,70	12,95	16,31	8,07	63,65	63,65	20,45	89,34	50,04	501,38
minimum [ng/l]	10	10	2	5	5	5	5	3	3	5	3	10	10	3	20	10	120
maximum [ng/l]	90	1700	8900	351	120	55	100	220	61	270	40	4810	4810	560	1550	1490	13125
median [ng/l]	20	17	3	11	7	7	7	5	8	8	3	22	22	8	40	30	259
5^{th} percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	11	3	35	10	159
10^{th} percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	11	3	35	10	175
25^{th} percentile [ng/l]	20	17	3	11	7	7	7	5	8	8	3	20	20	8	40	15	196

50th percentile [ng/l]	20	17	3	11	7	7	7	5	8	8	3	22	22	8	40	30	259
75th percentile [ng/l]	20	20	6	11	14	7	14	10	10	16	3	40	40	19	50	40	533
80th percentile [ng/l]	20	20	11	16	17	10	15	12	16	20	4	41	41	26	80	42	640
90th percentile [ng/l]	40	40	40	40	40	40	40	40	40	40	40	77	77	40	100	83	826
95th percentile [ng/l]	40	40	40	40	40	40	40	40	40	40	40	120	120	51	269	141	1314

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e, and own calculations

Table 26: Summary of measured and available discharge data for PAH (16 of EPA) [ng/l] in Flemish textile companies that discharge into sewer (2006-2009)

parameter	acenaphtylene	acenaphthene	anthracene	benzo(a)anthracene	benzo(b)fluoranthene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(ghi)perylene	indeno(1,2,3-cd)pyrene	chrysene	dibenzo(a,h)anthracene	phenanthrene	fluoranthene	fluorene	naphthalene	pyrene	PAH (16 of EPA)
Number of companies	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
number of measurements	321	329	329	330	316	329	327	329	326	326	323	324	327	323	323	343	234
Average value	29,84	60,39	212,12	27,39	20,95	18,06	23,89	67,12	20,84	28,60	15,34	305,16	74,78	194,22	438,54	309,85	1

[ng/l]																	203,70
minimum [ng/l]	0	6	2	5	5	5	0	3	3	5	3	11	15	3	10	10	54
maximum [ng/l]	1 400	3 300	16 500	733	690	460	1 000	4 500	450	533	315	5 890	3 330	6 170	15 400	19 900	23 860
median [ng/l]	20	20	6	11	7	7	7	10	8	16	3	48	25	18	80	55	510
5th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	159
10th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	185
25th percentile [ng/l]	20	17	3	11	7	7	7	5	8	8	3	20	15	8	40	15	235
50th percentile [ng/l]	20	20	6	11	7	7	7	10	8	16	3	48	25	18	80	55	510
75th percentile [ng/l]	21	25	25	25	21	21	25	26	24	30	21	180	55	44	405	183	920
80th percentile [ng/l]	25	40	28	35	25	25	25	35	25	40	25	253	70	82	515	225	1 147
90th percentile [ng/l]	40	78	50	42	40	40	40	43	40	52	40	682	123	398	868	486	1 820
95th percentile [ng/l]	40	136	132	59	40	40	49	71	42	73	40	1 886	212	970	1 348	776	5 143

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e, and own calculations

Comments accompanying Table 25 and Table 26:

- Chapter 3 highlights all measured and available discharge data (2006-2009), irrespective of the processes and techniques (candidate BAT, also see chapter 4) implemented by the textile companies.
- 4 of the 25 textile companies that discharge into surface water has stopped their activities, as have 6 or the 29 textile companies that discharge into sewer (situation September 2009).
- No information is available concerning the wastewater purification techniques used by 12 of the 26 textile companies that discharge into surface water. This is also the case for 11 of the 29 textile companies that discharge into sewer.
- Information about the used wastewater purification techniques is available for 10 of the 24 textile companies that discharge into surface water and 12 of the 29 textile companies that discharge into sewer.

d. *References*

The following sources were referenced when compiling paragraph 3.5:

Callebaut K. *et al.*, 2007;
Centexbel, 2009b, c and d;
EIPPCB, 2003a;
Jacobs A. *et al.*, 1998;
RIVM 2007a;
RIVM, 2008;
Van den Abeele L. *et al.*, 2010;
VMM, 2007a, c and e;
VMM, 2008b;
www.wikipedia.be

CHAPTER 4 AVAILABLE ENVIRONMENT-FRIENDLY TECHNIQUES

This chapter outlines the various measures that can be implemented in the textile industry to prevent or limit environmental damage. Paragraph 4.1 contains a number of general environment-friendly techniques. Paragraph 4.2 addresses the specific environment-friendly techniques that can be implemented in textile companies to limit the environmental impact of BFR (namely Deca-BDE and HBCD), Sb_2O_3 (antimony used as a synergist in combination with e.g. brominated flame retardants), PFT (namely PFOS and PFOA), NP/NPE and PAH (namely 16 PAH of EPA) via wastewater.

The following points are always addressed when discussing the environment-friendly techniques:
- description of the technique;
- applicability of the technique (technical feasibility);
- environmental benefit of the technique (environmental impact);
- financial aspects of the technique (economical feasibility);
-link to the BREF for the Textiles Industry (reference BREF TEX) .

The information in this chapter forms the basis used for the BAT evaluation in chapter 5. Under no circumstances is this chapter (chapter 4) aimed at passing judgement about particular techniques being, or not being, BAT. The fact that a technique is discussed in this chapter, does not automatically mean that the technique is a BAT.

4.1 Introduction

This chapter further outlines the specific environment-friendly techniques for textile companies that fall within the scope of this BAT study.
However, environment-friendly measures that transcend the sector, and which can also be used in the textile sector, are not addressed. Here are a few examples:

- Keeping the work place clean;
- Providing the required personal protection equipment to employees who perform activities with chemicals;
- Appropriately informing employees working with chemicals about their possible dangers via, for example, training, communication and safety sheets.

Further, this chapter also does not specifically address measures for reducing environmental problems in environmental compartments not examined in detail in this BAT study, e.g. water, air/odour/dust, soil, waste/by-products, energy. Here are a few examples:

- Keeping registers and/or balances concerning water consumption and energy consumption;
- Keeping windows and doors closed if work is carried out with drifting materials;
- Reporting leaking containers and repairing as quickly as possible.

Comments

- Some of the BAT for the textile industry can be found in the Flemish BAT study for the textile industry (Jacobs A. *et al.*, 1998). Further, the European BAT study for textiles (EIPPCB, 2003a) selects BAT for the IPPC textile companies.
- If measures from the above mentioned BAT studies are not specifically mentioned in this BAT study, this does not mean they are not applicable.

4.2 Specific environment-friendly techniques

This paragraph addresses the specific environment-friendly techniques that can be implemented in textile companies to limit the environmental impact of Deca-BDE, HBCD, Sb_2O_3, PFOS, PFOA, NP, NPE and the 16 PAH of EPA. The techniques have been divided into three categories: preventive measures (see paragraph 4.2.1), process-integrated measures (see paragraph 4.2.2) and end-of-pipe measures (see paragraph 4.2.3).

4.2.1 Preventive measures

- ***Make agreements with suppliers of purchased tissues and yarns concerning the chemicals used, and their quantities, on the tissues and yarns***

Technique description

Flemish textile companies process tissues and yarns that could have been purchased. In many cases (primarily for imports from outside the EU), there is no information about the chemicals used to produce these tissues and yarns, and the quantities in which they are present in the tissues and yarns. These chemicals are often released in later procedures (e.g. washing tissues and yarns) in Flemish textile companies and create emissions into water.

comment

The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:

- Selection of incoming textile raw materials: establish contacts between raw material suppliers and processors so that an environment-conscious chain is created, whereby information is exchanged by the type and load of chemicals applied to the textile material and left behind in every step of the life cycle (reference in BREF: paragraphs 5.1 and 4.2).
- Select wool yarns spun with biologically degradable spinning oils instead of formulations based on mineral oils and/or those containing alkylphenol ethoxylates (reference in BREF: paragraphs 5.1 and 4.2.2).
- Selected knitting products treated with water soluble and bio-degradable oils instead of conventional mineral oils (reference in BREF: paragraphs 5.2.2 and 4.2.3).

Technical feasibility

This measure is primarily relevant to the parameters NP/NPE and PAH. NPE are found, for example, in detergents, dispergators and wetting agents. Minerals oils are found, together with detergents, on yarns and tissues and are washed out prior to dying.

Because the parameters Deca-BDE, antimony, HBCD, PFOS and PFOA are not washed off, this candidate BAT is less relevant for these parameters.

It is not straight forward for textile companies to access the required information concerning dangerous substances in tissues and yarns. An active purchasing policy must be implemented and concrete agreements must be made for dangerous substances when orders are placed. Legislation (e.g. REACH or product standards) is a possible guideline for information exchange between suppliers and textile companies.

Comments

- With regards to product standards (e.g. Oekotex 100[155] or GUT[156]), specific measurements for the composition and quantity of chemicals (e.g. Deca-BDE, antimony, HBCD, PFOS, PFOA and PAH) in textiles have been imposed[157]. No product standards are known to be available for the parameters NP and NPE.
- HBCD is included in the candidate list with SVHC, for inclusion in appendix XIV of REACH (also see paragraph 2.4.3.c). Product specifications for HBCD can be expected in the future. This is not the case for Deca-BDE.
- PFOS are included in appendix XVII of REACH (limitations on production, trade and use). For PFOS, appendix XVII contains a limit for use in objects. (also see paragraph 2.4.3.c).
- According to the sector, NP/NPE enter Flemish textile companies via purchased tissues and yarns. No specific measurements are known to have been carried out for this group of parameters.
  NF and NPE have not been included (situation January 2010) in the candidate list of very concerning substances (SVHC) for inclusion in appendix XIV of REACH. Though NP and NPE are included in appendix XVII of REACH (limitations on production, trade and use). However, appendix XVII doe not contain a binding limitation for NF/NPE in mixes (of chemicals). Further, all textile processors are permitted to use NP/NPE as substance or in mixes in a concentration of 0.1 weight percentage or more, under the condition that these substances are not discharged or only if the wastewater will be appropriately treated.
- Purchased tissues and yarns could contain spinning oils and/or PAH, which are used to lubricate needles in knitting machines or for making yarns glide better when weaving. Also in the case of this group of parameters, no specific analyses are known to have been carried. Product specifications for PAH are not expected in the future.
  Anthracene is included in the candidate list with SVHC, for inclusion in appendix XIV of REACH (also see paragraph 2.4.3.c).

This measure is technically feasible for integrated textile companies, certainly for chemical substances that are part of legal determinations (e.g. REACH or product standards).

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[155] The Oeko-Tex® Standard 100 is a certificate for textiles (further info: see www.oeko-tex.com/).

[156] GUT is a carpet label (see http://www.gut-ev.de/).

[157] Measurement data is not known to be available in Flanders for Deca-BDE, HBCD, PFOS and PFOA present in tissues (also see chapter 3).

Integrated companies are better placed in the market than job-processing companies. This measure will be more difficult to realise for job-processing companies, particularly if many different types of tissues and yarns from many different suppliers are processed. These textile companies are better advised to take measures on partial flows or in later purification techniques.

However, it is not straight forward for textile companies to obtain supplier information about (all) chemical substances in tissues and yarns. However, there are currently (2010) no guidelines for an active purchasing policy concerning the presence of NP/NPE and PAH in purchased tissues and yarns.

Environmental impact
The chemical load in wastewater can be limited (if this is a source of emissions), by making agreements with suppliers of purchased tissues and yarns concerning the chemicals used, and their quantities, on tissues and yarns.

Economical feasibility
As such, this measure is not accompanied by additional investments. Though this measure could increase costs if a more expensive supplier is selected. In general, this measure is regarded as economically feasible.

> *comment*
> In practice, price levels often play a major role when selecting suppliers.

References
Company visits;
Centexbel, 2009b and c;
SCA, 2006;
VMM, 2009f;
www.eur-lex.europa.eu
www.ejustice.just.fgov.be
www.oeko-tex.com
www.gut-ev.de

- ***Make agreements with suppliers of formulations concerning the composition of chemicals***

Technique description
As far as textile-processing chemicals are concerned, Flemish textile companies could be using purchased formulations (also see paragraph 3.1.2).
For dangerous substances, suppliers of formulations are obligated to appropriately mention concentrations above 0.1% (g/g) on product packaging. In addition, for every dangerous product brought on to the market, suppliers must automatically supply (free of charge) an MSDS (Material Safety Data Sheets) or Safety information sheet to professional users.
This is the case for e.g. HBCD, PFOS, NP/NPE.
However, in practice, textile companies do not always know the exact concentrations of active substances in purchased formulations. Although, this is needed in order to correctly estimate the quantity of chemicals needed for a specific finishing activity.

Unknown and unexpected pollutants are also sometimes encountered in purchased chemicals (e.g. PAH as pollutants in preparates).

Examples:

- Textile companies often purchase flame retardants in the form of ready-to-use formulations via external parties.
- Detergents used in e.g. washing processes for natural and synthetic textiles, could possible contain NP/NPE.

Technical feasibility

Flemish textile companies are often fully aware of the (quantity of) active substances in purchased formulations. Although supplier information about dangerous substances is available via labels and/or MSDS sheets.

As also stated for the previous candidate BAT, legislation (e.g. REACH or product standards) is a possible guideline for information exchange between suppliers and textile companies.

This measure is technically feasible for integrated textile companies, certainly for chemical substances that are part of legal determinations (e.g. REACH or product standards). Integrated companies are better placed in the market than job-processing companies. This measure will be more difficult to realise in job-processing companies, particularly if many different types of finishing processes are implemented and thus many different formulations from various suppliers are used.

Environmental impact

The amount of chemicals required can be limited by making agreements with suppliers of formulations about the composition of chemicals. The advantage of forming the most accurate estimate for the required quantity of chemicals is that the quantity of waste (residual chemicals) can be limited, as can the load in the wastewater. Further, textile companies can also decide to use other formulations with a better composition and fewer emissions into wastewater.

Economical feasibility

The cost price of chemicals can be limited by implementing this measure. This measure is regarded as economically feasible for all textile companies.

> *comment*
> In practice, textile companies purchase enough chemicals to complete the to-be-processed batch. The driving force is the cost price of the textile, which is estimated to be 10 times higher than the cost price of chemicals.

References

Company visits;
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b.
Fedustria, 2008;
Fedustria-Centexbel, 2009
LNE-AMV, 2009;
VMM, 2009f.

- ***Make agreements with suppliers of formulations concerning the return of left-over chemical***

Technique description
In the interest of better waste processing, of chemical residues in particular, agreements can be made with suppliers of formulations concerning the return of chemicals that can no longer be implemented in the production process.

Technical feasibility
Various practical situations have been encountered, concerning the return of left-over chemicals:

- Free return of all excess products;
- Return of a limited amount of left-over chemicals;
- Return of left-over chemicals after payment;
- Refusal to return left-over chemicals by the supplier.

The technical feasibility of this measures is greatly determined by the specific situation.
This measure is expected to be more difficult to realise in a job-processing company than in an integrated textile company. Particularly if various types of finishing processes are implemented (smaller volumes) and the textile company works with many different chemical suppliers. Job-processing companies are advised to dispose of chemical residues via a qualified processing company (see elsewhere[158]).
In principle, this measure is technically feasibly for integrated companies (large volumes, limited number of suppliers). Chemical suppliers ask textile companies to guarantee that returned chemicals will not be contaminated. In practice, textile companies often place a non-return valve on IBCs.

Environmental impact
The quantity of waste (left-over chemicals), and the load in wastewater, can be limited by making agreements with suppliers of formulations about the return of left-over chemicals. Further, this measure can also result in better waste processing (by the chemical supplier).

Economical feasibility
The cost price for the return of left-over chemicals by the supplier is determined by the specific situation. The cost price for this measure is expected to rise proportionately, if the company works with multiple suppliers and/or if it purchases smaller quantities.

References
Company visits;
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b;
Fedustria, 2008;
Fedustria-Centexbel, 2009;
LNE-AMV, 2009

[158] Candidate BAT: Store waste residues containing BFR, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company.

- ***Optimise production planning***

Technique description

Effective production planning is needed to allow the production process to run smoothly. A concrete example of effective planning involves reducing the amount of switching in the production process. This help to restrict cleaning activities, for example. Plus, for example, machines, tools and pipes all need to be cleaned when switching from one textile finishing process to another.

Another example of effective production planning involves closely following up the production process (e.g. management tool) and optimising the used chemicals. This requires, for example, making the best possible estimate for the required solutions, with the lowest possible concentrations of active components, to limit the impact of residues and extraction. This assumes knowledge about the composition of the purchased formulations (also see elsewhere[159]).

> *comment*
>
> The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
>
> - Optimise production planning and make prior processes compatible with quality requirements of downstream processes (reference in BREF: paragraphs 5.1 and 4.1.1).
> - Reducing the quantity of created colorant by, for example, noting the quantity required per batch and using it as a reference, or by using optimised colorant formulations (reference in BREF: paragraphs 5.2.2 and 4.6.7).

Technical feasibility

In the first instance, effective production planning requires good communication with supplier of raw materials and support products (upstream), as well as buyers and clients (downstream).

Reducing the number of switches in the production process is primarily possible if the textile company produces large batches or a particular product or similar products, or if orders can be grouped.

Close follow-up of the production process is known to be implemented in the majority of textile companies.

Optimisation of production planning is more difficult to realise in a job-processing company than in an integrated textile company. The input in job-processing companies is received from third parties. And such companies are subject to a great deal of customer-dependence. Further, it is not always possible to know the history of goods that are going to be processed.

A characteristic of the current economic climate is customers require more just-in-time production and often award smaller assignments. This, to some degree, makes production planning more difficult.

[159] Candidate BAT: Making agreements with suppliers of formulations concerning the composition of chemicals

Environmental impact
The amount of chemicals required can be limited by optimising production planning. Further, water consumption, energy consumption and the quantity of waste can also be limited, as can the quantity and load of released wastewater.

Economical feasibility
The cost price of chemicals, water and energy can be limited by implementing this measure. This measure is regarded as economically feasible.

> *comment*
> As far as production planning is concerned, textile companies must, to a certain extent, rely on their clients.

References
Company visits;
Centexbel, 2009b;
EBFRIP-VECAP, 2007b.
Fedustria, 2008;
LNE-AMV, 2009;

- ***Use environment-friendly alternative chemicals for finishing activities wherever possible***

Technique description
The negative environmental impact caused by chemicals used in the textile industry for finishing activities can, in certain cases, be limited by using environment-friendly alternatives. This measure examines the alternative chemicals.

> *comment*
> Besides implementing environment-friendly alternative chemicals, other options are also available in the textile sector for preventing/reducing the use of chemicals in finishing activities. The following options have been mentioned in the available literature (LCSP, 2005): alternative (fire-proof) fibres, flamer barriers (e.g. fire-resistant middle layer made from melamine in mattresses) and "non-wovens". Because these options are, in many cases, linked to activities beyond the textile finishing process itself (e.g. production of mattresses), they have not been evaluated in this BAT study.

In practice, attention should primarily be given to substituting priority substances, particularly priority dangerous substances (also see paragraph 2.4.3.g).
The literature names various alternatives for Deca-BDE, HBCD, PFOS, PFOA, NP/NPE and PAH. Though it should be mentioned that not all these alternatives are technically equivalent in replacing the product in all applications. Thus the technical feasibility of alternatives for chemicals in finishing activities is greatly determined by the specific situation. That said, there is currently (2010) a great deal of legislation pushing textile companies to implement alternative chemicals.

- The sectoral environmental permit conditions for the textile sector (VLAREM II, article 5.41.1.5, also see paragraph 2.4.1.b) state that process baths with brominated flame retardants or antimony cannot be discharged.

- HBCD has been included in the candidate list of very concerning substances (SVHC[160]) for inclusion in appendix XIV of REACH (also see paragraph 2.4.3.c). VECAP contains agreements for reducing emissions of HBCE (and Deca-BDE).
- Limitations concerning the use of PFOS have been imposed via the PFOS guidelines (also see paragraph 2.4.3.e). PFOS has also been included in appendix XVII of REACH (also see paragraph 2.4.3.c). VLAREM II, article 4.1.11.8 also describes limitations concerning the use of PFOS.
- NF and NPE have not been included (situation January 2010) in the candidate list of very concerning substances (SVHC) for inclusion in appendix XIV of REACH. Though NP and NPE are included in appendix XVII of REACH (limitations on production, trade and use). However, appendix XVII doe not contain a binding limitation for NF/NPE in mixes (of chemicals). Further, all textile processors are permitted to use NP/NPE as substance or in mixes in a concentration of 0.1 weight percentage or more, under the condition that these substances are not discharged or only if the wastewater will be appropriately treated.
- Nonylphenols (4-nonylphenol) are identified as priority dangerous substances in appendix X of DPS (Priority Substances Co-guidelines, also see paragraph 2.4.3.g).
- As already stated in paragraph 2.4.1.b, article 5.41.1.5 (sectoral textile conditions) of VLAREM II requires alkylphenol ethoxylates (incl. NPE) and PAH-based mineral oils to be replaced wherever possible.
- Anthracene has been included in the candidate list of very concerning substances (SVHC[161]) for inclusion in appendix XIV of REACH (also see paragraph 2.4.3.c). Anthracene is also identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g) and list III in appendix 2C of VLAREM I (also see paragraph 2.4.1.a).
- Benzo(a)pyrene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene and indeno(1,2,3-cd)pyrene are identified as priority dangerous substances in appendix X of DPR (also see paragraph 2.4.3.g).

a. general

Introduction

Textile can be made fire-resistant in various ways, for example:

- by carbonising the flammable product by adding organo-phosphorous compounds; at a particular (fire) temperature, P-compounds form a layer of carbon that closes off the material from air (oxygen).

  comment

  Organo-phosphorous compounds as alternative chemicals for finishing activities in the textile industry are discussed in greater detail below.
- Removing free radicals by using bromine and chlorine-based compounds;

  comment

  Chlorine compounds as alternative chemicals for finishing activities in the textile industry are discussed in greater detail below.
- The use of antimony compounds (as a synergist in combination with e.g. Deca-BDE);

  comment

[160] Substances of Very High Concern

[161] Substances of Very High Concern

As already discussed in paragraph 3.2.3.b, Sb_2O_3 is used in the textile industry as a synergist in combination with e.g. Deca-BDE, in an established ratio. If the use of e.g. Deca-BDE is limited to prevented, the use of antimony trioxide will also decrease. This measure is aimed at e.g. reducing the use of Deca-BDE and HBCD. Alternatives for Sb_2O_3 are not examined in this BAT study.

- Forming non-inflammable gas by implementing crystal salts;
- Forming water vapour (cooling and diluting flammable gas);
- Adding fire-retarding fibres to mixes before the spinning process.

Fire retardants are distinguished based on their permanence in permanent fire retardants, on the one hand, and in non-permanent fire retardants on the other hand.

- Permanent fire retardants include, for example:
  - Chemically binding complex organo-phosphorous compounds to fibres by treating with an ammoniac or a melamine derivate.
  - Mixing a flame retardant in melt spinning or in polymer granulates.
  - Mixing fibres with polymers or co-polymers that are fire retardant (e.g. polyvinyl chloride, polyvinylidene chloride, polymer combinations with antimony trioxide);
  - Treating wool with e.g. zirconium salts.
- Non-permanent (not wash-proof) fire retardants include, for example:
  - aluminiumhydroxide;
  - Ammonium salts from phosphate, bromide, chloride, sulphonate;
  - boracid acid, borax.

Technical feasibility
One of the technical disadvantages could be that substitutes can have different characteristics (e.g. freezing point, water solubility) than to-be-replaced chemicals. Further, in certain cases, the efficiency of substitutes is less that of the to-be-replaced substance. The implementation of alternatives probably also needs process-related modifications (e.g. keeping chemicals with a lower freezing point warm when in storage).

Environmental impact
The aim of implementing more environment-friendly alternative chemicals for finishing processes in the textiles industry is to reduce environmental burden. However, in many cases, the alternative substances are equally negative (or possibly worse) in terms of environmental impact or only a limited amount of information is available about their environmental impact.

Economical feasibility
In many cases, alternative chemicals are more expensive because larger quantities are needed to achieve the same properties. Process modifications are also accompanied by costs.

b. Deca-BDE and HBCD
Technical feasibility
The use of alternatives to replace Deca-BDE and HBCD is greatly determined by the specific application (e.g. the fire-retarding mechanism that is used and the required fire-

retarding properties[162]). Further, Centexbel (2009c) indicates that the use of alternatives for Deca-BDE and HBCD is often more technically difficult for job-processing companies due to the variety of activities, the requirements of clients, the smaller batches that are produced, the higher number of suppliers, etc. In order to guarantee efficient planning and optimum production flow, job-processing companies are also obligated to implement a universal and effective fire retardant. Deca-BDE is the only fire retardant that meets this criteria. Deca-BDE can be used for all textile materials and also guarantees fire-resistance.

Organic phosphorous compounds

Products based on phosphorous are alternative chemicals for making textiles fire resistant. A few examples, found in existing literature, of organic phosphorous compounds that could be used as alternatives, include: triphenylphosfate, tricresylphosphate, resorcinol bis(diphenylphosphate), bisphenol A diphenylphosphate, tetrakis(hydroxymethyl) phosphoniumchloride, diphenylcresylphosphate and polytetrafluoroethylene (PTFE or teflon).

Organic phosphorous compounds are used on the front side of textiles, so that particular textile properties are hereby lost (technical limitation). Further, phosphorous compounds offer very little resistance against moisture (e.g are washed out when textile is cleaned). Thus, there are a few technical limitations when replacing Deca-BDE and HBCD with organic P compounds. However, in some cases, organic phosphorous compounds can be used in the production of mattress textiles.

Chlorine compounds

Chlorinated paraffins[163] (though not of the short chain type[164]) are possible alternatives for chemicals for making textiles fire retardant. These alternatives (for e.g. Deca-BDE) are, according to Centexbel (2009c), also never implemented, though are used in combination with (in this case) Deca-BDE. Chlorinated paraffins thus only partly replace Deca-BDE, and C-Cl compounds are stronger than C-Br compounds. This means chlorine compounds are less efficient as flame retardants than Deca-BDE and HBCD.

> *comment*
> The literature also mentions PCBs (polychlorinebiphenyls) as possible alternatives for Deca-BDE and HBCD. Because these are a group of very toxic organic chlorine compounds, these substance not further considered as possible substitutes for Deca-BDE and HBCD.

Melamine

Products based on melamine are also possible alternative chemicals for making textiles fire resistant. Melaminepyrophosphate is an example of a melamine product. In 2010, this product was tested as an alternative fire retardant. Centexbel indicates that insufficient fire-resistant properties were discovered.

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162 Legislation concerning fire behaviour (fire legislation) varies depending on e.g. the type of textile and the country where it is implemented. A few examples include 'Construction Product Directive' (Construction materials Guidelines) and the 'British Fire Safety Regulations' (CENTEXBEL, 2009c).

163 Particular fraction of heavy hydrocarbons in crude oil

164 Short chain paraffins (C10-13) are mutagenic and toxic for the reproduction function, and feature in the proposed candidate list of SVHC for inclusion in appendix XIV of REACH

Silane[165]
Another possible alternative for making textiles fire resistant is the silicium compound POSS (polyhedral oligomeric silsequioxane). According to Centexbel (2009c), silane is rarely used in the textile industry.

Zirconium salts
Zirconium salts are a technically feasible alternative fire retardant for wool. According to Centexbel (2009c), zirconium salts have already been in use in the textile sector for decades, for making wool fire resistant. In this case, the yarn itself is made fire-proof. In an additional step (e.g. if wool is incorporated into a carpet), an extra fire-proof coating can be added (e.g. using latex). The latter activity is often carried out in job-processing companies, where Deca-BDE is used as a fire retardant.

Other
Furthermore, the literature also makes reference to other alternatives for making textiles fire proof, such as:
- aluminiumtrihydroxide
Aluminiumhydroxide is a water soluble compound (is washed out) and is thus not a durable alternative for Deca-BDE in all applications.
For example, in the carpet industry, $Al(OH)_3$ has been used as fire retardant for the past 10-15 years. The formation of hydrates has a cooling effect. Deca-BDE is not used to make carpets, which will be used in residential settings, fire-proof.

- zinc borate
According to the sector, zinc borate is only used for specific applications (e.g. heavy-duty tents). This substance is also dangerous for the environment and public health (R-phrases, e.g. R-50, R-52).

- polymers
As far as synthetic fibres are concerned, mixes of polymers can be used to realise the required fire-resistant properties.

Environmental impact
As described in part a, in many cases, alternative substances have an equally negative impact (or even worse) on the environment or no, or very little, research has been done into environmental effects and health risks.
Here are a few concrete examples:

- Organic phosphorous compounds are not broken down in the AWZI[166]; possible displacement of the environmental problem (feasibility P emission limit value);
- Chlorinated paraffins often realise worse environmental scores than Deca-BDE or HBCD;
- PCBs belong, just like BFRs, to the group of persistent, bio-accumulable and toxic substances.

[165] Chemical compounds of silicium, hydrogen and oxygen.

[166] Physico-chemical P-removal, for example, is based on the principle of (co-)precipitation of phosphates. However, organic P-compounds are not removed from wastewater when this wastewater purification technique is implemented (Derden A. et al., 2008).

> *comment*
> An American study (IEPA, 2007) has divided possible alternatives for Deca-BDE based on their risk to humans and the environment. Here are a few examples:
> - Polytetrafluoro ethylene (PTFE or teflon) and zinc borate are not recommended in this study as alternatives for Deca-BDE because of the serious risks they pose;
> - triphenylphosphate, tricresylphosphate, tetrakis(hydroxymethyl) phosphoniumchloride, diphenylcresylphosphate, aluminium salts and melamine products are regarded in this study as potentially problematic due to their impact on humans and the environment;
> - bisphenol A diphenylphosphate, resorcinol bis(diphenylphosphate), aluminumtrihydroxide and magnesiumhydroxide are characterised in this study as possible alternatives and as potentially unproblematic.

Economical feasibility
The economical feasibility of this measure to substitute Deca-BDE and/or HBCD is determined by the specific situation.
In practice, the follow must be done to realise the same properties as the replaced substance:
- Often use larger quantities; larger quantities are needed of chlorine compounds, compared to e.g. Deca-BDE, to realise the same fire-retarding properties;
- Multiple substitutes are sometimes implemented.

Very little cost price data is available for alternatives of Deca-BDE and HBCD.

> *example*
> In a confirmed case (LCSP, 2005), the additional costs for alternatives to replace Deca-BDE are estimated at a factor of 2 to 2.5.

c. PFOS and PFOA
Technical feasibility
Today (2010), chemical producers are doing a great deal to bring alternatives for PFOS (phasing out cf. PFOS guidelines, also see paragraph 2.4.3.e) and PFOA (cf. reduction programmes, also see paragraph 2.5.b) on to the market which can be used in the textile industry. Textile companies are also known to be actively switching to alternatives for e.g. PFOS.
The following chemicals could possibly be considered as alternatives that can be used in the textile industry: PFBS (perfluorobutane sulphonate, C4 compound) and PFHA (perfluorohexane acid, C6 compounds).
The literature (SCA, 2006) refers to short-chain sulphonates with 4 carbons as a possible alternative for PFOS and/or PFOA for applications in the textile industry (e.g. carpets). The design and functionality of the textile determine whether alternatives for PFOS and/or PFOA can be implemented. A technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned). The use of alternatives for PFOS and/or PFOA is more feasible if the textile only needs to have one particular characteristic (e.g. only water-proof).

example
A Flemish textile company has indicated that tests were carried out in 2010 into using PFBS as an alternative for PFOS and/or PFOA, but technical limitations are encountered in applications where the textile must possess a combination of particular properties. PFHA is still being tested by the company in question.

Environmental impact
PFBS and PFHA are perfluorinated molecules that contain less than 8 carbons, and cannot strictly be regarded as PFT.

Comments

- PFBS is synthetisised by exchanging H atoms with F atoms.
- PFHA is formed via a process of chain distribution (telomerisation). PFHA is an example of a perfluoro telomere.

When PFBS is produced, PFOS (ppb level) appears to be produced as a by-product. However, commercial products are purified and contain maximum 20 ppb PFOS. Companies that switch to PFBS can thus still find small quantities of PFOS in wastewater.

A risk analysis (incl. NICNAS, 2005) has shown that, according to European (and US) classification criteria, PFBS is not toxic nor bio-accumulable. Though PFBS is persistent, like all molecules that are fully perfluorinated.

To date, little research is known to have been done into the toxicity of PFHA. The EWG website (Environmental Working Group, www.ewg.org) states that PFHA is persistent and accumulates in higher organisms.

Economical feasibility
The economical feasibility of this measure to substitute PFOS and/or PFOA is also determined by the specific situation. In general, one can assume that the cost price of e.g. PFBS is comparable with that of PFOS. In many cases, application levels are also comparable with those of PFOS products. A higher product quantity (approximately 15%) is required for very specific applications (e.g. realising a particular specification).

d. NP/NPE

Technical feasibility
NPE are not used as pure substances in the textile industry, though they are in preparates (e.g. emulsifying agents, dispersing agents, surface-active substances and wetting agents) provided by product suppliers. NPE in preparates can be replaced by, for example, alcohol ethoxylates (AE). Another potential alternative for NPE in washing products and tensides is linear alkylbenzene sulphonate. The sector (Centexbel, 2009c) states that legal determinations concerning the degradability of such products (incl. 648/2004/EC[167]) are currently in effect. Tensides without NP/NPE are currently (2010) available on the market. Textile companies can make a conscious decision to select these alternatives. The cost price and effectiveness often determine whether this choice is made in practice. The sector states that direct replacement of NPE can be

[167] EU ordinance of 31 March 2004 concerning detergents, repeatedly modified.

complicated in certain cases, for example, in very concentrated preparates (e.g. master batches) or in specific applications (e.g. anti-static behaviour of fibres).

Comments

- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
  - Replace alkylphenol ethoxylates (APE) and other dangerous surface-active substances with substitution products that are easy to degrade biologically or bio-eliminate in the wastewater purification system, and which do not form toxic metabolites (reference in BREF: paragraphs 5.1 and 4.3.3).
  - In wool washing, replace detergents containing alkylphenol ethoxylates with alcohol ethoxylates or other easy to degrade products that do not form toxic metabolites (reference in BREF: paragraphs 5.2.1 and 4.3.3).
  - In pigment printing, use printing pastes that are APE-free and biologically removable (reference in BREF: paragraph 5.2.2).
- The BREF for textiles (EIPPCB, 2003a) mentions textile companies that only still use products that are complete free from e.g. alkylphenol ethoxylates (APE).
- The use of APE-free detergents is potentially accompanied by process modifications.

Environmental impact

Nonylphenol ethoxylates and octylphenol ethoxylates display a lot of structural similarities. The ecological and toxic effects of both substances are also expected to be similar.

The BREF for textiles (EIPPCB, 2003a) states that the use of AE can help to limit environmental risks via wastewater and that the degradability of wastewater can be improved.

Comments

- AE are more than 99% bio-degradable via aerobic biological purification. There are no known harmful degradation products (only CO_2 and H_2O).
- AE also appears to be toxic after acute exposure.

Economical feasibility

The economical feasibility of this measure to substitute NPE is determined by the specific situation.

Examples:

- The cost price of AE is said to be 10-50% more than NPE.
- In practice, the follow must be done to realise the same properties as the replaced substance:
  - Larger quantities are often implemented;
    - On average, more AE is needed than AFE to realise the same effect: Average of 10.9g AE /kg wool[168] instead of 7.6g AFE/kg wool[169];
  - Multiple substitutes are sometimes implemented.

[168] range: 4,5-15,8 g/kg

[169] range: 3,5-20g/kg

e. 16 PAH of EPA

Technical feasibility

PAH in the wastewater of textile companies could possibly originate from mineral oils used for lubricating the needles of knitting equipment or for allow yarns to glide better when weaving. Synthetic oils can be used an alternative to these mineral oils.
Mineral oils are commonly used in the industry today (2010). Purchased tissues and yarns (imported from outside the EU, for example) can still contain mineral oils (also see elsewhere [170]).
Centexbel (2009c) mentions a number of technical bottlenecks concerning the replacement of mineral oils with synthetic oils. Tissues and yarns are often produced on a large scale (also outside the EU). In many cases, it is difficult to convince the companies involved to switch to alternatives. The costs price also plays an important role. Price supplements are charged for specific lots (e.g. where alternatives are used).
Further, it appears that synthetic oils are not always available (e.g. in production countries outside the EU).

The use of PAH-based carriers when dying textiles can be avoided and/or limited by using carrier-free colorants and dyes and/or by implementing HT dying equipment (also see elsewhere[171])
Carrier-free colorants and dyes and/or HT dying equipment can be implemented in specific situations, e.g. for colouring or dying modified polyester fibres. Technical limitations have been reported in the presence of wool (e.g. in combination with polyester fibres or with elastane).

Comments

- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
  - Selected knitting products treated with water soluble and bio-degradable oils instead of conventional mineral oils (reference in BREF: paragraphs 5.2.2 and 4.2.3).
  - Avoid the use of dangerous carrier by, for example:
    - using polyester fibres that can be dyed without carriers (modified PET or PTT);
    - Dye at high temperatures without using carriers (not possible in polyester/wool and elastane/wool mixes);
    - replace traditional carriers with compounds based on benzylbenzoate and N-alkylftalimide in wool/polyester dyes;
    (reference in BREF: paragraphs 5.2.2, 4.6.1 and 4.6.2).
- It could also be possible to form PAH (primarily the heavier ones, e.g. benzo(a)pyrene) on thermo-fixed tissues.

Environmental impact

Loading wastewater with PAH can be limited and/or avoided by implementing synthetic oils instead of mineral oils, or by using HT dying equipment.

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[170] Candidate BAT: Making agreements with suppliers of purchased tissues and yarns concerning the chemicals used, and their quantities, on the tissues and yarns.

[171] Candidate BAT: Modify and/or optimise the production process

Economical feasibility
The economical feasibility of this measures is determined by the specific situation.

f. summary
Substitution primarily possible

- HBCD can normally be substituted, except for a limited number of applications, like supple transparent materials. Alternatives for HBCD in niche applications include, for example, chlorinated paraffins. However, a (small) quantity of HBCD is still used when chlorinated paraffins are implemented.
  comment
  According to EBFRIP-VECAP (2010b), the use of HBCD is currently (2010) avoided wherever possible. The driving forces are cost price and the applicable legislation.
- Alcohol ethoxylates (AE) are quasi-perfect substitutes for NPE in products used in the textile industry.
- Technically, PAH-based mineral oils can also be perfectly replaced by synthetic oils. The use of PAH-based carriers when dying textiles can be avoided and/or limited by using carrier-free colorants and dyes and/or by implementing HT dying equipment, except in the presence of wool (e.g. in combination with polyester fibres or with elastane).

Substitution very limited
Deca-BDE is generally use as a fire retardant in the textile industry (Deca-BDE is a substitute for HBCD). Substitution possibilities for Deca-BDE are greatly determined by the specific application. For high-quality applications, for example (e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market) the use of Deca-BDE is required (Centexbel, 2009c). In the production of mattress textiles, for example, Deca-BDE can be replaced by organic phosphorous compounds.
Possible bottlenecks when replacing Deca-BDE with alternatives in textile applications, include:

- Change in fire-resistant mechanism;
- Change in properties of the textile (e.g. hardness, plasticity);
- Requirements for fire-resistant properties in high quality applications (e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market);
- More chemicals needed to realise the same fire-resistant properties in the textile;
- Remains necessary to use a (small) quantity of Deca-BDE when implementing particular alternatives (e.g. chlorinated paraffins or melamine).
- Additional cost of alternatives (e.g. factor of 2 to 2.5);
- Possible displacement of environmental problems (e.g. organic phosphorous compounds are not broken down in the AWZI, realisation of P emission limit value).

Substitution possibilities under development
There are a number of substitutes (e.g. PFBS) on the market as alternatives for PFOS and/or PFOA in particular textile applications, which can combine the 3 desired properties (oil, water and dirt-resistance). A technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned). The switch to alternatives for PFOS and/or PFOA is currently (2010) in full swing. Additional tests in

the textile industry must indicate which chemicals can be used as fully fledged alternatives for PFOS and/or PFOA in the textile industry.

References
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www.3M.com/pfos-pfoa;
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www.ewg.org

4.2.2 Process-integrated measures

- ***Modify and/or optimise the production process***

Technique description
The use of Deca-BDE, HBCD, Sb_2O_3, PFOS, PFOA, NP, NPE and/or PAH can be prevented and/or limited wherever possible by modifying and/or optimising the production process. Here are a few examples of measures for process modification and/or optimisation:

- Use synthetic raw materials that are not very flammable, like polyamides or glass fibre, to limit/prevent the use of Deca-BDE, HBCD and Sb_2O_3;
- use HT[172] equipment to apply paints on textiles, in order to limit the use of carriers (also see elsewhere [173]);

[172] High Temperature
[173] Candidate BAT: Use environment-friendly alternative chemicals for enrichment activities.

- Mix and colour printing paste residues (activity takes place in printing workshop of the textile company)
- Re-use process baths wherever possible;
- Re-use rinse waters to restore viscosity in coating pastes;
- Re-use rinse waters wherever possible (also see elsewhere[174]), for example, to restore the viscosity in coating pastes;
- Prevent problematic wastewater from entering the AWZI (also see elsewhere[175]).
- Collect and dispose of Deca-BDE and HBCD residue via a qualified processing company.

comment
The textiles BREF (EIPPCB, 2003a) selects the following technique as BAT: Optimise production planning and make prior processes compatible with quality requirements of downstream processes (reference in BREF: paragraphs 5.1 and 4.1.1).

Technical feasibility
It is best to modify the production process when new production lines are being designed. Process modifications in existing systems could possibly be more difficult to implement. Optimisation of the production process is deemed as technically feasible for all textile companies.

Comment concerning the use of poorly inflammable synthetic raw materials.
Centexbel (2009c) indicates that job-processing companies rely heavily on tissues and yarns that are supplied. For such textile enriching companies, it is technically impossible to modify tissues and yarns.

Comment about preventing problematic wastewater from entering the AWZI
Experience has shown that textile companies that used Deca-BDE and/or HBCD in the past and/or whose wastewater containing Deca-BDE and/or HBCD entered the AWZI (e.g. subsidiaries), still have problems with bromine-based components (possibly peak concentrations) in their wastewater due to after-effects (situation September 2009). The paragraphs below contain two examples. They demonstrate that it is impossible to fully clean out the internal sewer system, the buffer tanks and pumping pits. Particular technical actions can also suddenly cause higher concentrations of brominated flame retardants in the wastewater.

example 1 (Centexbel, 2009b)

- This example concerns a Flemish textile processor that also treats wastewater originating from to subsidiary companies. One subsidiary discharged the wastewater to the textile processor via a pipe and a pumping pit; the other company transported the wastewater to the textile processor.

[174] Candidate BAT: Wherever possible, re-use rinse waters from process baths in the production process; Candidate BAT: Dispose of rinse waters from process baths via a qualified processing company.

[175] Candidate BAT: Characterise released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal; candidate BAT: collect (certain) exhausted process baths and dispose of via a qualified processing company.

- Since the end of 2006, the supply of wastewaters containing Deca-BDE and HBCD (bath leftovers and rinse waters are sent to a qualified processing company) has been stopped to the AWZI.
- Analysis results prior to remediation:
  - Time 1
Buffer basin: 55 µg/l BDE209, silt contains 4.500 µg/kg DS (DS 31.2%)
Effluent after purification: 29 µg/l
  - Time 2
Buffer basin: 210 µg/l BDE209, silt contains 3.900 µg/kg DS (DS 26.3%)
Effluent after purification: 39 µg/l
  - Surface water input: Deca-BDE: 6.2 µg/l
Antimony: <20 µg/l
HBCD: <0.2 µg/l
  - Effluent (proportionate to volume): Deca-BDE: 120 µg/l
Antimony: 312 µg/l
HBCD: 3.3 µg/l
  - Effluent (grad sample): Deca-BDE: 150 µg/l
Antimony: 320 µg/l
HBCD: 1.2 µg/l

  The analyses (buffer basin silt) indicated that Deca-BDE and HBCD originated from the silt (buffer basin, later also demonstrated by the silt in the biology)
- Analysis results after first remediation (complete disposal of the silt from the buffer basin to a qualified processing company, cleaning of buffer basin and pipes (not the biology!); cost price € 156,000):
  - Surface water input: Deca-BDE: 0.2 µg/l
HBCD: <0.1 µg/l
  - Effluent (grad sample): Deca-BDE: 47 µg/l
HBCD: 3.1 µg/l
  - Effluent (mix sample): Deca-BDE: 88 µg/l
HBCD: 7.1 µg/l
- Additional analyses after first remediation:
  - Biology tank Deca-BDE: 632 µg/l
HBCD: 89 µg/l
  - Buffer basin Deca-BDE: 9.1 µg/l
HBCD: 0.6 µg/l
  - effluent: Deca-BDE: 19.7 µg/l
HBCD: 4.3 µg/l
- Analysis results after second remediation (buffer basis fitted with mixers to prevent silt collection in the buffer basin):
  - Surface water input: Deca-BDE: < 1.0µg/l
HBCD: < 1.0µg/l
  - Silt present in buffer basin: Deca-BDE: 76,000 µg/l
(8.9% DS, 854 mg/kg DS)
HBCD: 70,000 µg/l
(8.9% DS, 786 mg/kg DS)
  - Buffer basin: Deca-BDE: 481 µg/l
HBCD: 28.4 µg/l
  - biology: Deca-BDE: 3 130µg/l

HBCD: 233 µg/l

- effluent: Deca-BDE: 5.7µg/l

  HBCD: <2.0 µg/l

- Analysis results after activities (renewal of pumps in pumping pit for wastewater sent to subsidiary company via pipes):
  - Buffer basin: Deca-BDE: 146 µg/l

    HBCD: 3 µg/l
  - Storage wastewater at subsidiary company: Deca-BDE: 354 µg/l

    HBCD: <10 µg/l

  When renewing the pumps in the pumping pit, the underlying layer of silt was probably disturbed, and Deca-BDE and HBCD was released again (this pumping pit was not cleaned together with the buffer tank during the first remediation).

example 2 (Centexbel, 2009b)

- This example concerns a Flemish textile-processing company that discharges into sewer, and which has emptied and cleaned its buffer tank.
- 1 year after cleaning, the following values are still being found in wastewater:
  - Deca-BDE: 231 µg/l;
  - HBCD: 34 µg/l.

Environmental impact

Modification/optimisation of the production process could e.g. help to limit/prevent the use of chemicals. There could also be a favourable impact on other environmental compartments.

Economical feasibility

The cost price for modifying/optimising the production process is greatly determined by the implemented measures. This technique is generally regarded as economically feasible for all textile companies.

References

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RDC, 2001;
RIVM, 2007a;
VMM, 2005 and 2008;
VROM, 2002.

- ***Characterise released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal***

Technique description
As already indicated in paragraph 3.1.2, wastewater or liquid waste flows in the textile sector are released in the production process, during cleaning activities and in the company laboratory. Examples include wash-waters from yarns and/or textiles, exhausted process baths, rinse water from process baths and rinse water from cleaning activities.

These wastewaters or liquid waste flows must be characterised in order to evaluate which substances are present and in which concentrations. Regular sampling and analysis (e.g. in monitoring programmes and with quality safeguards in sampling and analysis) provide an insight into the characteristics of the wastewater or liquid waste flows. Results from these analyses allow the right choices to be made when re-deploying the production process or the treatment, or when disposing of these flows.

comment
The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:

- Characterise the various wastewater flows in the process (reference in BREF: paragraphs 5.3 and 4.1.2);
- Separate collection of unavoidable waste flows (reference in BREF: paragraph 5.1);
- Re-use rinse water in next painting process, or to re-configure, and re-use the paint bath if technically possible (reference in BREF): paragraphs 5.2.2 and 4.6.22).
- Recycle process liquids for making fibre-painted/yarn-washed products moth-proof, or for dyed yarns between different batches, and use processes that remove active substances from bath leftovers (reference in BREF: paragraphs 5.2.2 and 4.6.22).
- Separate the effluents at the source, based on the type and quantity of polluted substance, before mixing with other flows (so that the purification system only receives polluted substances that it is able to process) (reference in BREF: see paragraph 5.3).

Technical feasibility
The quantity and composition of particular liquid waste flows is known, such as, for example, exhausted process baths. It is advised to dispose of smaller partial flows via a qualified processing company.
In the absence of measurements and analysis, there is currently (2010) little or no information available about the quantity and composition of other partial flows. This is, for example, the case for wash-waters from tissues and yarns. Re-using wash-waters is not an option in the production process.

Based on a theoretical example (also see paragraph 3.4.3.c), the quantity of NPE per litre of released wastewater (specific partial flows in 4 treatments, namely wetting and bleaching, rinsing, dying and rinsing) can be estimated at 5-10 mg (Centexbel, 2009c). Further dilution will take place if these partial flows enter the general wastewater flow. However, for some companies, NPE-based wastewater flows represent a large share of all wastewater flows. In this case, disposal via a qualified processing company is not an option, though suitable wastewater purification would be recommended.

One-off sampling and measurement is of little use to job-processing companies, considering the wide variations in quantity and composition in the released wash-waters. For integrated companies with limited variation in activities, processes, to-be-treated materials, etc., one-off sampling and measurement may be enough to obtain an insight into the quantity and composition of certain partial flows.

The water analysis compendium (WAC) contains procedures for analysing components in water. Background information about the reference measurement methods for BFR, antimony, PFT, NP/ NPE and PAH can be found in appendix 2.

Comments

- The WAC method for determining perfluorotensides (WAC/IV/A/025) was published in Spring 2010.
- A method design for determining octyl and nonylphenols (WAC/IV/A/003) is currently being evaluated and will be available in Spring 2010.
- Two methods for PAH have been included in the WAC procedure (WAC/IV/A/002).

  According to Centexbel (2009 b and c), the measurement method used for PAH could possibly influence the analysis results. Centexbel also states that sampling and sample preparation could also have a major influence on the analysis results.

  Both measurement methods were thoroughly tested at the reference laboratory of VITO and similar results were obtained (also see appendix 2). It is not possible to determine PAH with only MS; it must always be used in combination with GC. Currently (2010), it is also not possible to not implement the WAC methods.

Generally, the characterisation of released wastewater or liquid waste flows – in the interest of re-use, treatment and/or disposal – is regarded as technically feasible. However, the final content of this measure must be determined at company level, and varies depending on the specific flow.

Environmental impact

By implementing this measure, wastewater and watery waste flows can be returned to the production process, treated or disposed of in a correct manner. This measure can help to limit the quantity and load of the wastewater, as well as the quantity of watery waste flows.

Economical feasibility

The cost price of this measure is determined by the specific implementation at company level. Measurement, monitoring and analysis equipment requires a certain level of investment. Sample analysis is also accompanied by certain costs. On the other hand, savings can be made in waste disposal costs. This measure is generally regarded as economically feasible for all textile companies.

References
Company information;
Centexbel, 2009b and c;
Fedustria-Centexbel, 2009;
EIPPCB, 2003a;
VMM, 200f;
VITO, 2010a;
www.emis.vito.be

- ***Collect exhausted process baths and dispose via a qualified processing company***

Technique description
Exhausted process baths with chemicals that could be disruptive or are difficult to degrade, must be directed away from the AWZI. These process baths must be collected separately and disposed of via a recognised processing company.

Technical feasibility
Deca-BDE, Sb_2O_3 and HBCD
VLAREM II chapter 5.41 (textiles) states, in the sectoral environmental permit conditions for the textile industry (article 5.41.1.5.§4), that process baths with brominated flame retardants or antimony cannot be discharged (also see paragraph 2.4.1.b).
Deca-BDE, HBCD and Sb_2O_3 are components in process baths used for finishing processes (also see paragraph 3.2.1). Currently (2010), the collection and disposal of process baths containing Deca-BDE and/or HBCD and Sb_2O_3 is normal practice[176]. This measure is technically feasible for all textile companies that implement process baths with Deca-BDE and/or HBCD and Sb_2O_3.

PFOS and PFOA
The use of PFOS is legally regulated. Thus, according to Guidelines 2006/122/EC (PFOS guidelines), PFOS cannot be brought on to the market for textiles if the quantity of PFOS is equal t or exceeds 1 $\mu g/m^2$ of the coated material. Further, these guidelines also state that the use of PFOS must be gradually phased out so that the use of safer alternatives becomes technically and economically feasibly (also see above). An exception can only be made for essential applications for which there are no safer alternatives, and when a report has been compiled concerning action taken to find safer alternatives, and when perfluorooctane acid (PFOA) and its salts have a similar risk profile to PFOS (also see paragraph 2.4.3.c). Agreements concerning phasing out (95% by 2010) and completely banning (by 2015) PFOA have been made within the PFOA Steward Programme (also see paragraph 2.4.4.b).
For many applications in the textile industry (e.g. carpets with an effect on one side), PFOS and/or PFOA are applied via spraying, as a foam or via a squeegee technique. In these cases, fewer PFOS and/or PFOA enters the wastewater. If the effect is needed on both sides of the textile, process baths with PFOS and/or PFOA and a binding product

[176] 1 textile company that definitely uses Deca-BDE and discharges into the sewer, disposes of Deca-BDE- based process baths and rinse waters via a qualified processing company, but states that it re-uses 100% of them in the production process (situation September 2009).

are used. PFOS and/or PFOA are rarely implemented as a concentrated liquid (also see paragraph 3.3.1).

NP/NPE

The use of NP and NF is legally regulated via REACH. NP and NPE cannot be brought on to the market as a substance or in mixes in a concentration of 0.1 weight percentage or more, or be used for e.g. textile and leather processing, except for applications without discharge into wastewater or for treatments in systems where a special treatment is used to completely remove the organic fraction from the process water before the wastewater is treated biologically (degreasing sheepskins) (also see paragraph 2.4.3.c).

Product supplier in the EU are also permitted to create mixes with NPE/NP in concentrations > 0.1% (g/g). Textile enrichers are also allowed to use products (EU or non-EU) that contain concentrations of more than 0.1% (g/g) NPE/NP, under the condition that they do not discharge these products in wastewater.

NP/NPE are not used as pure substances or in process baths implemented in the textile industry. It is not necessary to collect NP/NPE or have it disposed of via a qualified processing company of process baths.

However, NPE are supplied as surface-active substances in preparates (e.g. detergents, dispergators, wetting agents) by product suppliers. Such preparates are used, for example, in paint baths in finishing processes. NP/NPE are primarily released when washing tissues and yarns before they are dyed. If NP/NPE are used in the textile industry as a substance or in mixes in concentrations >0.1% (g/g), and no appropriate purification technique is available for the specific partial flow, then it is advised to dispose of the partial flows in question.

16 PAH of EPA

PAH are not implemented in the textile industry as such (e.g. in process baths), but enter the wastewater of textile companies indirectly (e.g. via textile raw materials). It is not necessary to collect PAH or have them disposed of via a qualified processing company of process baths.

In the same way as NP/NPE, PAH are (via mineral spinning oils) primarily released when tissues and yarns are washed.

