ABSTRACT

The Centre for Best Available Techniques (BAT) is founded by the Flemish Government, and is hosted by VITO. The BAT knowledge 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 identifies the BAT for the treatment of PFAS-containing industrial wastewater and drainage water. This is a new study in the series of BAT studies that the BAT knowledge centre of VITO draws up and publishes via the EMIS website.

The selection of BAT and policy recommendations were established based on a comparison with foreign regulations, company visits, information from scientific literature, reports, information provided by the members of the technical working group, and information from one-on-one conversation with experts that were available at the time of writing (information has been updated to 06/07/2023). Therefore, it is important to read the BAT-study as a snapshot of the information available at the time of publication. At the time of publication, there are still various knowledge gaps in the treatment of PFAS-contaminated industrial wastewater and drainage water due to limited availability of information and data in Flanders, which means that various questions cannot be answered concretely at this point. For instance, general achievable final concentrations per water treatment technology could not be determined at the time of writing. Moreover, these technologies are evolving very rapidly, and new information is becoming available at a fast pace, which could not be incorporated into this BAT-study. At the time of writing, several projects, studies, and initiatives had already been initiated or were in preparation for further research into available and innovative PFAS water treatment technologies that will eventually provide valuable information. This information can be incorporated into a revision of this BAT study. A revision will be able to further update the information on water treatment technologies, potentially specify the formulated BAT, and provide additional recommendations.

In addition of reviewing the main sectors and activities which can cause PFAS emissions to water, the main goal of this study is to identify and assess the techniques that are currently applied or under research for the treatment of PFAS-containing industrial wastewaters and drainage waters in Flanders or abroad. In this assessment, the relevant techniques are evaluated and compared based on several criteria, specifically taking into account the applicability for industrial wastewater/drainage water, short vs. long-chain PFAS, the matrix and other relevant contextual information. Generally, water treatment techniques for the removal of PFAS can be subdivided into two main groups: separation/concentration techniques and destruction techniques. Currently, the separation/concentration techniques are most widely applied for the treatment of PFAS-containing industrial wastewaters and drainage waters in Flanders. More specifically, granular activated carbon, ion exchange resins and membrane-based techniques are currently applied to a certain level on a commercial scale. Within the group of destruction techniques, which can destruct/mineralize PFAS, only the direct incineration of industrial wastewater is currently applied on a commercial scale. Nevertheless, there are additional techniques with application potential in Flanders, while other techniques are still emerging and require additional research.

While drafting this BAT-study the reporting limit for industrial wastewater decreased from 100 ng/l to 20 ng/l for quantitative PFAS and 50 ng/l for PFAS that can be measured indicatively (came into effect 10 days after publication of the Ministerial Decree on 09/03/2023). The information collected for the description of techniques in this study originated mainly from techniques that are primarily designed to achieve the old reporting limit of 100 ng/l. Nevertheless, a limited number of cases could show the removal of all detectable PFAS below 20 ng/l. Mainly with short-chain PFAS, PFBA in particular, difficulties are encountered in removing them below this threshold. For long-chain PFAS, there have already been several cases where they could be removed to below 20 ng/l. However, this remains difficult to achieve at very high influent concentrations and/or complex matrices.

Five environmentally friendly techniques were retained as BAT in this study. Two of the techniques were identified as a case-by-case BAT, provided the applicable preconditions are met. The technique specifically for drainage water was assessed by taking into account the drainage flow and duration for which three categories were defined. The approach proposed in this BAT study is based on the principle that PFAS should be removed from industrial wastewater and drainage water from long drainages or drainages with high flows, and short drainages with low flows for which the preconditions are met through the application of one or a combination of techniques. In this BAT study, it was determined that each situation requires a specific approach for the selection and optimization of the most suitable technique or combination of techniques for the purification of industrial wastewater and drainage water contaminated with PFAS. Furthermore, the choice of techniques will depend in most cases on the characterization of the industrial wastewater/drainage water that needs to be treated. Depending on the situation, this can be supplemented with exploratory lab and/or pilot tests taking into account the PFAS type, influent concentrations, the matrix and the desired effluent concentrations to assess the applicability and feasibility for each specific situation. When applying the water treatment techniques, it is imperative to monitor and follow up on the techniques, to apply pretreatment techniques in certain situations to protect their efficiency and their operation, and to optimize the design and management of this technique(s) specifically for the removal of PFAS

In addition, this study formulates recommendations for additional definitions in VLAREM and lists points of attention in the context of individual environmental permits. Furthermore, recommendations for Ecology Premium plus, further research and technological development are formulated within this study.

Formal discussions were conducted within a technical working group. The selection of BAT in this study was carried out in close consultation with the industry, consulting firms, representatives from various sectors, and specialists from the government agencies. This study was also reviewed critically by 17 external lectors.