Environmental impact

The load of the wastewater is limited and the operation of the AWZI is not disrupted if process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA are collected and disposed of via a qualified company. In directly, this may also restrict the use of products (e.g. chemicals) needed to operate the AWZI.

Of 3 textiles companies that discharge into surface water, and where Deca-BDE is definitely used for finishing activities, the average concentration of Deca-BDE in the effluent, in the period prior to disposal of process baths, amounted to 154.86 mg/l (17 measurements) with a range of <1µg/l - 1 153 µg/l. The Deca-BDE concentration in the effluent of the same companies, in the period after disposal of the process baths, amounted to 42.31 µg/l on average (32 measurements), with a range of <1 µg/l -370 µg/l.

Economical feasibility
The disposal of process baths via a qualified processing company is associated with extra costs for the textile company.

Examples:

- According to Centexbel (2009c), the cost price for disposing of process baths (with e.g. Deca-BDE and Sb_2O_3) amounts to 150-500 €/ 1,000 litres, depending on the solid matter content (the higher the solid matter content, the higher the price). EBFRIP-VECAP (2009c) states that the dry matter content of formulations is approximately 50% for Deca-BDE (and 70-75% for other substances).
- For process baths that contain dangerous substances, the price for disposal is even higher according to EBFRIP-VECAP (2009c): e.g. 1,500 € per 1,000 litres (in 2007, incl. handling costs for incineration using a chemical washer). Further, in order to prevent concrete erosion, the cement industry also sets requirements for the amount of bromine in cement (<50ppm).

Because the collection and disposal of process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA is currently (2010) a standard technique, this measure is regarded as economically feasible for all textile companies that use such process baths.

References
Company visits;
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b and 2009c.
Fedustria, 2008;
Land C.A., 2008;
LNE-AMI, 2006;
VMM, 2009a, b and f.

- ***Recuperate maximum amount of chemical surpluses***

Technique description
Chemical surpluses are created e.g. when packaging is emptied (also see elsewhere[177]), when pipes are emptied or when the required amount of solutions with active components for processing batches is over-estimated (also see[178]). These surpluses can be recuperated by re-using them in the production process wherever possible, e.g. by using them in the next finishing activity.

Comments

- There is a second option if it is not possible to re-use these chemical surpluses in the production process: the supplier returns the chemical surpluses.

[177] Candidate BAT: Empty chemical packaging properly when dry, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier.

[178] Candidate BAT: Optimise production planning.

However, this requires appropriate agreements to be made with the supplier (upstream) (also see elsewhere[179]).

- If the chemical leftovers cannot be returned to the chemical supplier, there is also a third option: Disposal via a qualified processing company (also see elsewhere[180]).
- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
    - Recuperation of printing paste by forcing paste in the pipes backwards using a bullet-shaped object (reference in BREF: paragraphs 5.2.2 and 4.7.5).
    - Do not discharge printing paste residue together with wastewater, but keep it in labelled drums and re-use (reference in BREF: paragraphs 5.2.2 and 4.7.6).

Technical feasibility
The technical feasibility of re-using chemical leftovers in the production process is greatly determined by the specific company situation (implemented processes, awarded assignments, etc.). Here are a few examples of technical bottlenecks:

- It is more technically difficult to implement this measure for just-in-time production and for the finishing of smaller batches.
- According to Centexbel (2009c), a condition for re-using chemical leftovers in the production process is that the concerned product must be stable in the long term. Biological degradation and development of e.g. algae (green) could occur if chemical leftovers are stored (for long periods).
- Further, Centexbel (2009c) states that the recuperation of chemical residues (e.g. via displacement) is not always possible in existing installations. However, the required features can be added to new machines.

This measure is generally regarded as being technically feasible.

Environmental impact
By recuperating the maximum amount of chemical leftovers, it is possible to reduce waste quantities, as well as quantities of (new) chemicals.

Economical feasibility
If this measure is implemented, savings can be made in the cost price of chemicals. This measure is economically feasible for all textile companies.

References
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b.
LNE-AMI, 2006;
LNE-AMV, 2009;

[179] Candidate BAT: Make agreements with suppliers of formulations concerning the return of left-over chemical

[180] Candidate BAT: Store waste residues containing BFR, antimony, PFT, NFn/NPE and/or PAH in an appropriate manner and dispose via a qualified processing company.

- ***Wherever possible, remove solid residues dry***

Technique description
Solid residues from equipment, installations and/or floors can be removed dry by using e.g. rubber blades, brushes, vacuum cleaners, paper, cloths or other absorbent material, a shovel or a squeegee. The solid material can be collected in a recipient (e.g. bucket). The next step will then be to wet-clean using water and possible cleaning products and disinfectants (see elsewhere[181]).

Technical feasibility
This action can be implemented both during and after the production process. This measure is regarded as technically feasible for all textile companies. The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

Environmental impact
Implementation of this measure results in the formation of a solid waste flow. However, because of implementation, water consumption in the following wet cleaning step can be limited, as can the quantity of released wastewater and its level of pollution. The use of chemicals (clean products and disinfectants) can also be limited.

Economical feasibility
This measure is not accompanied by a noteworthy increase of decrease in costs and is regarded as economically feasible for all textile companies.

References
EBFRIP-VECAP, 2007a and b.
Fedustria, 2008;
VMM, 2009f

- ***Empty chemical packaging properly dry, do not rinse with water, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier***

Technique description
As stated in paragraph 3.1.2, the packaging types used for textile finishing chemicals include: intermediary bulk containers (IBC), big bags, 25 kg metal buckets (paste), containers (1000l), metal recipients (50 kg), plastic or paper bags (up to 25 kg).

<u>IBCs, buckets, containers and recipients</u>
Packaging for chemicals like, for example, IBCs, buckets, containers and recipients with ready-to-use solutions, mixes of active substances, watery dispersions or viscous paste, must be scraped empty as effectively as possible. This packaging should, preferably, not be rinsed at the textile company itself.
Thereafter, emptied packaging must be stored in an appropriate manner in designated storage recipients, while awaiting disposal via a qualified processing company or via the chemicals supplier.

[181] Candidate BAT: Empty chemical packaging properly when dry, do not rinse with water, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier and candidate BAT: Use dry cleaning method on process baths before rinsing them with water.

Comments

- It is estimated that around 25 litres of chemicals are left behind per IBC of 1000 litres. The chemicals remaining in the packaging can be reduced to 1/5 (5 litres) by placing the IBCs on a sloping surface.
- Chemical suppliers may also return re-usable packaging. Thus IBCs are, for example, transported directly to external drum cleaners or they end up at the cleaners via the formulators. It is important to keep an inventory of the IBCs.

Sacks and big-bags

Sacks or big-bags with chemicals in powder form must take place in under-pressure. Thereafter, emptied packaging must be stored in an appropriate manner, while awaiting disposal via a qualified processing company or via the chemicals supplier. Emptied sacks must be packed in polyethylene sacks and stored in enclosed conditions.

Comments

- The precursor for not shifting the negative environmental impact of waste from the textile sector to other sectors (e.g. waste processing, drum cleaning) is that processing/cleaning must be done via qualified companies in accordance with the BAT for the concerned sector(s). The problem is that it is not always possible to monitor this or not enough monitoring takes place.
    - In practice, it appears that processing of packaging from dust-sensitive substances (e.g. paper sacks) is not always carried out by qualified processing companies (treated as old paper instead of, for example, being burnt in cement ovens as high caloric waste). In such cases, indirect emission into air and water have a considerable impact on the environment.
    - As far as packaging from liquid and viscous chemicals is concerned (e.g. IBCs of 1,000 litres), it appears that, in practice, not all IBCs are disposed of via qualified processing companies. Such cases also have a considerable impact on the environment, because an estimated 25 litres of product could be left behind in each IBC.
- The textiles BREF (EIPPCB, 2003a) selects the following technique as BAT: Use bulk containers and return packaging (reference in BREF: paragraph 5.1).

Technical feasibility

It is currently (2010) standard practice to empty chemical packaging effectively dry, to store in an appropriate manner and to dispose of via a qualified processing company or via the chemicals supplier.
Today (2010), it appears that 85-90% of the IBCs are not longer rinsed in the textile company, but are, after being dry-emptied, transported with the remaining contents to external processing companies (chemicals suppliers or drum cleaning companies).
This measure is technically feasible for all textile companies.

The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

Environmental impact

Water consumption is limited by dry-emptying packaging materials. This also limits the load of the wastewater. If the chemical leftovers are recuperated (also elsewhere[182]), chemical consumption can also be limited. Emissions into the air are avoided when sacks of powder-form chemicals are emptied in under-pressure. Emissions of chemicals into wastewater and the soil can be prevented by storing chemicals packaging in an appropriate manner. The amount of waste is reduced when re-usable packaging is returned by the chemicals supplier.

Economical feasibility

If packaging material for chemicals is dry-emptied, it is possible to make savings in the cost price of chemicals by recuperating a certain quantity. The storage of chemical packaging in an appropriate manner is not accompanied by cost increases or decreases. However, additional costs will be encountered when disposing of this packaging via a qualified processing company or via the chemicals supplier. This measure is currently (2010) state of the art and is regarded as economically feasible.

Examples:

- According to Centexbel (2009c), the cost price for a system where sacks are emptied in under-pressure, amounts to approximately 10,000 € (info derived from 1 Flemish textile company). This price also includes the dust filter.
- According to EBFRIP-VECAP (2009c), the cost price for a system where big-bags are emptied, amounts to 5 000 - 6 000 € (used in major companies).
- According to Centexbel (2009c), the cost price for disposing of packaging material amounts to 40 € per IBC. This is the cost price for rinsing the IBC and bringing the packaging on to the market via a tank cleaning company. However, there must only be maximum 5l of leftover product in the to-be-cleaned IBC. Fines must be paid for higher residue contents.

References

Centexbel, 2009b and c;
EBFRIP-VECAP, 2007a, b and c.
Fedustria, 2008;
VMM, 2009f

- ***Use dry cleaning method on process baths before rinsing them with water***

Technique description

A dry cleaning method can be used on process baths by letting them run empty, using the valve at the bottom of the bath, and scraping the surface using, for example, rubber blades, brushes, paper, cloths or other absorbent materials.

Technical feasibility

Centexbel (2009c) states that process baths currently (2010) used in the textile industry, feature a valve at the bottom. However, although process baths cannot be tilted, their height can be altered (containers can be lowered) to make the cleaning process easier.

[182] Candidate BAT: Recuperate maximum amount of chemical surpluses.

The dry cleaning method is often performed using mechanical tools (e.g. squeegee, rubber, vacuum cleaner).

Comments

- The presence of displacement devices (e.g. items placed to fill up unused space in the process bath and to limit the content of the process bath) could make it more difficult to access the process bath.

There are no know indications suggesting that this measure is not technically feasible in new installations. However, a number of bottlenecks could be encountered in existing systems. Despite this, the measure can generally be regarded as technically feasible because textile companies currently (2010) implement the measure wherever possible. It is in companies' best interest to recover the as much content as possible from process baths. The cost price of chemicals (approximately 3 €/kg) is the most decisive factor.

The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

Environmental impact

Implementation of this measure helps to limit water consumption, as well as the released quantity of wastewater and its load.

Economical feasibility

This measure is accompanied by savings in chemical costs (also see technical feasibility paragraph) and is regarded as economically feasible for all textile companies.

References

Centexbel, 2009b and c;
Fedustria, 2008;
Land C.A., 2008;
LNE-AMI, 2006;
EBFRIP-VECAP, 2007b.
VMM, 2009f

- ***Rinse process baths with a minimum amount of water***

Technique description

Once rinsing baths have been dry-emptied (also elsewhere[183]), the next step is to rinse the process baths with water and possibly detergents. The quantity of rinse water can be limited by, for example, rinsing more than once with a limited amount of water. The last rinse water (least polluted) can possibly be re-used as the first rinse water in the next cleaning activity for process baths.

Technical feasibility

There are no know indications suggesting that this measure is not technically feasible.

[183] Candidate BAT: Use dry cleaning method on process baths before rinsing them

> *example*
> According to EBFRIP-VECAP (2009c), high pressure cleaning is currently (2010) implemented in the textile sector to limit water consumption and to reduce the amount of wastewater. No concrete data is known to be available for the water-saving effect realised by implementing this technique in the textile industry.

Environmental impact
Implementation of this measure helps to limit water consumption, as well as the released quantity of wastewater and its load. Saving could also be made in the quantity of chemicals (detergents).

Economical feasibility
This measure is not accompanied by a noteworthy increase of decrease in costs and is regarded as economically feasible for all textile companies.

References
Centexbel, 2009b;
EBFRIP-VECAP, 2007b and 2009c.
Fedustria, 2008;
Land C.A., 2008;
LNE-AMI, 2006;

- ***Keep the amount of rinse water in cleaning activities to a minimum***

Technique description
The amount of rinse water used in cleaning activities can be limited by first using a dry cleaning method to remove residues from equipment, installations and/or floors (also see elsewhere[184]). The next step will then be to wet-clean using water and possible cleaning products and disinfectants. The quantity of water can be limited by, for example, cleaning more than once with a limited amount of water.

Technical feasibility
This measure is regarded as technically feasible for all textile companies.

Environmental impact
Implementation of this measure helps to limit water consumption, as well as the released quantity of wastewater. The use of chemicals (clean products and disinfectants) can also be limited.

Economical feasibility
This measure is not accompanied by a noteworthy increase of decrease in costs and is regarded as economically feasible for all textile companies.

References
Centexbel, 2009b;
EBFRIP-VECAP, 2007b.
Fedustria, 2008;

[184] Candidate BAT: Wherever possible, remove solid residues when dry

Land C.A., 2008;
LNE-AMI, 2006;

- ***Wherever possible, re-use rinse waters from process baths in the production process***

Technique description
Chemical residues, particularly Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA, in rinse water from process baths can be (partly) recuperated by separately collecting and re-deploying them, for example, for preparing chemicals (e.g. via dilution) for the next finishing activity.

Technical feasibility
A number of facilities, e.g. a storage tank, are needed in order to separately collect rinse waters from process baths. Further, in order to re-use this rinse water, measurement and modification equipment is needed to alter the process baths.

There are no indicators that rinse waters from process bath containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA cannot be collected. Currently (2010) there are many cases where rinse waters are re-used in the production process - though only is production planning is possible. Centexbel (2009c) states that this technique is more difficult to implement for job-processing companies (compared to integrated textile companies), due to the smaller production batches and the varying production activities. Further, the sector (Centexbel, 2009c) has identified a number of potential bottlenecks:

- Contamination risk from finishing chemicals;
- Potential reactions between chemicals.

If these rinse waters cannot be re-used in the production process, the other option is to dispose of them via a qualified processing company (also see elsewhere [185]).

> *example*
> A Flemish textile company (integrated company) indicates that 70% of rinse waters is re-used in the production process.

According to Centexbel, it is not practically possible to collect rinse waters that contain NP/NPE and/or PAH, because these substances originate from used products (e.g. detergents, emulsifiers, oils). This measure does not apply to rinse waters from process baths that contain NP/NPE and/or PAH.

Environmental impact
The amount of chemicals (active substances for the finishing process) required can be limited by implementing this technique. The load of the wastewater is limited and the operation of the AWZI is not disrupted if rinse waters from process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA are collected and re-used. In directly, this may also restrict the use of products (e.g. chemicals) needed to operate the AWZI.

[185] Candidate BAT: dispose of rinse waters from process baths via a qualified processing company

Economical feasibility
This measure is not accompanied by any pronounced increases or decreases in costs and is regarded as economically viable for all textile companies where rinse waters from process baths contain Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA.

References
Company visits;
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b.
Fedustria, 2008;
Land C.A., 2008;
LNE-AMI, 2006;

- ***Dispose of rinse waters from process baths via a qualified processing company***

Technique description
If chemical residues found in the rinse waters of process baths cannot be re-used in the production process (also see elsewhere[186]), the alternative is to dispose of these rinse waters via a qualified processing company.

> *comment*
> Such rinse waters are not released from the company laboratory.

Technical feasibility
This measure primarily applies to rinse waters from process baths that contain Deca-BDE, HBCD and/or Sb_2O_3. Today (2010) it is common practice to dispose of rinse waters from process baths, which contain Deca-BDE, HBCD and/or Sb_2O_3 and cannot be re-used in the production process, via qualified processing companies (and no longer send to the AWZI together with other wastewater).[187]

Centexbel (2009c) indicates that PFOS and/or PFOA do not appear in concentrated form in rinse waters from process baths in the textile industry. This can be attributed to the general environmental permit conditions in article 4.1.11.8 of VLAREM II and the sectoral environmental permit conditions in appendix 5.3.2.44° of VLAREM II (also see paragraph 2.4.1.b). According to the sector (Centexbel, 2009c), textile companies are currently (2010) able to comply with applicable PFT emission limit values. In such cases, it is not necessary to dispose of rinse waters containing PFOS/PFOA via a qualified processing company. However, it is recommended to dispose of such rinse waters if textile companies do not comply with PFOS/PFOA emission limit values.

> *comment*
> The concentration of PFOS and/or PFOA in rinse water from process baths can be limited by e.g.:
> - Complying with legal requirements for maximum permitted concentrations (article 4.1.11.8 of VLAREM II);

[186] Candidate BAT: wherever possible, re-use rinse waters from process baths in the production process

[187] 1 textile company that definitely uses Deca-BDE and discharges into the sewer, disposes of Deca-BDE- based process baths and rinse waters via a qualified processing company, but states that it re-uses 100% of them in the production process (situation September 2009).

- Re-using as much of these rinse waters as possible in the production process (also see elsewhere[188]).

NP/NPE and/or PAH are not used as such in the textile industry. These substances are present in used products, are formed during finishing processes or are introduced to the process via pollutants in e.g. tissues and colorants. NP/NPE and/or PAH primarily enter the wastewater of textile companies when tissues and yarns are washed. This measure does not apply to parameter groups that contain NP/NPE and/or PAH. It is more advisable to implement preventive measures and/or post-treatment techniques for this parameter.

Environmental impact
The load of the wastewater is limited and the operation of the AWZI is not disrupted if rinse waters from process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA are collected and re-used. In directly, this may also restrict the use of products (e.g. chemicals) needed to operate the AWZI.

Economical feasibility
Because the collection and disposal of rinse water from process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA is currently (2010) a standard technique, this measure is regarded as economically feasible for all textile companies that use such process baths.

> *Example*
> According to Centexbel (2009c), the cost price for disposing of rinse water from process baths (with e.g. Deca-BDE and Sb_2O_3) amounts to 150-500 €/ 1,000 litres, depending on the solid matter content (the higher the solid matter content, the higher the price).

References
Company visits;
Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b and 2009c.
Fedustria, 2008;
Land C.A., 2008;
LNE-AMI, 2006;

- ***Store waste residues containing Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company***

Description
Examples of waste containing residues of Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA include:

- Paper, cloths or other absorbent materials that are used for the dry-removal of solid residues (also see [189]);
- Laboratory waste

[188] Candidate BAT: Wherever possible, re-use rinse waters from process baths in the production process
[189] Candidate BAT: wherever possible, remove solid residues when dry

Comments

- Packaging waste has already been address in an earlier paragraph (also see[190]).
- NP/NPE are primarily released during washing processes on purchased tissues and yarns and are not implemented in the textile industry as such. Considering that NP/NPE-based solids residue are less relevant, this measure does not apply to the parameters NP/NPE.
- PAH originate from mineral oils, are present in e.g. purchased tissues and yarns or are formed on thermo-fixed tissues. According to Centexbel (2009c), it is incorrect to conclude that PAH are present in waste. This measure does not apply to the parameter PAH.

Paper, cloths or other absorbent materials must be stored in an appropriate manner, while awaiting to be disposed of via a qualified processing company. This waste can be stored, for example, in enclosed recipients in a specifically designated area.

Technical feasibility
The appropriate storage of this waste flow, and disposal via a qualified processing company, is currently (2010) common practice. This measure regarded as technically feasible for all textile companies.

Environmental impact
It is possible to prevent chemicals entering wastewater and the soil by storing waste containing Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and disposing of it via a qualified processing company.

Economical feasibility
According to the sector, waste disposal via a qualified processing company is accompanied by certain costs:

Examples:

- Rental price of containers for storing industrial waste, amounts to €8/month.
- The collection cost per ASP container[191] amounts to € 75.
- For each IBC, the cost price for rinsing and returning to the market, amounts to € 40.
- According to the sector, the processing costs for waste containing residues of Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA amount to:
  - 0.75 €/l;
  - 0.93 €/kg.

Because this measure is currently (2010) common practice, this measure is regarded as economically feasible for all textile companies that sue such process baths.

References

Centexbel, 2009b and c;
EBFRIP-VECAP, 2007b.
LNE-AMI, 2006;

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[190] Candidate BAT: Empty chemical packaging properly when dry, do not rinse with water, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier.

[191] Metal container specifically intended for storing dangerous waste

LNE-AMV, 2009.

4.2.3 End-of-pipe techniques

- ***Appropriately treat industrial wastewater by implementing a combination of suitable waste purification techniques***

Technique description

The aim of industrial wastewater purification is to make the wastewater suitable for discharge (into surface water or into sewer). In certain cases, and for specific components, it is advised to treat specific partial flows before they are sent to the central wastewater purification system.

The aim of primary purification is to physically remove solids and sedimentary matter from the wastewater. Secondary purification primarily involves the removal of organic substances and nutrients (e.g. nitrogen and phosphorous. The aim of tertiary purification is to thoroughly purify the wastewater (e.g. phosphorous) or to remove components from the wastewater that are difficult to break down. Tertiary purification techniques are not only implemented as effluent polishing after main biological purification, but are also used for pre-treating (concentrated) partial flows.

Comments

- Untreated process baths with BFR or antimony must never be discharged (VLAREM II, article 5.41.1.5.§4, also see paragraph 2.4.1.b).
- Under no circumstances can wastewater be diluted to comply with emission limit values (VLAREM II, article 5.2.3bis.1.23.§ 6).
- Problematic wastewater must be diverted away from the AWZI.
- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT (reference in BREF:: paragraph 5.3):
    - At least 3 different strategies are possible for wastewater treatment:
        - Central treatment in on-site biological wastewater purification system;
        - Central treatment at off-site purification system for urban wastewater;
        - Decentralised on-site (or off-site) treatment of selected or separated wastewater flows.

      All three strategies are BAT options according to the BREF for textiles (EIPPCB, 2003a), if they are correctly implemented for the current wastewater situation.
    - Characterise the various wastewater flows in the process (reference in BREF: paragraph 4.1.2).
    - Separate the effluents at the source, based on the type and quantity of polluted substance, before mixing with other flows (so that the purification system only receives polluted substances that it is able to process).
    - Select the most suitable treatment for the polluted wastewater flows.
    - Avoid introducing wastewater fraction into biological purification systems if there is a risk of these systems being disrupted.

  - Treat wastewater flows with a relevant non-biologically degradable fraction using suitable techniques before, or instead of, the final biological treatment.
  - Treat wastewater in an active silt system with low supply/micro-organism ratio, but only if concentrated waste flows containing non-biologically degradable compounds have been subject to a separate pre-treatment (reference in BREF: paragraph 4.10.1).
  - Implement chemical oxidation as pre-treatment on heavily loaded (COD >5,000 mg/l), selected and separated individual waste flows that do not contain non-biologically degradable compounds (reference in BREF: paragraph 4.10.7).
  - If possible keep specific residues from processes (printing paste residue and foulard fluid residue), which are heavily polluted, out of the wastewater flow altogether.
  - For specific cases, where wastewater contains printing paste pigments or latex from the production of carpet undersides, use precipitation/flocculation and incineration for the resulting silt as an alternative to chemical oxidation (reference in BREF: paragraph 4.10.5).
  - For azo-colorants, implement an anaerobic treatment for foulard fluids and printing pastes - prior to aerobic treatment - in order to effectively remove colour (reference in BREF: paragraph 4.10.6).
  - Implement additional physico-chemical treatments if concentrated wastewater flows contain non-biologically degradable compounds and cannot be treated separately, e.g.
    - tertiary treatment after biological treatment, e.g. adsorption using activated carbon (reference in BREF: paragraph 4.10.1);
    - ozonisation of difficult to degrade compounds (reference in BREF: paragraph 4.10.1);
    - combined biological, physical and chemical treatment by adding activated pulverised carbon and iron salts to the active silt system (reference in BREF: paragraph 4.10.3).
  - For effluent treatment in wool-washing sector:
    - Combine the use of dirt-removal/fat recuperation with effluent evaporation and integrated incineration of resulting silt, with complete recycling of water and energy (reference in BREF: paragraph 4.4.2);
    - Use coagulation/flocculation in existing companies, in combination with discharge into sewer via an anaerobic biological pre-treatment.
  - Do not discharge printing paste residue together with wastewater, but keep it in labelled drums and re-use (reference in BREF: paragraphs 5.2.2 and 4.7.6).

- The BAT study concerning internal cleaning of tanks and drums (Huybrechts D. *et al.*, 2002), the basic set-up for tank cleaning is seen as a combination of an oil/fat separator, physico-chemical and biological purification, possibly supplemented by a sand filter or flotation (existing BAT). Companies that only clean inert bulk and/or foods must use this basic set-up to thoroughly purify their effluents. For companies that also clean chemicals and/or process external wastewaters, in addition to the basis set-up, a few extra advanced water purification techniques are proposed as BAT, namely a membrane bio-reactor, the PACT process and active carbon filtration. Depending on the company-specific context, preference can be given to one or more of these techniques. Active carbon filtration is not only proposed for further purifying the effluent from biological purification, but also for pre-treating particular partial flows, e.g. rinse waters containing EOX . Finally, chemical oxidation and membrane filtration (nano-filtration or reverse osmosis) also offer interesting opportunities to purify effluents from tank cleaning. However, in 2002, these techniques were regarded as insufficient for the tank and drum cleaning sector to be selected as BAT. In membrane filtration, for example, the processing of generated concentrate flows presents a bottleneck. For drum cleaning, only water purification is deemed necessary, e.g biological and/or via active carbon filtration, and is thus regarded as BAT for partial flows that cannot be discharged (not for zero discharges) .

Technical feasibility

Table 27 provides an overview of wastewater purification techniques that are (or can be) implemented for the removal of the examined pollutants from textile-related wastewater. However, this list is not exclusive.

Comments

- Wastewater that contains Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA must be eradicated from the AWZI wherever possible.. This can be done by e.g.
  - characterising released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal;
  - collecting exhausted process baths and disposing of via a qualified processing company;
  - re-suing rinse waters from process baths in the production process wherever possible;
  - using a qualified processing company to dispose of rinse waters from process baths that contain Deca-BDE, HBCD and/or Sb_2O_3.

  If not, end-of-pipe measures must be implemented for the removal of Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA from wastewater (also see Table 27).
- Since 2006, a number of Flemish textile companies have stopped sending wastewater that contains Deca-BDE, HBCD and Sb_2O_3, (process baths and rinse water from process baths) to the AWZI. That said, substances like Deca-BDE and HBCD are still being measured in the effluents of these companies (major variations, periods with peak discharges), despite great efforts to clean up the AWZI (e.g. cleansing buffer basis and pipes, replacement of pumps). These companies are experiencing the after-effects of e.g. Deca-BDE and HBCD, due to these substances precipitating in silt and residues.
- Techniques that are used for the removal of suspended matter (e.g. sedimentation, lamella sedimentation, flotation and electro-coagulation) could also remove a part of the examined pollutants, which bond with the suspended matter. This is the case for e.g. Deca-BDE, HBCD, Sb_2O_3 and PAH.

Table 27: Overview of applicable wastewater purification techniques for the removal of NP/NPE, PAH, Deca-BDE and/or HBCD, Sb_2O_3, and PFOS and/or PFOA

Wastewater purification technique	**parameter**				
	NP/NPE	**PAH**	**Deca-BDE/ HBCD**	**Sb_2O_3**	**PFOS/PFOA**
Anaerobic purification	gg	gg	gg	gg	gg
Biological purification (e.g. active silt system)	0[192]	x[193]	0[194]	0[195]	0
Dosing active carbon in biological purification (PACT)	(x)[196]	x	gg	gg	gg
MBR (membrane bio-reactor)	gg	(x)[197]	x[198]	(x)[199]	gg
Chemical	gg	x[200]	x[201]	x[202]	gg

[192] NFn/NPE is not removed from wastewater via biological purification.

[193] PAH are removed from wastewater via biological wastewater purification. This results in a significant reduction in PAH-content in the wastewater of textile companies that discharge into surface water, compared to companies that discharge into the sewer. Biological purification (possibly in combination with other wastewater purification techniques) is used by most Flemish textile companies that discharge into surface water.

[194] Deca-BDE and HBCD are not soluble in water and probably precipitate on e.g. suspended matter and silt.

[195] In water, antimony compounds bond with e.g. floating matter and silt.

[196] Phenols are probably also removed from wastewater when a PACT system is implemented. Currently (2010), there are no concrete examples for the use of PACT for the removal of NFn/NPE from textile wastewater and about achievable removal yields.

[197] PAH that bond with suspended matter could also be removed from the wastewater. In the laundry sector, an MBR could be used for the removal of e.g. PAH for larger systems (volumes exceeding 50m³/d) (Van den Abeele L., 2010).

[198] BFRs that bond with suspended matter could also be removed from the wastewater. According to the bromine sector, MBR has been successfully implemented for the removal of HBCD from wastewater (also see example 3) (EBFRIP, 2009b). Currently (2010), MBR is not known to be implemented for the purification of textile (VITO, 2009c).

[199] Sb_2O_3 that bonds with suspended matter could also be removed from the wastewater. Currently (2010), there are no concrete examples for the use of MBR for the removal of Sb_2O_3 from textile wastewater and about achievable removal yields.

[200] If implemented in the laundry sector, this technique should also result in the reduction of PAH. Two pilot tests provided PAH-removal yields of 70 - 98 % (Van den Abeele L., 2009). In Flanders, there are at least 6 textile companies (surface water dischargers) that implement sand filtration in combination with biological purification.

[201] According to the sector, physico-chemical purification (e.g. using lime milk and poly-electrolyte) does not result in the removal of BFR from wastewater from coating processes (CENTEXBEL, 2009b). The combination of chemical precipitation and active carbon filtration is said to be suitable for the removal of BFR from wastewater (also see example 1). In Flanders there is at least 1 textile company (sewer discharger) that uses chemical precipitation, and 1 textile company (sewer discharger) that uses chemical precipitation in combination with biological purification for the removal of BFR from wastewater.

Wastewater purification technique	parameter NP/NPE	PAH	Deca-BDE/ HBCD	Sb_2O_3	PFOS/PFOA
precipitation (coagulation-flocculation)					
Micro-filtration, ultra-filtration	gg	x[203]	(x)[204]	gg	gg
Nano-filtration, reverse osmosis	(x)[205]	x[206]	(x)[207]	gg	gg
sand filtration	Gg	X[208]	x[209]	x[210]	gg
Adsorption (e.g. active carbon filtration)	X[211]	X[212]	x	gg	gg

[202] A major European producer of antimony trioxide (i2a) uses coagulation and flocculation in combination with sand filtration for the removal of e.g. antimony from wastewater (also see example 4). In Flanders there is at least 1 textile company (sewer discharger) that uses chemical precipitation, and 1 textile company (sewer discharger) that uses chemical precipitation in combination with biological purification for the removal of Sb_2O_3 from wastewater.

[203] This technique is used in the laundry sector for the removal of PAH from wastewater (also see example 6). In Flanders there is at least 1 textile company (surface discharger) that used sand filtration in combination with biological purification.

[204] SM (+ any bonded substances) is removed from wastewater by using MF or UF. Currently (2010), there are no concrete examples for the use of MF or UF for the removal of Deca-BDE and/or HBCD from textile wastewater and about achievable removal yields. It should be possible to remove BFRs from the wastewater of textile companies by using a combination of UF and RO (also see example 2). However, no information is available about removal yields.

[205] Phenols can be removed from wastewater by using nano-filtration or reverse osmosis, if appropriate membranes are selected. Currently (2010), there are no concrete examples for the use of NF or RO for the removal of NFn/NPE from textile wastewater and about achievable removal yields.

[206] In Flanders there is at least 1 textile company (surface discharger) that used sand filtration in combination with biological purification.

[207] It should be possible to remove BFRs from the wastewater of textile companies by using a combination of UF and RO (also see example 2). However, no information is available about removal yields. The bromine sector (EBFRIP, 2009b) states that such systems are expensive.

[208] PAH that bond with suspended matter could also be removed from the wastewater. In Flanders, there are at least 3 textile companies (surface water dischargers) that implement sand filtration in combination with biological purification (possibly on a partial flow).

[209] According to the bromine sector (EBFRIP, 2009b), sand filtration has been successfully implemented in The Netherlands for the removal of HBCD from wastewater in the bromine sector (large volumes). In Flanders there is at least 1 textile company (surface discharger) that uses sand filtration in combination with biological purification.

[210] A major European producer of antimony trioxide (i2a) uses coagulation and flocculation in combination with sand filtration for the removal of e.g. antimony from wastewater (also see example 4). In Flanders there is at least 1 textile company (surface discharger) that uses sand filtration in combination with biological purification.

[211] A Flemish chemicals company has successfully implemented active carbon filtration for the removal of mono-aromatic hydrocarbons (e.g. styrene and alkylphenol ethoxylates) (also see example 5) (An., 2009c). Currently (2010) active carbon filtration is not known to be implemented by Flemish companies for the removal of NFn/NPE from the wastewater.

[212] Currently (2010), there are no concrete examples for the use of active carbon filtration for the removal of PAH from textile wastewater and about achievable removal yields.

Wastewater purification technique	**parameter**				
	NP/NPE	**PAH**	**Deca-BDE/ HBCD**	**Sb_2O_3**	**PFOS/PFOA**
chemical oxidation	(x)[213]	X	gg	gg	gg
Ozonisation	gg	(x)[214]	gg	gg	gg
Evaporation	gg	gg	gg	gg	gg
Incineration	gg	gg	gg	gg	gg

SOURCES: EIPPCB, 2003a; EBFRIP-VECAP, 2006 and 2009b; Van den Abeele, 2009

Legend:
- x: Parameter (group) removed
- (x): Parameter (group) possibly / potentially partly removed
- 0: Parameter (group) not removed
- gg no data

Background knowledge concerning the wastewater purification techniques mentioned in Table 27 can be found in WASS (wastewater selection system) via www.emis.vito.be/WASS.

In the textiles BREF (EIPPCB, 2003a) contains a number of examples of AWZI configurations that are implemented in European textile companies (e.g. membrane techniques and chemical oxidation). However, these techniques have not been specifically screened for the removal of NP/NPE, PAH and possibly BFR, Sb_2O_3 and/or PFT from wastewater.

The paragraphs below contain examples of (combinations of) techniques that can be implemented for the removal of BFR (Deca-BDE and/or HBCD), Sb_2O_3, NP/NPE and PAH from wastewater.

Example 1: BFR- chemical precipitation – active carbon filtration (EBFRIP-VECAP, 2006)

- The example relates to the treatment of a specific partial flow containing BFR, which is treated separately using a number of waste purification techniques.
- The wastewater is collected in a buffer drum. Al or Fe salt is added at a pH of 7. The silt that sinks is transported via a disposal channel at the bottom of the buffer drum. The floating top layer is further treated using a thimble filter and an active carbon filter
- In this specific example, and under current environmental permit conditions (manual pH monitoring, capacity of 5 m³/day), a BFR end concentration of <3 µg/l is reported. However, no information is available about the initial BFR load in the wastewater.
- The investment cost for such a system is estimated at € 50,000 – €75,000.

[213] Chemical oxidation can be implemented for the removal of phenols. Currently (2010), there are no concrete examples for the use of chemical oxidation for the removal of NFn/NPE from textile wastewater and about achievable removal yields.

[214] If implemented in the laundry sector, this technique should also result in the reduction of PAH. Removal yields are unknown (Van den Abeele L., 2009).

Example 2: BFR – ultra-filtration – reverse osmosis (EBFRIP-VECAP, 2006)

- This example relates to the treatment of BFR-based wastewater in the textile industry.
- The wastewater passes through a UF installation (2 membranes, with pore sizes of approximately 0.01 µm). The released concentrate is re-used in the production process. The permeate released from the UF installation then passes to an RO installation. The concentrate and the formed demi-water are re-used in the production process.
- The investment cost for such a system is estimated at € 70,000 – € 90,000.

Example 3: HBCD – membrane bio-reactor (MBR) – active carbon filtration (EBFRIP-VECAP, 2009b and c)

- This example concerns the removal of HBCD from wastewater in the bromine sector, using an MBR. MBR is implemented in combination with pre-filtration (active carbon filtration).
- The untreated wastewater contains approximately 20,000 µg of HBCD per litre.
- After purification, concentrations less than 0.1 µg of HBCD per litre (typical values up to 0.02 µg/l) are found in the wastewater.
- The cost price for this wastewater purification system is estimated at in excess of € 200,000.
- For small/medium-sized textile companies, investments costs for an MBR for removing BFR from wastewater are deemed disproportionate to the realised environmental result.

Example 4: Sb_2O_3 *– sand filtration in combination with coagulation and flocculation* (i2a, 2009a)

- This example outlines the various steps implemented by a large European producer of antimony trioxide for the removal of e.g. antimony from wastewater.
- After collection (sand and fat collection, and pumping pit) and buffering (approximately 2,500 m^3), the wastewater is neutralised using natrium hydroxide or sulphuric acid.
- Thereafter, coagulation (using iron trichloride, 40% solution), neutralisation (using natrium hydroxide or sulphuric acid) and flocculation (using ploy-electrolyte) are carried out.
- From the sedimentation treatment, the settleable floccules are pumped away and treated further via silt thickening (up to approx. 4% ds) and silt drainage (up to approx. 25% ds).
- The purified water that is released during post-sedimentation still contains a small fraction of suspended particles (iron floccules to which heavy metals are bonded) which could still leave heavy metals on the surface or block pipes and sprayers when the water is re-used. The water is passed over a sand bed to remove remaining suspended matter from the wastewater. This sand is regularly cleaned by the counter-flow. The sand must be replaced after long-term use.
- The Sb purification yield of a sand filter varies depending on the initial concentration of this substance in the wastewater. In general, the removal yield for this parameter can be estimated at 50%.

Example 5: NP/NPE – active carbon filtration in combination with coagulation and flocculation (An, 2009c)

- This examples concerns the removal of e.g. alkylphenol ethoxylates (APEO) using active carbon filtration, preceded by physico-chemical wastewater purification.
  comment
  Active carbon filtration is used in the company for the removal of mono-aromatic hydrocarbons (primarily styrene). However, APEO also bond with the (non-selective) active carbon.
- The wastewater (150-200 m^3/day) is physico-chemically purified in advance by adding iron trichloride and poly-electrolyte. Part of the organic matter (e.g. 10-60% COD[215]) is thus removed from the wastewater (up to concentrations of 0.2 to 0.6 ppm).
- The pre-treated wastewater then passes through an active carbon system. Because part of the organic matter has already been removed from the wastewater, the active carbon will not unnecessarily become saturated with these organic compounds, and there will be more 'places' in the active carbon unit for e.g. APEO.
- This active carbon installation consists of two units in a series set-up, each with 7 tonnes of active carbon. The principle of the series set-up is as follows: wastewater with the highest APEO concentration first passes through active carbon drum 2 then through active carbon drum1 (also see Figure 10). If the to-be-absorbed component breaks through in active carbon drum 1, then this will be further identified as active carbon drum 2 (see step 2) for further extraction. The original active carbon drum 2 is disposed of (see step 1) and a fresh carbon-holder is placed as active carbon drum (see step 3). The exchange of active carbon drums takes place in collaboration with the supplier of the active carbon system. The APEO removal yield of the active carbon installation is reversely proportionate with the level of saturation in the active carbon (retention time of the active carbon installation). For example, 100% removal yield for fresh active carbon and 50% after a retention time of 50 days.
  > *comment*
  > In addition to placing active carbon units in series et-ups, the retention time of the active carbon installation can be further optimised (e.g. extended up to 3 months) by aerating the active carbon.
- After buffering, the wastewater is discharged via a WWTP, where it is further purified e.g. biologically.

215 www.emis.vito.be/WASS

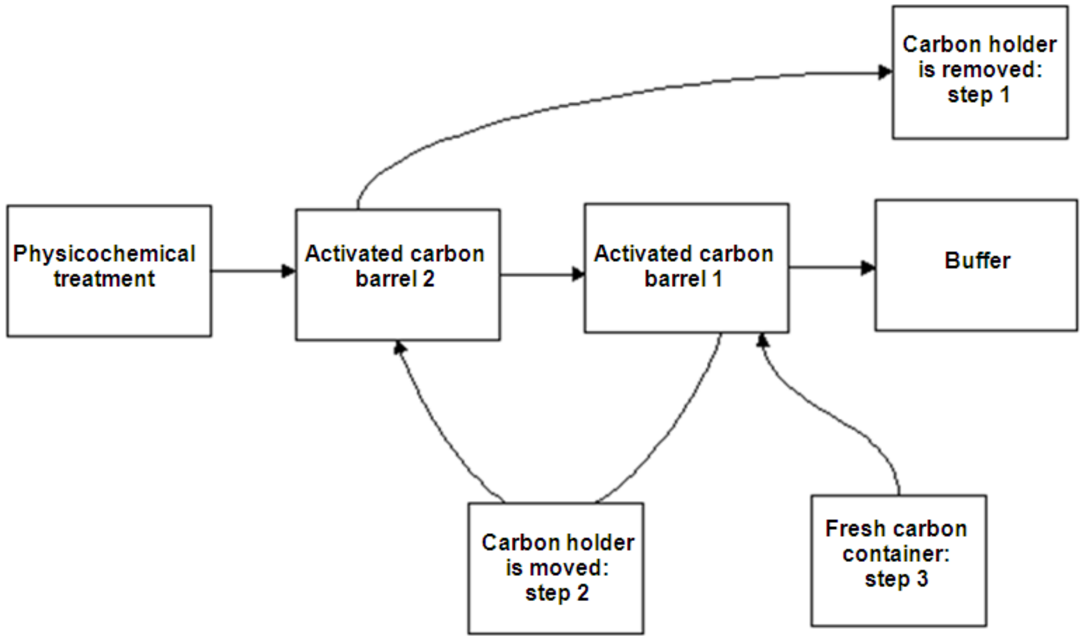

Figure 10: Schematic diagram of set-up and operation of active carbon system in series configuration

SOURCE: An., 2009c

- The cost price for exchanging the active carbon unit amounts to approximately € 13,000.
- By implementing this wastewater purification configuration with the specific environmental permit conditions of the concerned company (2009), an average APEO end concentration of 0.061 mg/l can be realised (range <0.040-<0.099 mg/l). The share of nonylphenol ethoxylate amounts to 0.023 mg/l (range <0.01-0.068 mg/l). In this case, 16 instant samples were analysed over a period of 8 months.

Example 6: PAH – ultra-filtration (Van den Abeele, 2009)

- This examples relates to the treatment of laundry wastewater using UF, which is placed on a washing tunnel for removing PAH and heavy metals.
- Tests demonstrate that the ultra-filtration membrane removes heavy metals and PAH from the water in the washing tunnel. The concentrate in which the heavy metals and PAH are found, is transported to a specialised processing company.
- However, no information is available removal yields and cost prices.

Comments

- There are no concrete examples for removal techniques and yields for the parameters PFOS and PFOA.
- Deca-BDE, HBCD, Sb_2O_3 and PAH bond with SM and silt.
- In the Netherlands, up to 910 µg/kg Deca-BDE was found in suspended matter at the AWZI.

- The following quantities of Deca-BDE and HBCD can be found in silt from wastewater purification in Europe:
  - Deca-BDE: < 0.1 - ± 8 000 µg/kg ds;
  - HBCD: < 0.3 - ± 9000 µg/kg ds.

Environmental impact
By appropriately treating industrial wastewater, by implementing a combination of suitable wastewater purification techniques, it is possible to limit the amount of impurities that enter the environment (soil, ground and/or surface water). If the purified wastewater is re-used, it is also possible to reduce the amount of fresh water. For particular wastewater purification techniques, energy is needed (e.g. aeration), waste is formed (e.g. silt that must be disposed of via an external processing company) and chemicals are required (e.g. physico-chemistry). Odour problems may be encountered if the wastewater purification installation does not function optimally.

Economical feasibility
The cost price for purifying the wastewater can vary greatly depending on the specific situation. The type, configuration and size of the wastewater purification installation, and thus also its cost price, are determined by e.g. the discharge situation (surface water versus sewer), the load of the wastewater (type and amount of pollution) and the to-be-treated volume.

The cost price for purifying the wastewater can be limited by implementing a number of measures (see earlier discussed BAT candidates):

- Prevent difficult to degrade compounds from entering the wastewater.
  examples
  - Use alternative chemicals that are less harmful to the AWZI and the environment;
  - Prevent partial flows containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA from entering the wastewater purification installation;
- Limit the amount of to-be-treated wastewater
  examples
  - Collect particular partial flows separately and treat specifically;
  - Limit the amount of rinse water for cleaning activities;
  - Dispose of partial flows via an external processing company (at an additional cost).

If the above mentioned boundary conditions for reducing the cost price for purifying wastewater, then this measure can generally be regarded as economically feasible for all textile companies.

Comments

- According to Centexbel (2009c) it is not economically feasible for individual textile companies to implement active carbon filtration if the company's general wastewater flow needs to be treated. In certain circumstances, active carbon filtration is economically feasible for textile companies when purifying specific partial flows.
- Centexbel (2009c) indicates that a number of textile companies (surface water dischargers) use sand filtration on the general wastewater flow for the removal

of e.g. COD and SM (situation September 2009). It is not advisable for textile companies that discharge into sewer to implement a sand filter. In this case, wastewater is not treated, or only to a limited extent using e.g. chemical precipitation.

- The BREF for textiles (EIPPCB, 2003a) select adsorption using active carbon as tertiary treatment after a biological treatment for treating concentrated wastewater flows that contain non-biologically degradable compounds which cannot be treated separately.
- Active carbon is regarded as a BAT for tank cleaning companies that also clean chemicals and/or process external wastewaters.
- Active carbon filtration is also selected as a BAT for drum cleaning, when treating partial flows that must be discharged.

References

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CHAPTER 5 SELECTION OF BEST AVAILABLE TECHNIQUES (BAT)

This chapter evaluates the environment-friendly techniques addressed in chapter 4, in terms of their technical feasibility, environmental impact and economical feasibility, and states whether the mentioned environment-friendly techniques can be regarded as BAT for the textile industry.

The techniques selected as BAT in this chapter, are considered as BAT for the textile industry, available for an average textile company. However, this does not mean that every company in the sector will be able to automatically implement each technique regarded as a BAT. Company-specific circumstances must also be taken into consideration.

The BAT selection in this chapter cannot be used as a standalone indicator, but must be seen in the general framework of the study. This means that one must consider the description of environment-friendly techniques in chapter 4 as well as the translation of BAT into recommendations and proposals for environmental legislation, in chapter 6.

5.1 Introduction

Table 28 evaluates the available environment-friendly techniques from chapter 4 using different criteria. This multi-criteria analysis makes it possible to evaluate whether or not a technique can be regarded as a Best Available Technique (BAT). The criteria not only relate to the different environmental compartments, but also address technical feasibility and the economic factors that must be considered. This makes it possible to make an integrated evaluation, according the definition of BAT (cf. Chapter 1).

Information about the criteria contents can be found in Table 28.

Technical feasibility

Proven: Indicates whether the technique has proven its worth in industrial practice (“-”: unproven; “+”: proven)

Safety: Indicates whether the technique results in an increased risk of fire, explosion and employment accidents in general, when safety measures are correctly implemented (“-”: increased risk; “0”: risk not increased; “+”: reduced risk);

Quality: Indicates whether the technique has an impact on the quality of the end product (“-”: reduces quality; “0”:no effect on quality; “+”: increases quality)

General: Estimates the general technical feasibility of the technique (“+”: “+” or “0” above; “-”: at least one of the above “-”).

Environmental benefit

Water consumption:	Re-use of wastewater and limitation of total water consumption;
Wastewater:	Introduction of polluted substances into the water, due to the plant being operated;
Air:	Introduction of polluted substances into the atmosphere, due to the plant being operated;
Soil:	Introduction of polluted substances into the soil and groundwater, due to the plant being operated;
Waste:	Prevention and management of waste flow;
Energy:	Energy savings, use of environment-friendly energy sources and re-use of energy;
Chemicals:	Impact on used chemicals and the quantity;
General:	Estimated impact on the environment as a whole.

For each technique, a qualitative evaluation is given for each of the criteria above, whereby:

- "-": Negative effect;
- "0": No/negligible impact;
- "+": Positive effect;
- "+/-": Sometimes positive effect, sometimes negative effect.

Economic evaluation

- "+": The techniques helps to save costs;
- "0" The technique has a negligible impact on costs;
- "-": The technique results in increased costs; additional costs are deemed feasible for the sector (i.e. for an average company) and are reasonable in proportion to the realised environmental benefit;
- "- -": The technique results in increased costs; the additional costs are deemed unfeasible for the sector (i.e. for an average company) or are not reasonable in proportion to the realised environmental benefit;

Finally, the last column contains an evaluation for whether the technique in question can be selected as a best available technique (**BAT: *yes*** or ***BAT: no***). Where this is greatly determined by the company and/or local conditions, **BAT: *fctc*** (from case to case) will be mentioned as evaluation.

The process followed for BAT selection has been presented schematically in Figure 11:

The first step involves examining whether the technique (the so-called "candidate BAT") is technically feasible, where the quality of the product and safety are taken into account (step 1).

If the technique is economically feasible, the effect on the various environmental compartments is examined (step 2). A general environmental evaluation can be made by weighing up the effects on the various environmental compartments. The following elements are taken into consideration when determining the latter:

If there are one or more positive environmental scores and not negatives, then the general effect is always positive;

If there are positive and negative scores, then general environmental effect will be determined by the following elements:

- The shift from a more difficult to control compartment to an easier to control compartment (e.g. from air to waste);
- Relatively large reduction in one compartment compared with increases in other compartments;
- The policy objective to realise reduction; incl. derived from the environmental quality standards for water, air, ... (for example, “distance-to-target" approach).

If the general environmental effect is positive, it is examined whether the technique will be accompanied by extra costs, whether these costs are reasonable in proportion with the realised environmental benefit, and are feasible for an average company in the sector (step 3).

Candidate BAT that cannot be combined with one another (because combination is not possible or is pointless) are compared against each other, and only the best is regarded as candidate BAT (step 4).

Finally, it is evaluated whether the technique in question can be regarded as a best available technique (BAT) (step 5). A technique is a BAT if it is technically feasible, improves the environment (in general), is economically feasible (evaluation “-“ or higher) and if there is not a “better” candidate BAT. If this is greatly determined by the company and/or local conditions, boundary conditions can be set for BAT selection.

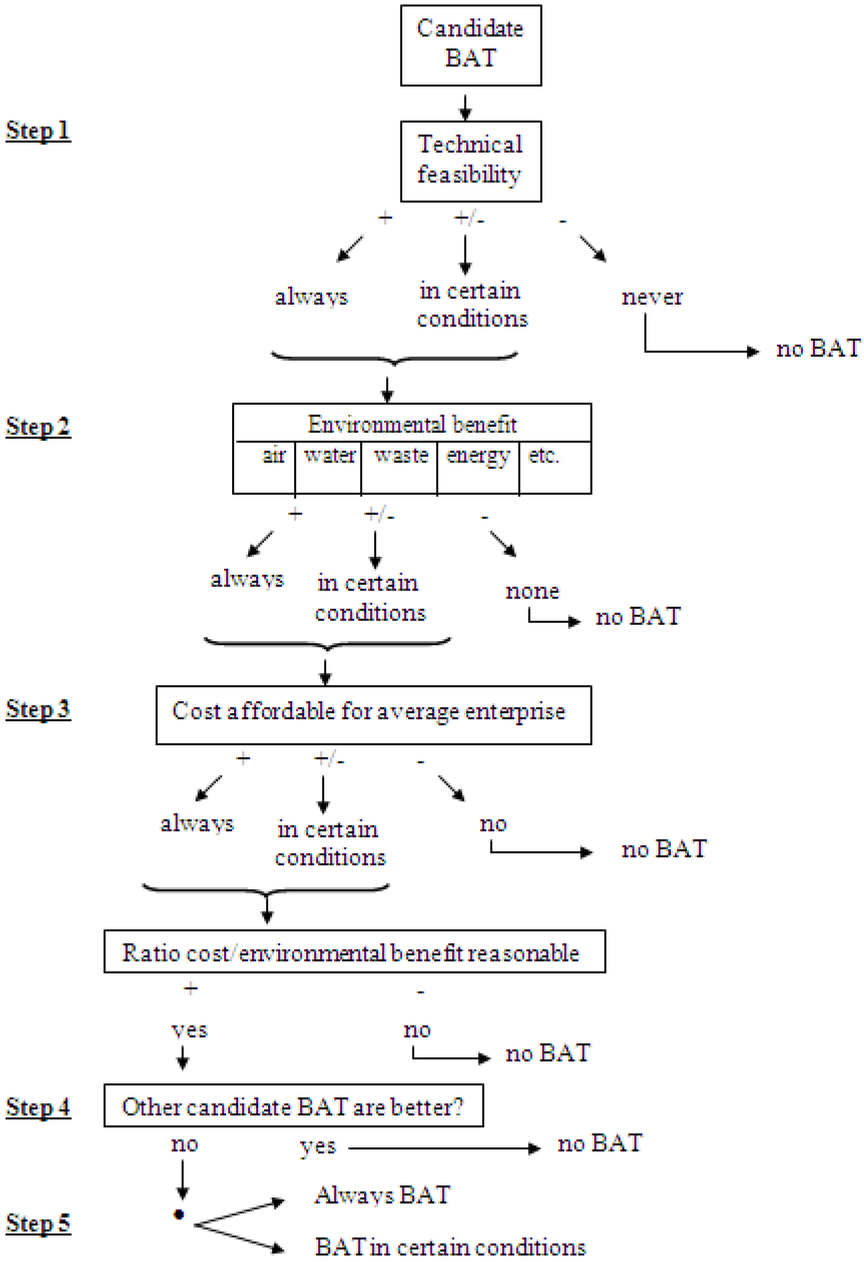

Figure 11: Selecting BAT based on scores for the various criteria

Important comments when using Table 28:

When using the table below, one should not forget the following points:

Evaluation of the various criteria is partly based on:

- Experience of operators with this technique;
- BAT selections carried out in other (international) comparable studies;
- Advice given by management committee.
- Evaluation by the authors

Wherever necessary, extra information will be provided in a footnote. For an explanation of the criteria and the scores, please refer to paragraph 5.1.

Evaluation of the criteria must be regarded as indicative, and does not necessarily apply in every individual case. The evaluation in no way releases an operator from his/her responsibility to e.g. investigate whether the technique is technically feasible in his/her specific situation, does not risk safety, does not cause unacceptable environmental problems or is accompanied by excessive costs. When evaluating a technique, it has always been assumed that appropriate safety/environment protection measures have been taken.

The table cannot be used as a standalone indicator, but must be seen in the general framework of the study. This means that one must consider the description of environment-friendly techniques in chapter 4 as well as the translation of table into recommendations and definitions for environmental legislation, in chapter 6.

The table provides a general evaluation for whether or not the environment-friendly techniques in question can be regarded as BAT for the textile industry. However, this does not mean that every company in the sector will be able to automatically implement each technique regarded as a BAT. Company-specific circumstances must also be taken into consideration.

5.2 Evaluation of the available environment-friendly techniques

Table 28: Evaluation of the available environment-friendly techniques and selection of the BAT

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Make agreements with suppliers of purchased tissues and yarns concerning the chemicals used, and their quantities, on the tissues and yarns	+[216]	0	0	+	+	0	0	0	0	0	0	+	0/-[217]	yes
Make agreements with suppliers of formulations concerning the composition of chemicals	+[218]	0	0	+	+	0	0	0	+	0	+	+	+	yes

[216] This measure is technically feasible for integrated textile companies, certainly for chemical substances that are part of legal determinations (e.g. REACH or product norms). More difficult to realise in a job-processing company than an integrated textile company, mainly if many different types of tissues, from many different suppliers, are processed.

[217] The measure could increase costs if a more expensive supplier is selected.

[218] This measure is technically feasible for integrated textile companies, certainly for chemical substances that are part of legal determinations (e.g. REACH or product norms). More difficult to realise in a job-processing company than an integrated textile company, particularly if many different types of enrichment processes are implemented and thus many different formulations from various suppliers are used.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Make agreements with suppliers of formulations concerning the return of left-over chemical	+/-[219]	0	0	+[220] / -[221]	+	0	0	0	+	0	+	+	+/0/-[222]	fctc[223]
Optimise production planning	+[224]	0	0	+	+	+	0	0	+	+	+	+	+	yes
Use environment-friendly alternative chemicals for finishing activities wherever possible to replace:														

[219] More difficult to realise in a job-processing company than an integrated textile company, certainly if many different types of enrichment processes (smaller volumes) are implemented and thus many different formulations from various suppliers are used. Job-processing companies are advised to dispose of chemical residues via a qualified processing company. In principle, this measure is technically feasible for integrated companies (large volumes, limited number of suppliers), if it can be guaranteed that returned products are not contaminated.

[220] Technically feasible for integrated textile companies

[221] Not technically feasible for job-processing companies

[222] In certain cases, the return of chemical residues by the supplier is accompanied by extra costs.

[223] BATs for integrated textile companies. No BAT for job-processing companies; for job-processing companies, the BAT entails disposing of chemical residues via a qualified processing company (see candidate BATs: Store waste residues containing BRF,, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company)

[224] More difficult to realise in a job-processing company than an integrated textile company.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Deca-BDE	+/-[225]	0	0	+/-	+/-[226]	0	0	0	0	0	-[227]/0	+/-[228]	0/-[229]	fctc[230]

[225] Substitution possibilities for Deca-BDE are rather limited and greatly determined by the specific application. For example, organic phosphorous compounds can be used as alternatives for Deca-BDE in the production of mattress textiles. Possible bottlenecks when replacing Deca-BDE with alternatives in textile applications, include: changing the fire-resistant mechanism, changing the properties of the textile (e.g. hardness, plasticity); the requirements for fire-resistant properties of top quality applications (e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market); it remains necessary to use a (smaller) quantity of Deca-BDE when implementing certain alternatives (e.g. chlorinated paraffins or melamine); possible shift in environment problem (e.g. organic phosphorous compounds are not broken down in the AWZI, feasibility of the P norm). The implementation of alternatives for Deca-BDE is often more technically difficult for job-processing companies than integrated companies.

[226] Alternative chemicals could achieve equally negative environment scores. In many cases, no or very little research has been done into the environmental impact and health risks of alternative chemicals.

[227] In specific cases, a large amount of alternative chemicals is needed to achieve the same effect.

[228] The overall environmental impact of this measure is greatly determined by the specific application.

[229] If more product is need to achieve the same effect or if 1 product is replaced by a combination of substitutes, this could be accompanied by sharp cost increases. The economical feasibility of alternatives is determined by the specific application (for example, the additional cost of alternatives could be a factor 2 or 2.5).

[230] BAT depending on feasibility of more environment-friendly alternatives (for example, BAT for making mattress textiles fire-resistant, but not BAT for realising fire-resistant properties in high quality applications in e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market) and the specific situation at the company (for example, BAT for integrated textile companies, not BAT for job-processing companies).

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
HBCD	+[231]	0	0	+	+/-[232]	0	0	0	0	0	-[233]/0	+/-[234]	0/-[235]	fctc[236]
PFOS and PFOA	+/-[237]	0	0	+/-	+	0	0	0	0	0	-[238]/0	+/-	0/-[239]	fctc[240]

[231] For the main part, HBCD can be substituted. The implementation of alternatives for HBCD is often more technically difficult for job-processing companies than integrated textile companies. Alternatives for HBCD in niche applications include, for example, chlorinated paraffins. However, a (small) quantity of HBCD is still used when chlorinated paraffins are implemented. HBCD only continues to be required for a limited number of specific applications (e.g. supple transparent materials).

[232] Alternative chemicals could achieve equally negative environment scores. In many cases, no or very little research has been done into the environmental impact and health risks of alternative chemicals.

[233] In specific cases, a larger amount of alternative chemicals is needed to achieve the same effect. A (small) quantity of HBCD is still used when chlorinated paraffins are implemented.

[234] The overall environmental impact of this measure is greatly determined by the specific application.

[235] If more product is need to achieve the same effect or if 1 product is replaced by a combination of substitutes, this could be accompanied by sharp cost increases. The economical feasibility of these alternatives is greatly determined by the specific situation.

[236] BAT, except for a limited number of applications, like supple transparent materials.

[237] There are a number of substitutes (e.g. PFBS) on the market as alternatives for PFOS and/or PFOA in particular textile applications. A technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned). The use of alternatives for PFOS and/or PFOA is more feasible if the textile only needs to have one particular characteristic (e.g. only water-proof). Additional tests in the textile industry must indicate whether e.g. PFBS can be used as fully fledged alternatives for PFOS and/or PFOA in the textile industry.

[238] In specific cases, a larger amount of alternative chemicals is needed to achieve the same effect.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
NP/NPE	+[241]	0	0	+	+	0	0	0	0	0	-[242]/0	+	0/-[243]	fctc[244]
PAH	+[245]	0	0	+	+	0	0	0	0	0	-[246]/0	+	0/-[247]	fctc[248]
Modify and/or optimise the production process	+[249]	0	0	+	0/+	0/+	0/+	0/+	0/+	0/+	+	+	0/-[250]	yes

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239 The economical feasibility of these alternatives is greatly determined by the specific situation.

240 BAT, if the required (combination of) textile properties can be achieved.

241 Alcohol ethoxylates (AE) are quasi-perfect substitutes for NPE in products used in the textile industry..

242 In specific cases, a larger amount of alternative chemicals is needed to achieve the same effect.

243 The economical feasibility of these alternatives is greatly determined by the specific situation.

244 BAT, if products containing more environment friendly alternatives (e.g. AE as replacement for NFn/NPE), are available on the market.

245 PAH-based mineral oils can also be perfectly replaced by synthetic oils.The use of PAH-based carriers when dying textiles can be avoided and/or limited by using carrier-free colorants and dyes and/or by implementing HT dying equipment, except in the presence of wool (e.g. in combination with polyester fibres or with elastane).

246 In specific cases, a larger amount of alternative chemicals is needed to achieve the same effect.

247 The economical feasibility of these alternatives is greatly determined by the specific situation.

248 BAT, if more environment friendly alternatives (e.g. synthetic oils as replacement for mineral oils) are available on the market, or if carrier-free colorants and dyes and/or HT dying equipment can be implemented (not in the presence of wool, e.g. in combination with polyester fibres or with elastane).

249 Process modification may be more technically complex in existing installations than in new production lines.

250 The economical feasibility of this technique is greatly determined by the implemented measures.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Characterise released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal	+[251]	0	0	+	+	0	0	0	+	0	0	+	0/-[252]	yes
Collect exhausted process baths and dispose via a qualified processing company														
Deca-BDE, HBCD and Sb_2O_3	+	0	0	+	+	0	0	0	0	0	+	+	-	yes
PFOS and PFOA	+	0	0	+	+	0	0	0	0	0	+	+	-	yes
NP/NPE	n/a	0	0	n/a										n/a
PAH	n/a	0	0	n/a										n/a
Recuperate maximum amount of chemical surpluses	+[253]	0	0	+	0	0	0	0	+	0	+	+	+	yes[254]

[251] The final design of this measure is determined by the specific situation; the required attention must be given to safeguarding the quality of sampling and analysis

[252] The cost price of this measure is determined by the final design at company level.

[253] The final design of this measures is determined by the specific company situation. It will thus be more technically difficult to implement this measure for just-in-time production and for the enrichment of smaller batches. Biological degradation and development of e.g. algae (green) could occur if chemical leftovers are stored (for long periods) The recuperation of chemical residues (e.g. via displacement) is not always possible in existing installations. However, the required features can be added to new machines.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Wherever possible, remove solid residues dry	+[255]	0	0	+	+	+	0	0	-/0	0	+	+	0	yes
Empty chemical packaging properly dry, do not rinse with water, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier	+[256]	0	0	+	+	+	+	+	+	0	+	+	+[257]/-[258]	yes
Use dry cleaning method on process baths before rinsing them with water	+[259]	0	0	+	+	+	0	0	0	0	0	+	0/+	yes
Rinse process baths with a minimum amount of water	+	0	0	+	+	+	0	0	0	0	+	+	0	yes

[254] There is a second option if it is not possible to re-use these chemical surpluses in the production process: the supplier returns the chemical surpluses. However, this requires appropriate agreements to be made with the supplier (upstream). If the chemical leftovers cannot be returned to the chemical supplier, there is also a third option: disposal via a qualified processing company.

[255] Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA are the most relevant parameters.

[256] Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA are the most relevant parameters.

[257] Savings can be made in the cost price of chemicals that are recuperated by dry-emptying packaging.

[258] However, additional costs may be encountered when disposing of this packaging via a qualified processing company or via the chemicals supplier.

[259] Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA are the most relevant parameters.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
Keep the amount of rinse water in cleaning activities to a minimum	+	0	0	+	+	+	0	0	0	0	+[260]	+	0	yes
Wherever possible, re-use rinse waters from process baths in the production process														
Deca-BDE, HBCD and Sb_2O_3	+[261]	0	0	+	+	0	0	0	0	0	+	+	-	yes
PFOS and PFOA	+[262]	0	0	+	+	0	0	0	0	0	+	+	-	yes
NP/NPE	n/a	0	0	n/a										n/a
PAH	n/a	0	0	n/a										n/a
Dispose of rinse waters from process baths via a qualified processing company														
Deca-BDE, HBCD and Sb_2O_3	+	0	0	+	+	0	0	0	0	0	+	+	-	yes[263]

[260] when implementing cleaning products and/or disinfectants

[261] if production planning is possible (more difficult in job-processing companies than in integrated textile companies) and contamination of enrichment chemicals and reactions between chemicals can be avoided.

[262] if production planning is possible (more difficult in job-processing companies than in integrated textile companies) and contamination of enrichment chemicals and reactions between chemicals can be avoided.

[263] BAT if production planning does not enable rinse waters from process baths to be re-used in the production process;

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
PFOS and PFOA	+	0	0	+	+	0	0	0	0	0	+	+	-	no[264]
NP/NPE	n/a	0	0	n/a										n/a
PAH	n/a	0	0	n/a										n/a
Store waste residues containing Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company	+	0	0	+	+	0	0	+	0	0	0	+	-	yes
Appropriately treat industrial wastewater by implementing a combination of suitable waste purification techniques														
Deca-BDE, HBCD and Sb_2O_3	+[265]	0	0	+	+	0/+[266]	-[267]/0	+	-[268]/0	-[269]/0	-[270]/0	+	--/-[271]	fctc[272]

[264] Not a BBT if applicable legal requirements are complied with (e.g. sector norms for PFOS, PFOA and some PFT excluding PFOS and PFOA in VLAREM II, appendix 5.3.2.44°).

[265] The to-be-implemented wastewater purification techniques must be determined at company level, depending on the specific situation (e.g. discharge situation, load in wastewater, to-be-treated volume). Examples of techniques that can be implemented for the removal of Deca-BDE and HBCD from the wastewater of textile companies, can be found in Table 27.

[266] If the purified wastewater is re-used in the production process.

[267] Odour problems may be encountered if the wastewater purification installation does not function optimally.

[268] Waste (e.g. silt) is formed in certain wastewater purification techniques (e.g. chemical precipitation).

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
PFOS and PFOA	?[273]	0	0	?										fctc[274]
NP/NPE	+[275]	0	0	+	0/+[276]	+	-[277]/0	0	-[278]/0	-[279]/0	-[280]/0	+	-[281]	fctc[282]

269 Energy is required in particular wastewater purification techniques.

270 Chemicals are needed in particular wastewater purification techniques (e.g. chemical precipitation).

271 The cost price for purifying industrial wastewater can vary greatly depending on the specific situation. If the treatment of the entire wastewater flow is not economically feasible, then it may be possible to specifically treat a particular partial flow.

272 Wastewater that contains Deca-BDE, HBCD and/or Sb_2O_3 must be eradicated from the AWZI wherever possible. This can be done by e.g. characterising released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal, collecting exhausted process baths and disposing of them via a qualified processing company, and re-using rinse waters from process baths in the production process wherever possible or disposing via a qualified processing company. If this is insufficient to reduce the concentrations in the wastewater to an acceptable level (see recommendations, paragraph 6.1), the BAT is to use a modified AWZI (possibly partial flow treatment) so that enough Deca-BDE, HBCD and/or Sb_2O_3 is removed from the wastewater.

273 Source-oriented measures (e.g. substitution) and process-integrated measures (e.g. divert as much wastewater containing PFOS and/or PFOA way from the AWZI; this can be done by, e.g. characterising released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal, collecting exhausted process baths and disposing of them via a qualified processing company, and re-using rinse waters from process baths in the production process) are known to be sufficient to meet applicable environmental requirements. Currently (2010), there are no known techniques for the removal of PFOS and PFOA from the wastewater of textile companies (also see Table 27)

274 The applicable norms in 2010 for the parameters PFOS and PFOA are the driving force to replace these substances wherever possible; e-o-p techniques are less necessary for this parameter group; currently (2010), there are no known problems for complying with PFOS/PFOA norms in the sector.

Technique	Technical				Environment									
	Proven	Safety	Quality	General	Wastewater	Water	Air	Soil	Waste	Energy	Chemicals	General	Cost feasibility and cost-effectiveness	BAT
PAH	+[283]	0	0	+	0/+	+	-/0	0	-/0	-/0	-/0	+	-[284]	fctc[285]

[275] The final design of the AWZI configuration must be determined at company level. Examples of techniques that can be implemented for the removal of NFn/NPE from wastewater in the textile industry, can be found in Table 27.

[276] If the purified wastewater is re-used in the production process.

[277] Odour problems may be encountered if the AWZI does not function optimally

[278] Waste (silt) is formed when particular wastewater purification techniques are used.

[279] Certain wastewater purification techniques require energy.

[280] Certain wastewater purification techniques require the use of chemicals.

[281] The cost price of wastewater can vary greatly depending on the type, design and size of the wastewater purification system.

[282] If source-oriented measures, as well as process-integrated measures, cannot be implemented or are insufficient to reduce concentrations in the wastewater to an acceptable level (see recommendations, paragraph 6.1) then end-of-pipe techniques will be needed. This could relate to specific partial flows, e.g. wash-waters from tissues and yarns.

[283] The final design of the AWZI configuration must be determined at company level. Examples of techniques that can be implemented for the removal of PAHs from the wastewater of textile companies, can be found in Table 27.

[284] The cost price of wastewater can vary greatly depending on the type, design and size of the wastewater purification system.

[285] f preventive and process-integrated measures are not enough to reduce PAH concentrations in the wastewater to an acceptable level (see recommendations, paragraph 6.1, (tertiary) end-of-pipe techniques are advised. However, these measures are primarily suited for wastewaters that have already been subject to biological purification. Thus end-of-pipe wastewater purification techniques are of little use to textile companies that discharge into the sewer. However, disconnection can be considered. Thus it is best for textile companies that discharge into the sewer to address the PAH problem in a preventive manner. That said, it is currently (2010) unclear whether maximum use is being made of such measures and which PAH concentrations can be achieved. PAK concentrations in the wastewater of textile companies that discharge into the sewer could possibly be higher than textile companies that discharge into surface water, because part of the PAH present in the wastewater are removed during biological purification.

5.3 BAT conclusions

The following conclusions can be formulated based on Table 28. The BAT that apply to all textile companies have been listed in paragraph 5.3.1. Additional BAT for textile companies with specific wastewaters can be found in paragraph 5.3.2.

5.3.1 General BAT

The following 14 techniques have been selected for all textile companies that fall within the scope of this BAT study:

- Making agreements with suppliers of purchased tissues and yarns concerning the chemicals used, and their quantities, on the tissues and yarns.
  Comments
  - No measurement data is available about the types of chemicals that enter Flemish textile companies via purchased tissues and yarns.
  - The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
    - Selection of incoming textile raw materials: establish contacts between raw material suppliers and processors so that an environment-conscious chain is created, whereby information is exchanged by the type and load of chemicals applied to the textile material and left behind in every step of the life cycle (reference in BREF: paragraphs 5.1 and 4.2).
    - Select wool yarns spun with biologically degradable spinning oils instead of formulations based on mineral oils and/or those containing alkylphenol ethoxylates (reference in BREF: paragraphs 5.1 and 4.2.2).
    - Selected knitting products treated with water soluble and bio-degradable oils instead of conventional mineral oils (reference in BREF: paragraphs 5.2.2 and 4.2.3).

- Making agreements with suppliers of formulations concerning the composition of chemicals.

- Optimise production planning
  comment
  The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
  - Optimise production planning and make prior processes compatible with quality requirements of downstream processes (reference in BREF: paragraphs 5.1 and 4.1.1).
  - Reducing the quantity of created colorant by, for example, noting the quantity required per batch and using it as a reference, or by using optimised colorant formulations (reference in BREF: paragraphs 5.2.2 and 4.6.7).

- Use environment-friendly alternative chemicals for finishing activities wherever possible.
  Comments
  - This measure is primarily aimed at further phasing out and/or ending the use of particular environmentally harmful substances (incl. priority dangerous substances). A summary can be found in Table 29.

Table 29: Determinations concerning further phasing out and/or ending the use of some environmentally-harmful substances

Parameter group	parameter	Determinations	Applicable legislation	Applicable agreements
BFRs	Deca-BDE	Discharge ban for process baths that contain BFR; Agreements to limit emissions of Deca-BDE	VLAREM II, article 5.41.1.5	VECAP
	HBCD	included in the candidates list of very concerning substances (SVHC[286]) for inclusion in appendix XIV of REACH; Discharge ban for process baths that contain BFR	appendix XIV of REACH; VLAREM II, article 5.41.1.5	VECAP
synergist	antimony	Discharge ban for process baths that contain antimony	VLAREM II, article 5.41.1.5	
PFT	PFOS	Limit on using and bring particular dangerous substances and preparates on to the market	appendix XVII of REACH; PFOS guidelines; VLAREM II, article 4.1.11.8	
	PFOA	Agreements to voluntarily phase out the production and/or use of PFOA (by 95% by 2010) and complete stop by 2015		PFOA Steward Program
NP/NPE	nonylphenol	Identified as priority dangerous substance; limits on the production, trade and	appendix X of DPS[287]; Appendix XVII of	

[286] Substances of Very High Concern

[287] Priority Substances Co-guidelines (also see paragraph 2.4.3.g)

		use of particular dangerous substances, mixes and objects.	REACH	
	Alkylphenol ethoxylates	Must be replaced as much as possible	VLAREM II, chapter 5.41 (textile sectoral conditions)	
	Nonylphenol ethoxylate	limits on the production, trade and use of particular dangerous substances, mixes and objects. Must be replaced as much as possible	Appendix XVII of REACH; VLAREM II, chapter 5.41 (textile sectoral conditions)	
PAH	anthracene	included in the candidates list of very concerning substances (SVHC[288]) for inclusion in appendix XIV of REACH; Identified as priority dangerous substance;	appendix XIV of REACH; appendix X of DPS; contents of list III in appendix 2C of VLAREM I	
	fluoranthene	Not (or no longer) identified as priority dangerous substance as indicator for other more dangerous PAH	Appendix X of DPS	
	naphthalene	Not (or no longer) identified as priority dangerous substance	Appendix X of DPS	
	Benzo(a)pyrene;	Identified as priority dangerous substance	appendix X of DPS; content of list III in appendix 2C of VLAREM I	
	benzo(b)fluoranthene;	Identified as priority dangerous substance	appendix X of DPS; content of list III in appendix 2C of VLAREM I	

[288] Substances of Very High Concern

	Benzo(ghi)perylene;	Identified as priority dangerous substance	appendix X of DPS; content of list III in appendix 2C of VLAREM I	
	benzo(k)fluoranthene;	Identified as priority dangerous substance	appendix X of DPS; content of list III in appendix 2C of VLAREM I	
	indeno(1,2,3-cd)pyrene	Identified as priority dangerous substance	appendix X of DPS; content of list III in appendix 2C of VLAREM I	

- It is currently (2010) very possible to substitute a number of substances.
  - For the main part, HBCD can be substituted. Alternatives for HBCD in niche applications include, for example, chlorinated paraffins (though not the short chain type[289]). However, a (small) quantity of HBCD is still used when chlorinated paraffins are implemented. HBCD only continues to be required for a limited number of specific applications (e.g. supple transparent materials).
  - Alcohol ethoxylates (AE) are quasi-perfect substitutes for NPE in products used in the textile industry.
  - Technically, PAH-based mineral oils can also be perfectly replaced by synthetic oils. The use of PAH-based carriers when dying textiles can be avoided and/or limited by using carrier-free colorants and dyes and/or by implementing HT dying equipment, except in the presence of wool (e.g. in combination with polyester fibres or with elastane).

- Currently (2010), substitution possibilities are still very limited for some substances, namely Deca-BDE. Even so, the use of alternatives to replace Deca-BDE is greatly determined by the specific application. For example, organic phosphorous compounds can be used as alternatives for Deca-BDE in the production of mattress textiles. Possible bottlenecks when replacing Deca-BDE with alternatives in textile applications, include:
  - Change in fire-resistant mechanism;
  - Change in properties of the textile (e.g. hardness, plasticity);
  - Requirements for fire-resistant properties in high quality applications (e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market);

[289] Short chain paraffins (C10-13) are mutagenic and toxic for the reproduction function, and feature in the proposed candidate list of SVHC for inclusion in appendix XIV of REACH

  - More chemicals needed to realise the same fire-resistant properties in the textile;
  - Remains necessary to use a (small) quantity of Deca-BDE when implementing particular alternatives (e.g. chlorinated paraffins or melamine).
  - Additional cost of alternatives (e.g. factor of 2 to 2.5);
  - Possible displacement of environmental problems (e.g. organic phosphorous compounds are not broken down in the AWZI, realisation of P emission limit value).

- The substitution possibilities for a number of substances are currently (2010) being tested. There are a number of substitutes (e.g. PFBS) on the market as alternatives for PFOS and/or PFOA in particular textile applications. A technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned). Additional tests in the textile industry must indicate which chemicals can be used as fully fledged alternatives for PFOS and/or PFOA in the textile industry.

- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
  - Replace alkylphenol ethoxylates (APE) and other dangerous surface-active substances with substitution products that are easy to degrade biologically or bio-eliminate in the wastewater purification system, and which do not form toxic metabolites (reference in BREF: paragraphs 5.1 and 4.3.3).
  - In wool washing, replace detergents containing alkylphenol ethoxylates with alcohol ethoxylates or other easy to degrade products that do not form toxic metabolites (reference in BREF: paragraphs 5.2.1 and 4.3.3).
  - In pigment printing, use printing pastes that are APE-free and biologically removable (reference in BREF: paragraph 5.2.2).
  - Selected knitting products treated with water soluble and bio-degradable oils instead of conventional mineral oils (reference in BREF: paragraphs 5.2.2 and 4.2.3).
  - Avoid the use of dangerous carrier by, for example:
    - using polyester fibres that can be dyed without carriers (modified PET or PTT);
    - Dye at high temperatures without using carriers (not possible in polyester/wool and elastane/wool mixes);
    - replace traditional carriers with compounds based on benzylbenzoate and N-alkylftalimide in wool/polyester dyes;
    (reference in BREF: paragraphs 5.2.2, 4.6.1 and 4.6.2).

- Modify and/or optimise the production process.
  comment
  The textiles BREF (EIPPCB, 2003a) selects the following technique as BAT: Optimise production planning and make prior processes compatible with quality requirements of downstream processes (reference in BREF: paragraphs 5.1 and 4.1.1).

- Characterise released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal.
  Comments
  - Regular sampling and analysis (e.g. in monitoring programmes and with quality safeguards in sampling and analysis) provide an insight into the characteristics of the wastewater or liquid waste flows. Results from these analyses allow the right choices to be made when re-deploying the production process or the treatment, or when disposing of these flows.
  - The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
    - Characterise the various wastewater flows in the process (reference in BREF: paragraphs 5.3 and 4.1.2);
    - Separate collection of unavoidable waste flows (reference in BREF: paragraph 5.1);
    - Re-use rinse water in next dying process, or to re-configure, and re-use the paint bath if technically possible (reference in BREF): paragraphs 5.2.2 and 4.6.22).
    - Recycle process liquids for making fibre-painted/yarn-washed products moth-proof, or for dyed yarns between different batches, and use processes that remove active substances from bath leftovers (reference in BREF: paragraphs 5.2.2 and 4.6.22).
    - Separate the effluents at the source, based on the type and quantity of polluted substance, before mixing with other flows (so that the purification system only receives polluted substances that it is able to process) (reference in BREF: see paragraph 5.3).

- Recuperate maximum amount of chemical surpluses.
  Comments
  - There is a second option if it is not possible to re-use these chemical surpluses in the production process: the supplier returns the chemical surpluses. However, this requires appropriate agreements to be made with the supplier (upstream). If the chemical leftovers cannot be returned to the chemical supplier, there is also a third option: Disposal via a qualified processing company.
  - The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT:
    - Recuperation of printing paste by forcing paste in the pipes backwards using a bullet-shaped object (reference in BREF: paragraphs 5.2.2 and 4.7.5).
    - Do not discharge printing paste residue together with wastewater, but keep it in labelled drums and re-use (reference in BREF: paragraphs 5.2.2 and 4.7.6).

- Wherever possible, remove solid residues dry.

- Empty chemical packaging properly dry, do not rinse with water, store in an appropriate manner and dispose via a qualified processing company or via the chemicals supplier.
  Comments
  - It is important to keep an inventory of the IBCs. This is a method for following up the IBC cycle (formulator – textile company – drum cleaner – formulator).

- Sacks and big-bags containing chemicals in powder form must, after being emptied, packed in polyethylene sacks, covered and stored, while awaiting disposal via a qualified processing company.
  - To prevent the negative environmental impact of chemicals packaging from being displaced from the textile sector to other sectors (e.g. waste processing, drum cleaning), processing/cleaning must be carried out via qualified companies. These companies must, in turn, implement the BAT for the concerned sector(s).
  - The textiles BREF (EIPPCB, 2003a) selects the following technique as BAT: Use bulk containers and return packaging (reference in BREF: paragraph 5.1).
- The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

- Use dry cleaning method on process baths before rinsing them with water.
  comment
  The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

- Rinse process baths with a minimum amount of water.
  comment
  The most relevant parameters for this measure, are Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA.

- Keep the amount of rinse water for cleaning activities to a minimum.

- Store waste residues containing Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company.

- Appropriately treat industrial wastewater by implementing a combination of suitable waste purification techniques.
  Comments
  - Wastewater that contains Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA must be eradicated from the AWZI wherever possible. This can be done by e.g. characterising released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal, collecting exhausted process baths and disposing of them via a qualified processing company, and re-using rinse waters from process baths in the production process wherever possible or disposing via a qualified processing company. If this is not possible, the BAT is to configure the AWZI so that Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA are removed from the wastewater.
    - The wastewater purification techniques that can be used in the textiles industry for the removal of e.g. Deca-BDE and/or HBCD, include: Membrane bio-reactor (MBR), sand filtration and adsorption (e.g. active carbon filtration). Deca-BDE and/or HBCD could also be (partly) removed by implementing chemical precipitation, micro-, ultra-, or nano-filtration or reverse osmosis.

        - Sand filtration can be used for the removal of Sb_2O_3 from the wastewater of textile companies. This substance could also be (partly) removed by implementing MBR or chemical precipitation.
        - Deca-BDE, HBCD and Sb_2O_3 are not removed from the wastewater by implementing biological (main) purification. However, these substances do bond with e.g. suspended matter and silt in water.
        - There are no known wastewater purification techniques that are deployed specifically for the removal of PFOS and PFOA. Current knowledge suggests that source-oriented and process-integrated measures are enough to comply with applicable sectoral emission limit values.

    (also see Table 27, paragraph 4.2.3).
- Companies that implemented measures in the past to divert wastewater containing Deca-BDE, HBCD and Sb_2O_3 away from the AWZI, could now encounter after-effects. For example, Deca-BDE, HBCD and Sb_2O_3 could possible be re-released from e.g. silt and deposits in pipes and pumps, and thus enter the wastewater. Examples of wastewater purification techniques that can be used in the textiles industry for the removal of these parameters, can be found in Table 27 (also see paragraph 4.2.3). Deca-BDE, HBCD and Sb_2O_3 are not removed from the wastewater by implementing biological (main) purification.
- NP/NPE must be kept out of the wastewater wherever possible by implementing preventive measures (e.g. substitution, collection of partial flows). If these substances enter the wastewater in concentration levels that are unacceptable for discharge, an appropriately modified AWZI (possibly partial flow treatment) must be implemented to remove NP/NPE from the wastewater. For example, adsorption (active carbon filtration) can be used for this purpose (also see Table 27, paragraph 4.2.3). Currently (2010) active carbon filtration is not known to be implemented by Flemish companies for the removal of NP/NPE from the wastewater. NP/NPE could also be (partly) removed by dosing active carbon during biological purification (PACT), nano-filtration/reverse osmosis or chemical oxidation. NP/NPE are not removed from the wastewater by implementing biological (main) purification.
- PAH must also be kept out of the wastewater wherever possible, by implementing preventive measures (e.g. substitution). If PAH enter the wastewater in concentration levels that are unacceptable for discharge, an appropriately modified AWZI (possibly partial flow treatment) must be implemented to remove these pollutants. To do this, one or more of the following techniques can be deployed: biological (main purification, dosage of active carbon during biological purification (PACT), micro-filtration/ultra-filtration, adsorption (active carbon filtration), membrane filtration or chemical oxidation. These substances can also be (partly) removed by implementing a membrane bio-reactor, chemical precipitation, sand filtration and/or ozonisation (also see paragraph 4.2.3, Table 27).
- The textiles BREF (EIPPCB, 2003a) selects the following techniques as BAT (reference in BREF:: paragraph 5.3):
    - At least 3 different strategies are possible for wastewater treatment:
        - Central treatment in on-site biological wastewater purification system;
        - Central treatment at off-site purification system for urban wastewater;

    - Decentralised on-site (or off-site) treatment of selected or separated wastewater flows.

  All three strategies are BAT options according to the BREF for textiles (EIPPCB, 2003a), if they are correctly implemented for the current wastewater situation.
- Characterise the various wastewater flows in the process (reference in BREF: paragraph 4.1.2).
- Separate the effluents at the source, based on the type and quantity of polluted substance, before mixing with other flows (so that the purification system only receives polluted substances that it is able to process).
- Select the most suitable treatment for the polluted wastewater flows.
- Avoid introducing wastewater fraction into biological purification systems if there is a risk of these systems being disrupted.
- Treat wastewater flows with a relevant non-biologically degradable fraction using suitable techniques before, or instead of, the final biological treatment.
- Treat wastewater in an active silt system with low supply/micro-organism ratio, but only if concentrated waste flows containing non-biologically degradable compounds have been subject to a separate pre-treatment (reference in BREF: paragraph 4.10.1).
- Implement chemical oxidation as pre-treatment on heavily loaded (COD >5,000 mg/l), selected and separated individual waste flows that do not contain non-biologically degradable compounds (reference in BREF: paragraph 4.10.7).
- If possible keep specific residues from processes (printing paste residue and foulard fluid residue), which are heavily polluted, out of the wastewater flow altogether.
- For specific cases, where wastewater contains printing paste pigments or latex from the production of carpet undersides, use precipitation/flocculation and incineration for the resulting silt as an alternative to chemical oxidation (reference in BREF: paragraph 4.10.5).
- For azo-colorants, implement an anaerobic treatment for foulard fluids and printing pastes, prior to aerobic treatment, in order to effectively remove colour (reference in BREF: paragraph 4.10.6).
- Implement additional physico-chemical treatments if concentrated wastewater flows contain non-biologically degradable compounds and cannot be treated separately, e.g.
    - tertiary treatment after biological treatment, e.g. adsorption using activated carbon (reference in BREF: paragraph 4.10.1);
    - ozonisation of difficult to degrade compounds (reference in BREF: paragraph 4.10.1);
    - combined biological, physical and chemical treatment by adding activated pulverised carbon and iron salts to the active silt system (reference in BREF: paragraph 4.10.3).
- For effluent treatment in wool-washing sector:
    - Combine the use of dirt-removal/fat recuperation with effluent evaporation and integrated incineration of resulting silt, with

complete recycling of water and energy (reference in BREF: paragraph 4.4.2);
        - Use coagulation/flocculation in existing companies in combination with discharge into sewer with an anaerobic biological pre-treatment.
    - Do not discharge printing paste residue together with wastewater, but keep it in labelled drums and re-use (reference in BREF: paragraphs 5.2.2 and 4.7.6).

5.3.2 BAT for integrated textile companies

Further to the BAT mentioned in paragraph 5.3.1, the following technique is an additional BAT: make agreements with suppliers of formulations concerning the return of left-over chemicals.

comment

For job-processing companies, the BAT entails disposing of chemical residues via a qualified processing company (see candidate BAT: Store waste residues containing Deca-BDE, HBCD, Sb_2O_3 and/or PFOS/PFOA in an appropriate manner and dispose via a qualified processing company)

5.3.3 BAT for textile companies that use Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA

The following 2 techniques are additional BAT for textile companies that use Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA:

- Collect exhausted process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA and dispose via a qualified processing company

  Comments
    - Deca-BDE, HBCD and Sb_2O_3 are components in process baths used for finishing processes (also see paragraph 3.2.1).
    - VLAREM II chapter 5.41 (textiles) states, in the sectoral environmental permit conditions for the textile industry (article 5.41.1.5.§4), that process baths with brominated flame retardants or antimony cannot be discharged (also see paragraph 2.4.1.b).
    - For many applications in the textile industry (e.g. carpets with an effect on one side), PFOS and/or PFOA are applied via spraying, as a foam or via a squeegee technique. In these cases, fewer PFOS and/or PFOA enters the wastewater. If the effect is needed on both sides of the textile, process baths with PFOS and/or PFOA and a binding product are used. PFOS and/or PFOA are rarely implemented as a concentrated liquid (also see paragraph 3.3.1)
    - The use of PFOS is regulated by law, in accordance with Guidelines 2006/122/EC (PFOS guideline, also see paragraph 2.4.3.e).
    - NP/NPE primarily enter the wastewater of textile companies via wash-waters from yarns and tissues. If the textile company uses substances or mixes with a NP/NPE concentration in excess of 0.1 % (g/g), then, according to appendix XVII of REACH, wastewater cannot be discharged or the organic fraction must

be completely removed from the process water before the wastewater is treated biologically (also see paragraph 2.4.3.c). In this case, if appropriate end-of-pipe techniques cannot be implemented, it is advised to collect the specific partial flow and dispose of it via a qualified processing company. It is not an option to re-use the wash-water from tissues and yarns.

  - The share of wash-waters from yarns and tissues that could contain NPE can, in job-processing companies, reach 50-60% of the total water quantity. Due to the size of these partial flows, Centexbel states that it is unfeasible to treat them separately using end-of-pipe wastewater purification techniques or to dispose via an external processing company. Also in integrated companies, a major part of the wastewater is released from the paint department (with washing activities). Thus it is in the best interest of textile companies to implement source-oriented measures and to only use substances or mixes with an NP/NPE concentration <0.1 % (g/g).
  - The quantity of to-be-treated or disposed of wastewater could possibly be limited by collecting only the first fraction of e.g. wash-waters from tissues and yarns. This measure requires a double piping system to be placed.

- Re-use rinse waters from process baths containing Deca-BDE, HBCD, Sb_2O_3, PFOS and/or PFOA in the production process wherever possible.
  comment
  A number of facilities, e.g. a storage tank, are needed in order to separately collect rinse waters from process baths. Further, in order to re-use this rinse water, measurement and modification equipment is needed to alter the process baths. If this measure cannot be implemented, e.g. due to production planning, then the following measure is a second option.

5.3.4 BAT for textile companies that use Deca-BDE, HBCD and/or Sb_2O_3

The <u>additional</u> BAT for textile companies that use Deca-BDE, HBCD and/or Sb_2O_3 is to dispose of rinse waters from process baths containing Deca-BDE, HBCD and/or Sb_2O_3 via a qualified processing company (if it is not possible to re-use these rinse waters in the production process because of production planning).

comment
If the textile company is unable to comply with the applicable legal determinations (e.g. sectoral emission limit values for PFOS, PFOA and some PFT, excluding PFOS and PFOA, in VLAREM II, appendix 5.3.2.44°), and if rinse waters cannot be re-used in the production process, then these rinse waters must also be disposed of via a qualified processing company. Wastewater that contains PFOS and/or PFOA must be eradicated from the AWZI wherever possible.. There are no known wastewater purification techniques that are deployed specifically for the removal of PFOS and PFOA.

CHAPTER 6 RECOMMENDATIONS BASED ON THE BEST AVAILABLE TECHNIQUES

This chapter presents a number of concrete recommendations and suggestions, based on the BAT analysis. We have adopted a 3-track approach:

- *Recommendations for environmental permit conditions: We examine how the BAT can be translated into environmental permit conditions, and formulate suggestions to reinforce and/or supplement existing environmental legislation for the textile industry;*
- *Recommendations for environmental investment support: We examine which environment-friendly techniques for the textile industry can be considered for an* environmental investment support*;*
- *Recommendations for further research and technological development: We identify a number of themes relevant to the textile industry where further research and technological development is required, and we describe a number of innovative technologies that could evolve into BAT in the future.*

6.1Recommendations for environmental legislation

6.1.1 Introduction

This BAT study primarily concerns the limitation and/or prevention of micro-pollutants (namely Deca-BDE, HBCD, Sb_2O_3, PFOS, PFOA, NP, NPE, PAH) in the wastewater of textile companies that perform finishing activities. The best available techniques are an important foundation for compiling and reinforcing environmental legislation. The following paragraphs contain recommendations for each of the examined (groups of) micro-pollutants.

6.1.2 Deca-BDE and/or HBCD

Based on the available information, it can be concluded that 5 textile companies (3 surface water dischargers and 2 sewer dischargers) definitely use Deca-BDE (and possible HBCD too) for their finishing activities (also see appendix 3) (situation September 2009).

6.1.2.1 BAT for reducing and/or preventing emissions into water

The general BAT for all textile companies have been listed in chapter 5, paragraph 5.3.1. Paragraph 5.3.2 mentions the general BAT for all integrated companies.
Thus, the BAT is to use environment-friendly chemicals for finishing activities wherever possible.
There are currently (2010) very limited substitution possibilities for Deca-BDE. Even so, the use of alternatives to replace Deca-BDE is greatly determined by the specific application. For example, organic phosphorous compounds can be used as alternatives for Deca-BDE in the production of mattress textiles. Possible bottlenecks when replacing Deca-BDE with alternatives in textile applications, include: changing the fire-

resistant mechanism, changing the properties of the textile (e.g. hardness, plasticity), the requirements for fire-resistant properties of top quality applications (e.g. hotels, boats, airplanes, trains, cinemas, theatres or for the English market), more chemicals needed to realise the same fire-resistant properties in the textile, it remains necessary to use a (smaller) quantity of Deca-BDE when implementing certain alternatives (e.g. chlorinated paraffins or melamine), additional cost of alternatives (e.g. factor of 2 to 2.5) or possible shift in environmental problem (e.g. organic phosphorous compounds are not broken down in the AWZI, feasibility of the P emission limit value).
For the main part, HBCD can be substituted. Alternatives for HBCD in niche applications include, for example, chlorinated paraffins. However, a (small) quantity of HBCD is still used when chlorinated paraffins are implemented. HBCD only continues to be required for a limited number of specific applications (e.g. supple transparent materials).

Further, there are a number of specific BAT for reducing and/or preventing emissions of Deca-BDE and/or HBCD into the water by textile companies. These have been listed in chapter 5, paragraph 5.3.3 and 5.3.4.
Wastewater that contains Deca-BDE and/or HBCD must be eradicated from the AWZI wherever possible.. Thus the BAT is to collect exhausted process baths containing Deca-BDE and/or HBCD and to dispose via a qualified processing company (also see VLAREM II, article 4.1.11.8) , re-use rinse waters from process baths containing Deca-BDE and HBCD in the production process wherever possible and to dispose via a qualified processing company.

comment

In 4 of the 5 examined textile companies, process baths containing Deca-BDE and/or HBCD are disposed of via an external processing company. 1 textile company states that 100% of all (rinse water from) BFR-based process baths are re-used in the production process (also see appendix 3).

If, despite these efforts, Deca-BDE and/or HBCD enter the wastewater (or have done so in the past), the BAT is to appropriately treat the wastewater by implementing a combination of suitable wastewater purification techniques. The final design of this BAT must be established at company level, depending on the specific situation. The wastewater purification techniques that can be used in textile companies for the removal of e.g. Deca-BDE and/or HBCD, include: sand filtration, adsorption (e.g. active carbon filtration) and a membrane bio-reactor (MBR). Deca-BDE and/or HBCD could also be (partly) removed by implementing chemical precipitation, micro-, ultra-, or nano-filtration or reverse osmosis. Deca-BDE and HBCD are not removed from the wastewater by implementing biological (main) purification. However, these substances do bond with e.g. suspended matter in water.
The cost price for deploying wastewater purification techniques can be limited by specifically purifying selected partial flows instead of the entire wastewater flow.

Comments

- Companies that implemented measures in the past to divert wastewater containing Deca-BDE and/or HBCD away from the AWZI, could now encounter after-effects. For example, Deca-BDE and HBCD could possibly be re-released from e.g. silt and deposits in pipes and pumps, and thus enter the wastewater. This is currently (2010) the case for 2 textile companies (1 surface water discharger and 1 sewer discharger) (also see appendix 3).

- The following wastewater purification techniques are implemented by the 5 examined textile companies that use Deca-BDE and/or HBCD for finishing activities (also see appendix 3) (situation September 2009):
    - Sand filtration combined with biological purification (1 company that discharges into surface water);
    - Chemical precipitation (namely coagulation/flocculation) (1 company that discharges into sewer);
    - Chemical precipitation (coagulation/flocculation) in combination with biological purification (1 company that discharges into sewer);
    - buffering, biological purification and post-sedimentation (2 companies that discharge into surface water).

6.1.2.2 BAT associated emission levels

Deca-BDE
Background information about the methodology for determining BAT associated emission levels (BAT-AELs) for Deca-BDE can be found in appendix 3. A summary of the BAT-AELs for Deca-BDE in the wastewater of textile companies can be found in Table 30.

Table 30: BAT-AELs for Deca-BDE in the wastewater of textile companies

	Discharge into surface water	Discharge into sewer
No Deca-BDE	<10 µg/l	<10 µg/l
Deca-BDE	<20 µg/l	-*

* As indicated in paragraph 3.2.2.c and appendix 3, 2 of the 9 textile companies that discharge into sewer are known to definitely use Deca-BDE for their finishing activities (situation September 2009). The first textile company implements the BAT but is encountering historical pollution (no 'normal company conditions'). The concerned company disposes of (rinse waters from) Deca-BDE-based process baths via an external processing company. The other textile company indicates that it re-uses 100% of (rinse waters from) Deca-BDE-based process baths in the production process (situation September 2009). Potential improvement options for the second textile company include optimising the recycling process for the (rinse waters from) Deca-BDE-based process baths or disposing of the partial flows via an external processing company. However, it is difficult to evaluate their effectiveness. Further, it cannot be ruled out that small quantities of Deca-BDE (in the form of diffuse powder) will be released in the textile company's production process. This could possibly have an influence on the Deca-BDE concentration in the wastewater.

After further refining the discharge data based on this additional information, we are of the opinion that the remaining data is insufficiently representative to extract BAT-AELs for Deca-BDE, for textile companies that discharge into sewer and implement Deca-BDE.
We assume that textile companies that discharge into sewer can, in principle, achieve similar (possibly slightly higher) Deca-BDE concentrations to textile companies that discharge into surface water. In companies that discharge into surface waters, part of the Deca-BDE could possibly be removed from the wastewater via sedimentation (bonding to e.g. silt) However, it is difficult to evaluate their effectiveness. Thus BAT-AELs for

textile companies that use Deca-BDE and discharge into sewer could possibly be slightly higher than those for textile companies that discharge into surface water.

The BAT-AELs imply implementation of e.g. the following BAT:

- Collect exhausted process baths and dispose via a qualified processing company
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

In textile companies that suffer from historical pollution, Deca-BDE emissions could temporarily be higher than the BAT-AEL in Table 30, despite the above mentioned BAT being implemented. After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for Deca-BDE <20 µg/l.

HBCD

Background information about the methodology for determining BAT associated emission levels for Deca-BDE can be found in appendix 3. A summary of the BAT-AELs for Deca-BDE in the wastewater of textile companies can be found in Table 31.

Table 31: BAT-AELs for HBCD in the wastewater of textile companies

	Discharge into surface water	Discharge into sewer
no HBCD	<2 µg/l	<2 µg/l
HBCD	<10 µg/l	<10 µg/l

The BAT-AELs imply implementation of e.g. the following BAT:

- Collect exhausted process baths and dispose via a qualified processing company
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

In textile companies that suffer from historical pollution, HBCD emissions could temporarily be higher than the BAT-AEL in Table 31, despite the above mentioned BAT being implemented. After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for HBCD <10 µg/l.

6.1.2.3 Recommendations for Deca-BDE and/or HBCD

Process baths containing Deca-BDE and/or HBCD must be diverted away from the AWZI. These parameters can possible be found in the effluent of textile companies, despite the companies stating that these substances are no longer used in the production process. There are a number of possible explanations, as described in the paragraphs below:

- Deca-BDE and/or HBCD can be present in the used formulations (mixes of chemicals). This it is important to know the composition of the used products. It is advised to consult with the formulations supplier. This matter requires a clear legal framework.

- Further, Deca-BDE and/or HBCD can also work its way into a textile company via purchased tissues and yarns, intermediary products (e.g. purchased products) and water intake. The measured concentrations of Deca-BDE in incoming surface water varied in a number of concrete examples (see paragraph 3.2.1) from <1 µg/l[290] to 8.5 µg/l. The measured HBCD concentrations in a few concrete examples were always under the reporting level (1µg/l).
- Furthermore, as the result of after-effects, concentrations of Deca-BDE and HBCD could rise again in the effluent of textile companies. Certainly two Flemish textile companies are currently (2010) experiencing such problems. As the impact of historical pollution is difficult to estimate, these companies will probably also encounter these problems in the future – namely increased concentrations and large variations of Deca-BDE and HBCD in the effluent, which are not directly linked to the production activities.

Other potential causes for variations in measured effluent values for Deca-BDE and/or HBCD can be sought within textile companies themselves:

- potentially inappropriate use of Deca-BDE/HBCD-based (rinse waters) process baths
  There is insufficient background information to make a statement about potentially inappropriate re-use of (rinse waters from) process baths in the production processes of the concerned companies. A potential improvement option is to dispose of (rinse waters from) process baths containing Deca-BDE and HBCD.
- Potentially inappropriate emptying and storage of packaging from powdered chemicals
  Sacks or big-bags with chemicals in powder form must take place in under-pressure. Thereafter, emptied packaging must be stored in an appropriate manner, while awaiting disposal via a qualified processing company or via the chemicals supplier. Emptied sacks must be packed in polyethylene sacks and stored in enclosed conditions. There is insufficient background information to make a statement about potentially inappropriate emptying and storage of packaging from powdered chemicals. In practice, small quantities of Deca-BDE (in diffuse powder form) could be released, which indirectly affects the Deca-BDE concentrations in textile wastewater.

Comments

- When evaluating brominated fire retardants in water, water samples are not filtered prior to extraction (see WAC/IV/A/030). Thus dissolved BFRs, and those that bond with particles, are both evaluated. Only in the case of latex-based samples may it be necessary to filter the extract with Na2SO4 to remove excess water and disruptive materials. This filtration has no impact on the results; the BFRs are in the extract (VITO, 2010c).
- With regards to the Deca-BDE measurement data (2009) in the BAT study, the analysis methods (incl. sample preparation) used to determine the Deca-BDE content in wastewater was examined. The concerned laboratories always analysed the brominated flame retardants in water in accordance with

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WAC/IV/A/030. The samples were not filtered prior to analysis. In other words, all the concerned Deca-BDE measurement data (2009) originates from samples analysed in accordance with WAC/IV/A/030 and none of the samples were filtered prior to the analysis (VITO, 2010d).

According to the management committee members, a proposal is required for sectoral emission limit values for Deca-BDE and HBCD in textile companies. Thus, as a sectoral emission limit value, we recommend the upper limit of the BAT-AELs range:

- Deca-BDE:
    - 20 µg/l for textile companies that use Deca-BDE and discharge into surface water;
      Comments
        - BAT-AELs cannot be determined for textile companies that use Deca-BDE and discharge into sewer (due to insufficient data, also see paragraph 6.1.2.2), whereby this BAT study does not contain a proposed sectoral emission limit value for Deca-BDE.
        - comment VMM:
          "For the parameter Deca-BDE, VMM uses the same emission limit value for textile companies that discharge into surface water as for companies that discharge into sewer. The reason being that the WWTP has no impact on this pollutant. However, due to historical pollution, one can temporarily deviate from 20 µg/l under condition that the concerned textile company implements the BAT and follows up the parameter Deca-BDE. If a downward trend cannot be seen in the measurement data, VMM will assume that the company has not implemented the BAT correctly or that the internal sewer system needs to be remediated. In any case, increased emission limit values will not be permitted for an undetermined or long-term period."
        - comment Fedustria/Centexbel:
          "In the case of historical pollution, it is important to note that a downward trend will not always be rectilinear. One characteristic of historical pollution is that Deca-BDE piles up at particular places in the sewer system or in the water purification installation. And after a particular action (e.g. replacement of a pump, re-start after long-term downtime (e.g. after holidays)), certain particles may return to circulation and (temporarily) cause higher concentrations in the effluent. This situation may still be encountered even if the company implements all BAT measures."
    - 10 µg/l for companies that do not use Deca-BDE;

- HBCD:
    - 10 µg/l for companies that use HBCD;
    - 2 µg/l for companies that do not use HBCD;

Companies that are encountering problems with historical pollution need a particular transition period to comply with the set emission limit values. This transition period must be clearly identified in the permit, as being the time needed to remediate the AWZI and the accompanying sewer system.

Comments

- By the time that these determinations are included in VLAREM, a certain transition period will already have passed (1-2 years).
- The use of HBCD in the textile industry is expected to be limited in the next 5 years due to legal determinations (e.g. REACH). One of the future possibilities is to introduce a ban on the use of HBCD, as well as a discharge ban.
- Under no circumstances can process baths or rinse waters from process baths that contain Deca-BDE and/or HBCD, be discharged.

6.1.3 Antimony

Based on the available information, it can be stated that 5 textile companies (3 surface water dischargers and 2 sewer dischargers) definitely use antimony trioxide as a synergist in combination with Deca-BDE (situation September 2009, also see paragraph 6.1.2 and appendix 3).
In 17 textile companies (9 surface dischargers and 8 sew dischargers), antimony is present in the wastewater. These companies state that they do not use brominated flame retardants (thus Sb_2O_3 not used as a synergist), but do perform paint activities (e.g. PA paints, PES paints).

6.1.3.1 BAT for reducing and/or preventing emissions into water

The general BAT for all textile companies have been listed in chapter 5, paragraph 5.3.1. Paragraph 5.3.2 mentions the general BAT for all integrated companies. Further, there are a number of specific BAT for reducing and/or preventing emissions of antimony into the water by textile companies. These have been listed in chapter 5, paragraph 5.3.3 and 5.3.4.

Wastewater that contains antimony must be eradicated from the AWZI wherever possible.. Thus the BAT is to collect exhausted process baths containing antimony and to dispose via a qualified processing company (also see VLAREM II, article 4.1.11.8), re-use rinse waters from process baths containing antimony in the production process wherever possible and to dispose via a qualified processing company.

> *comment*
> In 4 of the 5 examined textile companies that use antimony trioxide as a synergist in combination with Deca-BDE and/or HBCD, process baths that contain antimony trioxide (as well as Deca-BDE and/or HBCD) are disposed of via an external processing company. One textile company does not dispose of the (rinse water from) BFR-based process baths, but re-uses 100% in the production process (also see appendix 3).

If, despite these efforts, antimony enters the wastewater (or has done so in the past), the BAT is to appropriately treat the wastewater by implementing a combination of suitable wastewater purification techniques. The final design of this BAT must be established at company level, depending on the specific situation. Sand filtration is a wastewater purification technique that can be used in textile companies for the removal of e.g. antimony. Antimony could also be (partly) removed by implementing MBR or chemical precipitation (coagulation/flocculation). The cost price for deploying wastewater purification techniques can be limited by specifically purifying selected partial flows instead of the entire wastewater flow.

Comments

- Companies that implemented measures in the past to divert wastewater containing antimony trioxide (as well as Deca-BDE and/or HBCD) away from the AWZI, could now encounter after-effects. For example, antimony could possibly be re-released from e.g. silt and deposits in pipes and pumps, and thus enter the wastewater.
- The following wastewater purification techniques are implemented by the 5 examined textile companies that use antimony trioxide as a synergist in combination with Deca-BDE and/or HBCD for finishing activities (situation September 2009, also see appendix 3):
  - Sand filtration combined with biological purification (1 company that discharges into surface water);
  - Chemical precipitation (namely coagulation/flocculation) (1 company that discharges into sewer);
  - Chemical precipitation (coagulation/flocculation) in combination with biological purification (1 company that discharges into sewer);
  - buffering, biological purification and post-sedimentation (2 companies that discharge into surface water).

6.1.3.2 BAT associated emission levels

Background information about the methodology for determining BAT associated emission levels for antimony can be found in appendix 3. A summary of the BAT-AELs for antimony in the wastewater of textile companies that use Sb_2O_3 as a synergist in combination with Deca-BDE, can be found in Table 32.

Table 32: BAT-AELs for antimony the wastewater of textile companies that use Sb_2O_3 as a synergist in combination with Deca-BDE (no paint activities)

	Discharge into surface water	Discharge into sewer
Sb_2O_3	<1 mg/l	<1 mg/l

The BAT-AELs imply implementation of e.g. the following BAT:

- Collect exhausted process baths and dispose via a qualified processing company
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

In textile companies that suffer from historical pollution, antimony emissions could temporarily be higher than the BAT-AEL in Table 32, despite the above mentioned BAT being implemented. After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for antimony <10 µg/l (only for textile companies that do not perform paint activities).

comment

The BAT-AELs for antimony do not apply to textile companies that perform paint activities, because no specific BAT have been determined for the implemented (antimony-based) paints.

6.1.3.3 Recommendations for antimony

In VLAREM I, appendix 2C, antimony has been included in List II (families and groups of substances). List II contains substances that are part of the families and groups of substances mentioned in List I, as well as some individual substances and particular categories of substances that are part of the families and groups of substances (below) that are harmful to water, though which can be limited to a particular area and are determined by the characteristics of the receiving waters and their location.
However, antimony has not been included in the list of priority (dangerous) substances in appendix X of the Dangerous Substances Co-guidelines (Guidelines 2008/105/EC, also see paragraph 2.4.3.g).
It is advised to modify list 2C in VLAREM I to conform with appendix X of Guidelines 2008/105/EC.

Process baths that contain antimony must be kept away from the AWZI. These parameters could possibly be found in the effluent of textile companies, even if Sb_2O_3 is not (or no longer) used as a synergist in combination with e.g. Deca-BDE. There are a number of possible explanations for this, as described in the paragraphs below:

- Antimony trioxide can, in addition to e.g. Deca-BDE, be present in formulations used for making textiles fire resistant. This it is important to know the composition of the used products. It is advised to consult with the formulations supplier. This matter requires a clear legal framework.
- Further, antimony could also be a component in products used for paint activities in the textile industry.

Thus, a proposed sectoral emission limit values for antimony is required, for textile companies that use Sb_2O_3 as a synergist in combination with e.g. Deca-BDE. The recommendation is to use the upper limit of the BAT-AELs range, namely 1 mg/l, as sectoral emission limit value. The emission limit value proposal does not distinguish between textile companies that discharge into surface water and those that discharge into sewer.

Companies that are encountering problems with historical pollution need a particular transition period to comply with the set emission limit values. This transition period must be clearly identified in the permit, as being the time needed to remediate the AWZI and the accompanying sewer system.

Comments

- By the time that this determination is included in VLAREM, a certain transition period will already have passed (1-2 years).
- Under no circumstances can process baths or rinse waters from process baths, containing Sb_2O_3 as a synergist in combination with e.g. Deca-BDE, be discharged.

This BAT study has not established a emission limit value for companies that do not use Sb_2O_3 as a synergist in combination with e.g. Deca-BDE, but use antimony compounds in other applications (e.g. for paint activities). These companies are currently (2010) subject to the following range of emission limit values via special environmental permit conditions: 0.6-1 mg/l (also see Table 13, paragraph 2.4.1.d).

6.1.4 PFOS and PFOA

The use of PFOS is regulated by law, in accordance with Guidelines 2006/122/EC (PFOS guidelines).
Firm examples of processes in Flemish textile companies in which PFTs are used include e.g. post-treatments in piece-dying and coating textiles for mattresses. Definite information about the use of PFOS and PFOA, and the concentrations of these parameters in the effluent, is only available for a very limited number of companies.

6.1.4.1 BAT for reducing and/or preventing emissions into water

The general BAT for all textile companies have been listed in chapter 5, paragraph 5.3.1. Paragraph 5.3.2 mentions the general BAT for all integrated companies.
Thus, the BAT is to use environment-friendly chemicals for finishing activities wherever possible.
Currently (2010), the substitution possibilities for PFOS and PFOA are still being tested. There are a number of substitutes (e.g. PFBS) on the market as alternatives for PFOS and/or PFOA in particular textile applications. A technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned).

> *comment*
> During the production of e.g. PFBS, PFOS is created as by-product. This means, despite switching to e.g. PFBS, one continues to find small quantities of PFOS (ppb level) in the wastewater of textile companies.

Further, there are a number of specific BAT for reducing and/or preventing emissions of PFOS and PFOA into the water by textile companies. These have been listed in chapter 5, paragraph 5.3.3.
Thus, the BAT is to collect exhausted process baths containing PFOS and PFOA, and to dispose via a qualified processing company, and to re-use rinse waters from process baths containing PFOS and PFOA in the production process wherever possible.

Comments

- For many applications in the textile industry (e.g. carpets with an effect on one side), PFOS and/or PFOA are applied via spraying, as a foam or via a squeegee technique. In these cases, fewer PFOS and/or PFOA enters the wastewater. If the effect is needed on both sides of the textile, process baths with PFOS and/or PFOA and a binding product are used. PFOS and/or PFOA are rarely implemented as a concentrated liquid (also see paragraph 3.3.1)
- If the textile company is unable to comply with the applicable legal determinations (e.g. sectoral emission limit values for PFOS, PFOA and some PFT, excluding PFOS and PFOA, in VLAREM II, appendix 5.3.2.44°), and if rinse waters cannot be re-used in the production process, then these rinse

waters must also be disposed of via a qualified processing company. Wastewater that contains PFOS and/or PFOA must be eradicated from the AWZI wherever possible.. There are no known wastewater purification techniques that are deployed specifically for the removal of PFOS and PFOA.

In addition, the BAT for textile companies is to treat wastewater in an appropriate manner, using a combination of suitable wastewater purification techniques. The final design of this BAT must be established at company level, depending on the specific situation. Biological purification is not suitable for the specific removal of PFOS and/or PFOA from textile industry wastewaters. However, based on the available information, no wastewater purification techniques could be selected for the removal of PFOS and/or PFOA in the textiles industry. Current knowledge suggests that source-oriented measures (e.g. substitution) and process-integrated measures are enough to comply with applicable sectoral emission limit values. End-of-pipe wastewater purification techniques are less applicable to this parameter group.

6.1.4.2 BAT associated emission levels

BAT associated emission levels have not been established for the parameters PFOS and PFOA. The available measurement data was primarily anonymous and there was no or insufficient background information accompany this measurement data.

comment

- The intention was to have a measurement campaign carried out by VMM during the course of 2009, with regards to PFT in the wastewater of textile companies. However, based on the first screening, VMM decided not to deem PFT (incl. PFOS and PFOA) as a relevant parameter for the textile industry during their measurement campaign in 2009 (VMM, 2009e).
- In addition to the anonymous measurement data for textile companies from 2006 (LNE-AMI, 2009) and 2007 (Centexbel, 2009a), a limited amount of individual discharge data (2006-2008) was available for two Flemish textile companies (Centexbel, 2009c). The individual measurement data for PFOS and PFOA from these companies was within the range found in anonymous measurement data.

6.1.4.3 Recommendations for PFOS and PFOA

At this moment in time, there are no legal limitations for the use of PFOA in Europe. Voluntary programmes that contain firm agreements about (further) phasing-out the use of PFOA (e.g. PFOA Stewardship Program in America and Canada) are also recommended for other countries (cf. proposal by e.g. Norway to ban PFOA and individual salts and esters in consumer products).

Up-to-date (2010) information suggests that current sectoral emission limit values for these parameters are being met without problems. According to management committee members, there is no need for a emission limit values proposal.

6.1.5 NP and NPE

6.1.5.1 BAT for reducing and/or preventing emissions into water

The general BAT for all textile companies have been listed in chapter 5, paragraph 5.3.1. Paragraph 5.3.2 mentions the general BAT for all integrated companies.
Thus, the BAT is to use environment-friendly chemicals for finishing activities wherever possible. Alcohol ethoxylates (AE) are quasi-perfect substitutes for NPE in products used in the textile finishing sector.

Further, the BAT is to characterise released wastewater or liquid waste flows in the interest of re-use, treatment and/or disposal. Regular sampling and analysis (e.g. in monitoring programmes and with quality safeguards in sampling and analysis) provide an insight into the characteristics of the wastewater or liquid waste flows. Results from these analyses allow the right choices to be made when re-deploying the production process or the treatment, or when disposing of these flows.

Further, the BAT is to treat wastewater in an appropriate manner, using a combination of suitable wastewater purification techniques. The final design of this BAT must be established at company level, depending on the specific situation. Adsorption (e.g. active carbon filtration) can be implemented for the removal of NP and/or NPE from wastewater (possibly partial flow treatment). Currently (2010), no textile companies are known to implement active carbon filtration for the removal of NP/NPE from their wastewater. In addition, NP and/or NPE can be (partially) removed from the wastewater by implementing the following wastewater purification techniques: dosage of active carbon during biological purification (PACT), nano-filtration/reverse osmosis or chemical oxidation. NP/NPE are not removed when wastewater is purified biologically.

comment

Textile companies implement e.g. the following wastewater purification techniques (situation September 2009):

- (aerated) buffer and stirrers (2 sewer dischargers);
- biological purification (2 surface water dischargers);
- Biological purification in combination with UF/RO (1 surface water discharger).

6.1.5.2 BAT associated emission levels

BAT associated emission levels for the parameters NP and NPE have not been established due to insufficient measurement data and accompanying background information, and due to insufficient knowledge about process-integrated measures (e.g. no BAT selected for limit NP/NPE is wastewaters from yarns and tissues) and the concentrations they can help to realise.

6.1.5.3 Recommendations for NP and NPE

Nonylphenol and nonylphenol ethoxylates have been identified as priority dangerous substances (appendix X in Dangerous Substances Co-guidelines).

VLAREM currently contains no sectoral emission limit values for these substances. However, alkylphenol ethoxylates (thus also nonylphenol ethoxylates) must be replaced wherever possible (also see VLAREM II, chapter 5.41, textile sectoral emission limit values). It is unclear to which extent these product regulations are effectively followed up in practice. The Government fears that maximum substitution can only be enforced by introducing a sectoral emission limit values.

For the most part, NPEs can be substituted. Tensides without NP/NPE are currently (2010) available on the market. Textile companies can make a conscious decision to select these alternatives. The cost price and effectiveness often determine whether this choice is made in practice. Thus, limitations at the source are important for this parameter (group).

In the short-term, REACH regulations are not able to resolve the NP/NPE problems in textile sectoral wastewater, which have been caused by the finishing of purchased tissue and yarns. NF and NPE have not been included (situation January 2010) in the candidate list of very concerning substances (SVHC) for inclusion in appendix XIV of REACH. Though NP and NPE are included in appendix XVII of REACH (limitations on production, trade and use). However, appendix XVII does not contain a binding limitation for NF/NPE in mixes . Further, all textile processors are permitted to use NP/NPE as substance or in mixes in a concentration of > 0.1% (g/g), under the condition that these substances are not discharged or only if the wastewater will be appropriately treated.
Thus, in the first instance, textile companies must correctly inform themselves about the composition of detergents, namely NP/NPE content. If the concentration of NP/NPE in these mixes exceeds 0.1% (g/g), then a partial flow treatment must be implemented prior to biological purification, or the partial flow must be disposed of via an external processing company (=treatment without discharge into sewer or surface water).

A limited sample from textile companies indicates that more NPE (scale [mg/l]) is present in the effluent than NP (scale [µg/l]). NPE is fully converted into NF, though complete metabolisation has not yet taken place in the effluent. Thus, for the main part, the degradation of NPE into NP occurs once industrial wastewater has been discharged. Therefore, in addition to NP, it is also important for NPE to be measured and limited in the wastewater of textile companies. Currently (2010) there is still insufficient follow-up of NP/NPE in the wastewater of textile companies, via sampling and analysis. There is no driving force (= emission limit value) for the follow-up.

We are currently (2010) not aware of any measurements concerning the presence and concentrations of NP/NPE in purchased tissues. Therefore, the textile industry is not implementing specific measures (e.g. collecting wash-waters separately and disposing via a qualified external processing company or treating with e.g. active carbon) if concentration levels are unacceptable for discharge into the receiving surface water.

In the absence of measurements and analysis, there is currently (2010) little or no information available about the quantity and composition of other partial flows. This is, for example, the case for wash-waters from tissues and yarns (NP/NPE and PAH). In future, it is recommended to research problematic flows like e.g. wash-waters from tissues and yarns, and to perform a number of measurements and analyses. One-off sampling and measurement is of little use to job-processing companies, considering the wide variations in quantity and composition in the released wash-waters.

If source-oriented measures, as well as process-integrated measures, cannot be implemented or are insufficient to reduce concentrations in the wastewater to an acceptable level, then end-of-pipe techniques will be needed. This could relate to specific partial flows, e.g. wash-waters from tissues and yarns.

Source-oriented and process-integrated measures that are currently (2010) being implemented are not enough to realise acceptable concentrations in the effluent. Thus there is a need for information about additional measures for reducing NP/NPE is the wastewater if textile companies. Considering the limited feasibility of end-of-pipe wastewater purification techniques, it is best to adopt a preventive approach when addressing NP/NPE problems in textile wastewater (see above). However, there is currently no driving force (e.g. emission limit values) to implement the preventive measures.

An emission limit values proposal for the parameters NP/NPE cannot be formulated in this BAT study because insufficient measurement data and knowledge is available about the effect of source-oriented and process-oriented measures. There is a need for additional research into the effect of source-oriented and process-integrated measures on NP/NPE concentrations in the wastewater of textile companies. An option for the Government could be to introduce an emission limit value for NP/NPE, in order to spur companies on effectively implement the required measures. Currently (2010), an emission limit value for NP/NPE is only known to have been imposed on one textile company via special environmental permit conditions, namely 0.33µg/l (based on the PNEC).

6.1.6 PAH (16 of EPA)

PAH in the wastewater of textile companies originate from e.g. PAH-based mineral oils (released when washing e.g. yarns and tissues) and PAH-based carriers in colorants and paints (released when dying polyester at low temperatures).

6.1.6.1 BAT for reducing and/or preventing emissions into water

The general BAT for all textile companies have been listed in chapter 5, paragraph 5.3.1. Paragraph 5.3.2 mentions the general BAT for all integrated companies.
PAH in wastewater must also be avoided wherever possible. Thus, the BAT is to use environment-friendly chemicals for finishing activities wherever possible. Technically, PAH-based mineral oils can be perfectly replaced by synthetic oils. The use of PAH-based carriers when dying textiles can be avoided and/or limited by using carrier-free colorants and dyes and/or by implementing HT dying equipment, except in the presence of wool (e.g. in combination with polyester fibres or with elastane).

If PAH enter the wastewater, an appropriately modified AWZI (possibly partial flow treatment) must be implemented to remove these pollutants. To do this, one or more of the following techniques can be deployed: biological purification, dosage of active carbon during biological purification (PACT), micro-filtration/ultra-filtration, adsorption (active carbon filtration), membrane filtration or chemical oxidation. These substances can also be (partly) removed by implementing a membrane bio-reactor, chemical precipitation, sand filtration and/or ozonisation.

comment

The following wastewater purification techniques are implemented by the 22 examined textile companies (situation September 2009, also see appendix 3):

- Biological purification (4 companies that discharge into surface water)
- Biological purification combined with ultra-filtration/reverse osmosis (1 company that discharges into surface water)
- Biological purification in combination with chemical precipitation (1 company that discharges into surface water and 1 company that discharges into sewer)
- Biological purification in combination with sand filtration (possibly used for a partial flow) (3 companies that discharge into surface water)
- Chemical precipitation (namely coagulation/flocculation) (1 company that discharges into surface water and 3 companies that discharge into sewer);
- Aerated buffer (possibly with stirrers) (6 companies that discharge into sewer)
- pH-neutralisation (1 company that discharges into sewer)
- Sedimentation basins (1 company that discharges into sewer).

6.1.6.2 Emission levels

Because insufficient information is available about the extent to which process-oriented measures are implemented to limit PAH in the wastewater of textile companies (e.g. PAH-based mineral oils and the use of PAH-free carriers, HT paint equipment), it cannot be said with certainty that the discharge data complies with the BAT (e.g. process-integrated measures). This it is not possible to determine BAT-AELs for the parameter group PAH. Though emission levels have been determined based on partially filtered discharge data. Background information about the methodology for determining emission levels can be found in appendix 3. A summary of the emission levels for PAH (16 of EPA) in the wastewater of textile companies can be found in Table 33.

Table 33: Emission levels for PAH (16 of EPA) in the wastewater of textile companies

parameter	Discharge into surface water		Discharge into sewer	
	With paint activities	Without paint activities	With paint activities	Without paint activities
acenaphthene	<100 ng/l	<100 ng/l	<100 ng/l	<100 ng/l
acenaphtylene	*	*	*	*
anthracene	<100 ng/l	<100 ng/l	<400 ng/l	<100 ng/l
benzo(a)anthracene	<300 ng/l	<300 ng/l	<300 ng/l	<300 ng/l
benzo(b)fluoranthene	Σ <100 ng/l	Σ <100 ng/l	Σ <100 ng/l	Σ <100 ng/l
benzo(k)fluoranthene				
benzo(a)pyrene	<100 ng/l	<100 ng/l	<100 ng/l	<100 ng/l
benzo(ghi)perylene	Σ <100 ng/l	Σ <100 ng/l	Σ <100 ng/l	Σ <100 ng/l

indeno(1,2,3-cd)pyrene				
chrysene	**	**	**	**
dibenzo(a,h)anthracene	<100 ng/l	<100 ng/l	<100 ng/l	<100 ng/l
phenanthrene	<100 ng/l	<100 ng/l	<200 ng/l	<100 ng/l
fluoranthene	<100 ng/l	<100 ng/l	<300 ng/l	<100 ng/l
fluorene	***	***	***	***
naphthalene	****	****	****	****
pyrene	<100 ng/l	<100 ng/l	<300 ng/l	<100 ng/l

* The average BMKN for acenaphthylene amounts to 4000 ng/l (also see paragraph 2.4.1.d).
** The average BMKN for chrysene amounts to 1000 ng/l (also see paragraph 2.4.1.d).
*** The average BMKN for fluorene amounts to 2000 ng/l (also see paragraph 2.4.1.d).
**** The average BMKN for naphthalene amounts to 2400 ng/l (also see paragraph 2.4.1.d).

Comments

- Emission levels that are lower than reporting limits, are reported as being < reporting limit.
- For acenaphthylene and chrysene, the concentration in the effluent of textile companies is always lower than the respective BMKN. Thus no emission levels have been determined for these parameters.
- In addition, for the parameters fluorene and naphthalene, the concentration in the effluent of textile companies is normally lower than the respective BMKN (also see appendix 3). Emission levels have also not been determined for these parameters.

6.1.6.3 *Recommendations for PAH (16 of EPA)*

In VLAREM I, appendix 2C, naphthalene and fluoranthene (as indicator for other more dangerous PAH) have been placed in List III (priority substances in water policy).
However, naphthalene and fluoranthene have not been identified as priority dangerous substances in appendix X of the Dangerous Substances Co-guidelines (Guidelines 2008/105/EC, also see paragraph 2.4.3.g).
It is advised to modify list 2C in VLAREM I to conform with appendix X of Guidelines 2008/105/EC.

Mineral oils are the main source of PAH in the wastewater of textile companies. Minerals oils are found, together with detergents, on yarns and tissues and are washed out prior to dying. It is recommended to implement an active purchasing policy for yarns and tissues that are free of mineral oils. Article 5.41.1.5 of VLAREM II (also see paragraph 2.4.1.b) states that PAH-based mineral oils must be substituted wherever possible. This helps to provide a clear legal framework for replacing mineral oils with synthetic oils in textile applications. Further, it is recommended to investigate the intake of PAH via tissues and yarns. Available analysis techniques (e.g. GCMS and/or HPLC) are currently (2010) not known to be implemented for determining PAH in tissues and yarns. As of 01/04/2010, the Oekotex certificate will contain product standards. Thus textile yarns and tissues will be subject to analysis at Oekotex 100.

PAH-based mineral oils are primarily replaceable. Though the extent to which the switch to synthetic oils has manifested itself in the textile sector, is not yet (2010) clear. Therefore, insufficient information is available about the impact of the introduced measures on the textiles industry. Regular sampling and analysis is thus needed to generate such knowledge. Oekotex 100 can be a driving force in this matter (product standards for PAH applicable from 01/04/2010).

PAH are biologically removed in the AWZI. The lighter PAH (e.g. naphthalene) volatalise or break down. The heavier PAH adsorb with solid particles. Textile companies that biologically purify their industrial wastewater are able to realise acceptable PAH concentrations in the effluent.

If preventive and process-integrated measures are not enough to reduce PAH concentrations in the wastewater to an acceptable level, (tertiary) end-of-pipe techniques are advised. However, these measures are primarily suited for wastewaters that have already been subject to biological purification. Thus end-of-pipe wastewater purification techniques are of little use to textile companies that discharge into sewer. However, disconnection can be considered. Thus it is best for textile companies that discharge into sewer to address the PAH problem in a preventive manner. That said, it is currently (2010) unclear whether maximum use is being made of such measures and which PAH concentrations can be achieved.

The recommendation is to retain the existing sectoral emission limit values for textile companies that discharge into surface water, namely 0.001 mg/l (= 1 000 ng/l) for PAH(total) except naphthalene. The available discharge data suggests that this emission limit value is feasible for textile companies that discharge into surface water. The members of the steering committee do not deem it necessary to formulate an additional proposal for sectoral or special emission limit values for individual PAH.

A proposed sectoral emission limit valuefor PAH (individual or sum) for textile companies that discharge into sewer cannot be presented in this BAT study because it is insufficiently clear whether preventive measures (BAT) are currently being fully implemented and whether the available discharge data thus fully complies with BAT.

Based on the discussions within the steering committee, it is recommended to scrap the existing PAH sectoral emission limit value for textile companies that discharge into sewer and to impose the emission limit values for PAH (individual or sum) for these companies via special environmental permit conditions. When establishing the special environmental permit conditions, consideration can then be given to the emission levels found in Table 33, additional (expected) preventive measures and the impact of the WWTP.

Comments

- Article 2, point 6, of the IPPC guidelines includes the following determination. When determining the emission limit levels of the installation for indirect discharges into water, one can take into account the effect if a purification station, under the condition that an equivalent level of environmental protection is generally safeguarded and that this does not additionally burden the environment with pollutants, without prejudicing the determinations in Guidelines 2006/11/EC and the guidelines adopted to implement them.

- According to VMM, a dilution factor can be implemented when determining emission limit values for priority dangerous substances (PDS) / polluted substances (PS) that are discharged by sewer dischargers via an WWTP and where these substances are removed in the WWTP in the same way that surface water dischargers remove them in their own water purification systems. In practice, this approach can be used for, for example, the parameter PAH (VMM, 2010).
- It is common knowledge that PAH are removed from the wastewater in the WWTP, in the biological purification phase (Van den Abeele L. et al., 2010). The necessary measures must be taken to prevent high PAH emissions into the environment in case of overflow.

6.1.7 Summary

Table 34 contains an insight into the recommendations for environmental legislation, as found in paragraphs 6.1.2 to and including 6.1.6. If there is need for additional research concerning discharge data, this has been mentioned in the table. This and other definite recommendations for further research and technological developments can be found in paragraph 6.3.

Table 34: Summary of recommendations for environmental legislation

Parameter / parameter group	BAT-AELs		Proposal – sectoral wastewater emission limit values		Recommendation - special wastewater emission limit values		Recommendation - need for additional measurement data	
	OW	RIO	OW	RIO	OW	RIO	OW	RIO
Deca-BDE (used by the textile company)	<20 µg/l	-[291]	20 µg/l	-[292]	-	+[293]	-	-
Deca-BDE (not used by the textile company)	<10 µg/l	<10 µg/l	10 µg/l	10 µg/l	-	-	-	-
HBCD (used by the textile company)	<10 µg/l	<10 µg/l	10 µg/l	10 µg/l	-	-	-	-
HBCD (not used by the textile company)	<2 µg/l	<2 µg/l	2 µg/l	2 µg/l	-	-	-	-
Sb_2O_3	<1 mg/l	<1 mg/l	1 mg/l	1 mg/l	-	-	-	-

[291] due to insufficient data

[292] due to insufficient data

[293] see comments in chapter 6, paragraph 6.1.2.3 (page 186)

PFOS/PFOA	-	-	-	-	-	-	+	+
NP/NPE	-	-	-	-	+	+	+	+
PAH	-[294]	-[295]	0,001 mg/l excl. naphthalene (= existing sectoral environmental permit conditions)	+ (delete existing sectoral environmental permit conditions)	-	+	-	-

Legend: -: No recommendation made
+: Recommendations made
OW: Discharge into surface water
RIO: Discharge into sewer

6.2Recommendations for environmental investment support

6.2.1 Introduction

Companies that make environmental investments in Flanders can receive a subsidy for such investments from the Flemish Government: - the environmental investment support. This paragraph makes recommendations to allow one or more of the discussed environment-friendly technologies to be considered for this investment support.

a. Legal basis

The Flemish decree concerning the economic support policy, dated 31 January 2003, is the framework for this environmental investment support. The determinations in this investment support decree have been further defined via a Ruling by the Flemish Government. On 16 May 2007, the Flemish Government drastically altered regulations for the environmental investment support The old environmental investment support regulations were annulled and new regulations, via a call system, have been in effect since 1 October 2007.

b. A new subsidy based on a call system

A call system means that, within a particular period, a call will be made to companies for possible projects (subsidy applications for qualified technologies). Companies that want to carry out a project (investment) and want to receive a subsidy for it, can then respond to the call. A sealed envelope is assigned to the call system; in other words, each call has a fixed budget.

All submitted projects will be ranked per call, using a particular scoring system, and a subsidy will be awarded to the best ranked projects until the entire budget of the call has been used up.

[294] emission levels were derived.

[295] emission levels were derived.

Projects with the best scores (performance factors) will always receive support. Projects with the lowest scores will only receive support if the total requested subsidy is less than the assigned budget.

c. *Environmental investment support and environmental investments*

- The environmental investment support is awarded to environmental investments. Environmental investments are investments in new environment-friendly technologies, energy technologies that result in energy-saving, as well as combined heat and power (CHP) and renewable energy (RE). Comprehensive information about the environmental investment support can be found via www.ondernemen.vlaanderen.be.

d. *Limitative Technologies List (LTL) for environmental investments*

Investments considered for the environmental investment support have been included in a limitative technologies list (LTL). This list can be accessed via the link above.

The limitative technologies list contains the following details for each technology:
- Number;
- Name;
- Description;
- Technology type;
- Performance factor;
- The additional cost percentage;
- Essential components.

Each of the details above has been explained below:

- *The number of the technology:*
  This is the code in the web application. Technologies can be selected in the web application by entering the number of the concerned technology;

- *The name of the technology:*
  The name is the technology's first means of identification;

- *The description of the technology:*
  The description provides a bit more information about the technology, implementation possibilities, limitations in then application, etc.

- *The technology type:*
  The technology type states which kind of technology is involved (environment-friendly technology; energy technology with energy-saving; combined heat and power or renewable energy);

- *The performance factor of the technology:*
  The performance factor indicates the score of the technology. Projects are ranked based on the technology's performance factor. Projects with a high performance factor thus receive a high score and have more chance of being ranked favourably. The performance factor is determined by the extent that the technology contributes

to realising the Kyoto objectives or environmental objectives set by the Flemish Government.
Technologies that make a major contribution to environmental objectives or offer major environmental benefits, will receive a high score;

- *The additional cost percentage;*
  The additional cost is an indicator of extra costs incurred by the company due to investing in the environment-friendly technology. This additional cost is the extra investment, less the savings and accompanying incomes during the first five years of implementation. The additional cost is expressed as a percentage of the total investment cost (additional cost percentage);

- *The essential components of the technology:*
  The essential components indicate which exact components come into consideration for support. The application is made by stating the cost price of the essential components, which the web application will use to calculate the support. All components are essential. In other words, an investment amount must be filled in for all components. If an essential component is missing, then, in principle, an application for the technology cannot be made.

e. Support intensity

Support is calculated based on the additional cost and amounts to 40% for small and medium-sized companies and 20% for large companies.
The subsidy amount will amount to maximum 1.75 million Euros per application.

6.2.2 Evaluating environment-friendly techniques for the textile industry against the criteria for the environmental investment support

VITO's BAT centre supports the Flemish Energy Agency in compiling the limitative technologies list. In accordance with the BAT approach, a technology will be added to the list if it meets *all* the conditions below:
- The technology has outgrown the experimental phase (implementation in industrial sector possible in the short-term) but is not (yet) a standard technology* in the sector;
- Implementation of the technology is not yet obligatory in Flanders e.g. to comply with VLAREM II**;
- The technology offers a clear environmental benefit compared to the standard technology;
- It is accompanied by a meaningful investment cost;
- The investment cost is higher than the standard technology;
- The additional cost compared to the standard technology will not be paid back in the short term (within 5 years) via the realised net savings.

* 'Standard technology' refers to technology in which an average company (in the sector) would currently invest if new investment was needed.
Comment:

A standard technology is thus a technology that is currently freely offered on the market by suppliers. However, a standard technology is necessarily a technique that is already implemented within the sector.
Relationship BBT – standard technology – environmental investment support*:*
In many cases, the term 'BAT' and the term 'standard technology' will be used together. In this case, the BAT does not qualify for the environmental investment support.
However, in some cases, the BAT is not (yet) a standard technology. This is, for example, the case for BAT that are relatively expensive compared to the existing standard technology and/or for BAT in which companies do not yet standarly invest if new investments are needed. In the latter case, the environmental investment support could be useful to accelerate market introduction or market expansion. Such BAT will be considered for the environmental investment support.

** If Flemish emission limit values are applicable, a subsidy will only be awarded if the technology is able to realise better results than the Flemish emission limit values.
If Flemish emission limit values are not applicable, the technologies on the list must have one of the following objectives:
- To overcome (existing) European emission limit values;
- To realise environmental benefits for which no European emission limit values have been approved.

Table 35 evaluates the environment-friendly techniques from chapter 4 using the criteria above. Only techniques with a significant investment cost are evaluated. An 'x' means the concerned criterion has been satisfied. A '*' means the concerned criterion has not been satisfied. End-of-pipe techniques have, in accordance with the Ministerial Ruling of 3 June 2005, been scrapped from the LTL and have thus not been included in Table 35.

A technology will only be considered for an environmental investment support if all criteria have been satisfied. If one of the criteria is not satisfied, the technique will not necessarily be evaluated against the remaining criteria.

Table 35: Evaluation of environment-friendly techniques against criteria for environmental investment support

	Criteria						
Technology	… is proven but is not yet a standard technology	… is not mandatory in Flanders	… has a clear environmental benefit compared to the standard technology	… has an investment cost higher than the standard technology	… has a pay-back time of ≥ 5 years (additional costs compared to	**… satisfies all criteria for the environmental investment support**	**… already part of the LTL**
Use environment-friendly alternative chemicals for finishing activities wherever possible to replace:							
Deca-BDE	x	x	x	x	*		
HBCD	x	x	x	x	*		
PFOS	x	*					
PFOA	x	x	x	x	*		
NP	x	x	x	x	*		
NPE	x	*					
PAH	x	x	x	x	*		
Wherever possible, re-use rinse waters from process baths in the production process.							
Deca-BDE, HBCD and Sb_2O_3	x	*					
PFOS	x	*					
PFOA	x	x	x	x	*		

6.2.3 Recommendations for the LTL

Based on the evaluation of environment-friendly techniques against the criteria for the environmental investment support, no technologies have qualified to be included in the LTL. There are also no recommendations for modifying technologies that are already part of the LTL.

6.3 Suggestions for further research and technological development:

This section makes suggestions for further research and technological development. A 2-track approach has been used:

- Recommendations for improving available information and knowledge;
- Recommendations for developing new environment-friendly technologies.

6.3.1 Recommendations for improving available information and knowledge

When compiling the BAT study, a number of gaps were noticed in the available knowledge/information. Further research in these domains is recommended in order to fill these gaps. An overview of the concerned domains and the accompanying research recommendations has been provided in Table 36. Table 36 also shows a number of ongoing research projects that were noticed when compiling the BAT study, though this list is not necessarily comprehensive.

Table 36: Recommendations for further research to improve available information and knowledge

Missing or incomplete knowledge/information	*Research recommendation*	*Ongoing research projects*
Level of implementation for source-oriented and process-integrated measures to limit emissions of PAH into wastewater, e.g. HT paint equipment, PAH-free carriers in colorants and paints, synthetic oils	Regular sampling and analysis to generate additional knowledge.	
Effect of biological purification on the removal of PAH	Generate additional knowledge via regular sampling and analysis.	
Emission data for e.g. the parameters PFOS, PFOA and NP/NPE	Further validate the measurement methods (status of WAC methods, see appendix 2).	
Emission data for e.g. the parameters PFOS, PFOA and NP/NPE	Additional measurement programmes (VMM, LNE-MI, companies), e.g. on specific partial flows (e.g. wash-waters from tissues and yarns).	
Sampling and analysis	Regular sampling and analysis (e.g. in monitoring programmes and with quality safeguards in sampling and analysis)	

	provide an insight into the characteristics of the wastewater or liquid waste flows. Results from these analyses allow the right choices to be made when re-deploying the production process or the treatment, or when disposing of these flows.	
Origin of Deca-BDE and/or HBCD in wastewater of textile companies that do not use these substances.	Additional research into the origin of these emissions.	
Origin of antimony in the wastewater of textile companies.	Research into origin of these emissions (synergist in combination with e.g. Deca-BDE or paint activities).	Antibomose study (2008-2010): research by VOKA, Essenscia and VITO concerning the prevalence of e.g. antimony in industrial wastewater, financed by IWT and 24 Flemish companies. Most important conclusion of first phase (completed in 2009): source measures not possible in all companies. The second phase will examine whether these parameters can be removed from the wastewater in a technically and economically feasible manner.
Origin of NP/NPE and PAH in the wastewater of textile companies.	Research into the origin of these emissions, e.g. via analysis of purchased tissues and yarns or via analysis of wash-water from tissues and yarns.	GCMS (possibly HPLC too) has been established as analysis method for determining PAH in tissues and yarns.
Ambiguity about the performance of the wastewater purification techniques in removing the parameters Deca-BDE, HBCD, antimony, NP/NPE and PAH from the	Additional research into the removal yield of wastewater purification techniques is advised.	

wastewater of textile companies.		

6.3.2 Recommendations for developing new environment-friendly technologies

When compiling the BAT study, it was established that existing BAT do not always offer the best or most complete solution for the environmental problems encountered in the textiles industry, either:

- Because there are no BAT for a particular environmental aspect, or
- Because existing BAT only resolve the environmental problem incompletely/insufficiently, or
- Because existing BAT have technical, economical or environmental limitations (in other words, are difficult to implement or implement universally, are expensive, have major cross-media effects).

Further research and development of new environment-friendly techniques is recommended in this case, and can lead to a new BAT at a later phase. An overview of the concerned environmental aspects and the accompanying research recommendations has been provided in Table 37. Table 37 also shows a number of innovative technologies that are currently available, though this list is not necessarily comprehensive. It is recommended that these developments be followed up and possibly supported so that these environment-friendly technologies can develop into market-worthy products.

Table 37: Recommendations for developing new environment-friendly technologies

Environmental aspects for which the existing BAT do not offer an ideal solution	*Recommendation*	*Techniques being developed*
There is no information about type and quantity of chemicals that enter Flemish textile companies via purchased tissues and yarns.	Fine-tune/further validate analysis methods for determining e.g. NP/NPE and PAH in tissues and yarns.	GCMS (possibly HPLC too) has been established as analysis method for determining PAH in tissues and yarns. No analysis method is known to be available for determining NP/NPE in tissues and yarns.
Use of environment-friendly alternatives for PFOS and/or PFOA.	Additional tests in the textile industry must indicate which chemicals can be used as fully fledged alternatives for PFOS and/or PFOA in the textile industry.	A number of substitutes (e.g. PFBS[296] and PFHA[297]) on the market as alternatives for PFOS and/or PFOA in particular textile applications. A

[296] C4 compound

[297] C6 compound

		technical problem encountered when using alternatives for PFOS and/or PFOA is managing to retain a combination of particular properties in the textile (oil, water and dirt resistant, quickly cleaned).
Techniques for removing PFOS and/or PFOA from the wastewater of textile companies.	There is a need for additional research into specific wastewater purification techniques (and removal yields) for the parameters PFOS and PFOA.	

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www.emis.vito.be
www.oeko-tex.com
www.fedustria.be
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www.milieu-en-gezondheid.be
www.sica-chauny.com
www.vmm.be
www.wikipedia.be
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ABBREVIATIONS

AE	Alcohol ethoxylates
APE	Alkylphenol ethoxylates
BAT	Best Available Technique
BAT	Best Available Techniques
BDE	Bromodiphenyl ether

- BDE 28 — 2.4.4’-tribromodiphenyl ether
- BDE 47 — 2.2’,4.4’-tetrabromodiphenyl ether
- BDE 66 — 2.3’,4.4’-tetrabromodiphenyl ether
- BDE 99 — 2.2’,4.4’,5-pentabromodiphenyl ether
- BDE 100 — 2.2’,4.4’0.6-pentabromodiphenyl ether
- BDE 153 — 2.2’,4.4’,5.5’-hexabromodiphenyl ether
- BDE 154 — 2.2’,4.4’,50.6’-hexabromodiphenyl ether
- BDE 183 — 2.2’2.3,4.4’,5’,6-heptabromodiphenyl ether
- BDE 205 — 2.3,3’,4.4’,5.5’,6-octabromodiphenyl ether
- BDE 209 — Decabromodiphenyl ether (Deca-BDE)

BS	Government Gazette
BFR	Brominated Flame Retardant
BMKN	Basic environmental quality standards
BS	Settleable particles
BSEF	Bromine Science and Environmental Forum
BFRs	Brominated Flame Retardants
BOD	Biological Oxygen Demand
Centexbel	Belgian Textile Research Center
CCl_2	perchloreethylene
COD	Chemical Oxygen Demand
DBDPE	Decabromediphenylethane
Deca-BDE	Decabromediphenyl ether
DIR OW	Discharged directly into surface water
DPS	Daugher Directive Priority Substances
EBFRIP	European Brominated Flame Retardants Industry Panel
EFRA	European Flame Retardants Association
EPA	United States Environmental Protection Agency
EPER	European Pollutant Emission Register
Fedustria	Federation of the Textile, Wood an Furniture Industries
gg	no data
HBCD	Hexabromecyclododecane
i2a	International Antimony Association
IBC’s	Intermediate Bulk Containers
INDIR OW	Discharged indirectly into surface water
KRLW	Water Framework Directive
KWS	Hydrocarbons
LNE	Environment, Nature and Energy Department at the Flemish Government -AMI: Environmental inspection agency -AMV: Environmental permit agency
MSDS	Material Safety Data Sheets

N_{tot}	Nitrogen total
NACE	Nomenclature générale des Activités economiques dans les Communautés Européennes
NP	Nonylphenols
NPE	Nonylphenol ethoxylates
OAS	Surface active substances
Octa-BDE	Octabromodiphelyl ether (cannot be used in the EU since 2004)
PAH	Polycyclic aromatic hydrocarbons

PAH 16	16 of EPA
	o Acenaphtylene:
	o Acenaphthene;
	o Anthracene;
	o Benzo(a)anthracene;
	o Benzo(b)fluoranthene;
	o Benzo(k)fluoranthene;
	o Benzo(a)pyrene;
	o Benzo(ghi)perylene;
	o Indeno(1,2,3-cd)pyrene;
	o Chrysene;
	o Dibenzo(a,h)anthracene;
	o Phenanthrene;
	o Fluoranthene;
	o Fluorene;
	o Naphthalene;
	o Pyrene;

PBB	Polybromobiphenyl (can no longer be used in the EU)
PBDE	Polybrominated diphenyl ethers; including Octa-BDE, Penta-BDE and Deca-BDE
PCB	Polychlorobiphenyl
Penta-BDE	Pentabromodiphelyl ether (cannot be used in the EU since 2004)
PFT	Perfluorinated tensides o PFOA — Perfluoroactane acid or pentadecafluorooctane acid o PFOS — Perfluorooctane sulphonate or heptadecafluorooctane sulphonate o PFBS — Perfluorobutane sulphonate or nonafluorobutane sulphonate o PFHA — Perfluorohexane acid o PFHS — Perfluorohexane sulphonate o PFOSA — Perfluorooctane sulphonamide o PFBA — Perfluorobutane acid or heptafluoro butyric acid o PFC5A — Perfluoropentanoic acid o PFHpA — Perfluoroheptane acid o PFNA — Perfluorononanoic acid or heptadecafluorononanoic acid o PFDA — Perfluorodecanoic acid or nonadecafluorodecanoic acid o PFuDA — Perfluoroundecane acid o PFDoA — Perfluorododecane acid o PFC14A — Perfluoroquaterdecanoic acid

- PFPA — Nonafluoropentanoic acid
- PFHxA — Undecafluorohexanoic acid
- PFHpA — Tridecafluoroheptanoic acid
- PFUnA — Perfluoroundecane acid
- PFHxS — Tridecafluorohexanoic sulphonate
- PFDS — Perfluorodecanoic sulphonate
- PFTeA — Perfluorotetradecanoic acid

PDS	Priority dangerous substances
PNEC	Predicted No Effect Concentration
PS	Pollutants
P_{tot}	Phosphorous total
R.D.	Royal Decree
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RIO	Discharged into sewer
Sb_2O_3	Antimony trioxide
SM	Suspended Solids
SVHC	Substances of Very High Concern
TBB	2-ethylhexyl 2,3,4,5-tetrabromobenzoate
TBBP-A	Tetrabromobisphenol-A; 2.2’,6.6’-tetrabromo-4.4’-isopropylidenediphenol (one of the two most commonly used BFRs, said not to be used in Flanders)
TBPH	2-ethylhexyl tetrabromophthalate
THPC	Tetra(hydroxymethyl)phosphonium chloride
VECAP	Voluntary Emission Reduction & Control Action Program
VITO	Flemish Institution for Technological Research
VMM	Flemish Environment Agency
WWTP	(municipal) Waste Water Treatment Plant

LIST OF TERMS

Detection limit:	the smallest quantity of substance or lowest concentration of a component in a sample, for which the presence can still be established.
Wastewater:	Polluted water that one disposes of, must dispose of or has the intention to dispose of, excluding rain water that has not come into contact with polluted substances
Industrial wastewater:	All wastewater that does not comply with the definition of household wastewater or cooling water
Determination limit:	the smallest quantity of substance or lowest concentration of a component in a sample, which can be quantified with an analysis method.
Daily average:	the content or concentration determined on the basis of a 24-hour sample proportionate to the volume
Formulation:	Mixes of chemicals
Dangerous substances	toxic, persistent and bio-accumulable substances or groups of substances and other substances or groups of substances that are of equal concern
Accuracy:	the level of consistency between the average value obtained from a (large) number measurements and the actual value; the acceptable accuracy mentioned in appendix 4.2.5.2, Art.4, is expressed as a systematic deviation percentage or bias, which is calculated as the difference between the average experimental value and the actual value, calculated against the actual value.
Monthly average:	the value determined on the basis of all 24-hour samples for the concerned month, which have a composition consistent with the volume.
Precision:	the amount of spread in the analysis results. When determining the precision, one must state the conditions (time, calibration, operator, device, etc.) that have been altered when performing the analysis; the pre-set minimum requirement is that the factor be time-varied, in other words, the concerned analyses be carried out on different days and in different series; the acceptable precision mentioned in appendix 4.2.5.2, Art. 4, is expressed as the percentage interval around the average

value in which 95% of the measurement results, performed via the above mentioned method, are found.

Preparate: (Ready-to-use) mixes of chemicals

Priority substances: substances for which the list has been established in accordance with EC guidelines 2000/60/EG as list III in appendix 2C accompanying the ruling; this includes priority dangerous substances in water policy, for which measures must be taken.

Reporting limit: the value below which a component is reported as non-quantifiable (’<’) this amounts to at least the determination limit.

Reference measurement method: methodology that must be implemented in order to determine a particular parameter; reference measurement methods include European (EN) international (ISO) or other normative methods or methods that are validated by the reference lab of the Flemish Institute for Technological Research (VITO) under assignment from the Flemish Government. This measurement method is described in the water analysis compendium (WAC). The compendium was approved by ministerial decree and contents of the WAC were announced in an extract in the Government Gazette (see MR of 15 April 2009 [2009/202141]).

In addition to the measurement methods in the compendium, other measurement methods can also be used that have been declared as equivalent methods by the qualified authorities. If the laboratory wants to use other analysis methods than those in the compendium, it must be able to demonstrate equivalence. The results of the equivalence investigation must be submitted to the qualified authorities and VITO. The qualified authority will decide, after advice from VITO, whether the analysis method is actually equivalent and will inform the laboratory of the decision via registered letter.

OVERVIEW OF APPENDICES

Appendix 1:	BAT study steering committee
Appendix 2:	Background information about reference measurement methods for BFR, antimony, PFT, NP / NPE and PAH
Appendix 3:	Background information about the methodology for determining the BAT associated emission levels for textile companies
Appendix 4:	Final comments

APPENDIX 1: BAT STUDY STEERING COMMITTEE

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Visited companies

- Masureel Veredeling (Wevelgem)
  Contact person: Hans Roelandt

- Concordia Textiles (Waregem)
  Contact persons: David Dieryckxvisschers, Frank Delabie and Johan Algoet

APPENDIX 2: BACKGROUND INFORMATION ABOUT REFERENCE MEASUREMENT METHODS FOR BFR, ANTIMONY, PFT, NP / NPE AND PAH

Reference measurement methods

The procedures for analysing components in water (reference measurement methods) have been included in the Water Analysis Compendium (WAC). The paragraphs below provide an overview of the WAC documents most relevant to the study (also see www.emis.vito.be).

Comments

- The Ministerial Decree of 15 April 2009 concerning the compendium for analysing water [2009/202141] established WAC methods for a number of parameters. The WAC methods included in the contents of the most recent MD must be used, 10 days after publication of the MD in the Belgian Book of Statutes, when exercising article 1.1.2, definition of "reference measurement method", in version II of VLAREM.
- WAC methods that have not (yet) been established via the MD of 15/04/09 are regarded as recommended methods.

WAC/I/A/010: Guidelines for the conservation and treatment of water samples (02/2009 MD 15/04/09, 02/2010 design method).

- These procedures describe how to handle samples when determining the content of inorganic and organic parameters in water. These procedures also contain guidelines for sample volume, recipient material and sample storage.
- BFR and PFT are part of the ‘other organic parameters’ category in table 1 of the WAC/I/A/010. With regards to PFT, a separate category will probably be created in the future. NP is part of the 'phenol compounds’ category.

WAC/I/B/001: Definitions and terminology (01/2007)

- These WAC procedures provide an overview of the main definitions concerning performance characteristics and measurement uncertainty. The definitions for demonstrability limit, determination limit, reporting limit, precision, accuracy and reference measurement method have been included in VLAREM II, part I (general determinations), chapter 1.1 (legal basis and definitions), article 1.1.2 (also see paragraph 2.4.1.b)
- The determination limit of a substance is approximately a factor of 2 higher than the demonstrability limit. However, the demonstrability limit can vary depending on the laboratory that conducts the analysis.
- A blank sample is normally free of the measured substance, but a certain quantity of a particular substance could still be measured due to contamination. This is, for example, the case for DECA-BDE in dust particles that are suspended in the air, which are possibly released by electrical equipment like printers and computers. Currently, 0.5 µg/l DECA-BDE is found in the blank sample.

WAC/III/B: Recommended methods for determining elements (February 2009)

- These procedures describe the analysis methods that can be used to determine e.g. antimony in water: For antimony, please refer to:
    - WAC/I/A/010: Guidelines for conserving and handling water samples (02/2009);
    - WAC/III/B/001: Degradation for determining selected elements in water – nitric acid degradation (01/2007);
    - WAC/III/B/010: Determining the selected elements with indicative plasma atomic emission spectrometry (01/2008);
    - WAC/III/B/012: Determining Sb, As and Se with hydride-atomic absorption spectrometry (design, 01/2007).

WAC/IV/A/030: Determining brominated fire retardants in water (01/2008)

- These procedures describe the method for extracting, purifying and analysing a number of brominated flame retardants in water. The procedures apply to the following compounds:
    - BDE 28 2.4.4’-tribromodiphenyl ether
    - BDE 47 2.2’,4.4’-tetrabromodiphenyl ether
    - BDE 99 2.2’,4.4’,5-pentabromodiphenyl ether
    - BDE 100 2.2’,4.4’0.6-pentabromodiphenyl ether
    - BDE 153 2.2’,4.4’,5.5’-hexabromodiphenyl ether
    - BDE 154 2.2’,4.4’,50.6’-hexabromodiphenyl ether
    - BDE 183 2.2’2.3,4.4’,5’,6-heptabromodiphenyl ether
    - BDE 209 Decabromodiphenyl ether (DECA-BDE)
    - Hexabromocyclododecane (HBCD)
    - Decabromediohenyl ethane (DBDPE)

  The procedures state that, in some cases, the reliability of the HBCD determinations will be lower due to adsorption/degradation phenomena. In such cases, the calculated HBCD content can only be reported as indicative.
- BFR are determined via GC-MS, which involves gas chromatography with mass spectrometric detection. The sample reparation process must be followed before performing the GC-MS analysis. This sample preparation consists of fluid/fluid extraction, possibly followed by purification of the sample extract.

  comment

  Water samples are not filtered prior to extraction. Thus dissolved BFRs, and those that bond with particles, are both evaluated. Only in the case of latex-based samples may it be necessary to filter the extract with Na2SO4 to remove excess water and disruptive materials. This filtration has no impact on the results; the BFRs are in the extract.
- Discharge data from before 2006 must be interpreted with a certain degree of caution, considering that the measurement method was had not been fully defined. With regards to DECA-BDE, emission limit values also need to be interpreted with a degree of caution considering the likelihood of contamination via dust particles in the air.

WAC/IV/A/025: Determination of perfluorinated tensides (01/2010 design method)

- The procedures describe the method used for extracting and measuring perfluorinated compounds in drinking, ground, surface and waste water, and is aimed at quantifying the following components:
  - Heptafluorobutyric acid PFBA
  - Nonafluoropentanoic acid PFPA
  - Undecafluorohexanoic acid PFHxA
  - Tridecafluoroheptanoic acid PFHpA
  - Pentadecafluorooctanoic acid PFOA
  - Heptadecafluorononanoic acid PFNA
  - Nonadecafluorodecanoic acid PFDA
  - Perfluoroundecanoic acid PFUnA
  - Perfluorododecanoic acid PFDoA
  - Nonafluorobutane sulphonate PFBS
  - Tridecafluorohexane sulphonate PFHxS
  - Heptadecafluorooctane sulphonate PFOS
  - Perfluorodecane sulphonate PFDS
  - Perfluorooctane sulphonamide PFOSA
  - Perfluorotetradecanoic acid PFTeA
- Water samples are extracted using solid phase extraction. The extracts are analysed with liquid chromatography with tandem mass spectrometric detection (LC-MS/MS). The content of different PFCs is calculated using the internal standard method for ^{13}C-characterised fluorine compounds.
- The analysis itself can be carried out fairly straight-forwardly, but is subject to matrix effects that require the analysis process to be closely followed up using quality parameters. Depending on the implemented method, less reliable contents may be obtained for a few perfluorinated compounds due to insufficient recovery, losses via adsorption or possible interference. In this case, the measured contents can only be reported as indicative.

WAC/IV/A/003 (being compiled)

- A method design for determining octyl and nonylphenols is currently being evaluated and will be available in Spring 2010.
- Nonylphenols (NP) are determined via GC-MS, which involves gas chromatography with mass spectrometric detection.

WAC/IV/A/021 (being compiled)

- Nonylphenol ethoxylates (NPE) are determined via liquid chromatography.
- Calibration is realised using a standard (often poly-NPE with 6 C_2H_4O groups).

WAC/IV/A/002: Determination of polycyclic aromatic hydrocarbons in water (01/2005 MD 15/04/09, 12/2009 design method)

- These procedures describe an analysis method for determining polycyclic aromatic hydrocarbons (PAH) in surface water, groundwater, drinking water and wastewater, and is aimed at quantifying the 16 PAH of EPA:
  - Acenaphtylene:
  - Acenaphthene;
  - Anthracene;
  - Benzo(a)anthracene;

  - Benzo(b)fluoranthene;
  - Benzo(k)fluoranthene;
  - Benzo(a)pyrene;
  - Benzo(ghi)perylene;
  - Indeno(1,2,3-cd)pyrene;
  - Chrysene;
  - Dibenzo(a,h)anthracene;
  - Phenanthrene;
  - Fluoranthene;
  - Fluorene;
  - Naphthalene;
  - Pyrene;
- Two techniques are used to determine PAH in water: Gas chromatography with mass spectrometric detection (GC/MS) and liquid chromatography (HPLC) with fluorescence detection and UV or diode array detection. Both methods have been thoroughly tested by the reference laboratory at VITO and provide analogous results.

comment

Here are a few noteworthy points when taking samples for determining BFR, antimony, PFT, NP/NPE and PAH:

- BFR, antimony and PAH could possibly bond with SM in wastewater. The SM content around the control flume or the measurement channel can be higher than the average amount in the wastewater. These samples must be taken after the control flume or measurement channel, in the zone where most of the discharged wastewater is mixed.
- BFR, antimony, NP/NPE and PAH could possibly bond with plastic materials (e.g. measurement channel and recipients). Thus sampling, as well as storage and transport of samples to analyse these parameters, should preferably take place in glass receptacles. When determining antimony, receptacles may not be used which could possibly contain antimony compounds themselves. In contrast, when determining PFT, one is allowed to use polypropylene receptacles.

references

- Water Analysis Compendium (WAC) http://www.emis.vito.be/ShowPage.cfm?PageID=525
- Compendium for Sampling and Analysis (CMA) under the waste materials decree and the soil remediation decree http://www.emis.vito.be/index.cfm?PageID=565
- Ecotips, Precision & accuracy dominate WAC, February – March 09/1, pg 26-27, 2009
- i2a, 2009a
- VITO, 2008b

APPENDIX 3: BACKGROUND INFORMATION ABOUT THE METHODOLOGY FOR DETERMINING THE BAT ASSOCIATED EMISSION LEVELS FOR TEXTILE COMPANIES

Introduction

This appendix provides more background information about the methodology for determining BAT associated emission levels for discharging industrial wastewater from textile companies. The methodology is based on the method for determining BAT associated emission levels (BAT-AELs), which has been developed by the BAT centre at VITO (Derden A. *et al.*, 2009).

The methodology for determining BAT-AELs, for the discharge of industrial wastewater, consists of the following five steps:

1. Selection of companies;
2. Collection of all available discharge data;
3. Selection of parameters;
4. Analysis of discharge data;
5. and determination of BAT-AELs.

The 5 steps have been followed for the parameters Deca-BDE, HBCD, antimony and PAH (16 of EPA). Only steps 1 and 2 were completed for the parameters PFOS, PFOA, NP and NPE.

Determining BAT associated emission levels in 5 steps

Step 1: selection of companies;

The starting point for determining BAT-AELs is to select the companies for which discharge data must be collected. When making this selection, the heterogeneity (e.g. integrated companies versus job-processing companies) of the sector must be sufficiently reflected in the discharge data. Background information is also needed about the discharge situation (surface water/sewer), implemented production processes/techniques (e.g. making textiles and/or paint fire-resistant), raw materials/end products (e.g. use of Deca-BDE in combination with Sb_2O_3 or antimony-based paints), implemented water purification techniques (e.g. biological purification, sand filtration, etc.) and permitted emission limit values (e.g. special environmental permit conditions. This means anonymous discharge data (via LNE-AMI) will normally be of little use.

All Flemish textile companies that use Deca-BDE, HBCD, antimony trioxide, PFOS and/or PFOA, or whose wastewater contains Deca-BDE, HBCD, antimony, PFOS, PFOA, NP, NPE and/or PAH, have been identified. These companies have been divided into two groups, namely textile companies that discharge into surface water and those that discharge into sewer. Overall, there are 30 textile companies that discharge into surface water and 39 textile companies that discharge into sewer.

Step 2: collection of all available discharge data

All available discharge data (= raw data set) for the examined parameters (Deca-BDE, HBCD, antimony, PFOS, PFOA, NP, NPE and PAH) was then collected, for all textile companies selected in step 1. The measurement data was supplied by the Flemish Government, on the one hand, namely the Flemish Environment Agency (VMM) and the Environment, Nature and Energy Department, Environment Inspection agency (LNE-AMI). And, on the other hand, Centexbel performed, together with Fedustria, conducted a questionnaire among its member companies, whereby additional measurement data was obtained. Both instant samples and 24-hour mix samples (volume-based or time-based samples) were collected from the industrial wastewater of the textile companies.

> *comment*
> With regards to discharge data from the companies, the exact type of sample could not be conclusively determined in the case of all data. Thus, the variation between the instant samples (momentary values) and the 24-hour samples (average values) could not be thoroughly examined.

Some measurements or discharge data (as well as the concrete number of textile companies that discharge into surface water or the sewer) varied depending on the studied parameter (group) (see chapter 3).

<u>Step 3: selection of parameters</u>
In this BAT study, the parameters, for which BAT associated emission levels need to be determined, are established in consultation with members of the steering committee (also see appendix 1). This is the case for the parameters Deca-BDE, antimony and HBCD. Emission levels will be determined for the individual PAH (16 of EPA). For the parameters PFOS, PFOA, NP and NPE, the members of the steering committee have only asked to highlight the discharge data.

The available discharge data that is collected in step 2 is then evaluated against the basic environmental quality standards and the determination and/or reporting limits (also see chapter 2, paragraph 2.4.1.d).
Parameters that are discharged in concentrations lower than the current basic environmental quality standards (BMKN) for the final receiving surface water, are not deemed as relevant for determining BAT-AELs. This is the case for the following PAH.

- Acenaphtylene[298];
- Chrysene[299].

Concentrations of the parameters fluorene[300] and naphthalene[301] in the effluent of all textile companies that discharge into surface water (with and without paint activities), as well as those that discharge into sewer (without paint activities), are always lower than the respective BMKN. These two additional PAH are also not regarded as relevant for determining the BAT-AELs for these groups of companies.

> *comment*
> The exercise for fluorene and naphthalene has been done for textile companies that discharge into sewer and perform paint activities.

[298] Annual averages BMKN of 4 µg/l(=4000 ng/l)
[299] Annual averages BMKN of 1 µg/l(=100 0ng/l)
[300] Annual averages BMKN of 2 µg/l(=200 0ng/l)
[301] Annual averages BMKN of 2,4 µg/l(=2 40 0ng/l)

Parameters for which the discharge concentrations are lower than the determination limit (cf. reference method or, in the absence of a reference measurement method, another available method) are also not regarded as relevant for determining BAT-AELs. None of the studied parameters (are known to) have discharge concentrations that are systematically lower than the determination limit.

Step 4: analysis of discharge data
The available discharge data (see step 2) for the selected parameters (see step 3) was then analysed. The aim of this analysis was to detect as much discharge data as possible which was not consistent with the BAT and/or which was not representative for the concerned sector or group of activities. This discharge data was not taken into account when determining the BAT-AELs. During the analysis, the link with the to-be-collected background information (step 1) was fundamental in helping to effectively sieve through the discharge data. The required background knowledge was obtained via Centexbel, in collaboration with Fedustria.

a. Deca-BDE
A summary of the measured and available discharge data for Deca-BDE from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.2.2.c).

1 of the 14 textile companies that discharge into surface water and 2 of the 9 that discharge into sewer have halted their activities (situation September 2009). The discharge data from these companies was not used in this analysis for determining BAT-AELs for the parameter Deca-BDE.

No information is available concerning the use of Deca-BDEF for 2 of the 14 textile companies that discharge into surface water. Based on the available discharge data (<determination limit (0.5 µg/l) and <reporting limit (1 µg/l), apart from 1 analysis result (3.20µg/l) from 1 of the 2 companies), it can be assumed that Deca-BDE is not implemented in the production process.
For 3 of the 9 textile companies that discharge into sewer, it cannot be said with certainty whether or not they use Deca-BDE. In two of these companies, the Deca-BDE concentrations in the wastewater are often <determination limit (0.5 µg/l) and <reporting limit (1 µg/l), with the exception of two measurements at 1 of the companies (0.66 and 0.81 µg/l). Only 1 Deca-BDE measurement (2009) is available for the third textile company, namely 231,00 µg/l. This is a textile company where the discharge of Deca-BDE was stopped and the buffer basin was cleaned. The analysis result dates from 1 year after discharge was stopped and the buffer basin was cleaned. In addition to Deca-BDE, HBCD (34 µg/l) and antimony (88 µg/l) were also measured.
The discharge data from these textile companies was also not used in this analysis for determining BAT-AELs for the parameter Deca-BDE.

8 of the 14 textile companies that discharge into surface water indicate that they do not use Deca-BDE. However, in 3 of these companies Deca-BDE concentrations were measured in 2009, which were >reporting (1 µg/l), with respective maximums of 2.2; 5.4 and 3.2µg/l.
2 of the 9 textile companies that discharge into sewer indicate that they do not use Deca-BDE. In 1 of these companies, Deca-BDE concentrations >reporting limit (1 µg/l), were measured in 2009, namely 5.50µg/l. Based on the available company

information, no clear cause can be attributed. It could possibly be a case of historical pollution (after-effects), Deca-BDE could be present in the water intake or the Deca-BDE could originate from purchased yarns/tissues.

3 of the 14 textile companies that discharge into surface water and 2 of the 9 companies that discharge into sewer definitely use Deca-BDE for their finishing activities. A summary of the measured and available discharge data for Deca-BDE in the 3 companies that discharge into surface water and the 2 companies that discharge into sewer, and which certainly do not use Deca-BDE to enrich textiles, can be found in Table 38.

> *comment*
> According to i2a (2009b), there are currently (2010) 29 textile companies in Europe who, as clients of the antimony industry, purchase Sb_2O_3 to use as a synergist in combination with BFR. Most of these companies are thought to be located in England and Belgium (8 textile companies). Thus there could be more textile companies in Flanders that implement Deca-BDE, but have failed to mention this.

Table 38: Summary of the measured and available discharge data for Deca-BDE by 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use Deca-BDE for their finishing activities (2006-2009)

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	59	44
Average value [µg/l]	68,54	500,30
minimum [µg/l]	0,08	0,10
maximum [µg/l]	1 153,00	6 600,00
median [µg/l]	8,80	94,00
5th percentile [µg/l]	0,10	0,17
10th percentile [µg/l]	0,10	1,84
25th percentile [µg/l]	3,00	19,83
50th percentile [µg/l]	8,80	94,00
75th percentile [µg/l]	34,50	370,00
80th percentile [µg/l]	47,80	484,00
90th percentile [µg/l]	142,00	735,40
95th percentile [µg/l]	376,00	1 545,60

Legend: OW: Discharge into surface water
RIO: Discharge into sewer

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

In the past, the Deca-BDE-based process baths and rinse waters from these 5 textile companies were still sent to the AWZI. 4 of the 5 textile companies implement e.g. the following BAT (situation September 2009): characterise released wastewater or liquid waste, collect exhausted process baths and dispose of via a qualified processing company, and dispose of rinse waters from process baths via a qualified processing company. The fifth company indicates that it internally recuperates 100% of the (rinse waters of) Deca-BDE-based process baths. The following BAT are implemented in this company: characterise released wastewater or liquid waste flows and re-use rinse waters from process baths in the production process wherever possible.

The discharge data for each of these 5 textile companies from the period that (rinse waters of) process baths with Deca-BDE still entered the AWZI, were then scrapped from the data set because they are not consistent with the BAT. A summary of the excluded discharge data for Deca-BDE in the 3 textile companies that discharge into surface water (2007-2009), and the 2 textile companies that discharge into sewer (2008-2009), can be found in Table 39, Figure 12 and Figure 13.

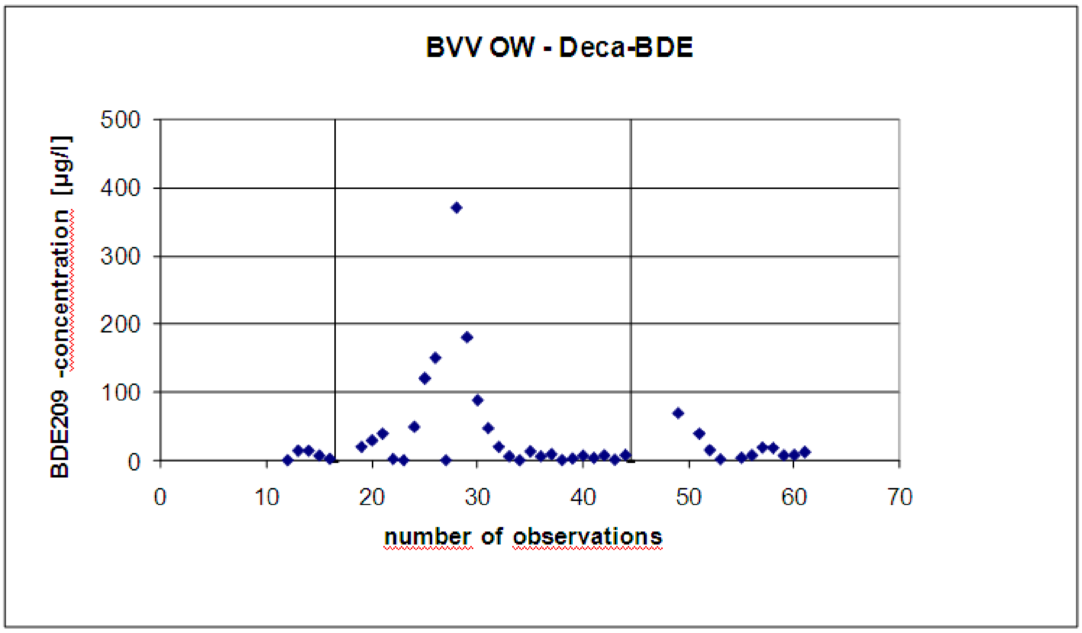
Table 39: Summary of the measured and available discharge data for Deca-BDE by 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use Deca-BDE for their finishing activities (2007-2009) and who divert their (rinse waters from) process baths away from the AWZI

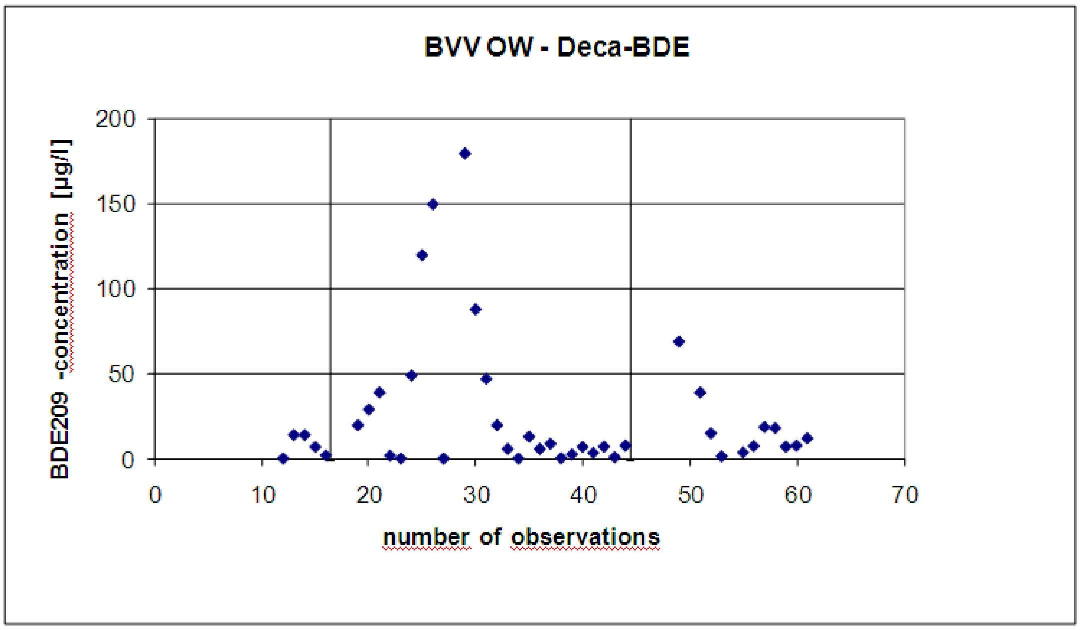
	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	42	39
Average value [µg/l]	33,60	329,23
minimum [µg/l]	0,08	0,10
maximum [µg/l]	370,00	6 600,00
median [µg/l]	8,25	73,00
5th percentile [µg/l]	0,10	0,10
10th percentile [µg/l]	0,38	1,39
25th percentile [µg/l]	3,45	6,45
50th percentile [µg/l]	8,25	73,00
75th percentile [µg/l]	26,68	220,00
80th percentile [µg/l]	39,00	307,20
90th percentile [µg/l]	86,10	530,00
95th percentile [µg/l]	148,50	759,80

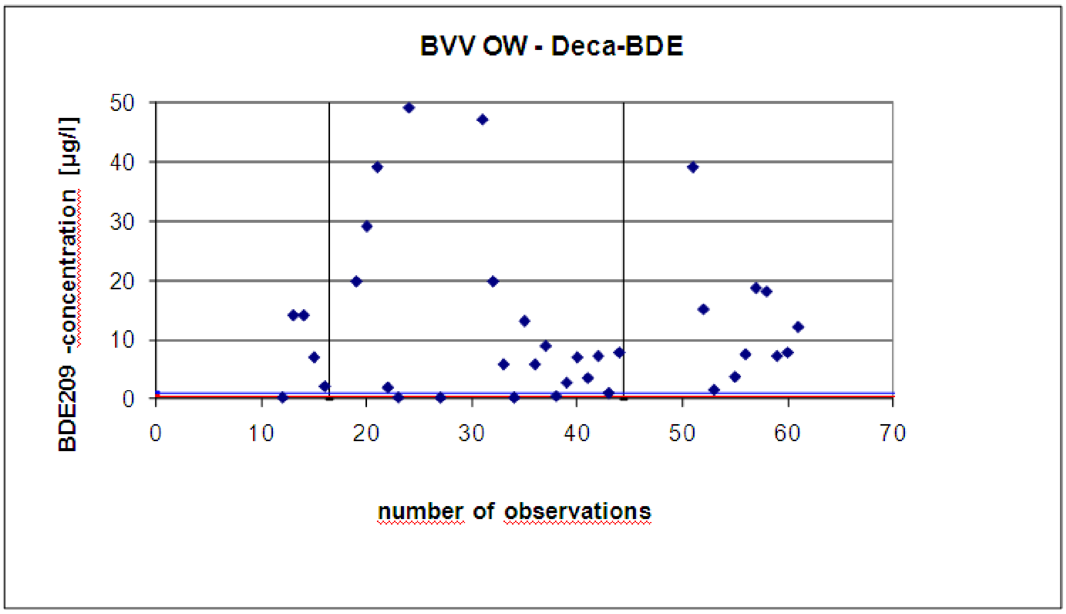
Legend: OW: Discharge into surface water
RIO: Discharge into sewer

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

Discharge into surface water







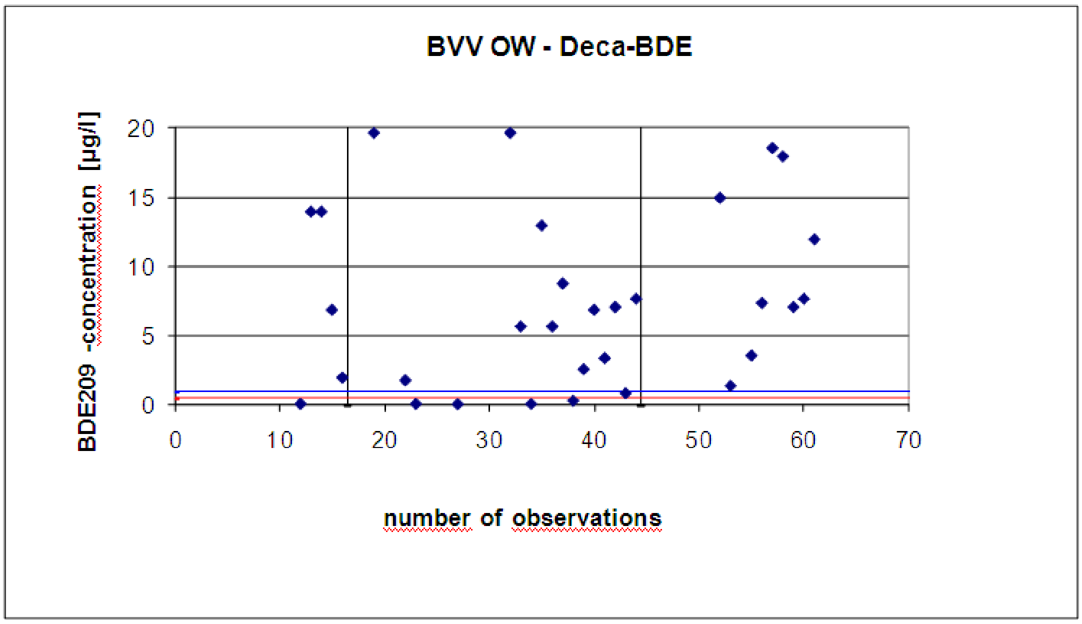
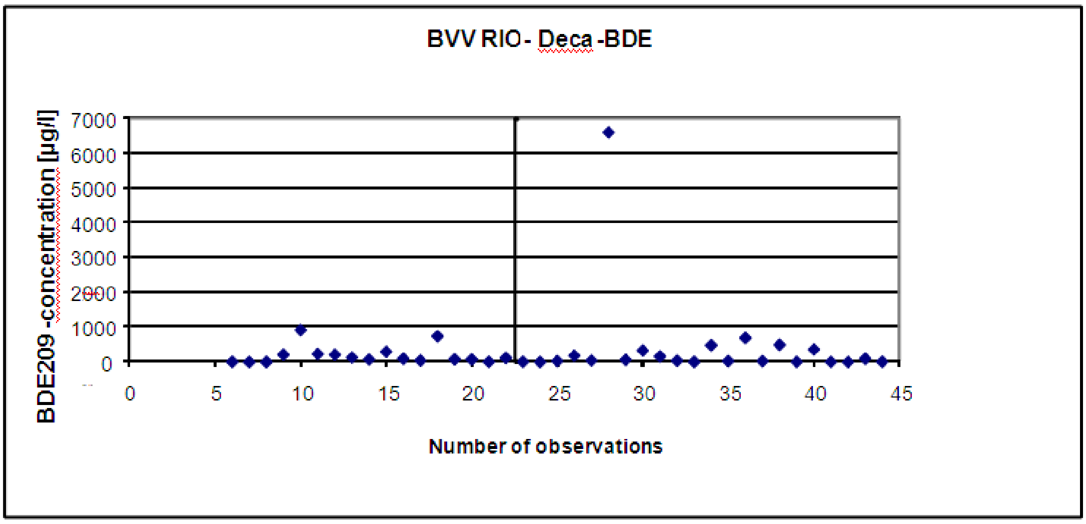
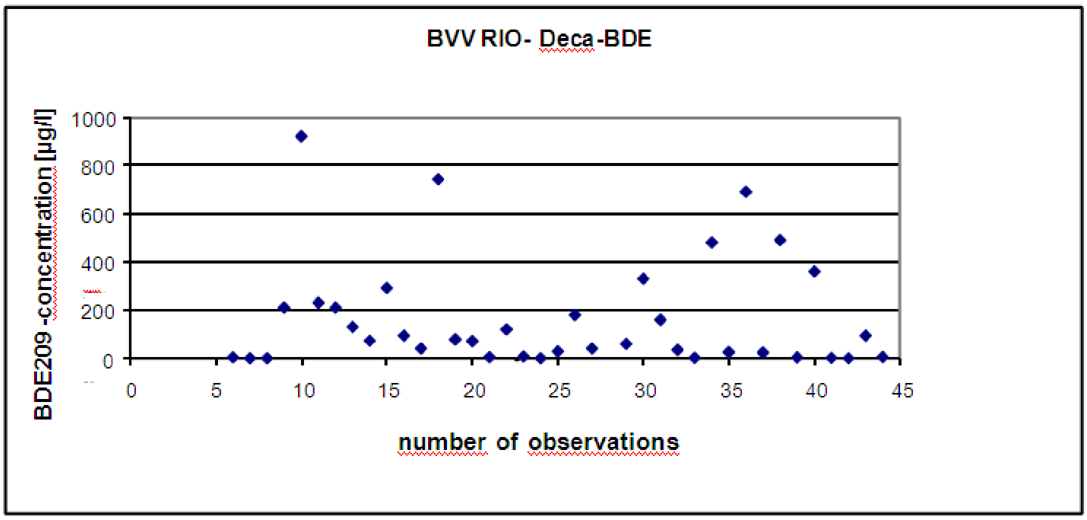


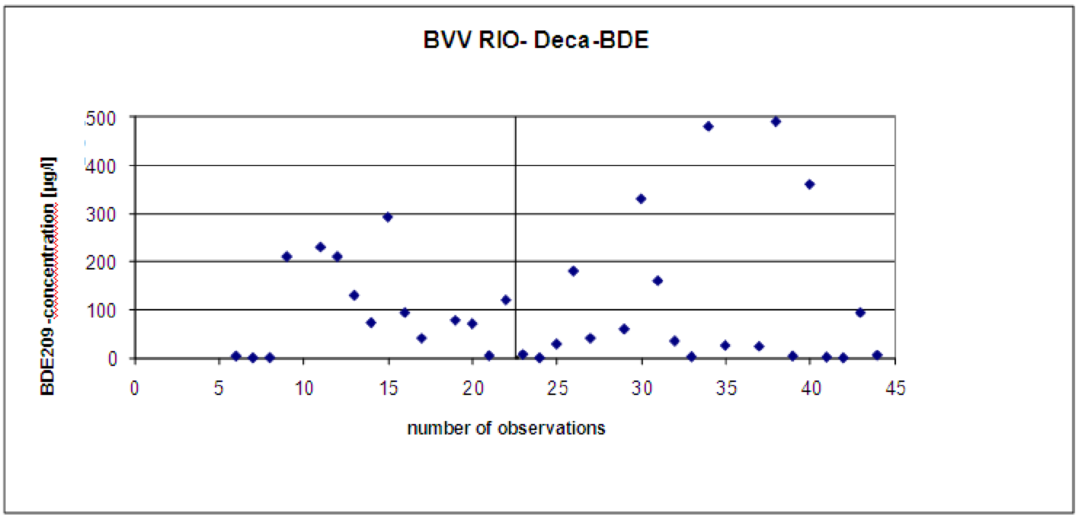
Figure 12: Schematic representation of the measured and available discharge data for Deca-BDE from 3 Flemish textile companies that discharge into surface water(2007-2009), which certainly implement Deca-BDE for their finishing activities and which dispose of their (rinse waters from) process baths via external processing companies, with variation in scale on the Y axis and an indicator for the determination limit (0,5 µg/l) and the reporting limit (1 µg/l)

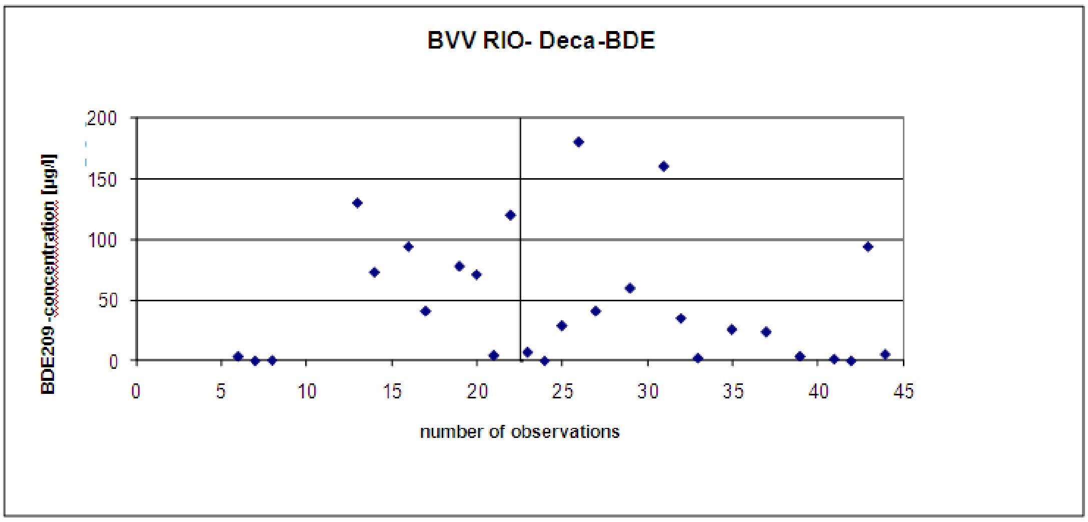
The three textile companies that definitely implement Deca-BDE, dispose of their (rinse waters from) process baths via external processing companies and discharge into surface water, all implement biological purification on their wastewaters (always in combination with buffering and post-sedimentation and, in 1 company (no. 2), in combination with sand filtration). However, until the end of 2008, this company encountered problems associated with historical pollution (after-effects).

Discharge into sewer









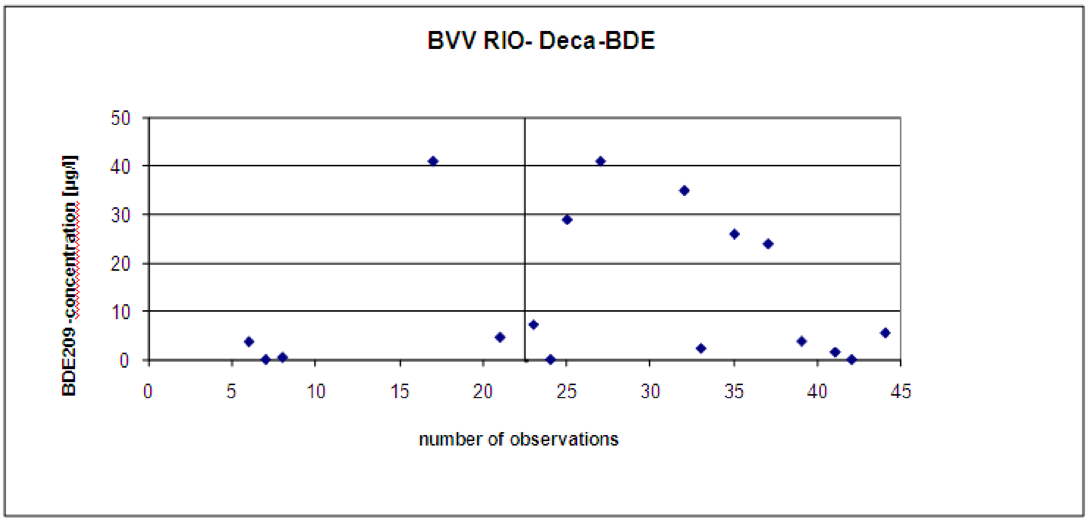


Figure 13: Schematic representation of the measured and available discharge data for Deca-BDE for 2 Flemish textile companies that discharge into sewer (2008-2009), which definitely implement Deca-BDE for their finishing activities and divert their

(rinse waters from) process baths away from the AWZI, with variation in scale on the Y axis

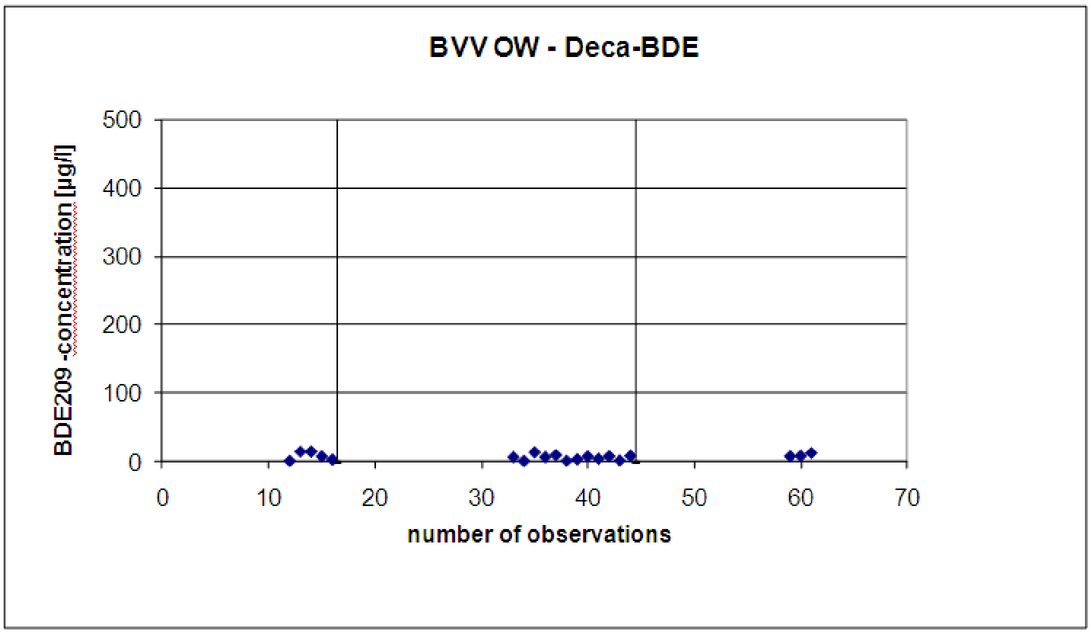
The two textile companies that definitely implement Deca-BDE and discharge into sewer both use chemical precipitation (coagulation/flocculation) (followed by biological purification in one company). One of the companies (no. 1) disposes of its (rinse waters from) Deca-BDE-based process baths via a qualified processing company but is experiencing problems caused by historical pollution, despite extensive remediation (e.g. cleaning internal discharge system). The other company (no. 2) that discharges into sewer, does not dispose of its (rinse waters from) Deca-BDE-based process baths via a qualified processing company, but states that it used 100% of them in the production process (situation September 2009). Further, it cannot be ruled out that small quantities of Deca-BDE (in the form of diffuse powder) will be released in the production process. This could possibly have an influence on the Deca-BDE concentration in the wastewater.

Table 40, Figure 14 and Figure 15 take a closer look at the measurement data from the 5 examined textile companies for 2009.

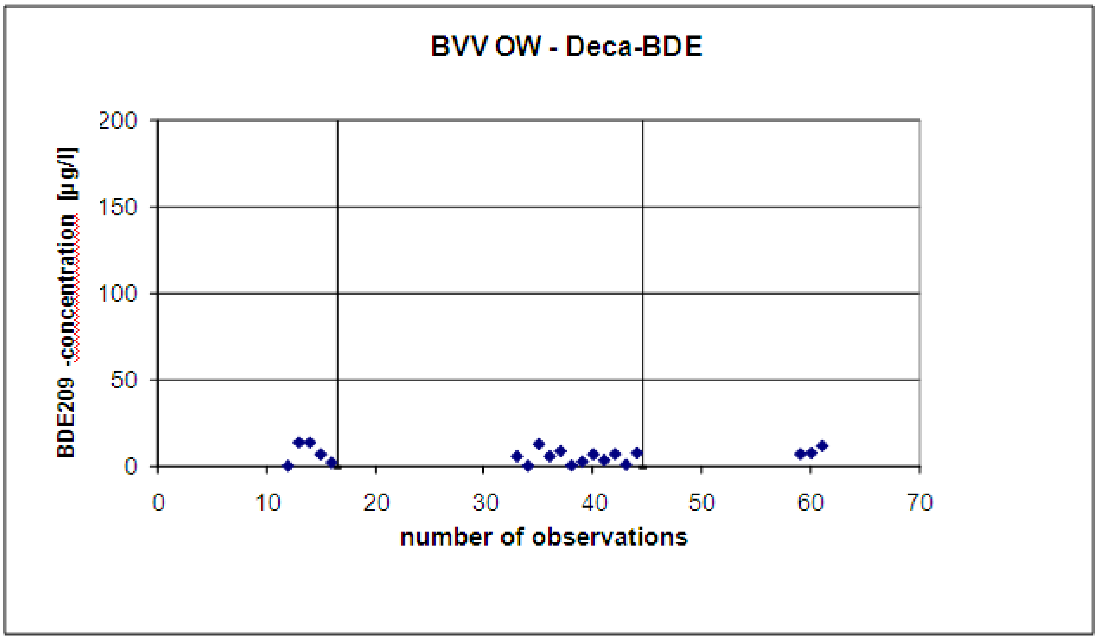
Table 40: Summary of the measured and available discharge data for Deca-BDE in 2009 for 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use Deca-BDE for their finishing activities and who divert their (rinse waters from) process baths away from the AWZI

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	20	20
Average value [µg/l]	6,30	168,17
minimum [µg/l]	0,10	0,10
maximum [µg/l]	14,00	742,00
median [µg/l]	6,90	56,00
5th percentile [µg/l]	0,10	1,53
10th percentile [µg/l]	0,31	2,32
25th percentile [µg/l]	2,45	5,38
50th percentile [µg/l]	6,90	56,00
75th percentile [µg/l]	7,98	180,00
80th percentile [µg/l]	9,44	384,00
90th percentile [µg/l]	13,10	510,00
95th percentile [µg/l]	14,00	692,60

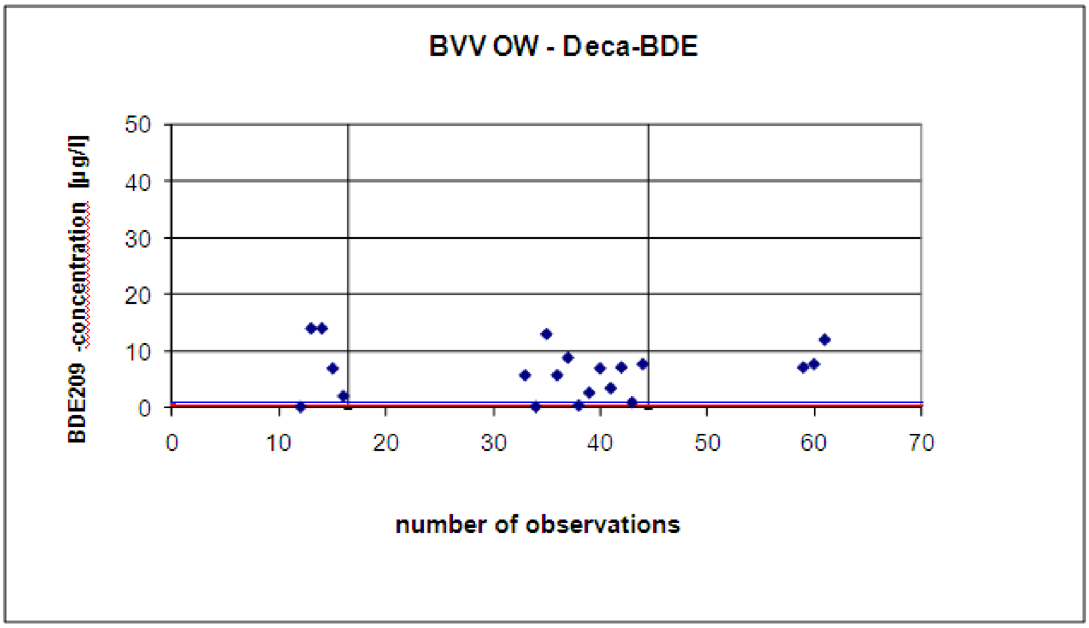
Discharge into surface water



BVV OW - Deca-BDE
BDE209 -concentration [µg/l]
500
400
300
200
100
0
0
10
20
30
40
50
60
70
number of observations



BVV OW - Deca-BDE
BDE209 -concentration [µg/l]
200
150
100
50
0
0
10
20
30
40
50
60
70
number of observations



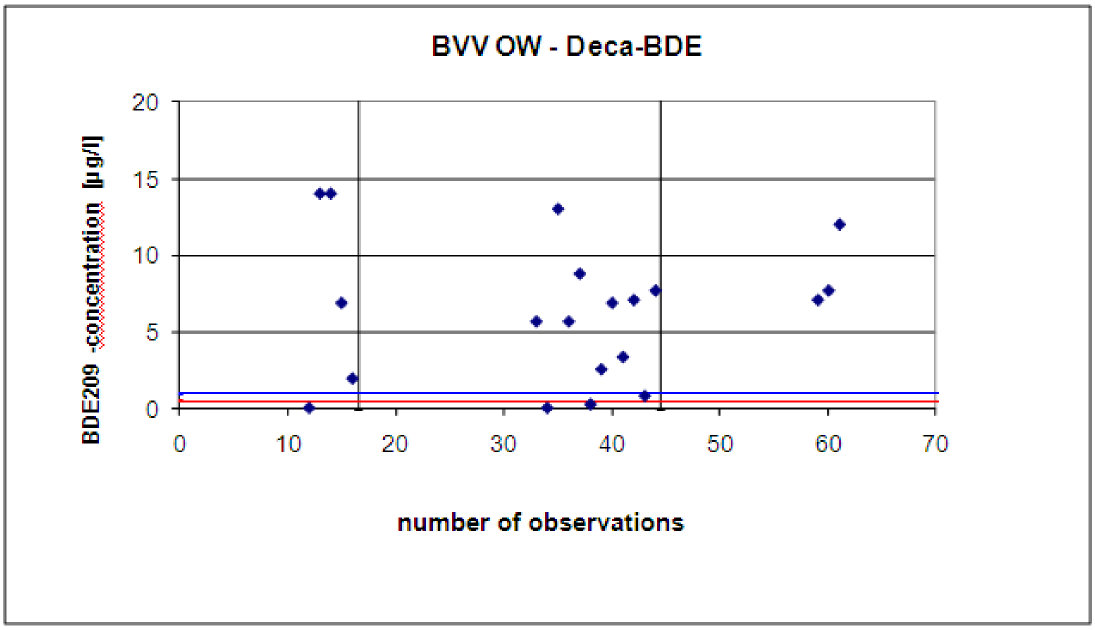
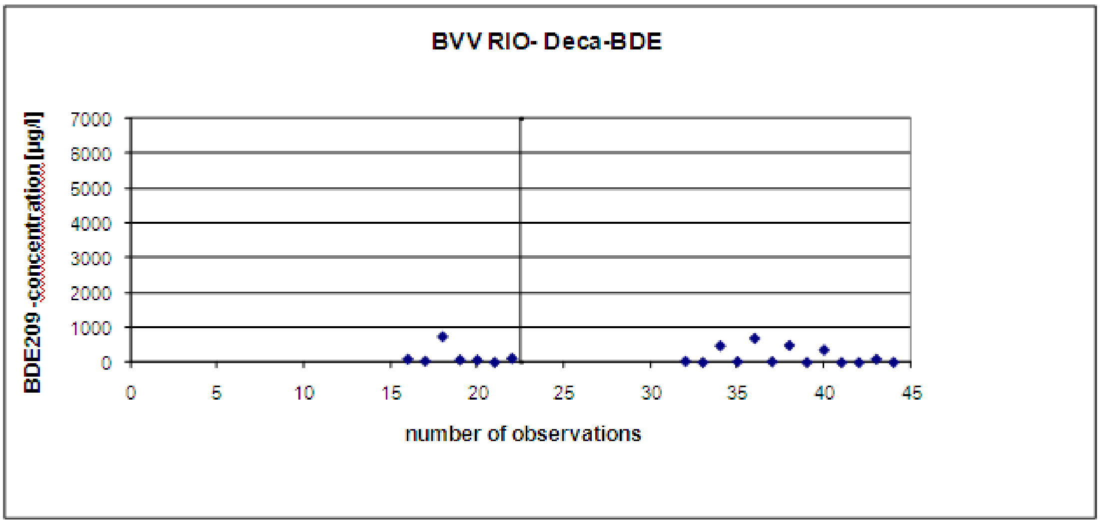
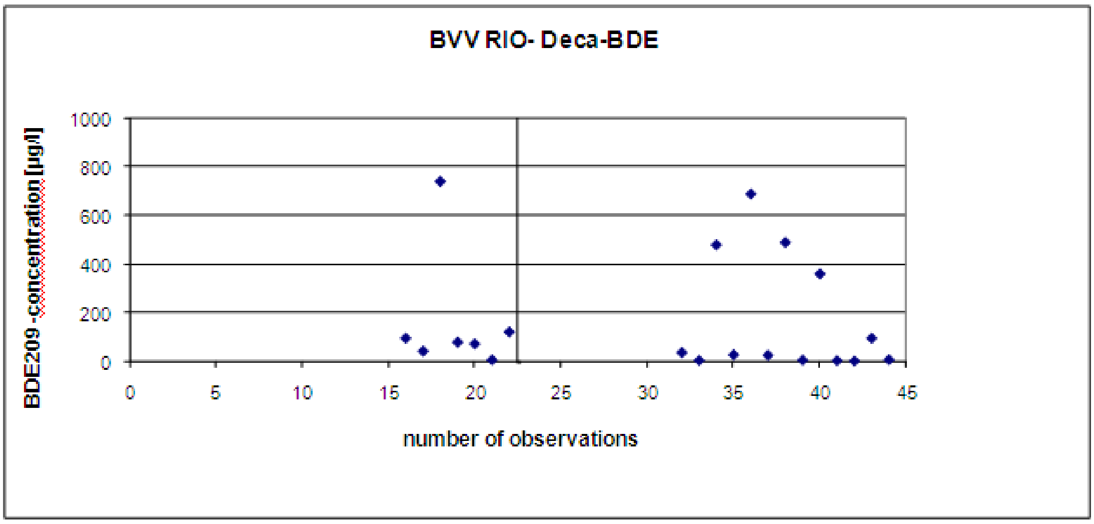


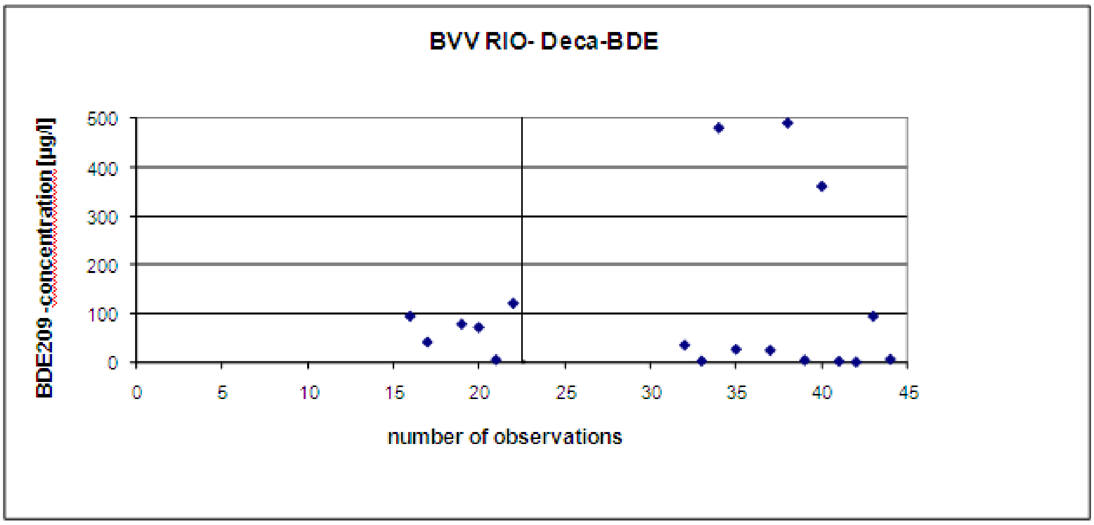
Figure 14: Schematic representation of the measured and available discharge data for Deca-BDE in 2009 from 3 Flemish textile companies that discharge into surface water, which certainly implement Deca-BDE for their finishing activities and which dispose of their (rinse waters from) process baths via external processing companies, with variation in scale on the Y axis and an indicator for the determination limit (0,5 µg/l) and the reporting limit (1 µg/l)

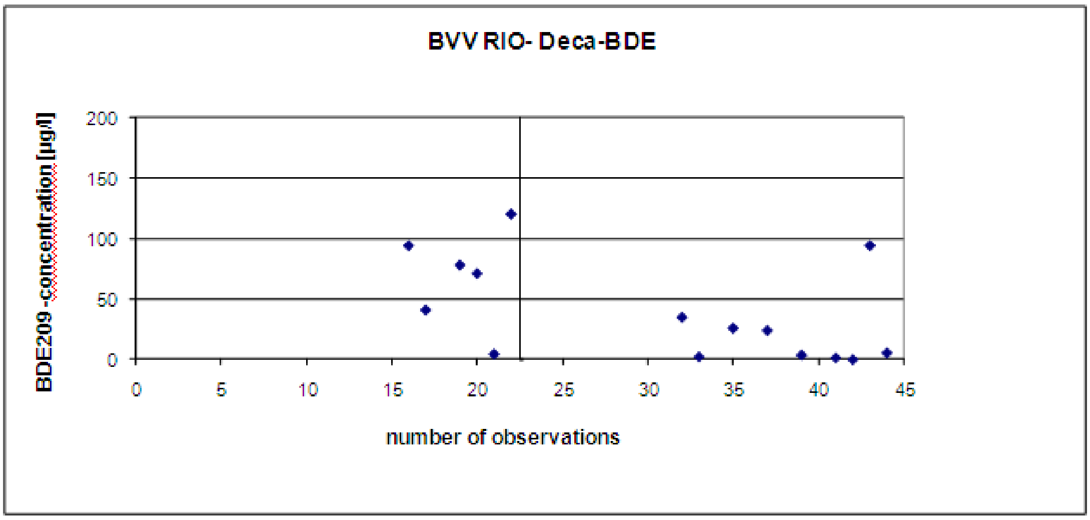
If we only consider the discharge data for 2009 (3 companies that discharge into surface water, 20 measurements, then the average Deca-BDE concentration amounts to 6.30 µg/l (<1 µg/l - 14 µg/l), with a median of 6.90 µg/l. The measurement data for 2009 shows Deca-BDE concentrations in the effluent of textile companies have fallen sharply since 2009, thanks to the VECAP programme and the efforts of the companies and the Government.

Discharge into sewer






BVV RIO- Deca-BDE
BDE209 -concentration [µg/l]
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
number of observations


BVV RIO- Deca-BDE
BDE209 -concentration [µg/l]
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
number of observations

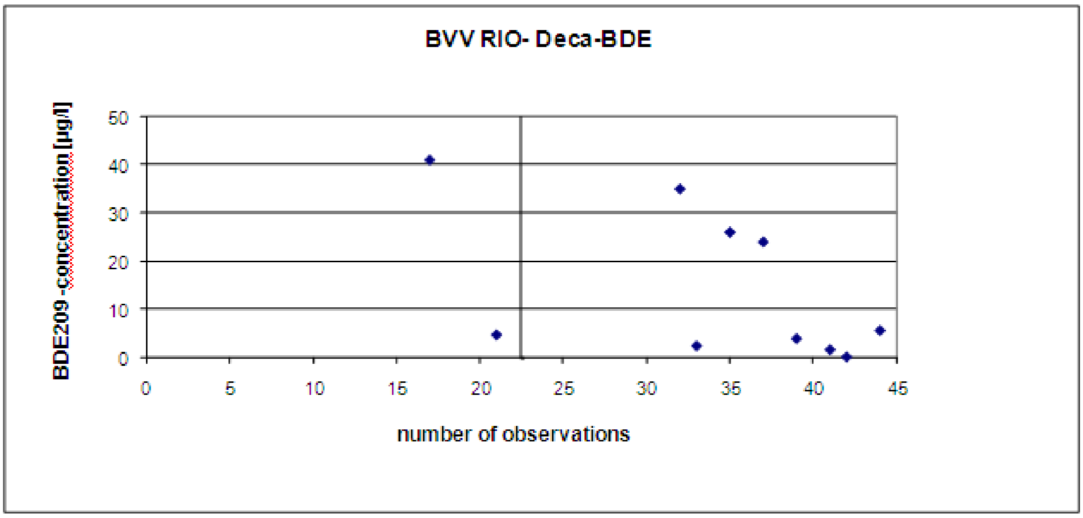

BVV RIO- Deca-BDE
BDE209 -concentration [µg/l]
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
number of observations

Figure 15: Schematic representation of the measured and available discharge data for Deca-BDE for 2 Flemish textile companies that discharge into sewer, which definitely implement Deca-BDE for their finishing activities and divert their (rinse waters from) process baths away from the AWZI, with variation in scale on the Y axis

If we only consider the discharge data for 2009 (2 companies that discharge into sewer, 20 measurements), then the average Deca-BDE concentration amounts to 168.17 µg/l (<1 µg/l - 742 µg/l), with a median of 56.00 µg/l. Despite all the efforts, Deca-BDE concentrations in the effluent of textile companies that discharge into sewer continue to be significantly higher than those realised by textile companies that discharge into surface water. In addition, there are major variations in the measurement data (2009) of sewer dischargers. These variations are the result of historical pollution, which 1 of the 2 companies is still suffering from to date (2010). Other causes could be attributed to the fact that, in the case of the second company, small quantities of Deca-BDE (in diffuse powder form) are released in the production process. This could also have a negative influence on Deca-BDE concentrations in the wastewater. The company in question states, via Centexbel, that 30-100 µg/l of brominated flame retardants were discovered in the effluent in 2009. The definitive measurement date for this company shows that the Deca-BDE concentration in 2009 varied between <1 µg/l to 690 µg/l.

b. HBCD

A summary of the measured and available discharge data for HBCD from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.3.3.c).

1 of the 14 textile companies that discharge into surface water and 2 of the 9 textile companies that discharge into sewer have halted their activities (situation September 2009).

No information is available concerning the use of HBCD for 2 of the 14 textile companies that discharge into surface water. Based on the available discharge data (<determination limit (0.5 µg/l) and <reporting limit (1 µg/l), apart from 1 analysis result (0.78µg/l) from 1 of the 2 companies), it can be assumed that HBCD is not implemented in the production process.
For 3 of the 9 textile companies that discharge into sewer, it cannot be said with certainty whether or not they use HBCD. In two of these companies, the HBCD concentrations in the wastewater are often <determination limit (0.5 µg/l) and <reporting limit (1 µg/l), with the exception of 1 measurement at 1 of the companies (0.85 µg/l). Only 1 measurement (2009) is available for the third company, namely 34.00 µg/l. There is no background information for this measurement.

8 of the 14 textile companies that discharge into surface water indicate that they do not use HBCD. The HBCD concentration of 1 of these companies (1 measurement) amounted to 1.10 µg/l (>reporting limit (1 µg/l)). Based on the available company information, no clear cause can be attributed to the presence of BFR in the wastewater.
For the 2 textile companies that discharge into sewer and state that they do not use HBCD, all measurement values are below the determination and reporting limits.

3 of the 14 textile companies that discharge into surface water and 2 of the 9 companies that discharge into sewer use BFR (incl. HBCD) for their finishing activities. A summary of the measured and available discharge data for HBCD in the 3 companies that discharge into surface water (2006-2009), and the 2 companies that discharge into sewer, can be found in Table 41.

Table 41: Summary of the measured and available discharge data for HBCD by 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use BFR (e.g. HBCD) for their finishing activities (2006-2009)

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	39	24
Average value [µg/l]	4,96	2,07
minimum [µg/l]	0,10	0,10
maximum [µg/l]	85,00	10,00
median [µg/l]	1,42	0,65
5th percentile [µg/l]	0,13	0,12
10th percentile [µg/l]	0,19	0,15
25th percentile [µg/l]	0,79	0,23
50th percentile [µg/l]	1,42	0,65
75th percentile [µg/l]	3,20	2,65
80th percentile [µg/l]	4,30	3,38
90th percentile [µg/l]	7,26	7,12
95th percentile [µg/l]	16,20	7,99

Legend: OW: Discharge into surface water
RIO: Discharge into sewer
SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

In the past, none of these companies disposed of BFR-based process baths and rinse waters via external processing (entered the AWZI). However, 4 of the 5 companies have now implemented this (situation September 2009). These companies implement e.g. the following BAT: characterise released wastewater or liquid waste, collect exhausted process baths and dispose of via a qualified processing company, and dispose of rinse waters from process baths via a qualified processing company. The fifth company indicates that it internally recuperates 100% of the rinse waters of BFR-based process baths. The following BAT are implemented in this company: characterise released wastewater or liquid waste flows and re-use rinse waters from process baths in the production process wherever possible.

The discharge data for each of the companies for the period that (rinse waters from) BFR-based process baths entered the AWZI, were then scrapped from the data set. A summary of the excluded discharge data for HBCD in the 3 companies that discharge into surface water (2007-2009), and the 2 companies that discharge into sewer (2008-2009), can be found in Table 42, Figure 16 and Figure 17.

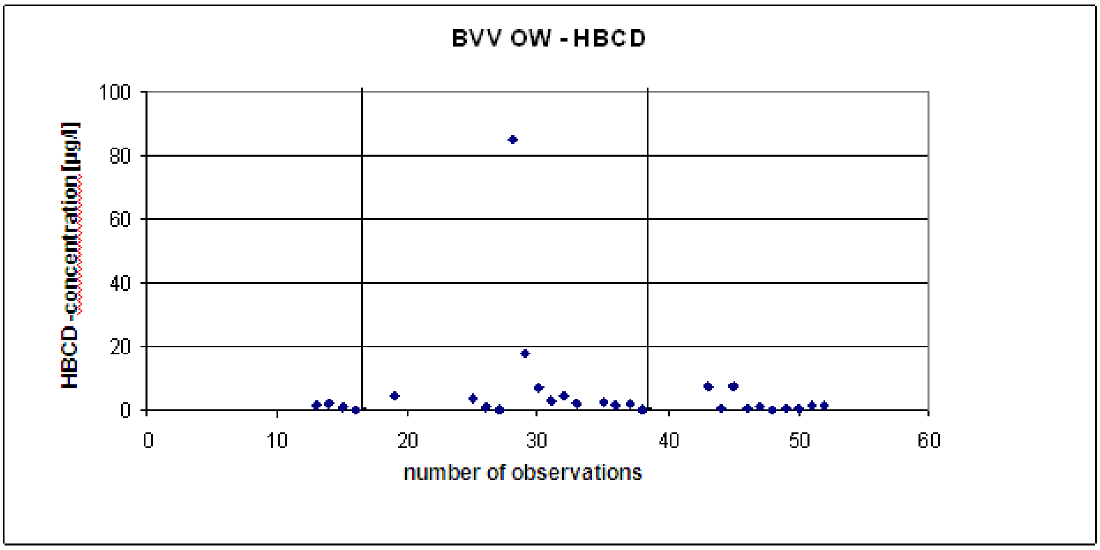
Table 42: Summary of the measured and available discharge data for HBCD by 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use BFRs (e.g. HBCD) for their finishing activities (2007-2009) and who divert their (rinse waters from) process baths away from the AWZI

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	28	22
Average value [µg/l]	5,69	2,21
minimum [µg/l]	0,10	0,10
maximum [µg/l]	85,00	10,00
median [µg/l]	1,50	0,65
5th percentile [µg/l]	0,16	0,11
10th percentile [µg/l]	0,23	0,15
25th percentile [µg/l]	0,66	0,24
50th percentile [µg/l]	1,50	0,65
75th percentile [µg/l]	3,55	2,95
80th percentile [µg/l]	4,30	3,66
90th percentile [µg/l]	7,29	7,64
95th percentile [µg/l]	14,33	8,00

Legend: OW: Discharge into surface water
RIO: Discharge into sewer

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

Discharge into surface water



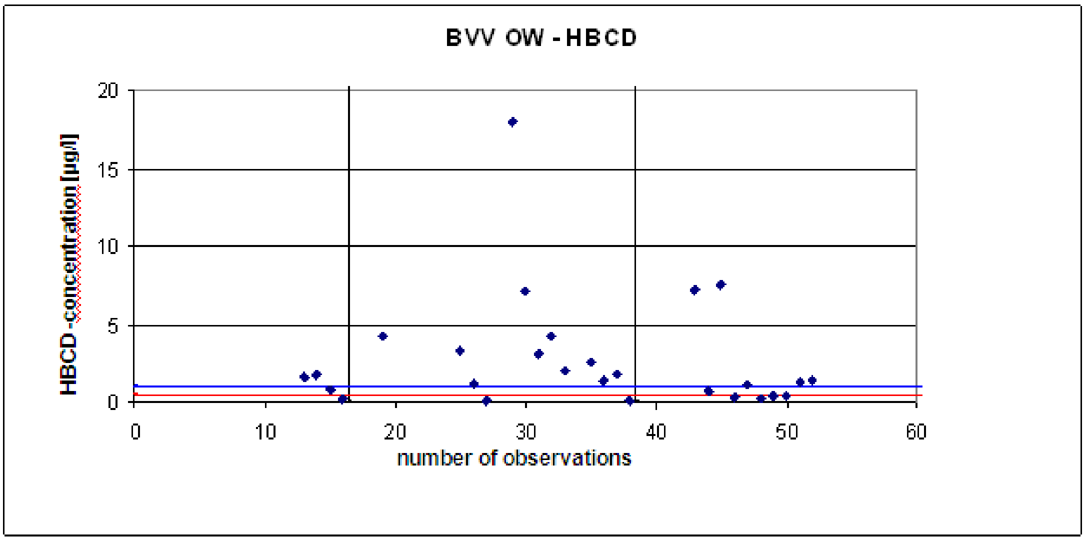


Figure 16: Schematic representation of the measured and available discharge data for HBCD from 3 Flemish textile companies that discharge into surface water (2007-2009), which certainly implement BFRs (e.g. HBCD) for their finishing activities and which divert their (rinse waters from) process baths away from the AWZI, with variation in scale on the Y axis and an indicator for the determination limit (0,5 µg/l) and the reporting limit (1 µg/l)

The three textile companies that definitely implement BFRs (e.g. HBCD), dispose of their (rinse waters from) process baths via external processing companies and discharge into surface water, all implement biological purification on their wastewaters (always in combination with buffering and post-sedimentation and, in 1 company in combination with sand filtration).

With the exception of 2 measurements (85 µg/l and 18 µg/l) from a textile company (no. 2) that suffered problems associated with historical pollution (after-effect) until the end of 2008, all HBCD concentrations measured in the wastewater of the 3 companies that discharge into surface water were <10 µg/l.

Discharge into sewer

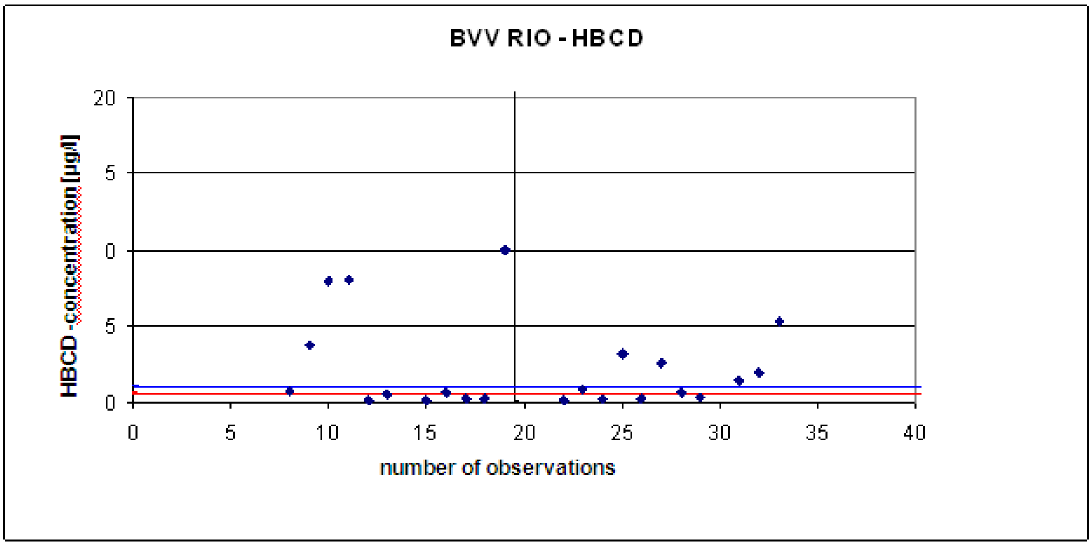


Figure 17: Schematic representation of the measured and available discharge data for HBCD from 2 Flemish textile companies that discharge into sewer (2008-2009) with an indicator for the determination limit (0,5 µg/l) and the reporting limit (1 µg/l)

The two textile companies that discharge into sewer both use chemical precipitation (coagulation/flocculation) (followed by biological purification in 1 company). One company (no.1) disposes of its BFR-based process baths and rinse waters via a qualified processing company. The other company (no. 2) re-uses 100%z of its BFR-based process baths and rinse waters in the production process.
All HBCD concentrations measured in the wastewater of two textile companies that discharge into sewer, were less than or equal to 10 µg/l.

b. antimony

A summary of the measured and available discharge data for antimony from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.2.3.c).

5 of the 24 textile companies that discharge into surface water and 8 of the 21 textile companies that discharge into sewer have <u>halted</u> their activities (situation September 2009).

<u>No information</u> is available about the origin of antimony in the wastewater for 3 of the 21 textile companies that discharge into surface water and 3 of the 21 textile companies that discharge into sewer.

11 of the 24 companies that discharge into surface water indicate that they <u>do not use BFR</u>. Though these companies do perform paint-related activities (PA paints and PES paints). The average antimony concentration amounts to 1.654 mg/l, with a maximum

of 32.340 mg/l (251 measurements). The median value is <0.02 mg/l. High antimony concentrations are found in a limited number (2) of companies. Though this measurement data dates back to before 2009.

8 of the 21 textile companies that discharge into sewer do not use BFRs However, antimony is present in wastewater and paint-related activities. The average antimony concentration amounts to 0.383 mg/l, with a maximum of 13.130 mg/l (226 measurements). The median value amounts to 0.06 mg/l. High antimony concentrations are only encountered in 1 company. Though this measurement data dates back to before 2009.

3 of the 24 textile companies that discharge into surface water and 2 of the 21 companies that discharge into sewer, implement antimony trioxide as a synergist in combination with Deca-BDE (also see paragraph a). A summary of the measured and available discharge data (2006-2009) for antimony in the 3 companies that discharge into surface water, and the 2 companies that discharge into sewer, can be found in Table 43.

> *comment*
> According to i2a (2009b), there are currently (2010) 29 textile companies in Europe who, as clients of the antimony industry, purchase Sb_2O_3 to use as a synergist in combination with BFR. Most of these companies are thought to be located in England and Belgium (8 textile companies). Thus there could be more textile companies in Flanders that implement antimony trioxide as synergist in combination with Deca-BDE, but have failed to mention this.

Table 43: Summary of the measured and available discharge data for antimony from 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use Sb_2O_3 as a synergist in combination with Deca-BDE (2006-2009)

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	95	99
Average value [mg/l]	0,731	3,163
minimum [mg/l]	0,009	0,263
maximum [mg/l]	23,360	19,810
median [mg/l]	0,128	1,350
5th percentile [mg/l]	0,010	0,432
10th percentile [mg/l]	0,015	0,498
25th percentile [mg/l]	0,021	0,743
50th percentile [mg/l]	0,128	1,350
75th percentile [mg/l]	0,330	3,580
80th percentile [mg/l]	0,374	4,202
90th percentile [mg/l]	0,649	8,490
95th percentile [mg/l]	1,117	14,010

Legend: OW: Discharge into surface water
RIO: Discharge into sewer

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

In the past, none of these companies disposed of Sb_2O_3-based process baths and rinse waters via external processing (entered the AWZI). However, 4 of the 5 companies have now implemented this (situation September 2009). These companies implement e.g. the following BAT: characterise released wastewater or liquid waste, collect exhausted process baths and dispose of via a qualified processing company, and dispose of rinse waters from process baths via a qualified processing company. With regards to the fifth company, it is known that 100% of BFR-based (and thus also Sb_2O_3-based) rinse water from process baths is internally recuperated. For example, the following BAT are implemented in this company: characterise released wastewater or liquid waste flows and re-use rinse waters from process baths in the production process wherever possible.

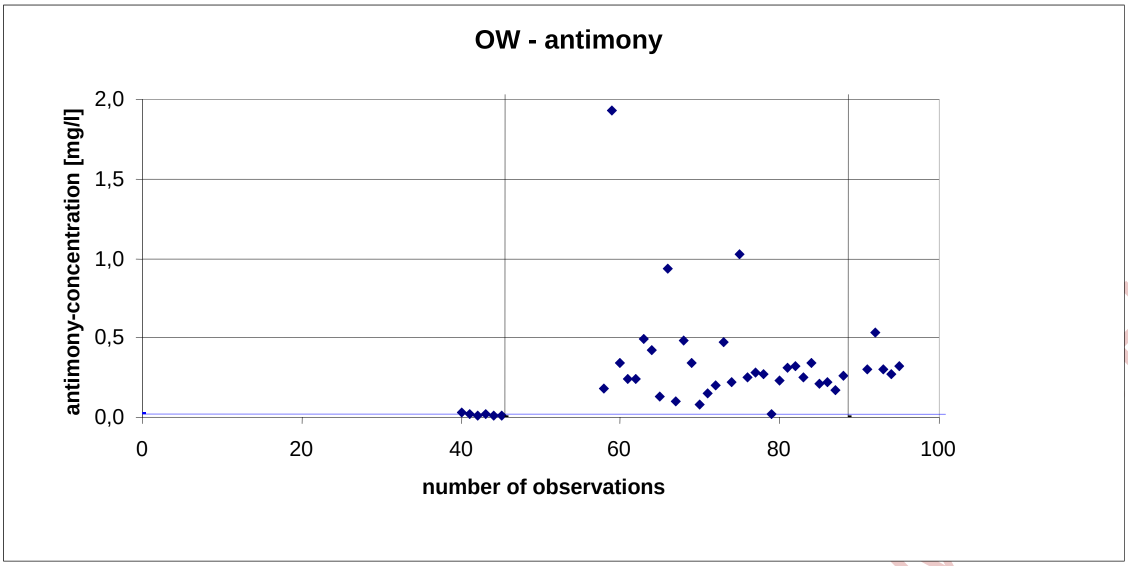
The discharge data for each of the companies for the period that (rinse waters from) Deca-BDE-based process baths entered the AWZI, were then scrapped from the data set. A summary of the excluded discharge data for Sb_2O_3 in the 3 companies that discharge into surface water (2007-2009), and the 2 companies that discharge into sewer (2008-2009), can be found in Table 44, Figure 18 and Figure 19.

Table 44: Summary of the measured and available discharge data for antimony from 5 Flemish textile companies (3 surface water dischargers and 2 sewer dischargers) that certainly use Sb_2O_3 as a synergist in combination with Deca-BDE (2007-2009)

	Discharge situation	
	OW	RIO
	Individual discharge data	
Number of companies	3	2
number of measurements	42	51
Average value [mg/l]	0,309	1,593
minimum [mg/l]	0,011	0,427
maximum [mg/l]	1,930	5,230
median [mg/l]	0,253	1,320
5th percentile [mg/l]	0,015	0,494
10th percentile [mg/l]	0,018	0,513
25th percentile [mg/l]	0,157	0,743
50th percentile [mg/l]	0,253	1,320
75th percentile [mg/l]	0,335	2,035
80th percentile [mg/l]	0,342	2,360
90th percentile [mg/l]	0,492	3,320
95th percentile [mg/l]	0,917	3,860

Legend: OW: Discharge into surface water
RIO: Discharge into sewer

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations



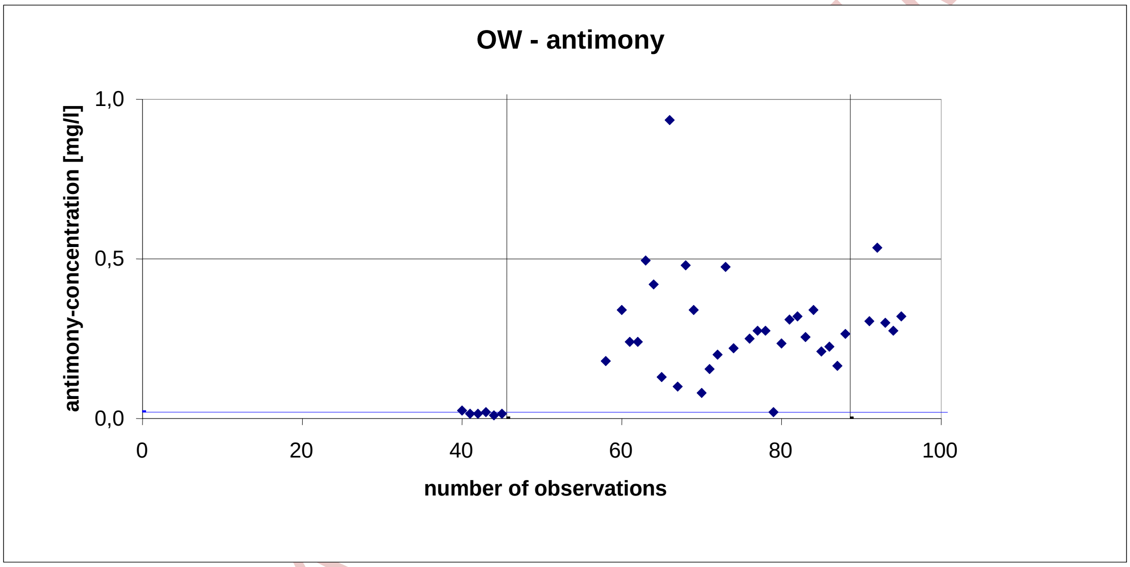
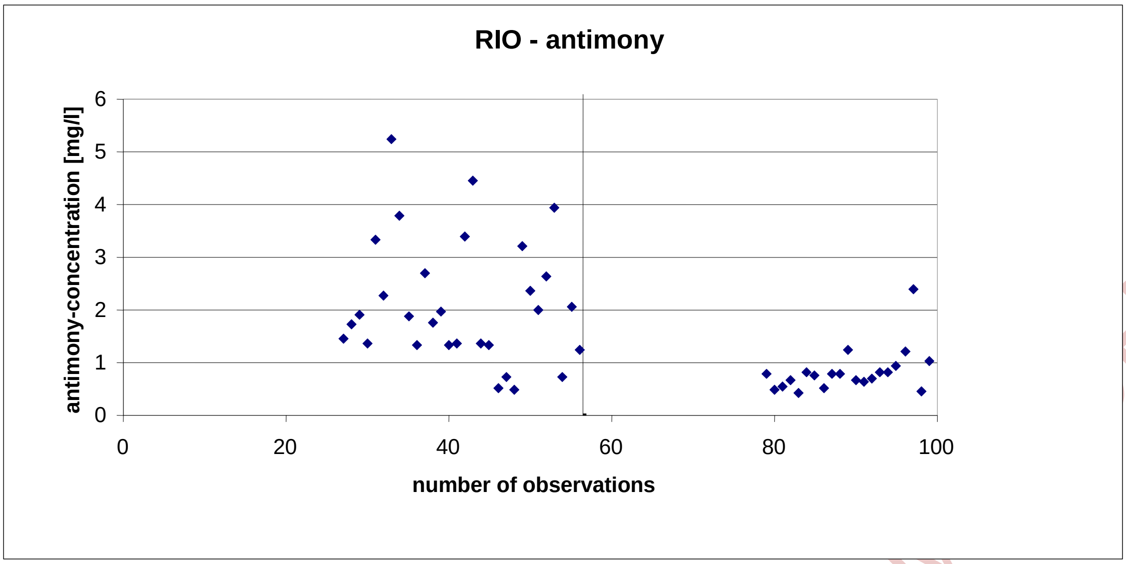
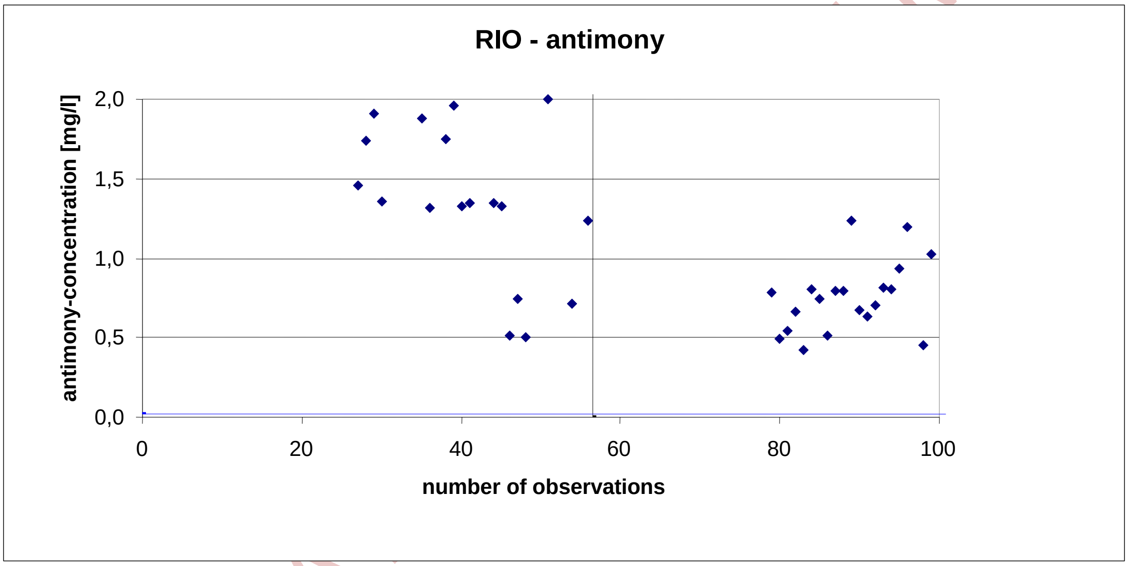


Figure 18: Schematic representation of the measured and available discharge data for antimony from 3 Flemish textile companies that discharge into surface water (2007-2009), which certainly implement Sb_2O_3 as a synergist in combination with Deca-BDE and which dispose of their (rinse waters from) process baths via external processing companies, with variation in scale on the Y axis and an indicator for the reporting limit (0.02 mg/l)

One textile company (no.2) that discharges into surface water implements sand filtration (in addition to biological purification), but experienced problems associated with historical pollution up until the end of 2008 (antimony concentrations up to 1.930 mg/l). The other two companies (no.1 and no.3) that discharge into surface water implement buffering, biological purification and post-sedimentation (antimony concentrations up to 0.534mg/l).





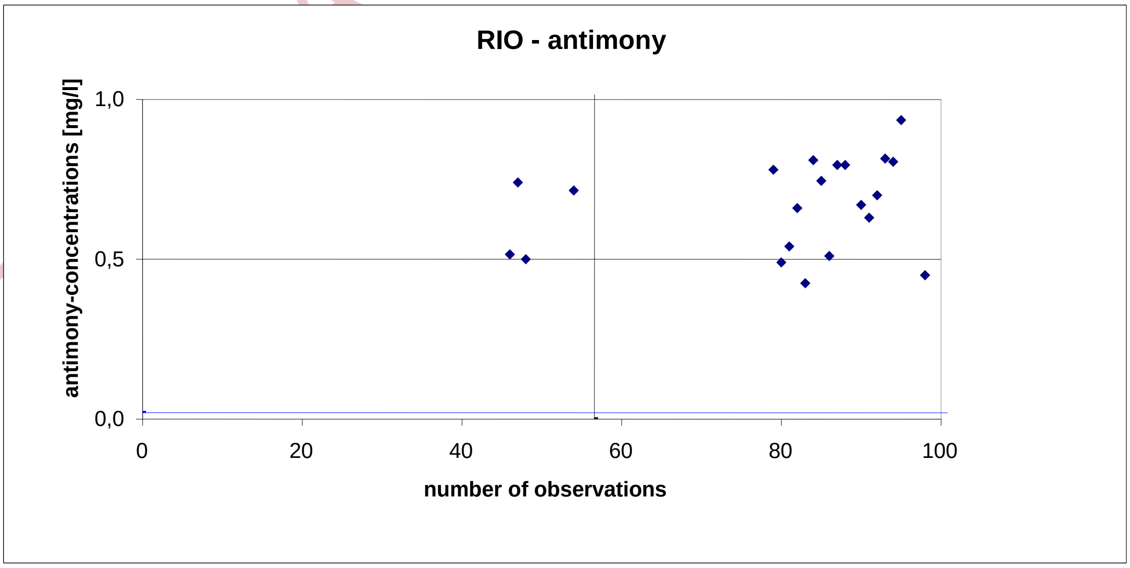


Figure 19: Schematic representation of the measured and available discharge data for antimony from 2 Flemish textile companies that discharge into sewer (2007-2009), which certainly implement Sb_2O_3 as a synergist in combination with Deca-BDE and

which dispose of their (rinse waters from) process baths via external processing companies, with variation in scale on the Y axis and an indicator for the reporting limit (0.02 mg/l)

The two textile companies that discharge into sewer both use chemical precipitation (coagulation/flocculation) (followed by biological purification in 1 company).
One company (no.1) that discharges into sewer disposes of its (rinse waters from) Deca-BDE-based process baths (and thus also Sb_2O_3-based) via a qualified processing company, but is still encountering problems associated with historical pollution despite far-reaching remediation (e.g. cleaning of internal discharge system) (situation September 2009). The average antimony concentration of this company amounts to 2.127 mg/l (30 measurements 2008-2009, with a maximum of 5.230 mg/l.
The other company (no.2) that discharges into sewer, does not dispose of its (rinse waters from) Deca-BDE-based process baths (and thus also Sb_2O_3-based) via a qualified processing company, but states that it uses 100% of them in the production process (situation September 2009). 3 of the 21 measurement values were >1 mg/l (with a maximum of 2.4 mg/l).

c. PFOS and PFOA

A summary of the measured and available discharge data for PFOS and PFOA from Flemish textile companies (2006-2007) can be found in chapter 3 (paragraph 3.3.1.c). The average PFOS concentration amounts to 0.7 µg/l with a maximum of 3 µg/l. The average PFOA concentration is 3.8 µg/l and the maximum is 11.6 µg/l. However, there is no background information for this measurement data.
Only a few concrete measurement results are available for two Flemish textile companies (see chapter 3). These results do not allow extensive analysis of the measurement data, and nor do they allow BAT-AELs to be determined for the parameters PFOS and PFOA.

d. NP and NPE

NP

A summary of the measured and available discharge data for NP from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.4.2.c). The average NP concentration varies between 0.23 and 1.31 µg/l, with maximums of 50 to 100 µg/l for companies that discharge into surface water. For textile companies that discharge into sewer, the average NP concentration varies from 0.03-15.26 µg/l, with maximums from 0.34-155.00 µg/l.

NPE

A summary of the measured and available discharge data (annual averages [mg/l]) for NP from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.4.3.c). The average NPE concentration amounts to 0.054 mg/l (based on the annual averages), with a maximum of 0.180 mg/l for textile companies that discharge into surface water. For textile companies that discharge into sewer, the average concentration is 0.422 mg/l (based on annual averages) with a maximum of 1.270 mg/l.

e. 16 PAH of EPA

A summary of the measured and available discharge data for PAH (16 of EPA) from Flemish textile companies (2006-2009) can be found in chapter 3 (paragraph 3.5.2.c).

4 of the 25 textile companies that discharge into surface water has stopped their activities, as have 6 or the 29 textile companies that discharge into sewer (situation September 2009).

<u>No information</u> is available concerning the activities and/or wastewater purification techniques implemented by 12 of the 26 textile companies that discharge into surface water. This is also the case for 11 of the 29 textile companies that discharge into sewer. On the whole, it can be stated that the PAH concentration in the effluent of these textile companies is around the same level as that off textile companies for which background information is available about the activities and wastewater purification techniques that are implemented.

For 10 of the 24 textile companies that discharge into surface water, information is available about the implemented activities and wastewater purification techniques. A summary of the measured and available discharge data for PAH (16 of EPA) in the 12 companies that discharge into surface water (2006-2009) can be found in Table 45. For 12 of the 29 textile companies that discharge into sewer, information is available about the implemented activities and wastewater purification techniques. Table 46 provides a summary of measured and available discharge data for PAH (16 of EPA) [ng/l] in these 12 textile companies that discharge into sewer (2006-2008)

Table 45: Summary of measured and available discharge data for PAH (16 of EPA) [ng/l] in Flemish textile companies that discharge into surface water (2006-2009)

parameter	acenaphtylene	acenaphthene	anthracene	benzo(a)anthracene	benzo(b)fluoranthene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(ghi)perylene	indeno(1,2,3-cd)pyrene	chrysene	dibenzo(a,h)anthracene	phenanthrene	fluoranthene	fluorene	naphthalene	pyrene	PAH (16 of EPA)
Number of companies	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
number of measurements	156	156	159	160	159	155	159	155	159	160	155	158	159	160	158	160	143
Average value [ng/l]	24,27	33,26	30,59	17,67	13,84	11,70	13,37	12,39	13,38	16,18	8,64	76,84	37,05	22,89	87,75	59,46	466,22
minimum [ng/l]	10	10	2	5	5	5	5	3	3	5	3	10	10	3	25	10	120
maximum [ng/l]	90	930	3190	351	60	40	100	220	61	145	40	4810	610	560	1300	1490	8973
median [ng/l]	20	17	3	11	7	7	7	5	8	8	3	22	15	8	40	15	252
5th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	159
10th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	159
25th percentile [ng/l]	20	17	3	11	7	7	7	5	8	8	3	20	15	8	40	15	195
50th	20	17	3	11	7	7	7	5	8	8	3	22	15	8	40	15	252

percentile [ng/l]																	
75th percentile [ng/l]	20	20	10	11	14	7	9	10	10	16	3	40	32	16	58	42	554
80th percentile [ng/l]	20	20	16	22	20	10	14	11	16	29	6	40	40	40	80	58	640
90th percentile [ng/l]	40	40	40	40	40	40	40	40	40	40	40	59	76	40	100	120	840
95th percentile [ng/l]	40	40	40	40	40	40	40	40	40	43	40	142	100	64	229	181	1083

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

Table 46: Summary of measured and available discharge data for PAH (16 of EPA) [ng/l] in 12 Flemish textile companies that discharge into sewer (2006-2009)

parameter	acenaphtylene	acenaphthene	anthracene	benzo(a)anthracene	benzo(b)fluoranthene	benzo(k)fluoranthene	benzo(a)pyrene	benzo(ghi)perylene	indeno(1,2,3-cd)pyrene	chrysene	dibenzo(a,h)anthracene	phenanthrene	fluoranthene	fluorene	naphthalene	pyrene	PAH (16 of EPA)
Number of companies	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
number of	210	204	207	205	204	205	204	209	207	203	206	191	204	198	207	208	131

measurements																	
Average value [ng/l]	26,96	63,11	321,02	23,00	21,99	18,28	27,66	96,70	23,84	26,66	17,79	370,14	62,74	280,96	436,88	372,33	1263,74
minimum [ng/l]	0	6	2	5	5	5	5	3	3	5	3	11	15	3	10	10	54
maximum [ng/l]	270	3300	16500	270	690	270	1000	4500	450	530	315	5890	2150	6170	4940	19900	23860
median [ng/l]	20	20	7	15	14	7	14	12	12	20	3	47	30	23	160	60	529
5th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	172
10th percentile [ng/l]	20	17	2	5	5	5	5	3	3	5	3	11	15	3	35	10	185
25th percentile [ng/l]	20	17	3	11	7	7	7	5	8	8	3	23	15	8	40	15	250
50th percentile [ng/l]	20	20	7	15	14	7	14	12	12	20	3	47	30	23	160	60	529
75th percentile [ng/l]	25	31	27	26	25	25	25	36	25	33	25	190	59	55	546	162	938
80th percentile [ng/l]	25	40	40	39	26	26	26	40	26	40	25	270	74	132	661	214	1110
90th percentile [ng/l]	40	65	62	40	40	40	40	50	40	46	40	753	120	745	980	490	1754
95th percentile [ng/l]	40	116	223	50	40	40	50	92	49	60	40	2445	156	1568	1385	819	4945

SOURCE: Centexbel, 2009a and c, LNE-AMI, 2009, VMM, 2009a and e and own calculations

As already mentioned in chapter 3.5.2.b, textile raw materials (tissues treated with mineral oils, PAH-based carriers in textile paints) form a major and constant source of discharged PAH, particularly phenanthrene (also see paragraph e.1) and pyrene (also see paragraph e.2). This is also confirmed by the measurement data summarised in Table 45 and Table 46. Phenanthrene and pyrene is found in concentrations >reporting limit in textile companies (7 surface dischargers and 6 sewer dischargers) that perform paint activities, as well as in textile companies (3 surface dischargers and 6 sewer dischargers) that have not explicitly stated they implement these activities.
Further, PAH (primarily the heavier ones, e.g. benzo(a)pyrene) (also see paragraph e.6) could also be formed on thermo-fixed tissues.

A significant difference is noticed in the concentration of (a few) PAH in the wastewater of textile companies that discharge into sewer (higher concentrations) and those that discharge into surface water (lower con concentrations). In this case, the difference can be attributed to the use of biological wastewater techniques in the textile companies. The fact that PAH are removed in biological wastewater purification installations is confirmed by the analysis of PAH measurements in wastewater from WWTP, which was carried out while reviewing the BAT study for laundries and linen lessors (Van den Abeele L. *et al.*, 2010).

PAH are characterised by low water solubility, and their propensity to bond with e.g. suspended matter or silt in the water. This is primarily the case with heavier PAH. The lighter PAH (e.g. naphthalene) in wastewater volatalise or break down.

e.1 Phenanthrene

Discharge into surface water

Companies that perform dying activities

In the case of paint activities (surface water dischargers), the average phenanthrene concentration amounts to 33.46 ng/l (7 companies, 70 measurements), with a maximum of 280 ng/l (also see Figure 20).

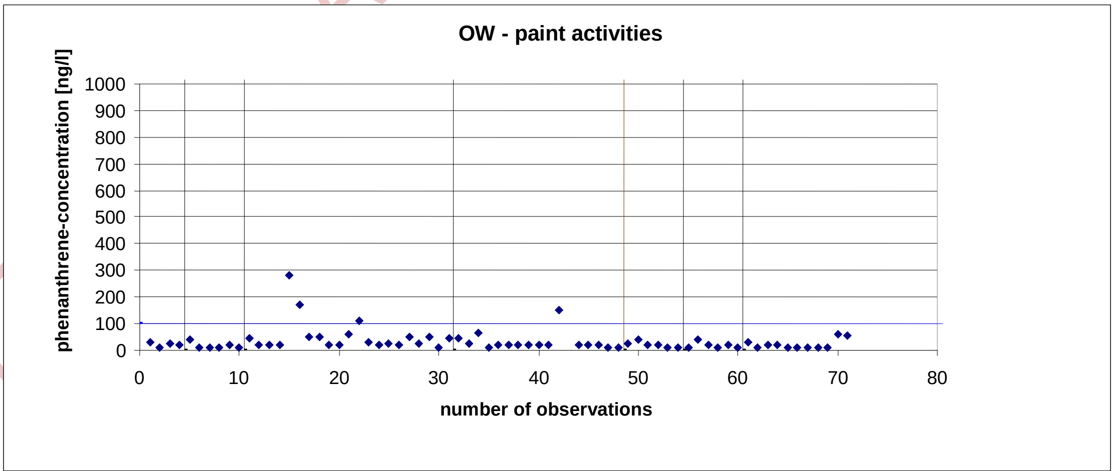


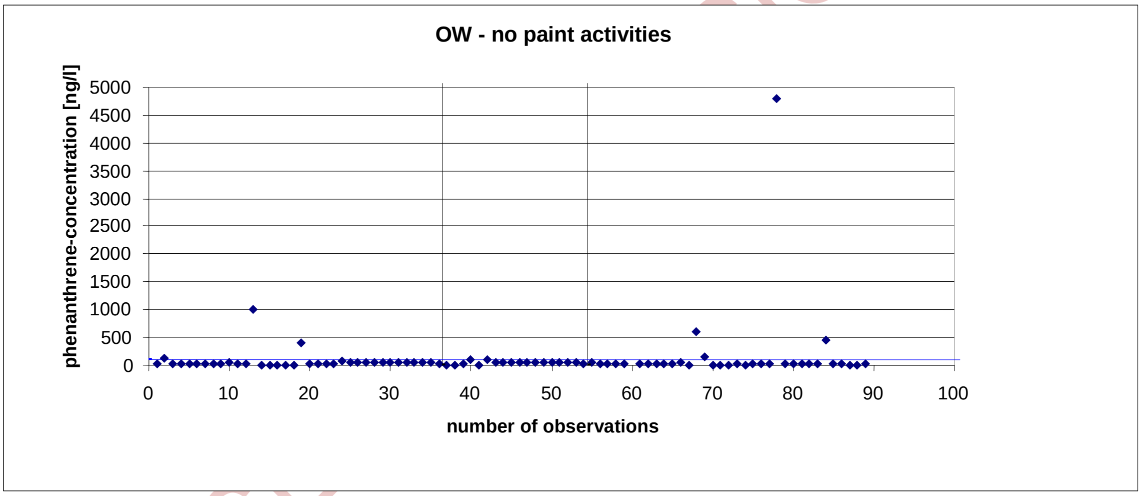
Figure 20: Schematic representation of the measured and available discharge data for phenanthrene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Phenanthrene is removed from wastewater by using biological purification. 6 of the 7 companies that discharge into surface water implement biological main purification (2 only biology, 2 biology combined with sand filtration, 1 biology combined with UF/RO and 1 in combination with physico-chemistry). 1 of the 7 companies only implements physico-chemical purification. For the parameter phenanthrene, there is no noticeable difference between the implemented wastewater purification techniques and the concentration of parameters in the effluent of textile companies that discharge into surface water.

Phenanthrene concentrations 100 ng/l in the effluent of textile companies that discharge into surface water and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

<u>Companies that do not perform paint activities</u>

The average concentration for phenanthrene amounts to 111.35 ng/l (3 companies, 88 measurements) with a maximum of 4,810 ng/l (= irregularity) for textile companies (surface water dischargers) that do not perform paint activities (1 measurement >1 000 ng/l) (also see Figure 21).



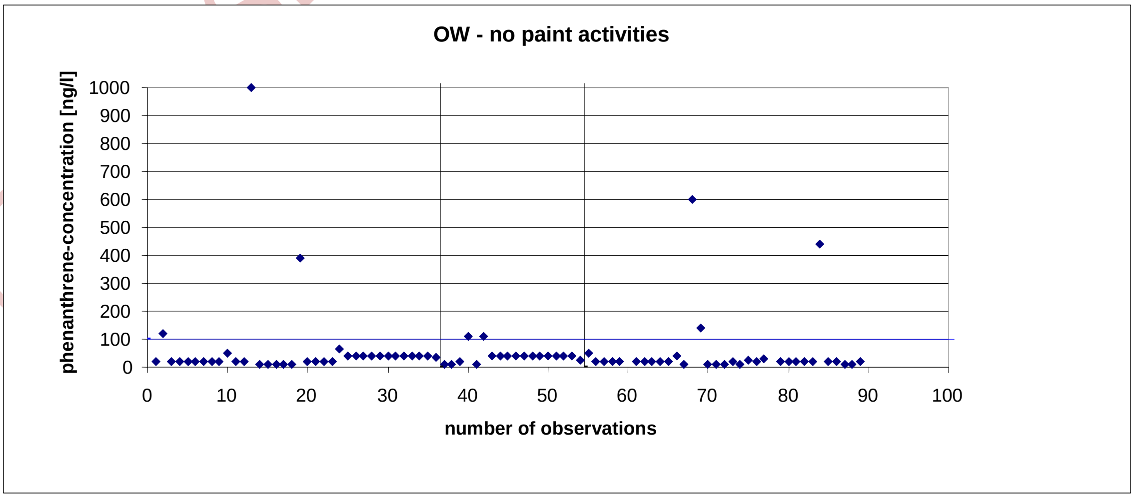


Figure 21: Schematic representation of the measured and available discharge data for phenanthrene from 3 Flemish textile companies that do not perform paint activities and

discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

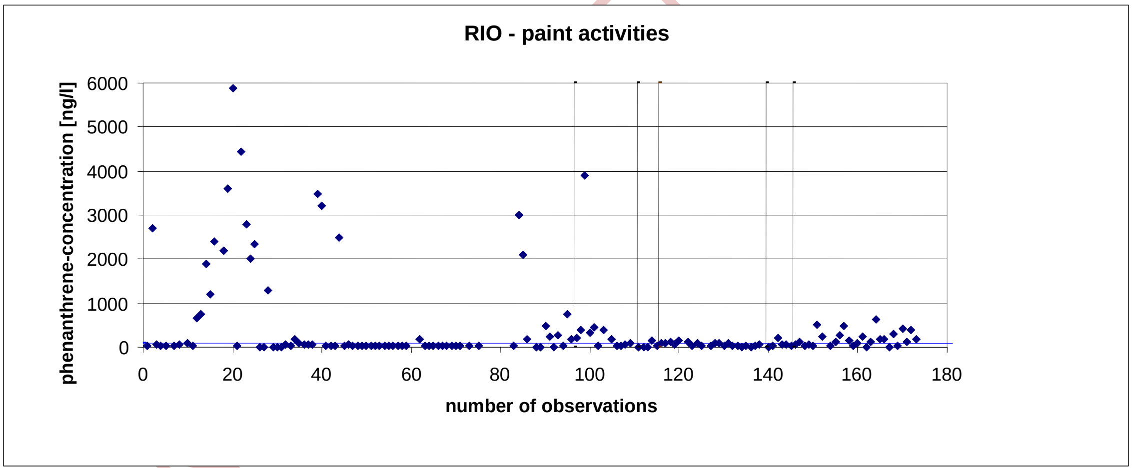
All 3 textile companies that discharge into surface water implement biological purification (phenanthrene can be removed biologically). 1 of the 3 companies combines biological purification with sand filtration. Again, for the parameter phenanthrene in companies that discharge into surface water, there is no noticeable difference between the implemented wastewater purification techniques and the concentration of parameters in the effluent. There is also no clear difference in phenanthrene concentrations in the wastewaters of textile companies (surface water dischargers) that perform, or do not perform, paint activities.

Phenanthrene concentrations >100 ng/l in the effluent of textile companies that do not perform paint activities but do discharge into surface water, are regarded as irregularities possibly caused by abnormal operating conditions.

Discharge into sewer

<u>Companies that perform dying activities</u>

In the case of paint activities (sewer dischargers), the average phenanthrene concentration amounts to 431.39 ng/l (6 companies, 152 measurements), with a maximum of 5,890 ng/l (18 measurements >1,000 ng/l) (also see Figure 22).



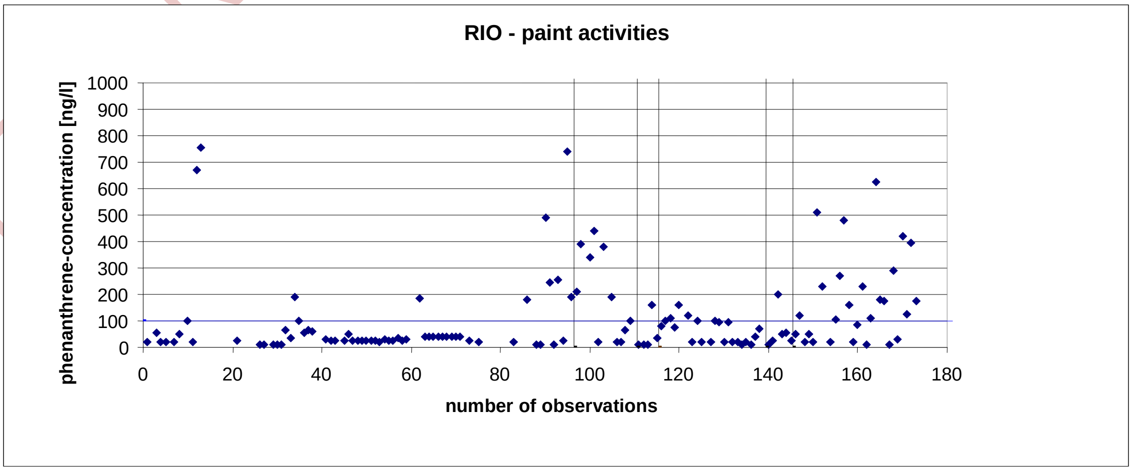


Figure 22: Schematic representation of the measured and available discharge data for phenanthrene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

The examined textile companies that discharge into sewer, and also perform paint activities, implement the following wastewater purification techniques:

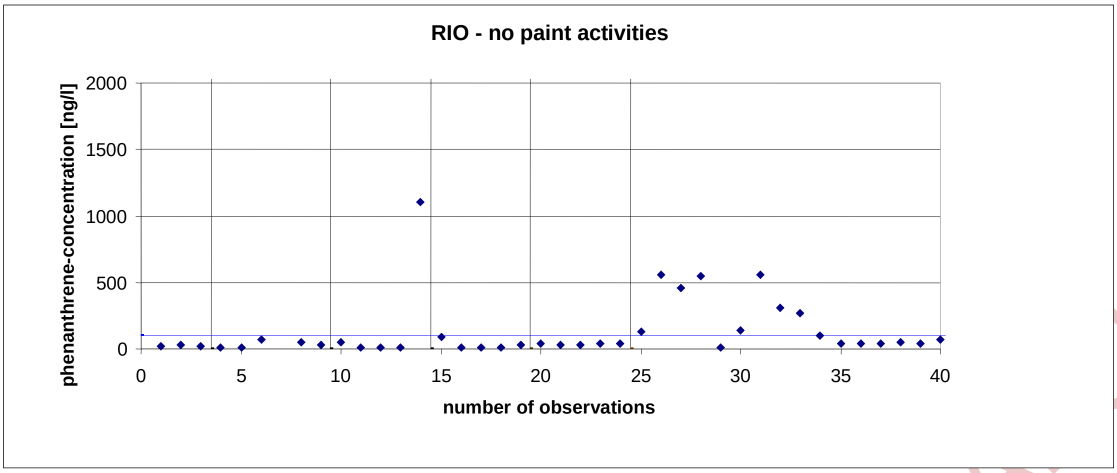
- (aerated) buffer, 2 with stirrers (4)
- pH neutralisation (1)
- 1 physico-chemistry (1).

The concentrations of phenanthrene are significantly higher in the effluent of textile companies that perform paint activities and discharge into sewer, compared to those that perform paint activities and discharge into surface water. One possible explanation for this could be the PAH-based carriers in paints and pigments used for paint activities. However, it is unclear whether the examined companies implement the BAT to avoid/limit the use of PAH-based carriers when dying textiles (see chapter 5).

Phenanthrene concentrations >200 ng/l in the effluent of textile companies that perform paint activities but do discharge into surface water, are regarded as irregularities possibly caused by abnormal operating conditions.

<u>Companies that do not perform paint activities</u>

The average phenanthrene concentration in the effluent of textile companies that discharge into sewer and do not perform paint activities, amounts to 131. 44 ng/l on average (6 companies, 39 measurements), with a maximum of 1,100 ng/l (1 measurement >1,000ng/l) (also see Figure 23).



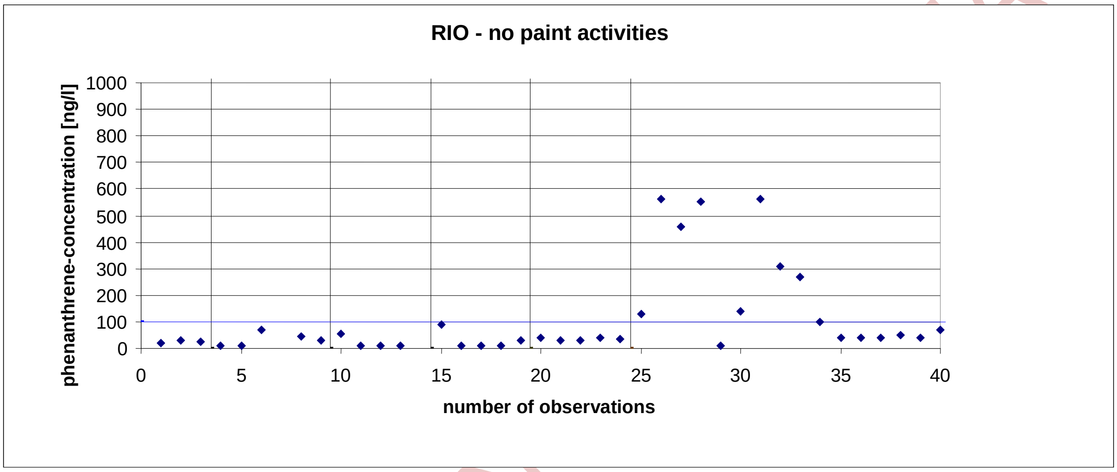


Figure 23: Schematic representation of the measured and available discharge data for phenanthrene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

The companies that discharge into sewer and do not perform paint activities, implement the following wastewater purification techniques:

- physico-chemistry (2);
- physico-chemistry in combination with biological main purification (1);
- aerated buffer (2);
- collection and sedimentation (1).

Phenanthrene concentrations >100 ng/l in the effluent of textile companies that do not perform paint activities but do discharge into surface water, are regarded as irregularities possibly caused by process modifications.

e.2 Pyrene

Discharge into surface water

Companies that perform dying activities

For textile companies (surface water dischargers) that perform paint activities, the average pyrene concentration amounts to 29.06 ng/l (7 companies, 71 measurements), with a maximum of 270 ng/l (also see Figure 24).

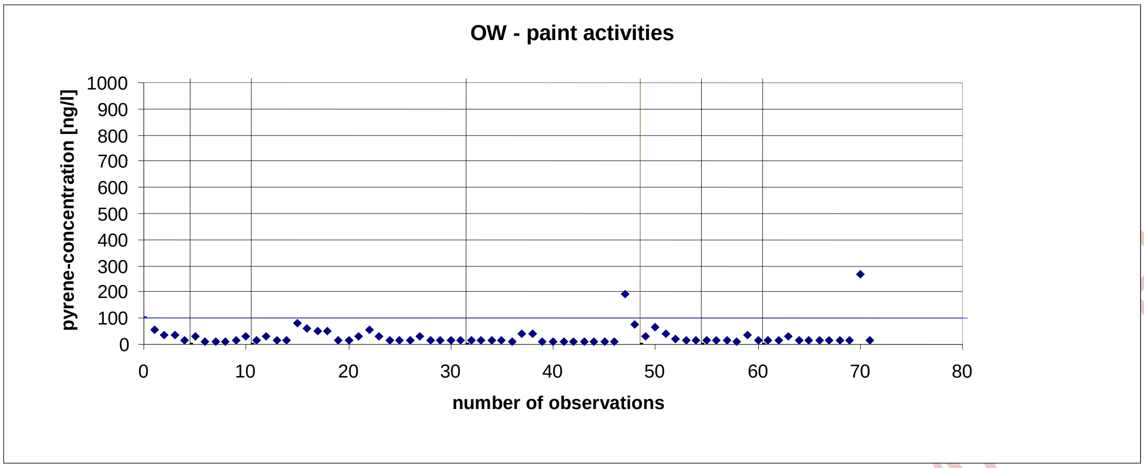
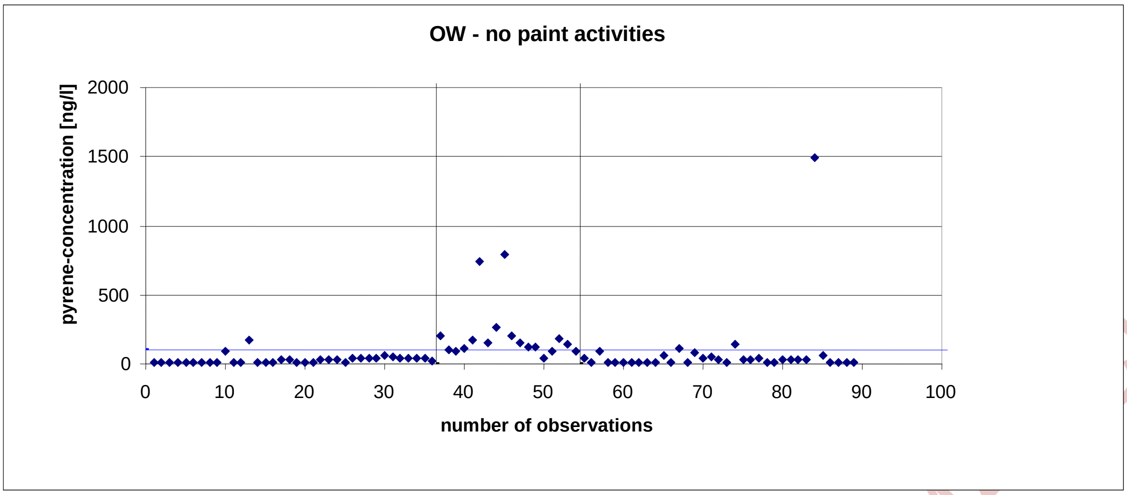


Figure 24: Schematic representation of the measured and available discharge data for pyrene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Pyrene concentrations 100 ng/l in the effluent of textile companies that discharge into surface water and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

<u>Companies that do not perform paint activities</u>
The average concentration for pyrene (surface water dischargers) amounts to 83.72 ng/l (3 companies, 89 measurements) with a maximum of 1,490 ng/l (= irregularity) for textile companies that do not perform paint activities (1 measurement >1 000 ng/l) (also see Figure 25).



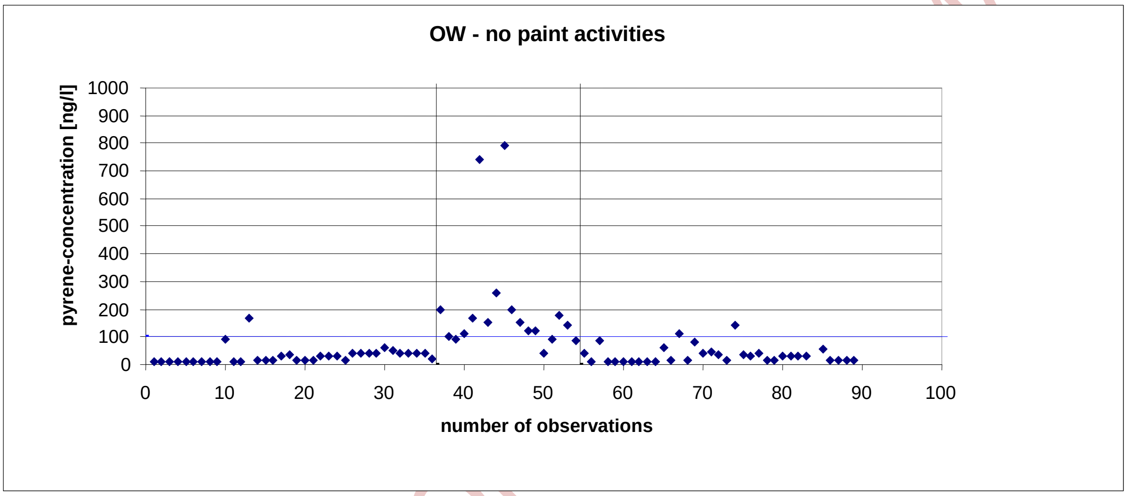


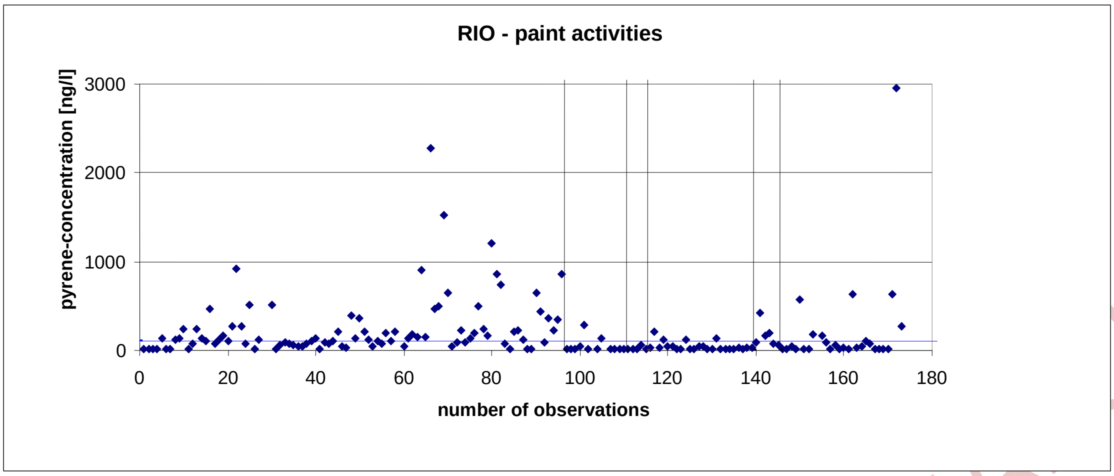
Figure 25: Schematic representation of the measured and available discharge data for pyrene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Pyrene concentrations 100 ng/l in the effluent of textile companies that discharge into surface water and do not perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

Discharge into sewer

<u>Companies that perform dying activities</u>

For textile companies (sewer dischargers) that perform paint activities, the average pyrene concentration amounts to 395.01 ng/l (6 companies, 169 measurements), with a maximum of 19,900 ng/l (6 measurements >1000 ng/l, of which 2 measurements > 3000 ng/l) (also see Figure 26).



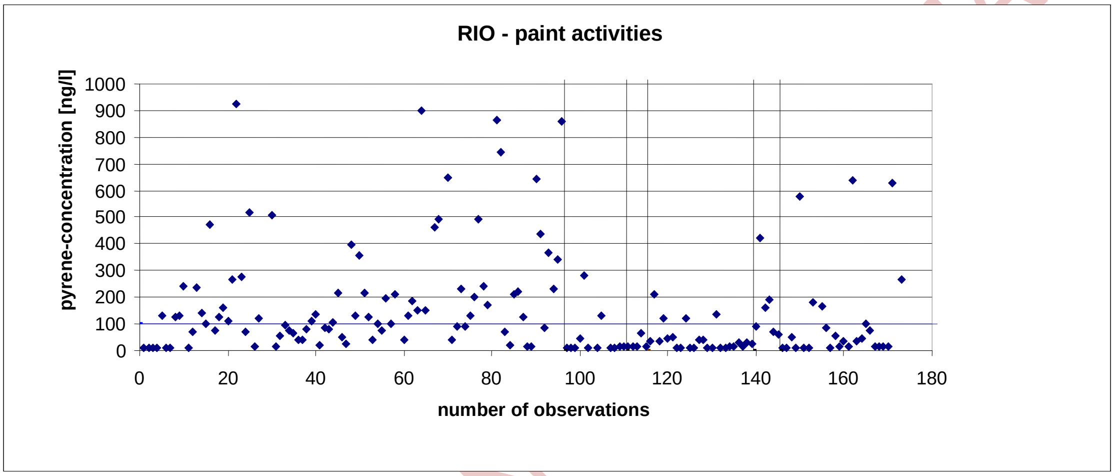
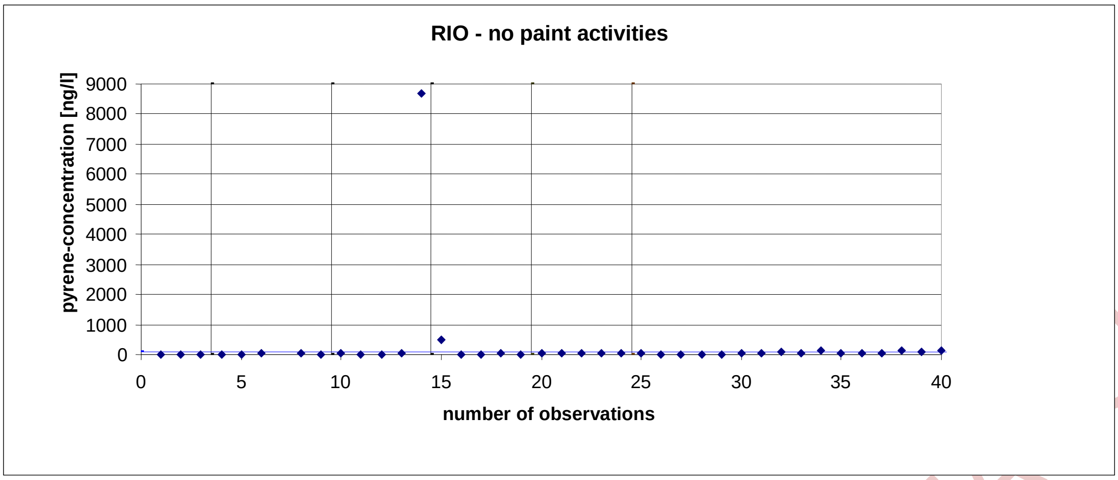


Figure 26: Schematic representation of the measured and available discharge data for pyrene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

The concentrations of pyrene are significantly higher in the effluent of textile companies that discharge into sewer and perform paint activities, compared to those that perform paint activities and discharge into surface water. One possible explanation for this could be the PAH-based carriers in paints and pigments used for paint activities.
However, it is unclear whether the examined companies implement the BAT to avoid/limit the use of PAH-based carriers when dying textiles (see chapter 5).

Pyrene concentrations 300 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

<u>Companies that do not perform paint activities</u>
For textile companies (sewer dischargers) that do not perform paint activities, the average concentration for pyrene amounts to 274.05 ng/l (6 companies, 39 measurements) with a maximum of 8,700 ng/l (= irregularity) (1 measurement >1 000 ng/l) (also see Figure 27).



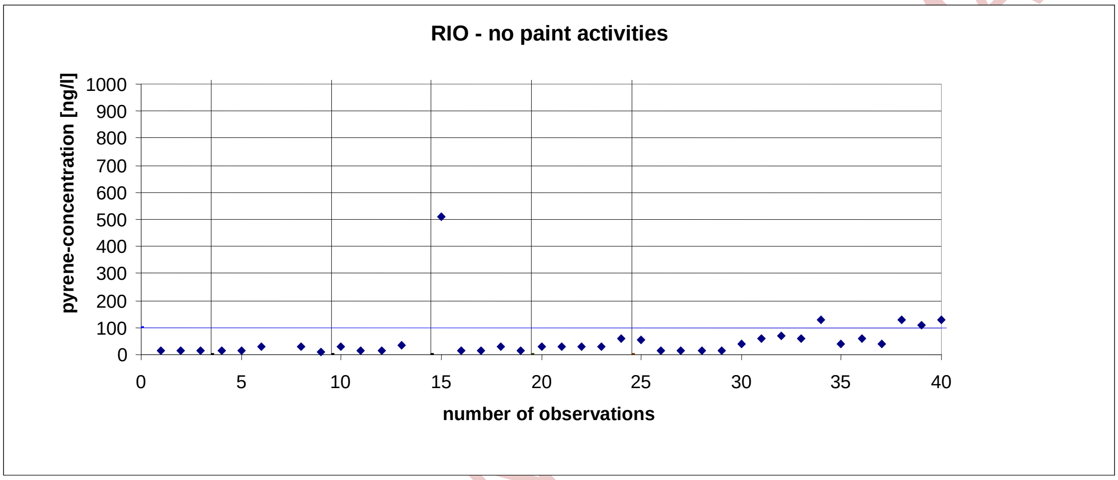


Figure 27: Schematic representation of the measured and available discharge data for pyrene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

Pyrene concentrations 100 ng/l in the effluent of textile companies that discharge into the sewer and do not perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

e.3 Acenaphthene

Acenaphthene can be removed biologically.

Discharge into surface water

Companies that perform dying activities

Acenaphthene is rarely found in concentrations >reporting limit in wastewater from textile companies that discharge into surface water (also see Figure 28 and Figure 29).

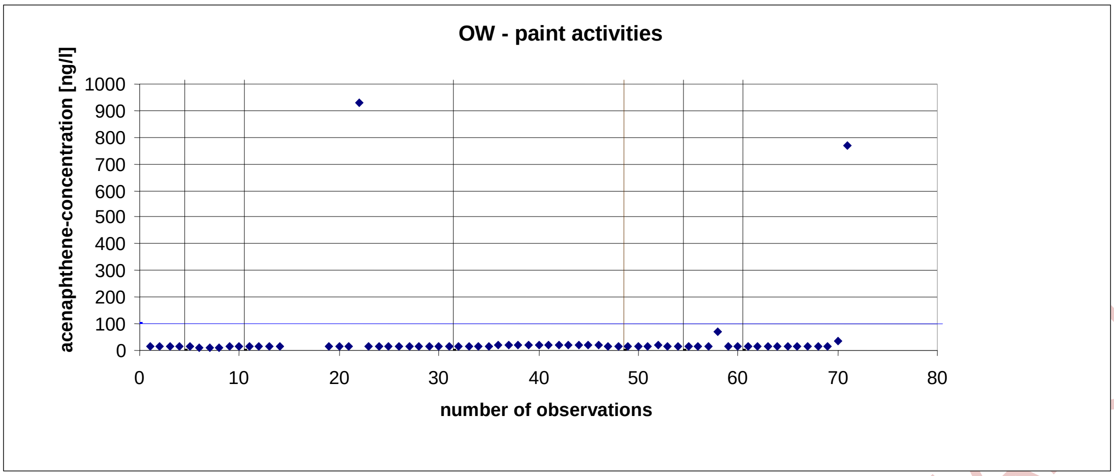


Figure 28: Schematic representation of the measured and available discharge data for acenaphthene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

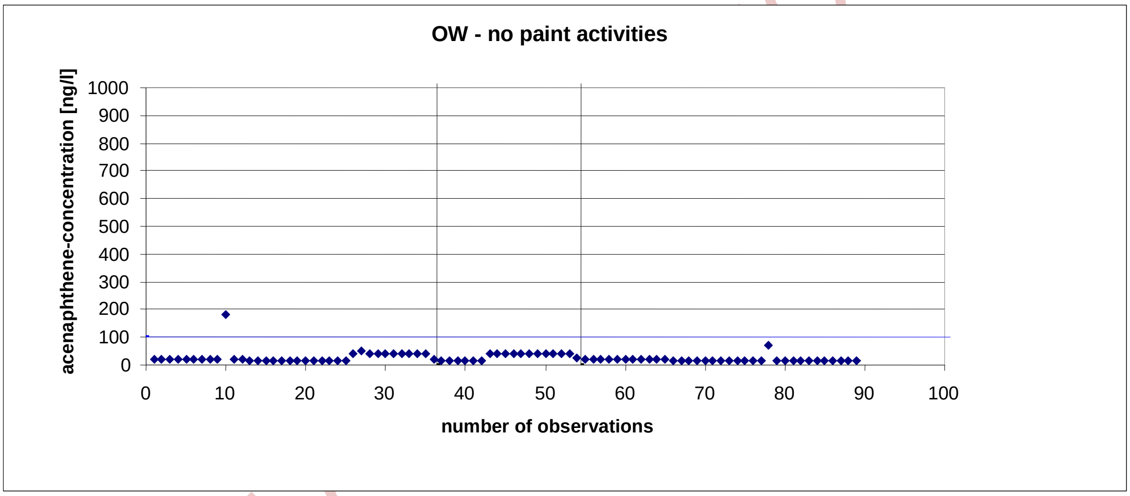


Figure 29: Schematic representation of the measured and available discharge data for acenaphthene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Acenaphthene concentrations >100 ng/l in the effluent of textile companies that discharge into surface water are regarded as irregularities possibly caused by abnormal operating conditions.

Discharge into sewer

Acenaphthene in concentrations >reporting limit was only found in 1 textile company that discharges into sewer and performs paint activities (also see Figure 30 and Figure 31).

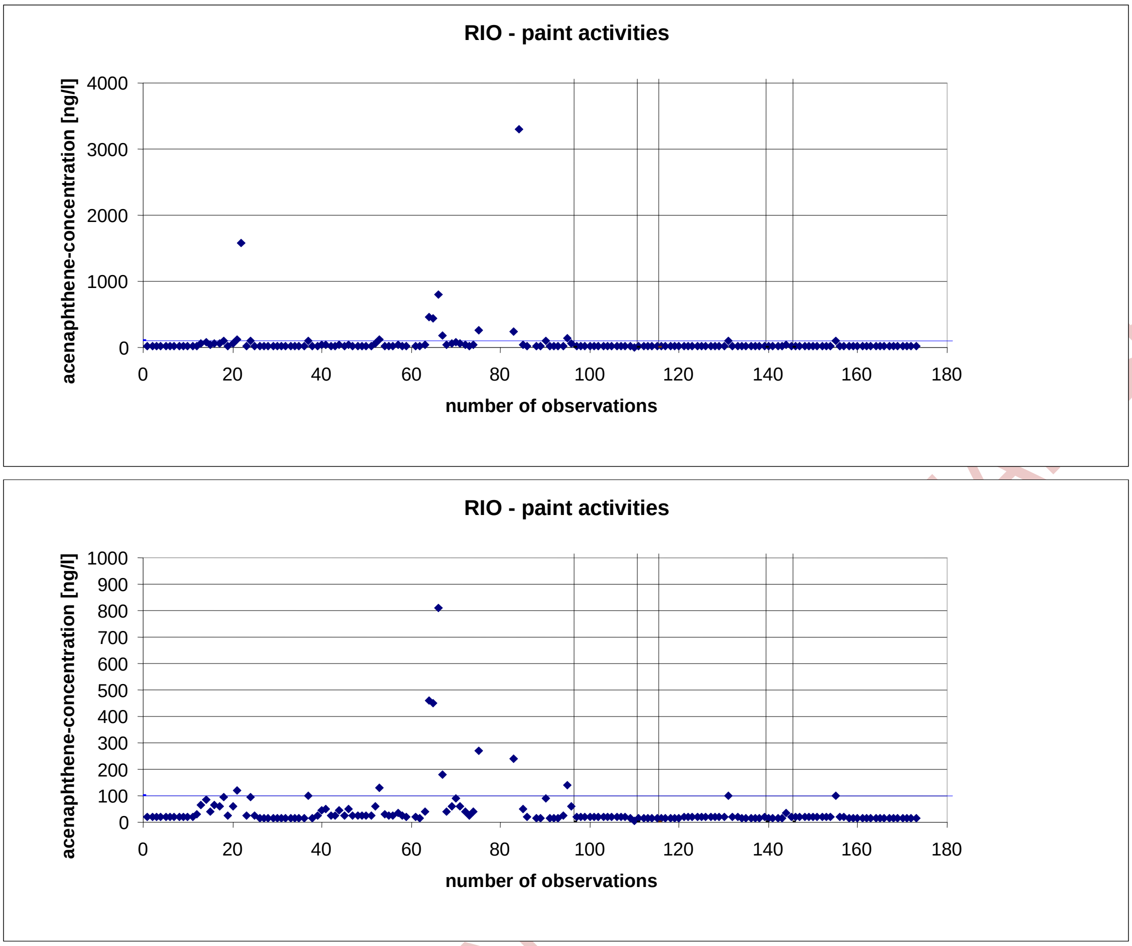


Figure 30: Schematic representation of the measured and available discharge data for acenaphthene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

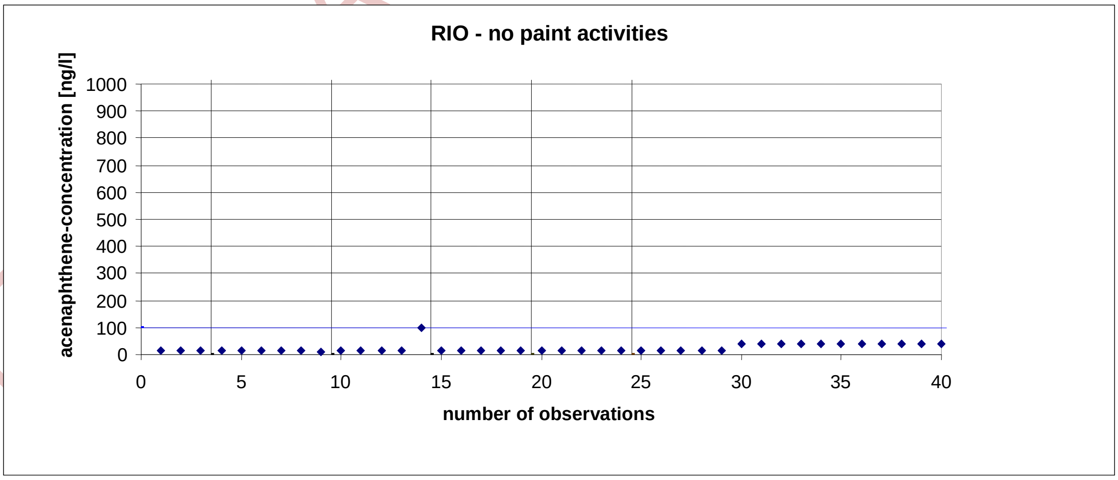


Figure 31: Schematic representation of the measured and available discharge data for acenaphthene from 6 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Acenaphthene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer are regarded as irregularities possibly caused by abnormal operating conditions.

e.4 anthracene

Anthracene has been included in the candidate list of very concerning substances (SVHC[302]) for inclusion in appendix XIV of REACH (also see paragraph 2.4.3.c). Anthracene is also identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g) and list III in appendix 2C of VLAREM I (also see paragraph 2.4.1.a). Biological processes only have limited success in breaking down anthracene.

Discharge into surface water

In none of the examined companies (including those that implement paint activities and those that do not) were anthracene concentrations >reporting limit (100 ng/l) discovered in the wastewater of textile companies that discharge into surface water, (also see Figure 32 and Figure 33).

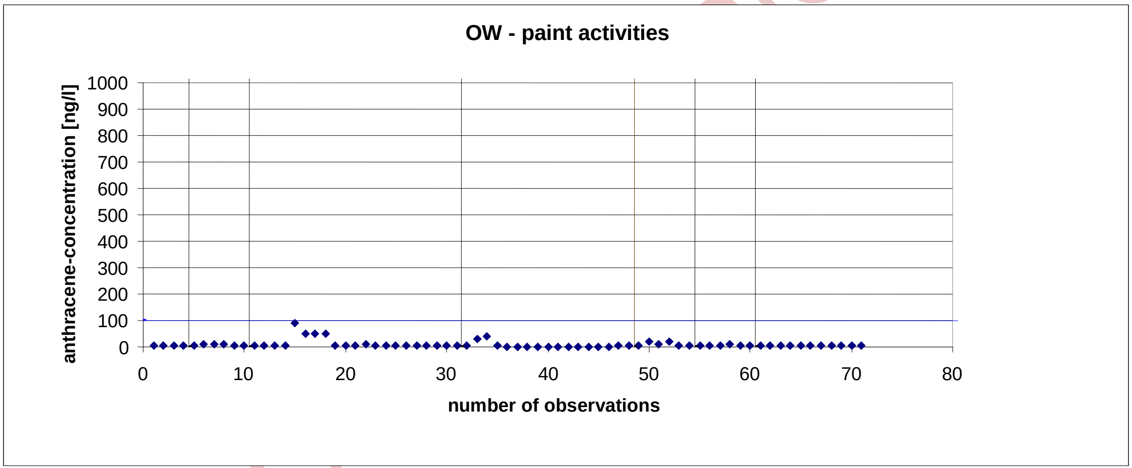


Figure 32: Schematic representation of the measured and available discharge data for anthracene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

302 Substances of Very High Concern

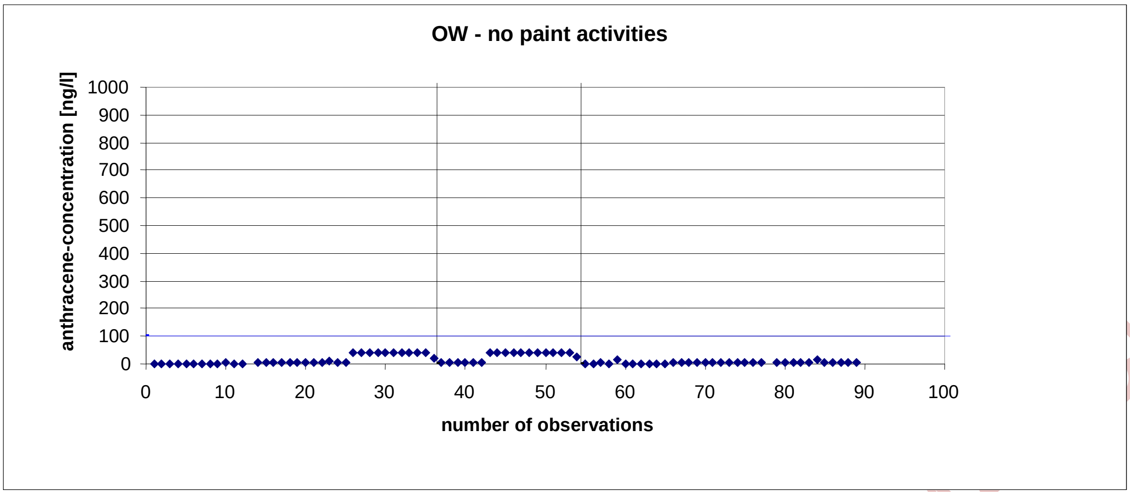


Figure 33: Schematic representation of the measured and available discharge data for anthracene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

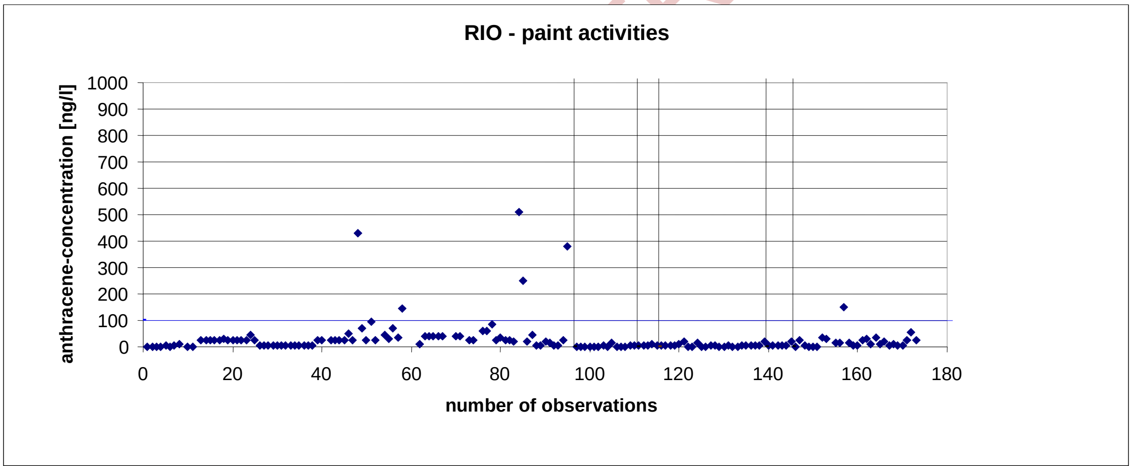


Figure 34: Schematic representation of the measured and available discharge data for anthracene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l) (7 measurements >1 000 ng/l)

Anthracene concentrations >400 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

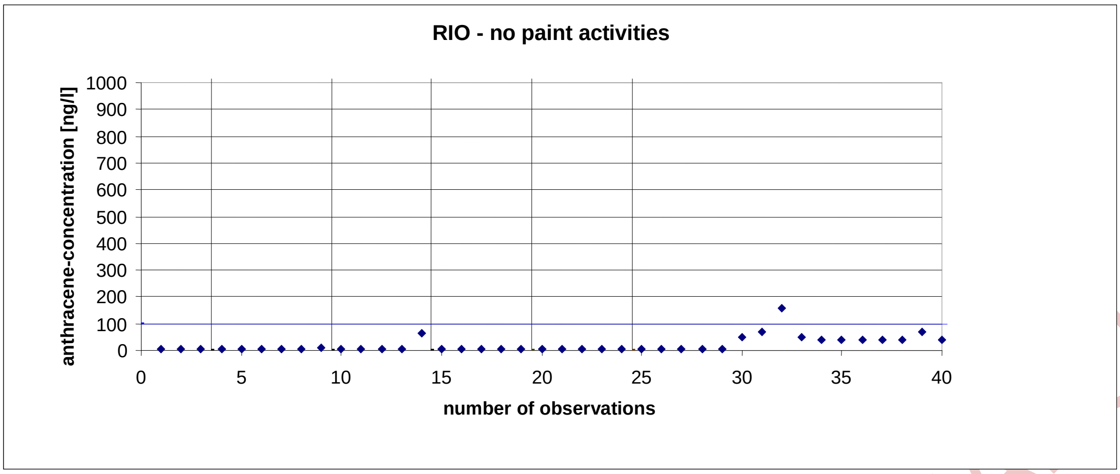


Figure 35: Schematic representation of the measured and available discharge data for anthracene from 6 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Anthracene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and do not perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

e.5 Benzo(a)anthracene

Discharge into surface water

The concentration of benzo(a)anthracene in the effluent of textile companies that discharge into surface water is only sporadically >reporting limit (also see Figure 36 and Figure 37).

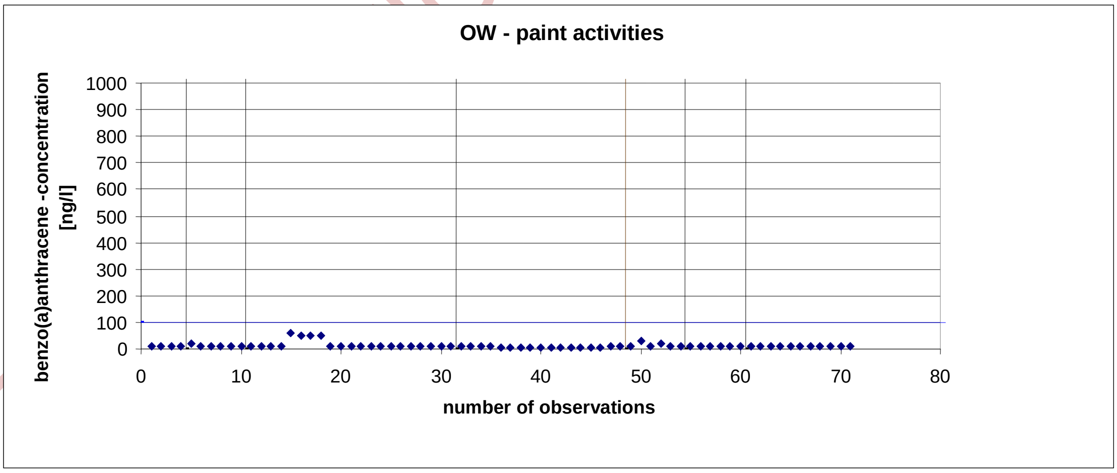


Figure 36: Schematic representation of the measured and available discharge data for benzo(a)anthracene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

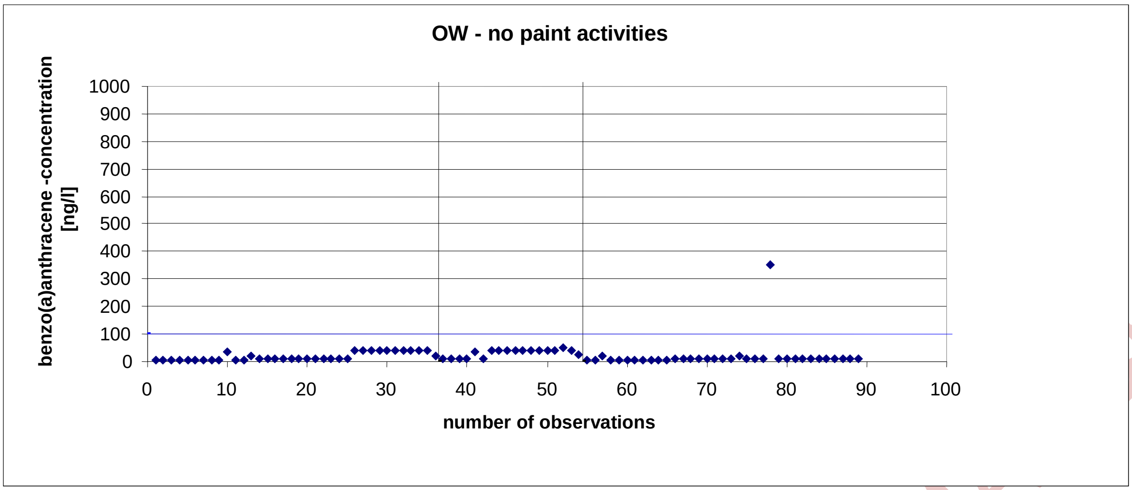


Figure 37: Schematic representation of the measured and available discharge data for benzo(a)anthracene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(a)anthracene concentrations >300 ng/l in the effluent of textile companies that discharge into surface water are regarded as irregularities possibly caused by abnormal operating conditions.

Discharge into sewer

The concentration of benzo(a)anthracene in the effluent of textile companies that discharge into sewer is also only sporadically >reporting limit (also see Figure 38 and Figure 39).

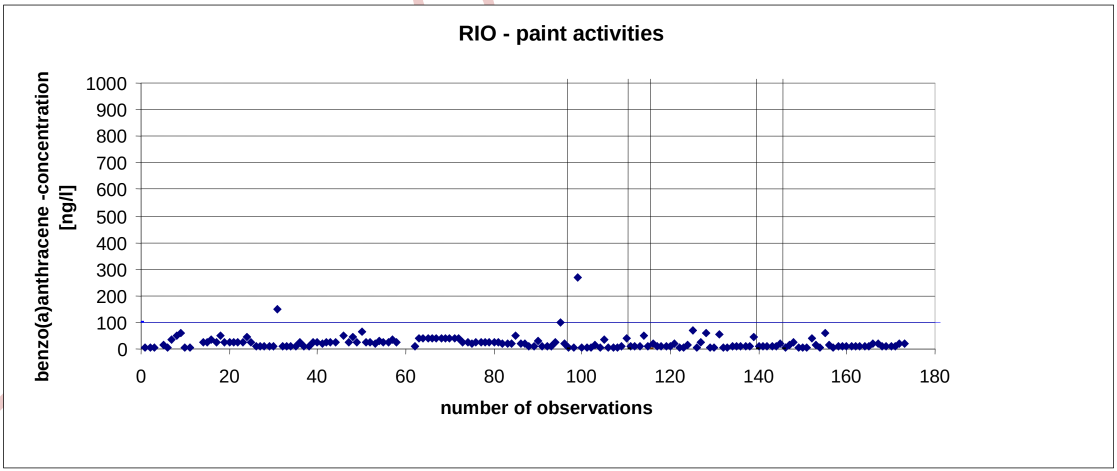


Figure 38: Schematic representation of the measured and available discharge data for benzo(a)anthracene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

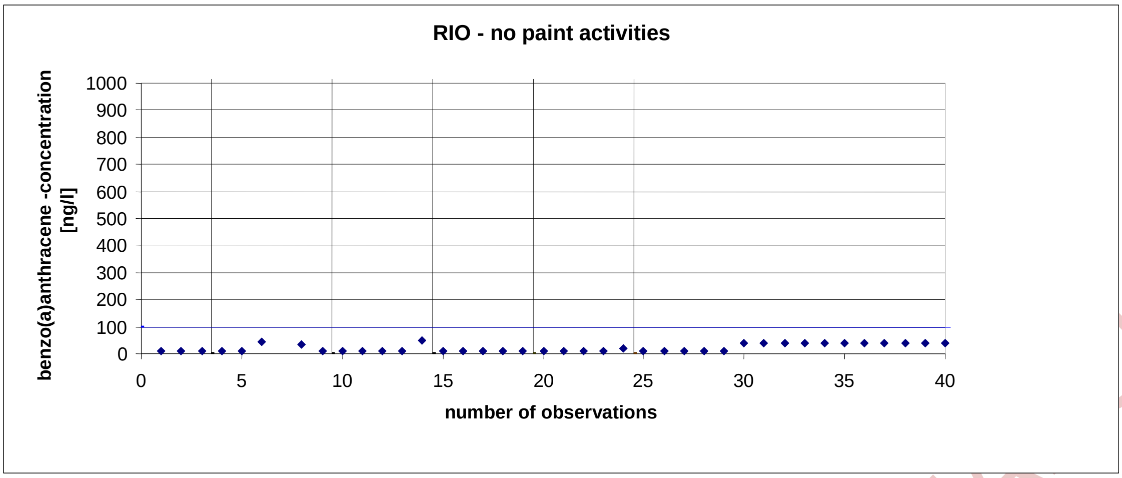


Figure 39: Schematic representation of the measured and available discharge data for benzo(a)anthracene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

e.6 Benzo(a)pyrene

Benzo(a)pyrene has been identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g).

Discharge into surface water

In none of the examined companies (including those that implement paint activities and those that do not) were benzo(a)pyrene concentrations >reporting limit discovered in the wastewater of textile companies that discharge into surface water, (also see Figure 40 and Figure 41).

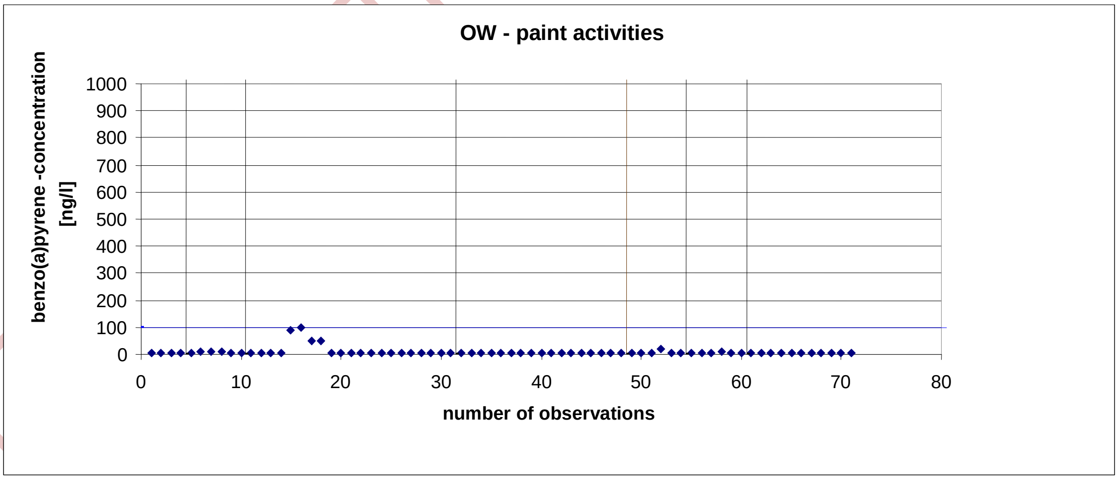


Figure 40: Schematic representation of the measured and available discharge data for benzo(a)pyrene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

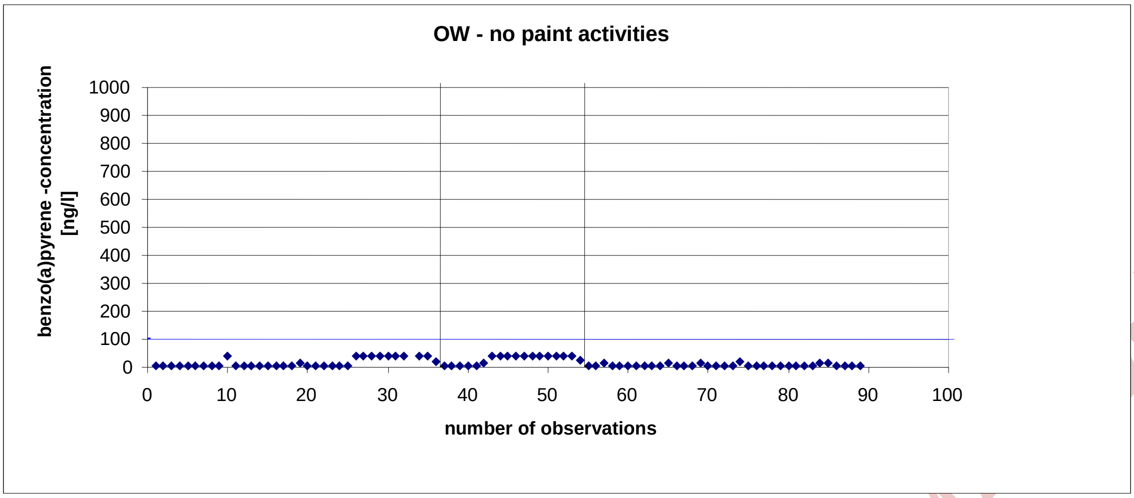


Figure 41: Schematic representation of the measured and available discharge data for benzo(a)pyrene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

Benzo(a)pyrene concentrations >reporting limit were discovered a limited number of times in the wastewater of 3 textile companies (2 with paint activities, 1 without paint activities) that discharge into sewer (also see Figure 42 and Figure 43).

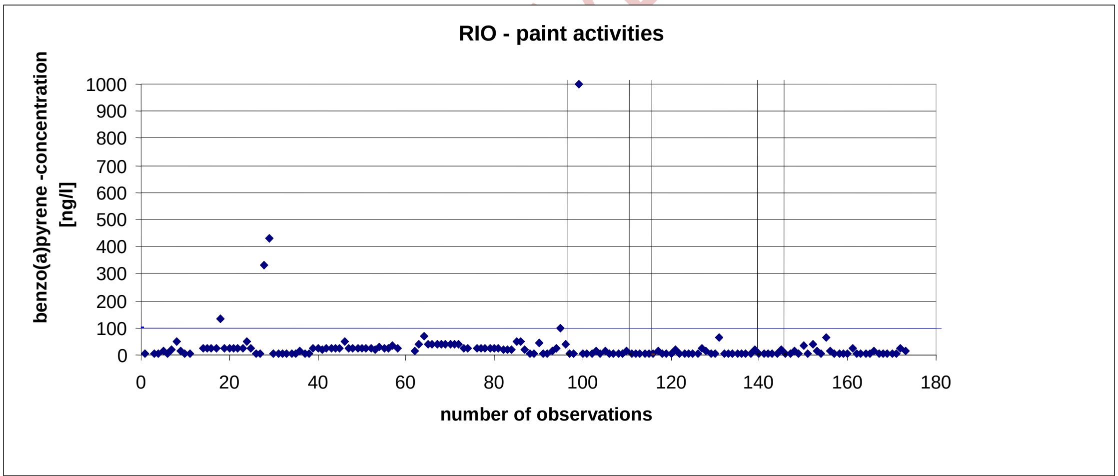


Figure 42: Schematic representation of the measured and available discharge data for benzo(a)pyrene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(a)pyrene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

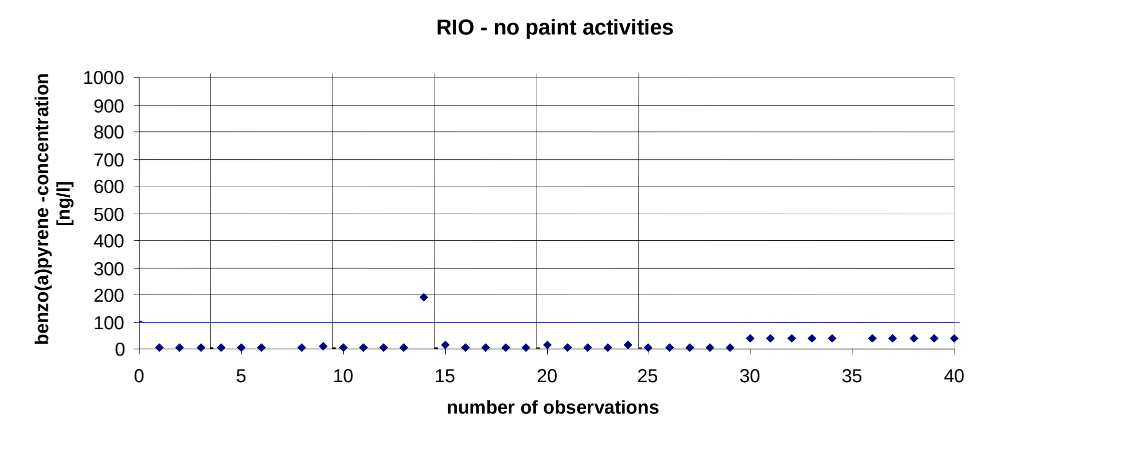


Figure 43: Schematic representation of the measured and available discharge data for benzo(a)pyrene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(a)pyrene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and do not perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

e.7 Benzo(b)fluoranthene

Benzo(b)fluoranthene has been identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g).

Discharge into surface water

The concentrations of benzo(b)fluoranthene in the effluent of textile companies that discharge into surface water (2006-2009) are always below the reporting limit (100 ng/l) (also see Figure 44 and Figure 45). The maximum concentration amounts to <60 ng/l for textile companies that discharge into surface water and implement paint activities. For those companies that do not implement paint activities and discharge into surface water, the benzo(b)fluoranthene concentration in the effluent is maximum <43 ng/l.

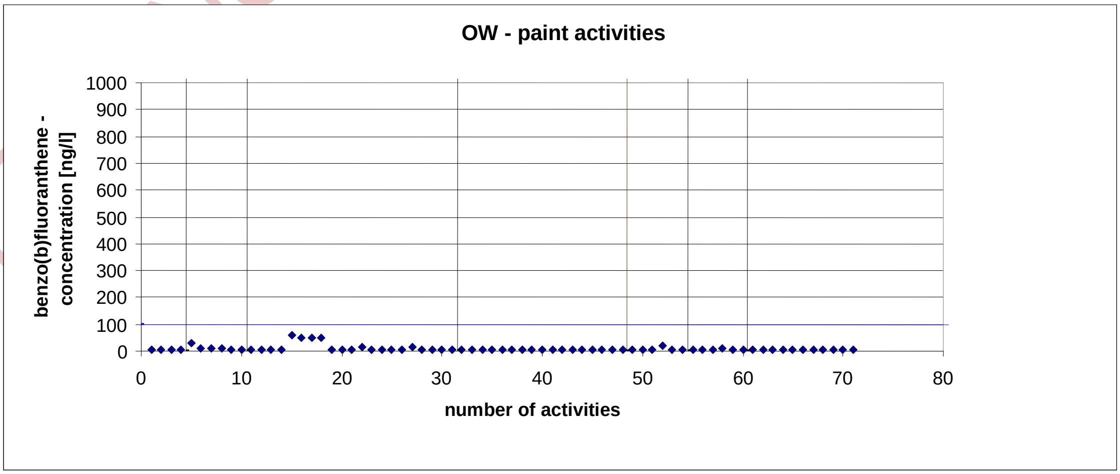


Figure 44: Schematic representation of the measured and available discharge data for benzo(b)fluoranthene from 7 Flemish textile companies that perform paint activities and

discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

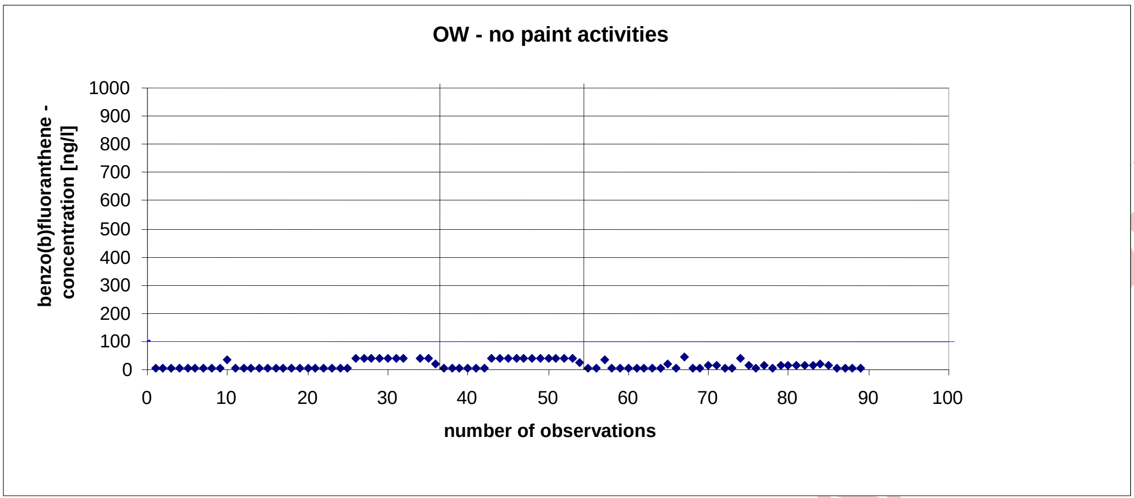


Figure 45: Schematic representation of the measured and available discharge data for benzo(b)fluoranthene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

In 2 textile companies that discharge into sewer and implement paint activities, benzo(b)fluoranthene was found on a few occasions in concentrations >reporting limit (also see Figure 46 and Figure 47).

The maximum concentration amounts to <690 ng/l for textile companies that discharge into sewer and implement paint activities. For those companies that do not implement paint activities and discharge into sewer, the benzo(b)fluoranthene concentration in the effluent is maximum <40 ng/l.

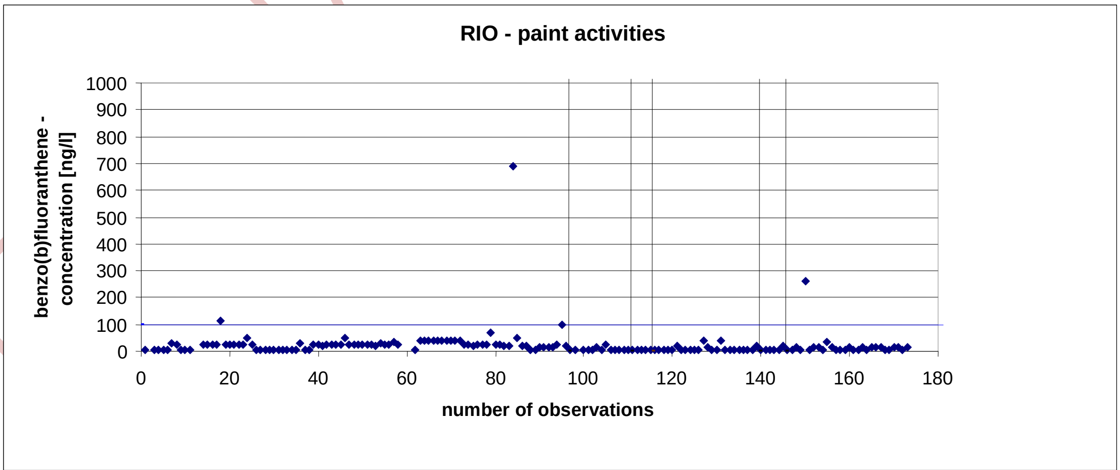


Figure 46: Schematic representation of the measured and available discharge data for benzo(b)fluoranthene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(b)fluoranthene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

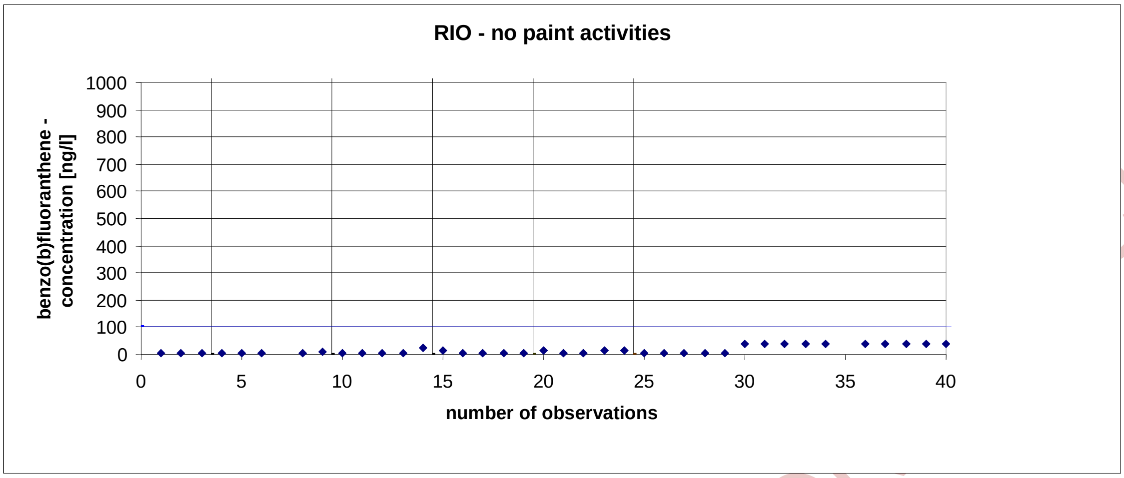


Figure 47: Schematic representation of the measured and available discharge data for benzo(b)fluoranthene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

e.8 Benzo(k)fluoranthene

Benzo(k)fluoranthene has been identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g). Benzo(k)fluoranthene can be removed biologically.

Discharge into surface water

The concentrations of benzo(k)fluoranthene in the effluent of textile companies that discharge into surface water (2006-2009) are always below the reporting limit (100 ng/l) (also see Figure 48 and Figure 49). The maximum concentration amounts to <20 ng/l for textile companies that discharge into surface water and implement paint activities. For those companies that do not implement paint activities and discharge into surface water, the benzo(b)fluoranthene concentration in the effluent is maximum <40 ng/l.

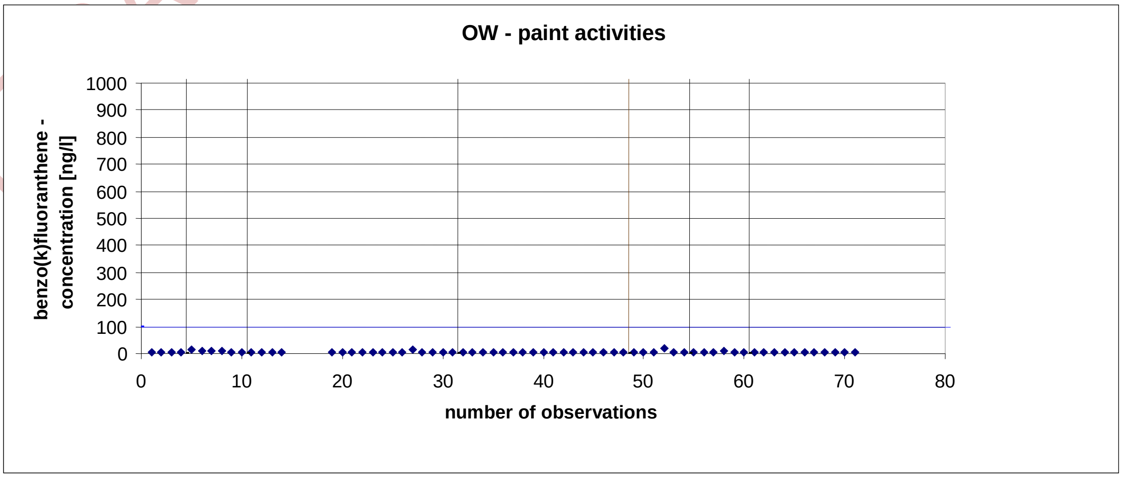


Figure 48: Schematic representation of the measured and available discharge data for benzo(k)fluoranthene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

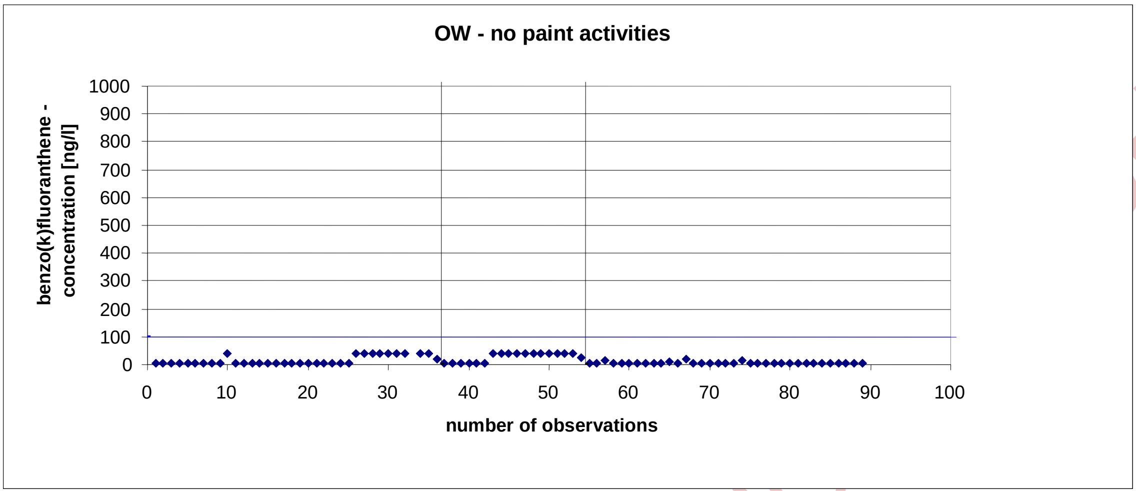


Figure 49: Schematic representation of the measured and available discharge data for benzo(k)fluoranthene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

Sporadic concentrations of benzo(k)fluoranthene, which were higher than the reporting limit, were only found in the effluent of 1 textile company that implements dying activities. The maximum concentration amounts to <270 ng/l for textile companies that discharge into sewer and implement paint activities. For those companies that do not implement paint activities and discharge into sewer, the benzo(k)fluoranthene concentration in the effluent is maximum <40 ng/l.

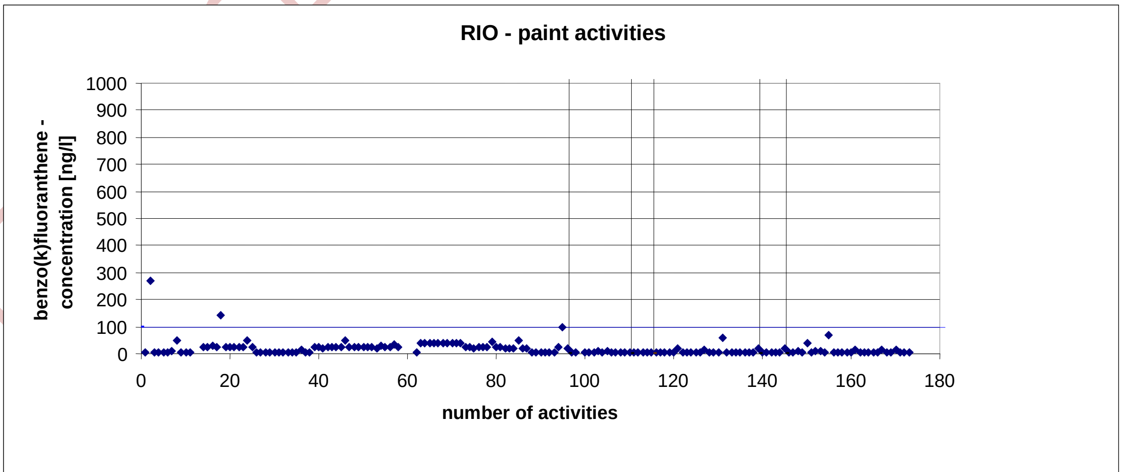


Figure 50: Schematic representation of the measured and available discharge data for benzo(k)fluoranthene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(k)fluoranthene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

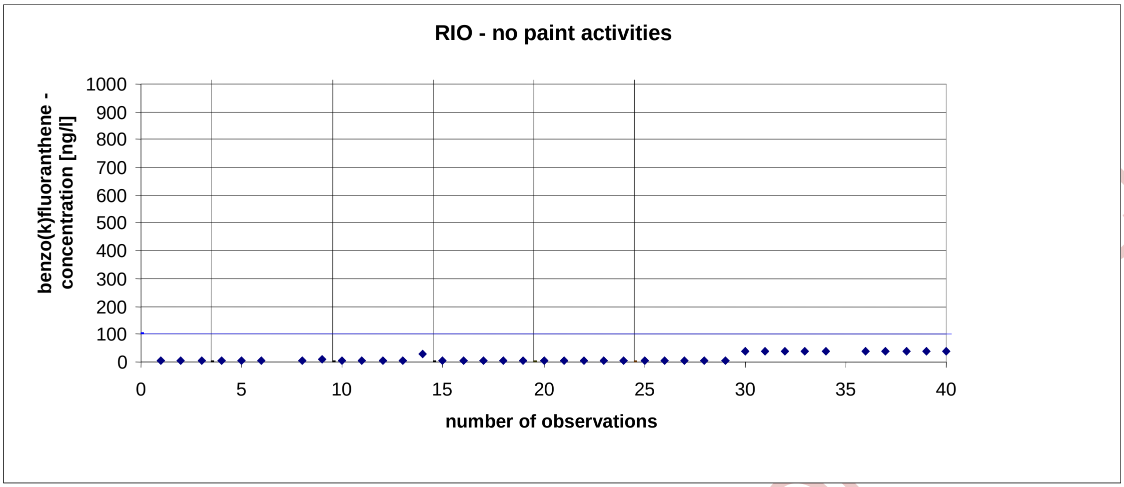


Figure 51: Schematic representation of the measured and available discharge data for benzo(k)fluoranthene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

e.9 benzo(ghi)perylene

Benzo(ghi)perylene has been identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g).

Discharge into surface water

The concentrations of benzo(ghi)perylene in the effluent of textile companies that discharge into surface water (2006-2009) are always below the reporting limit (100 ng/l), with the exception of 1 measurement (220 ng/l) for a textile company that implements dying activities (also see Figure 52 and Figure 53). The maximum concentration amounts to <44 ng/l for textile companies that discharge into surface water and do not implement dying activities.

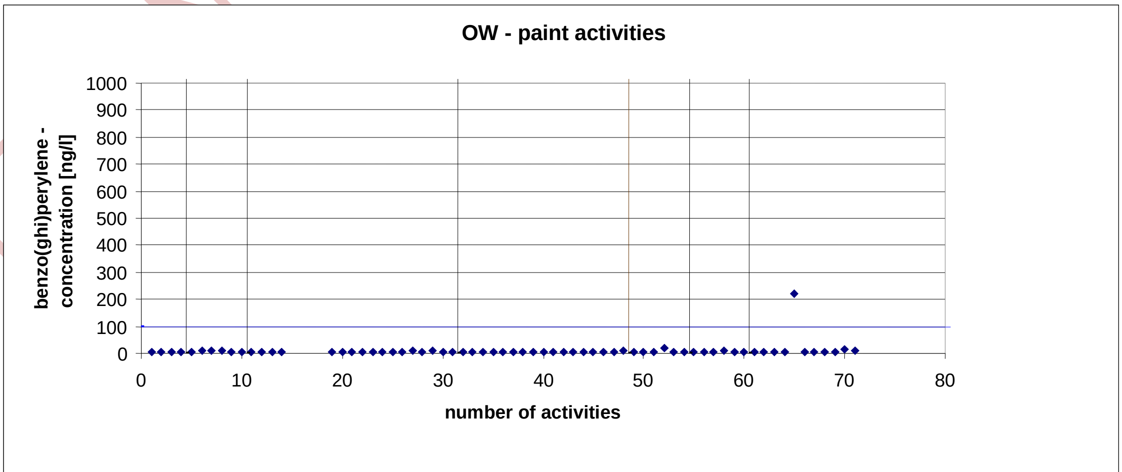


Figure 52: Schematic representation of the measured and available discharge data for benzo(ghi)perylene from 7 Flemish textile companies that perform paint activities and

discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Benzo(ghi)perylene concentrations >100 ng/l in the effluent of textile companies that discharge into surface water and perform dying activities, are regarded as irregularities possibly caused by abnormal operating conditions.

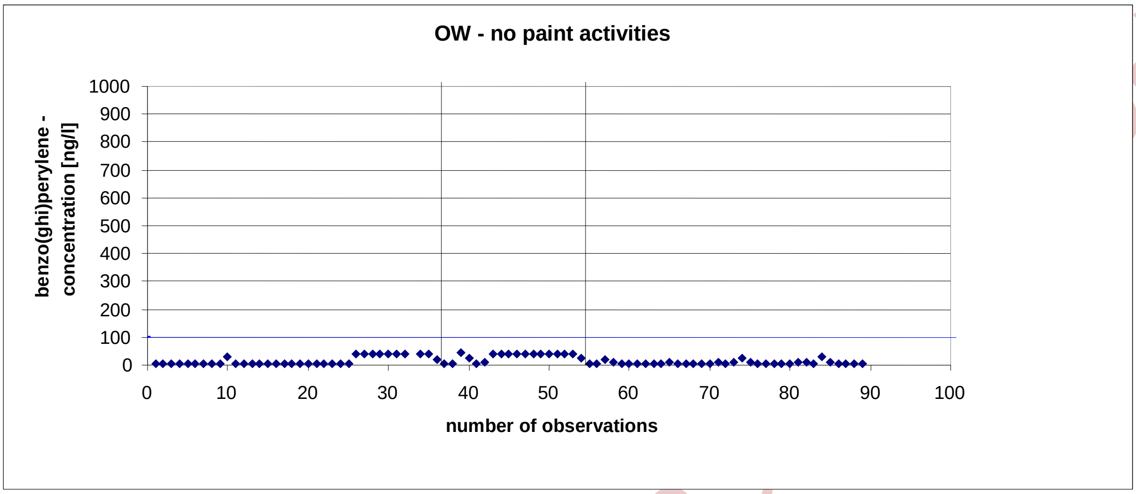


Figure 53: Schematic representation of the measured and available discharge data for benzo(ghi)perylene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

On a limited number of occasions, benzo(ghi)perylene in concentrations >reporting limit (100 ng/l), with a maximum of 4500 ng/l (with dying activities) were found in the effluent of 3 textile companies (2 with dying activities and 1 without) that discharge into sewer (also see Figure 54 and Figure 55)

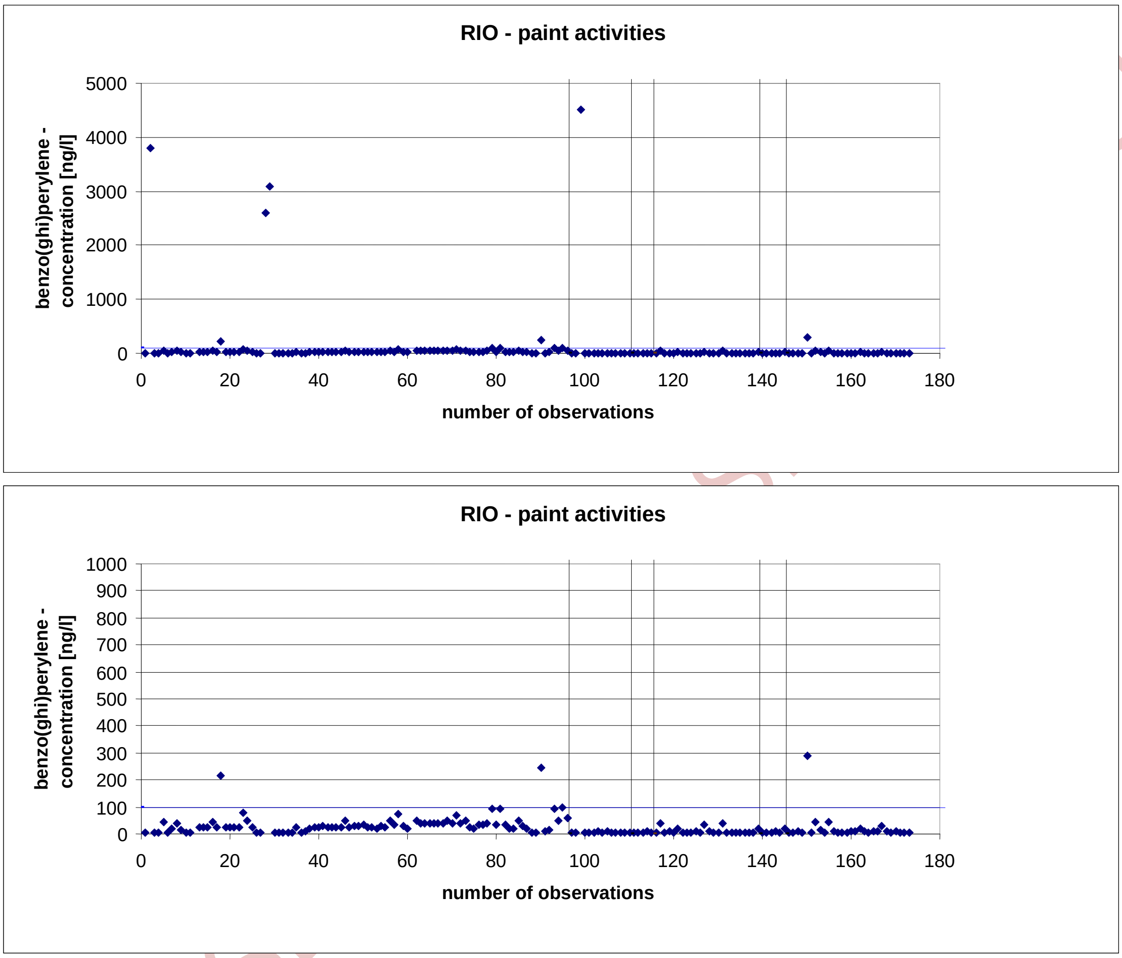


Figure 54: Schematic representation of the measured and available discharge data for benzo(ghi)perylene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

Benzo(ghi)perylene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform dying activities, are regarded as irregularities possibly caused by abnormal operating conditions.

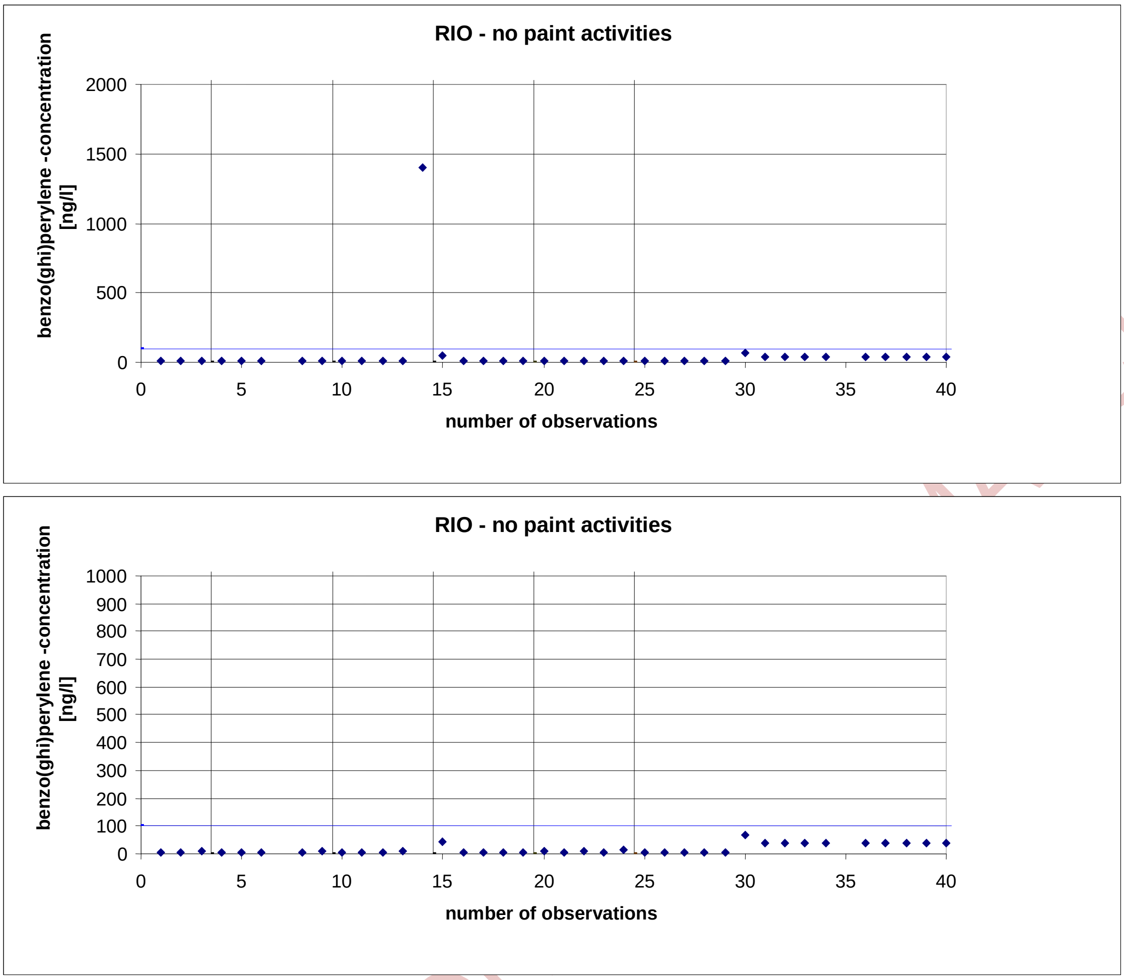


Figure 55: Schematic representation of the measured and available discharge data for benzo(ghi)perylene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

Benzo(ghi)perylene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and do not perform dying activities, are regarded as irregularities possibly caused by abnormal operating conditions.

e.10 Indeno(1,2,3-cd)pyrene

Indeno(1,2,3-cd)pyrene has been identified as a priority dangerous substance in appendix X of DPR (also see paragraph 2.4.3.g) and can be removed biologically.

Discharge into surface water

The concentrations of indeno(1,2,3)pyrene in the effluent of textile companies that discharge into surface water (2006-2009) are always below the reporting limit (100 ng/l) (also see Figure 56 and Figure 57). The maximum concentration amounts to <61 ng/l for textile companies that discharge into surface water and implement dying activities. For textile companies that discharge into sewer and do not perform dying activities, the maximum concentration amounts to <40 ng/l.

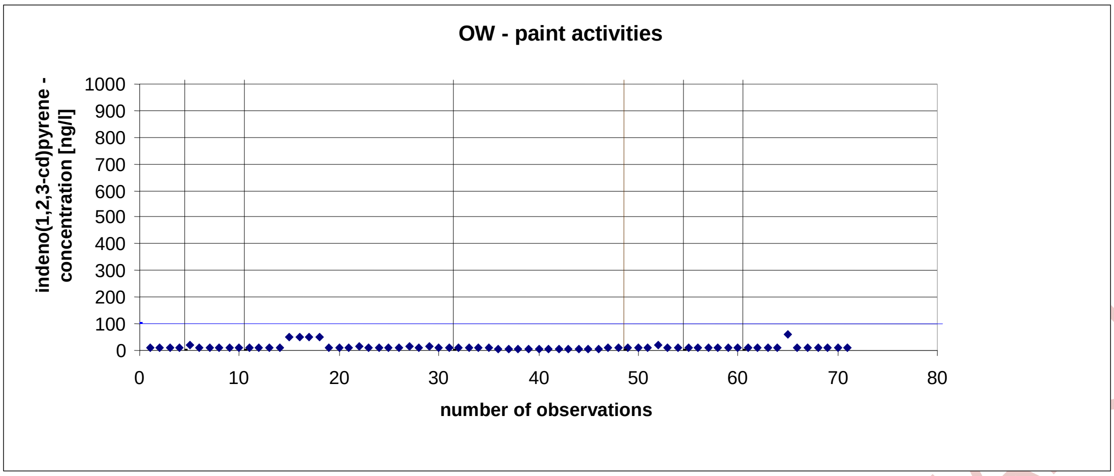


Figure 56: Schematic representation of the measured and available discharge data for indeno(1,2,3-cd)pyrene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

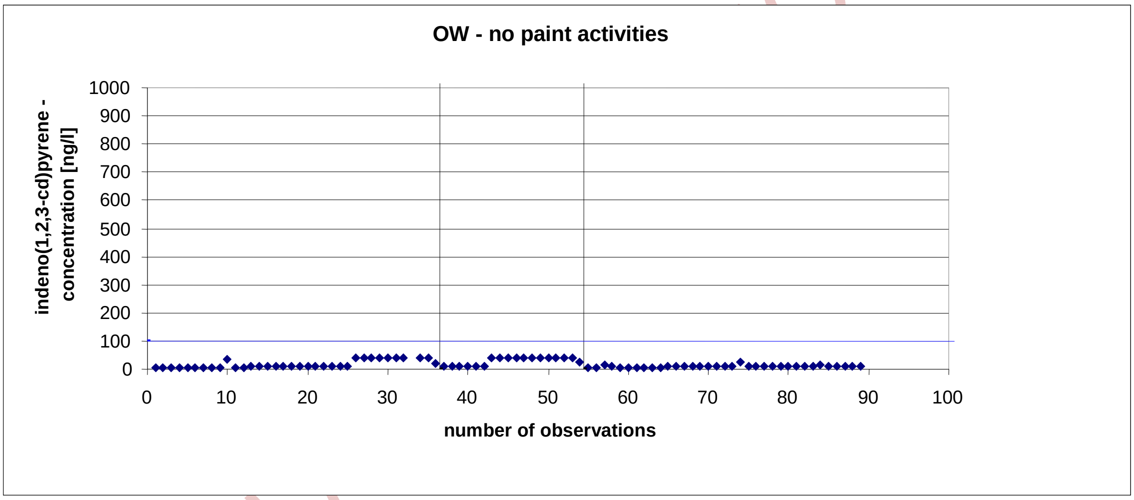


Figure 57: Schematic representation of the measured and available discharge data for indeno(1,2,3-cd)pyrene from 3 Flemish textile companies that do not perform dying activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

On a limited number of occasions, benzo(ghi)perylene in concentrations >reporting limit (100 ng/l), with a maximum of 450 ng/l (also see Figure 54 and Figure 55) was found in the effluent of 3 textile companies with dying activities that discharge into sewer. For textile companies that discharge into sewer and do not perform dying activities, the maximum concentration amounts to <85 ng/l.

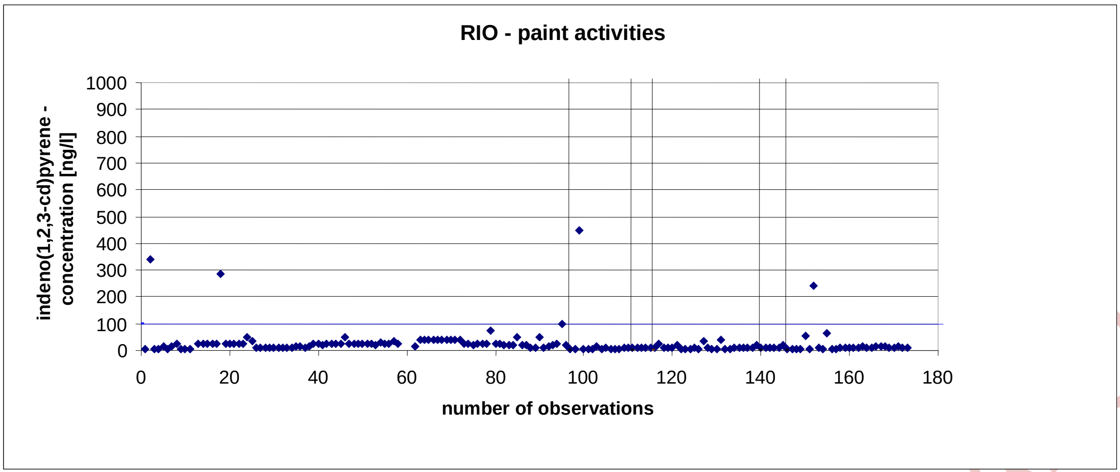


Figure 58: Schematic representation of the measured and available discharge data for indeno(1,2,3-cd)pyrene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Indeno(1,2,3-cd)pyrene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

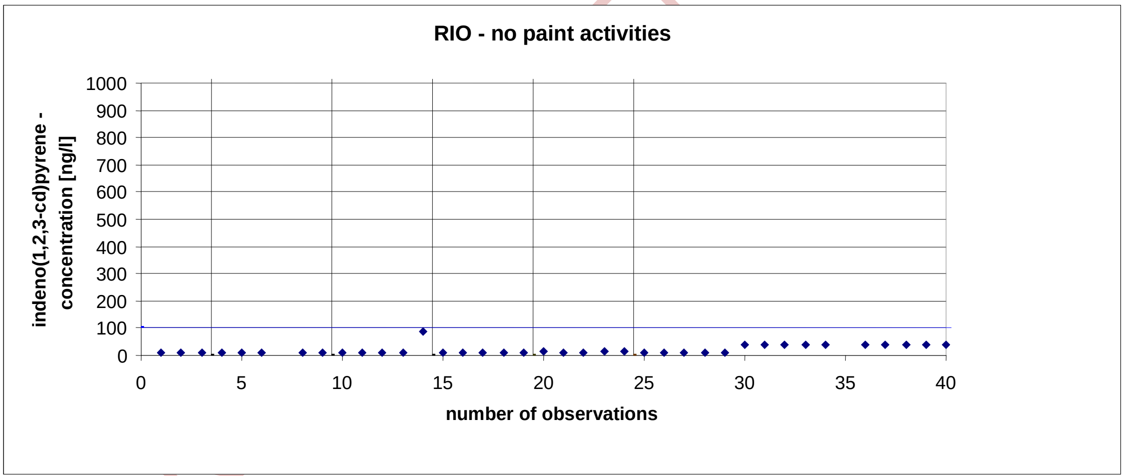


Figure 59: Schematic representation of the measured and available discharge data for indeno(1,2,3-cd)pyrene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

e.11 Dibenzo(a,h)anthracene

Dibenzo(a,h)anthracene can be broken down biologically.

Discharge into surface water

The concentrations of dibenzo(a,h)anthracene in the effluent of textile companies that discharge into surface water (2006-2009) are always below the reporting limit (100 ng/l) (also see Figure 60 and Figure 61). The maximum concentration amounts to <20 ng/l for textile companies that discharge into surface water and implement dying activities.

For textile companies that discharge into surface water and do not implement dying activities, the maximum concentration is <40 mg/l.

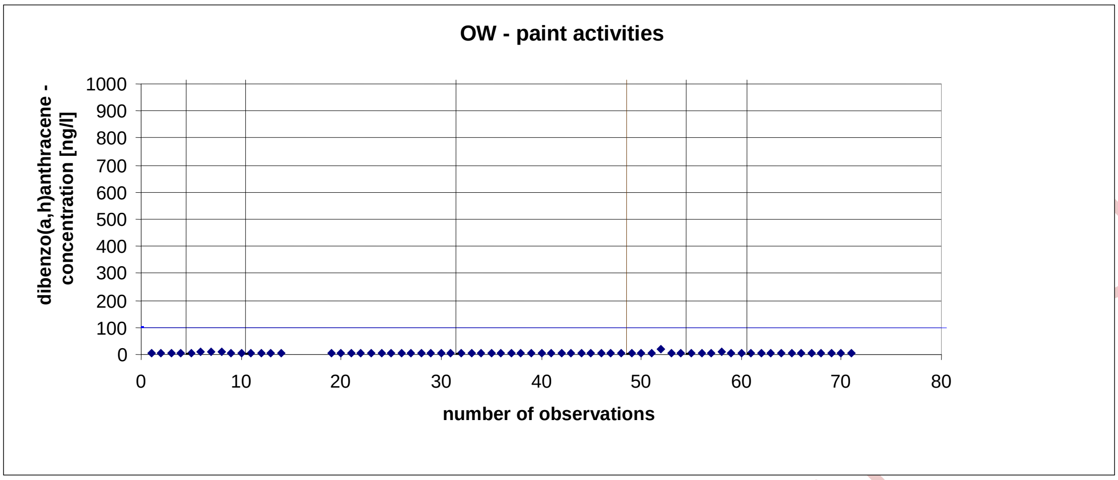


Figure 60: Schematic representation of the measured and available discharge data for dibenzo(a,h)anthracene from 7 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

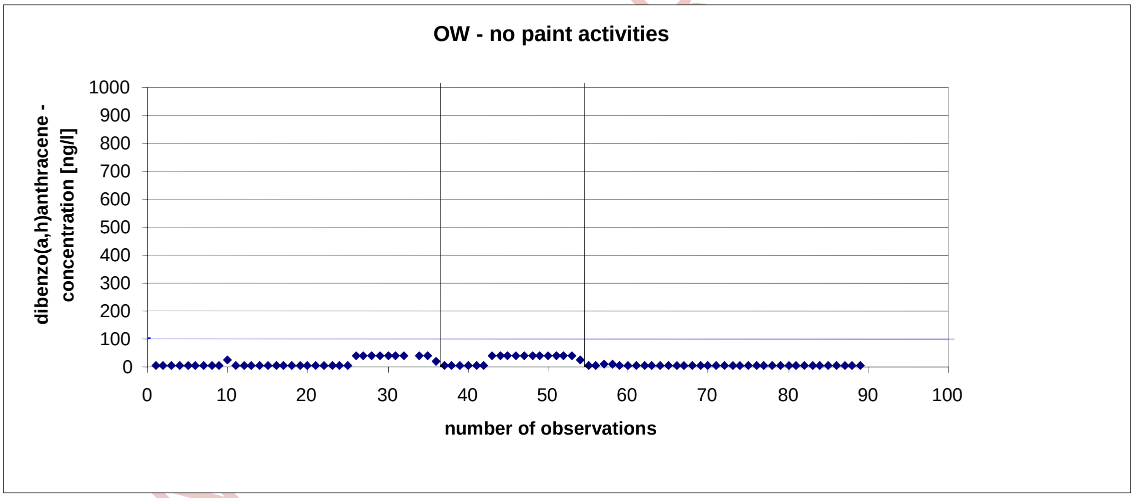


Figure 61: Schematic representation of the measured and available discharge data for dibenzo(a,h)anthracene from 3 Flemish textile companies that do not perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Discharge into sewer

Dibenzo(a,h)anthracene in a concentration >reporting limit is only encountered a few times in the wastewater of textile companies that discharge into sewer and perform dying activities (maximum concentration is 315 ng/l) (also see Figure 62). The maximum concentration amounts to <74 ng/l for textile companies that discharge into sewer and do not implement dying activities (also see Figure 63).

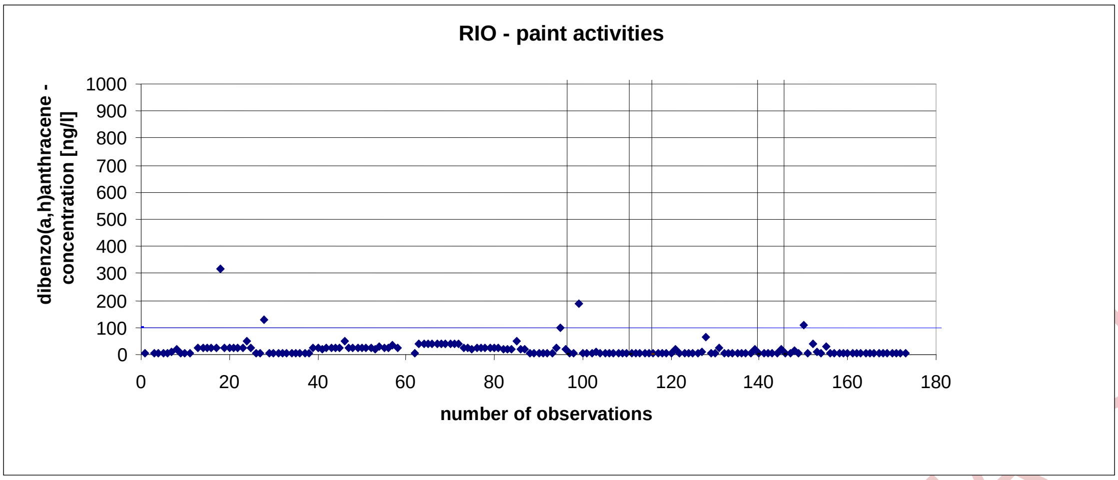


Figure 62: Schematic representation of the measured and available discharge data for dibenzo(a,h)anthracene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Dibenzo(a,h)anthracene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer and perform paint activities, are regarded as irregularities possibly caused by abnormal operating conditions.

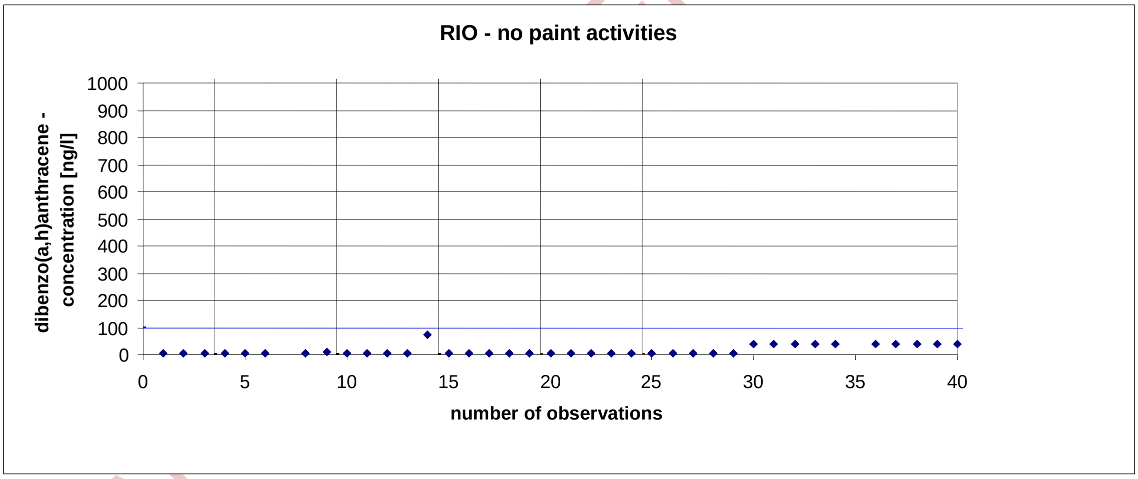


Figure 63: Schematic representation of the measured and available discharge data for dibenzo(a,h)anthracene from 6 Flemish textile companies that do not perform dying activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

e.12 Fluoranthene

Fluoranthene can be removed biologically. The measurement data shows that also fluoranthene, in concentrations >reporting limit, is regularly encountered in the wastewater of textile companies that discharge into surface water. Fluoranthene probably also enters the textile company via imported tissues.

Discharge into surface water

For textile companies that discharge into surface water, there was 1 measurement >reporting limit, namely 610 ng/l (also see Figure 64).

The maximum fluoranthene concentration amounts to <400 ng/l for textile companies that discharge into surface water and do not implement dying activities (also see Figure 65).

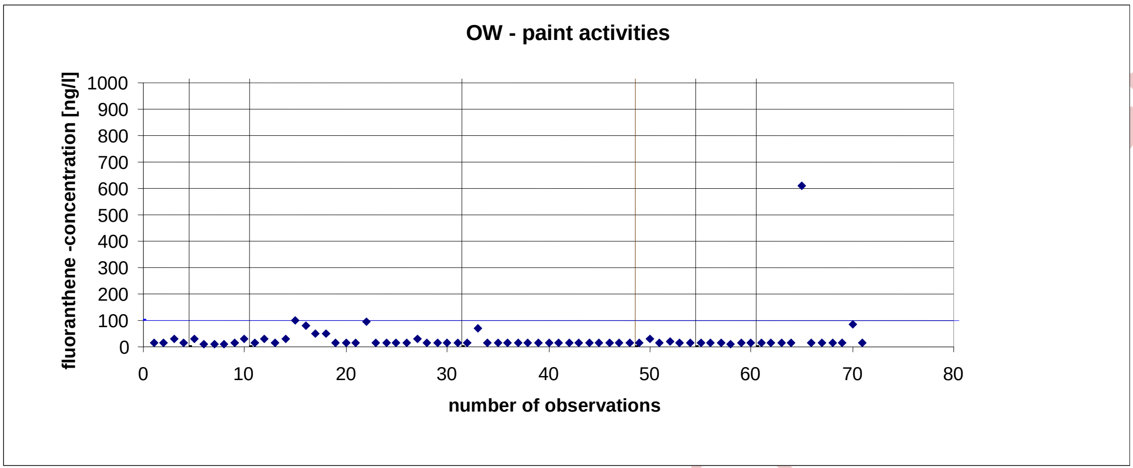


Figure 64: Schematic representation of the measured and available discharge data for fluoranthene from 6 Flemish textile companies that perform paint activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

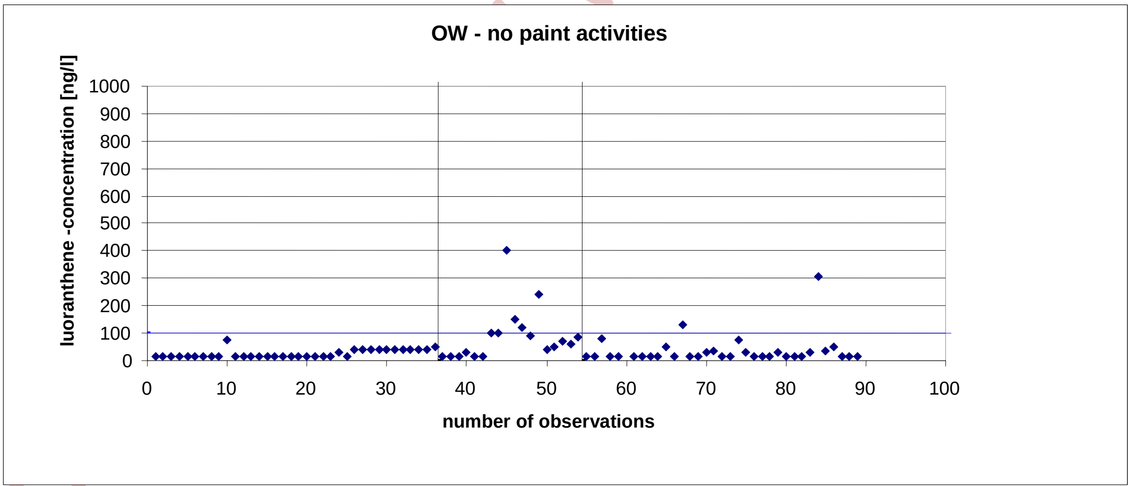


Figure 65: Schematic representation of the measured and available discharge data for fluoranthene from 6 Flemish textile companies that do not perform dying activities and discharge into surface water (2006-2009), with an indicator for the reporting limit (100 ng/l)

Fluoranthene concentrations 100 ng/l in the effluent of textile companies that discharge into surface water (with and without dying activities), are regarded as irregularities possibly caused by abnormal operating conditions.

Discharge into sewer

Fluoranthene is also regularly encountered in concentrations >reporting limit in the wastewater of textile companies that discharge into the sewer.

For textile companies that discharge into sewer and perform dying activities, the maximum fluoranthene concentration amounts to 2,150 ng/l (=irregularity) (also see Figure 66).

The maximum fluoranthene concentration amounts to 890 ng/l in the effluent of textile companies that discharge into sewer and implement dying activities (also see Figure 67).

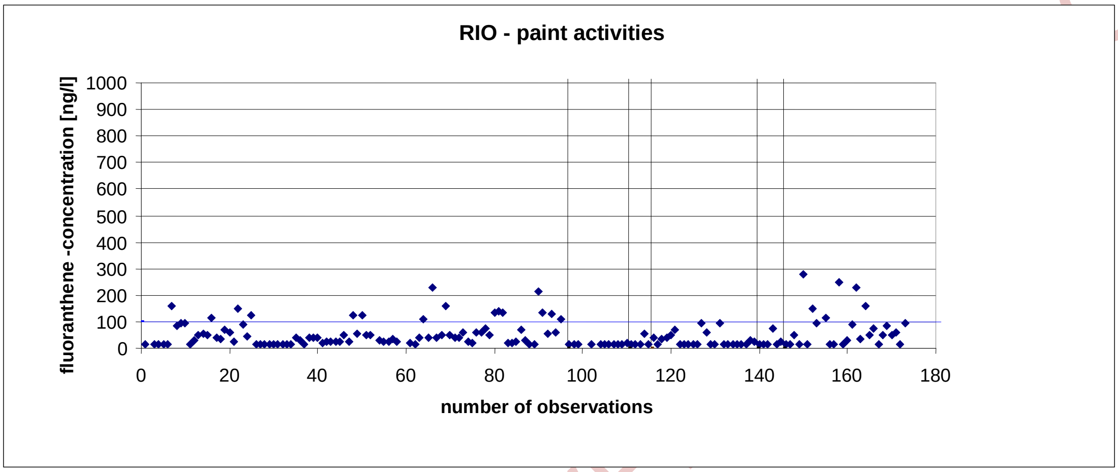


Figure 66: Schematic representation of the measured and available discharge data for fluoranthene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Fluoranthene concentrations >300 ng/l in the effluent of textile companies that discharge into sewer (with dying activities) are regarded as irregularities possibly caused by abnormal operating conditions.

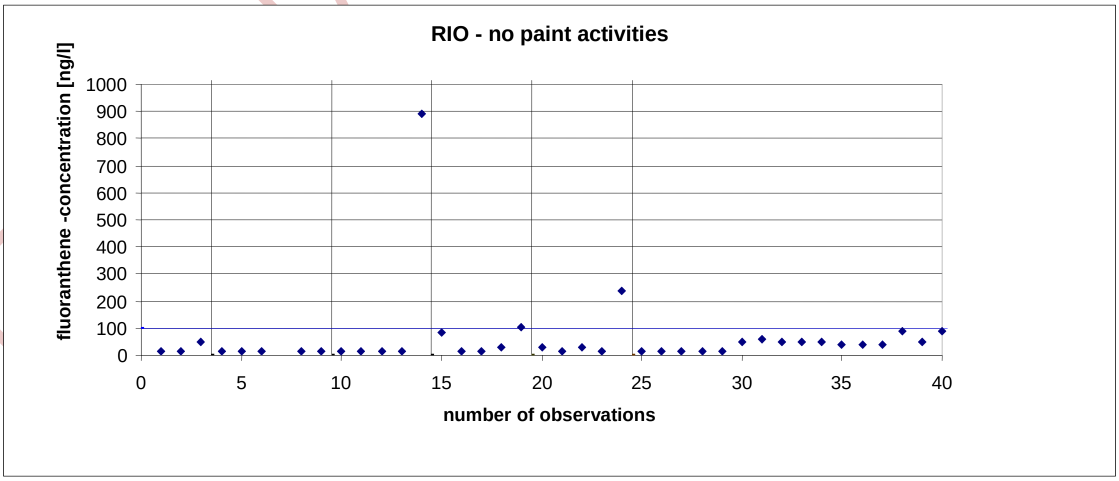


Figure 67: Schematic representation of the measured and available discharge data for fluoranthene from 6 Flemish textile companies that do not perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l)

Fluoranthene concentrations >100 ng/l in the effluent of textile companies that discharge into sewer (without dying activities) are regarded as irregularities possibly caused by abnormal operating conditions.

e.13 Fluorene

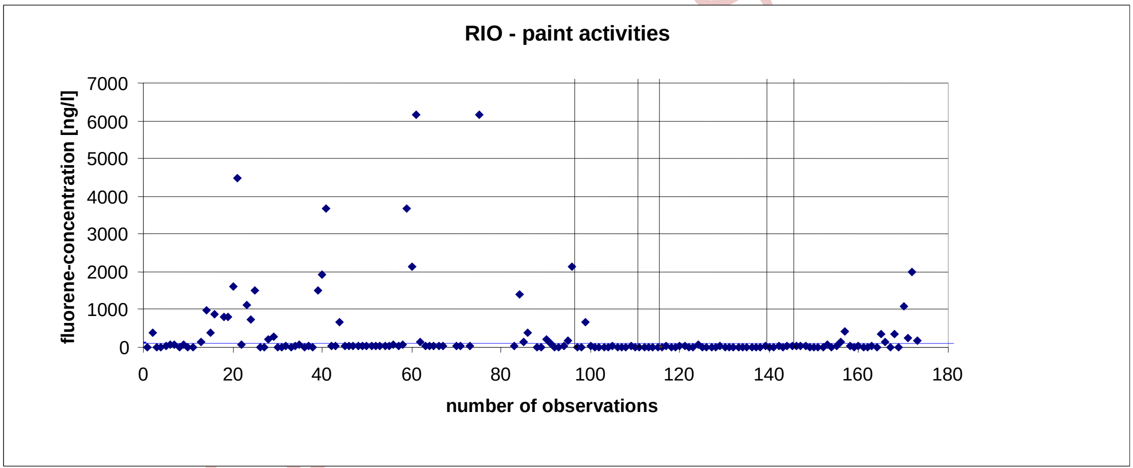
Fluorene can be removed biologically.

Discharge into surface water

Fluorene in concentrations >BMKN (2,000 ng/l) is not found in the effluent of textile companies that discharge into surface water. The maximum concentration in the effluent of textile companies that implement dying activities amounts to 610 ng/l and 270 ng/l for textile companies that do not perform dying activities.

Discharge into sewer

Fluorene in concentrations >BMKN (2,000 ng/l) is not found in the effluent of textile companies that discharge into sewer and do not perform dying activities (maximum concentration is 1,560 ng/l). Though this was the case for the effluent of 1 textile company that discharges into sewer and implements dying activities (maximum concentration 6,170 ng/l) (also see Figure 68).



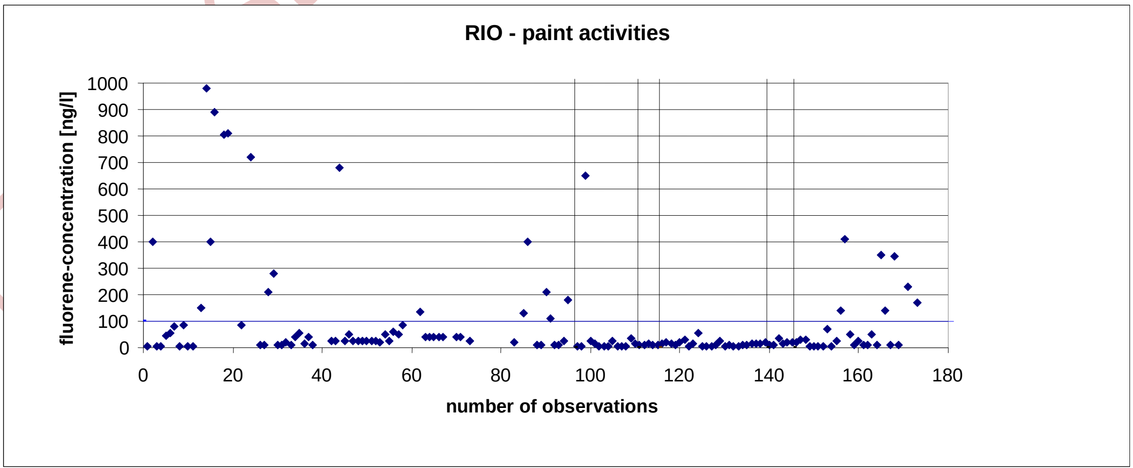


Figure 68: Schematic representation of the measured and available discharge data for fluorene from 6 Flemish textile companies that perform paint activities and discharge

into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

Fluorene concentrations >2,000 ng/l (=BMKN) in the effluent of textile companies that discharge into sewer (with dying activities) are regarded as irregularities possibly caused by abnormal operating conditions.

e.14 Naphthalene

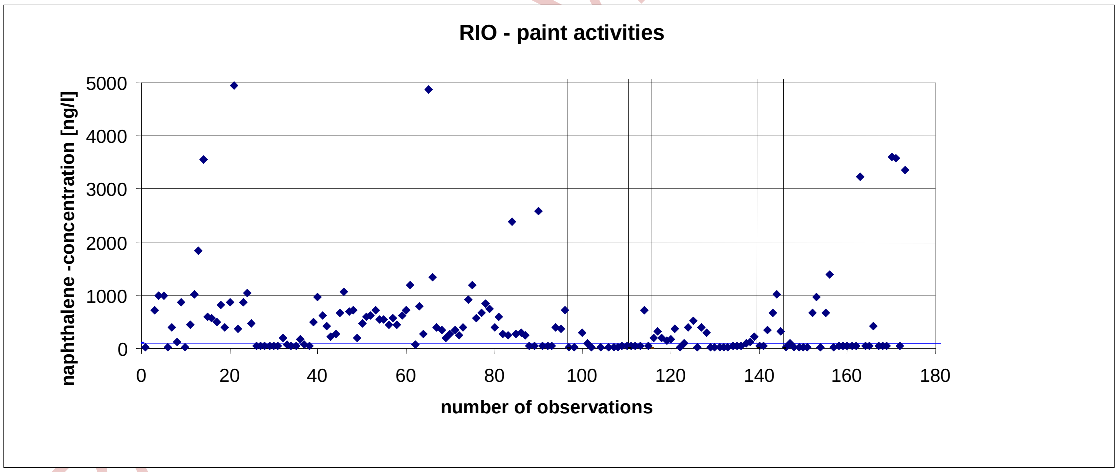
Naphthalene is removed using biological purification.

Discharge into surface water

Naphthalene in concentrations >BMKN (2,400 ng/l) is not found in the effluent of textile companies that discharge into surface water. The maximum concentration in the effluent of textile companies that implement dying activities amounts to 1,300 ng/l and 962 ng/l for textile companies that do not perform dying activities.

Discharge into sewer

Naphthalene in concentrations >BMKN (2,400 ng/l) is not found in the effluent of textile companies that discharge into sewer and do not perform dying activities (maximum concentration is 360 ng/l). Though this was the case for the effluent of 2 textile companies that discharge into sewer and implement dying activities (maximum concentration 4,940 ng/l) (also see).



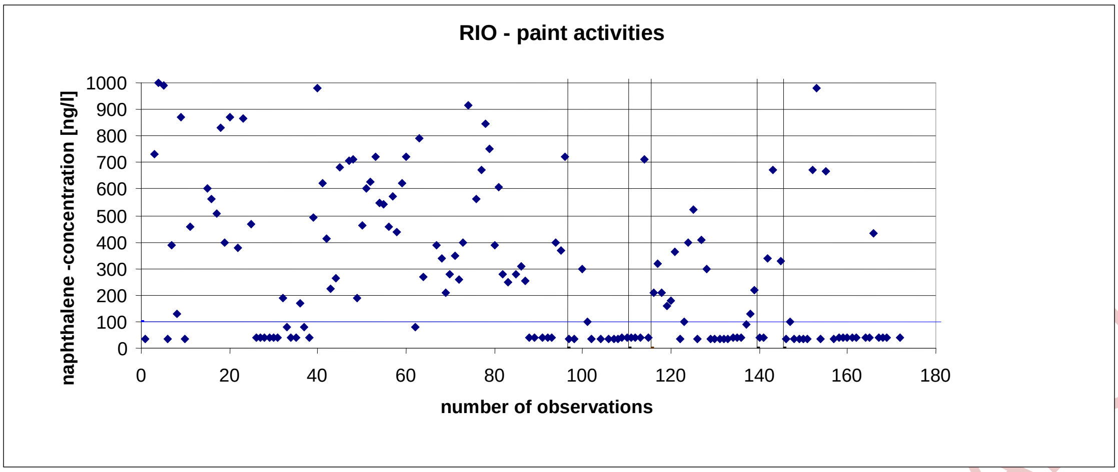


Figure 69: Schematic representation of the measured and available discharge data for naphthalene from 6 Flemish textile companies that perform paint activities and discharge into sewer (2006-2009), with an indicator for the reporting limit (100 ng/l), with variation in scale on the Y axis.

Naphthalene concentrations >2,400 ng/l (=BMKN) in the effluent of textile companies that discharge into sewer (with dying activities) are regarded as irregularities possibly caused by abnormal operating conditions.

Step 5: determination of BAT-AELs.

After analysing the discharge data (step 4), we arrived at various sets of discharge data that form the basis for determining the BAT-AELs for discharging industrial wastewater.

BAT-AELs are generally determined as the (range of) emission levels that are realised under normal operating conditions when BAT are implemented. The lower limit of the BAT-AEL-range is the lowest emission level that is realised under normal operating conditions when BAT are implemented. The upper limit of the BAT-AEL-range is the highest emission level that is realised under normal operating conditions when BAT are implemented. This study only establishes the upper limit.

a. Deca-BDE

Discharge into surface water

All Deca-BDE discharge data >20 µg/l from textile companies that discharge into surface water almost certainly does not comply with the BAT, or can be attributed to historical pollution (after-effects). Historical pollution is not regarded as 'normal operating conditions'.

If the following BAT are implemented:

- Collect exhausted process baths and dispose via a qualified processing company, and
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

the BAT-AEL for Deca-BDE will be <20 µg/l.

Emissions could temporarily be higher in textile companies experiencing problems with historical pollution (Deca-BDE entered the AWZI in the past), despite implementation of the BAT above (e.g. during remediation work in the AWZI). After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for Deca-BDE <20 µg/l.

For textile companies that do not use Deca-BDE, the BAT-AEL is <10µg/l.

Discharge into sewer
As indicated in paragraph 3.2.2.c, 2 of the 9 textile companies that discharge into sewer are known to definitely use Deca-BDE for their finishing activities (situation September 2009).
One of the textile companies collects the exhausted Deca-BDE-based process baths and disposes of them via a qualified processing company. Wherever possible, rinse waters from these process baths are also re-used in the production process or are disposed of via a qualified processing company. However, this company is suffering from historical pollution (not ‘normal operating conditions’).
The other textile company does not dispose of its (rinse waters from) Deca-BDE-based process baths via a qualified processing company, but states that it uses 100% of them in the production process (situation September 2009). However, it cannot be ruled out that small quantities of Deca-BDE (in the form of diffuse powder) will be released in the production process. This could possibly have an influence on the Deca-BDE concentration in the wastewater.

After further refining the discharge data based on this additional information, we are of the opinion that the remaining data is insufficiently representative to extract BAT-AELs for Deca-BDE, for textile companies that discharge into sewer and implement Deca-BDE.

For textile companies that do not use Deca-BDE, the BAT-AEL is <10µg/l.

b. HBCD

Discharge into surface water
All HBCD discharge data >10µg/l in textile companies that discharge into surface water, can be attributed to historical pollution (after-effects). Historical pollution is not regarded as ‘normal operating conditions’.

If the following BAT are implemented:

- Collect exhausted process baths and dispose via a qualified processing company, and
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

the BAT-AEL for HBCD will be <10 µg/l.

Emissions could temporarily be higher in textile companies experiencing problems with historical pollution (HBCD entered the AWZI in the past), despite implementation of the BAT above (e.g. during remediation work in the AWZI). After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for HBCD <10 µg/l.

For textile companies that do not use HBCD, the BAT-AEL is <2µg/l.

Discharge into sewer
All HBCD concentrations measured in the wastewater of two textile companies that discharge into sewer, were less than or equal to 10 µg/l.

If the following BAT are implemented:
- Collect exhausted process baths and dispose via a qualified processing company, and
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

the BAT-AEL for HBCD will be <10 µg/l.

For textile companies that do not use HBCD, the BAT-AEL is <2µg/l.

c. antimony

The BAT-AELs determined for antimony in this study do not apply to textile companies that perform dying activities, because no specific BAT have been determined for the implemented (antimony-based) paints.

Discharge into surface water
Almost all antimony discharge data >1 mg/l, from textile companies that use Sb_2O_3 as a synergist in combination with Deca-BDE and also discharge into surface water, can be attributed to historical pollution (after-effects). Historical pollution is not regarded as ‘normal operating conditions’.

If the following BAT are implemented:
- Collect exhausted process baths and dispose via a qualified processing company, and
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

the BAT-AEL for antimony will be <1 mg/l (only for textile companies that do not perform dying activities).

Emissions could temporarily be higher in textile companies experiencing problems with historical pollution (Sb_2O_3 entered the AWZI in the past), despite implementation of the BAT above (e.g. during remediation work in the AWZI). After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for antimony <10 µg/l (only for textile companies that do not perform paint activities).

Discharge into sewer
Most of the antimony discharge data >1 mg/l, from textile companies that use Sb_2O_3 as a synergist in combination with Deca-BDE and also discharge into sewer, can be attributed to historical pollution (after-effects). Historical pollution is not regarded as ‘normal operating conditions’.

If the following BAT are implemented:
- Collect exhausted process baths and dispose via a qualified processing company
- Dispose of rinse waters from process baths via a qualified processing company, and/or
- Wherever possible, re-use rinse waters from process baths in the production process.

the BAT-AEL for antimony will be <1 mg/l (only for textile companies that do not perform dying activities).

Despite implementing the above mentioned BAT, textile companies experiencing problems with historical pollution could temporarily have higher emissions. After a transition period (=time needed to remediate the AWZI and the accompanying sewer system) it must also be possible for these companies to achieve the BAT-AEL for antimony <10 µg/l (only for textile companies that do not perform paint activities).

d. PFOS and PFOA
BAT associated emission levels have not been established for the parameters PFOS and PFOA. The available measurement data was primarily anonymous and there was no or insufficient background information accompany this measurement data.

e. NP and NPE
BAT associated emission levels for the parameters NP and NPE have not been established due to insufficient measurement data and accompanying background information, and due to insufficient knowledge about process-integrated measures (e.g. no BAT selected for limit NP/NPE is wastewaters from yarns and tissues) and the concentrations they can help to realise.

f. PAH (16 of EPA)
Discharge into surface water
The emission levels for PAH in the wastewater of textiles companies (with and without dying activities) are:
- phenanthrene: <100 ng/l
- pyrene: <100 ng/l
- acenaphthene <100 ng/l
- anthracene <100 ng/l
- benzo(a)anthracene <300 ng/l
- benzo(a)pyrene <100 ng/l
- sum of benzo(b)fluoranthene and benzo(k)fluoranthene <100 ng/l
- sum of benzo(ghi)-perylene and indeno(1,2,3-cd)pyrene <100 ng/l
- dibenzo(a,h)anthracene <100 ng/l
- fluoranthene <100 ng/l

Comments

- Emission levels that are lower than reporting limits, are reported as being < reporting limit.
- For the parameters acenaphtylene, chrysene, fluorene and naphthalene, the concentration in the effluent of textile companies that discharge into surface water will always be lower than the respective BMKN. Thus no emission levels have been determined for these parameters.

Discharge into sewer

The emission levels for PAH in the wastewater of textile companies are:

- phenanthrene: <200 ng/l (with dying activities);
  <100 ng/l (without dying activities);
- pyrene: <300 ng/l (with dying activities);
  <100 ng/l (without dying activities);
- acenaphthene <100 ng/l (with and without dying activities);
- anthracene <400 ng/l (with dying activities);
  <100 ng/l (without dying activities);
- benzo(a)anthracene <300 ng/l (with and without dying activities);
- benzo(a)pyrene <100 ng/l (with and without dying activities);
- sum of benzo(b)fluoranthene and benzo(k)fluoranthene
  <100 ng/l (with and without dying activities);
- sum of benzo(ghi)-perylene and indeno(1,2,3-cd)pyrene
  <100 ng/l (with and without dying activities);
- dibenzo(a,h)anthracene
  <100 ng/l (with and without dying activities);
- fluoranthene <300 ng/l (with dying activities);
  <100 ng/l (without dying activities);
- fluorene <2,000 ng/l (with and without dying activities) (-BMKN);
- naphthalene <2,400 ng/l (with and without dying activities) (-BMKN);

comment

- Emission levels that are lower than reporting limits, are reported as being < reporting limit.
- For the parameters acenaphtylene and chrysene, the concentration in the effluent of textile companies that discharge into sewer will always be lower than the respective BMKN. Thus no emission levels have been determined for these parameters.

APPENDIX 4: FINAL COMMENTS

This report is consistent with what the BAT centre at VITO currently regards as BAT and accompanying recommendations. The conclusions of the BAT study are partly based on discussions within the steering committee, but are not binding for members of the steering committee.

This appendix contains the comments or differing viewpoints that members of the management committee and the steering committee formulated about the proposed end report on behalf of their respective organisations. In accordance with procedures within VITO's BAT centre concerning the execution of BAT studies, these comments or differing viewpoints are no longer incorporated into the text (unless they are minor text corrections), but are included in this appendix. A reference to this appendix has been placed in the footnotes of the concerned chapters.

No comments were received concerning the proposed end report for the BAT study for the textile industry – reducing emissions of brominated flame retardants (BFR), antimony trioxide (Sb2O3), perfluorinated tensides (PFT), nonylphenols (NP), nonylphenol ethoxylates (NPE) and polycyclic aromatic hydrocarbons (PAH)