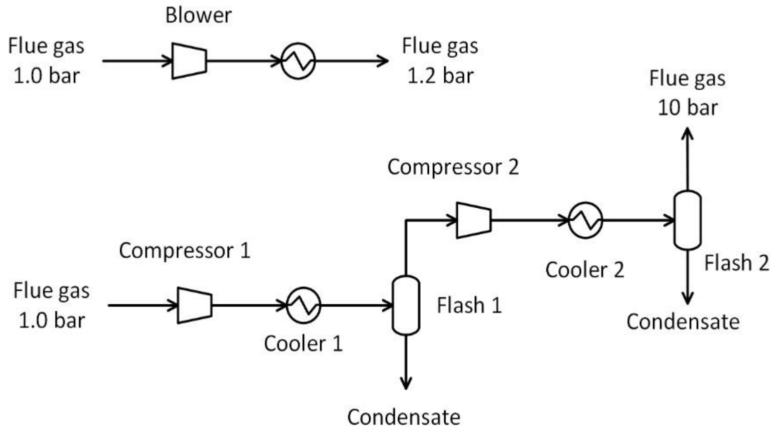
FLUE GAS PRESSURISATION

map-it CCU

Flue gas pressurization involves increasing the pressure of flue gases using blowers or compressors to facilitate efficient carbon capture. This process is essential for enhancing the performance of various carbon capture technologies by ensuring optimal gas flow and pressure conditions. The schematic shows increasing the pressure of the flue gas, which is at atmospheric pressure, to 1.2 bar using a blower. This is done to overcome the pressure drop in the downstream equipment. The schematic also shows a two-stage compression system where the flue gas is pressurized to a final pressure of 10 bars. In this case, the flue gas undergoes a series of compression, cooling, and separation stages.



Flue gas pressurization

REMOVED COMPONENTS

- Water is removed as condensate after every compression and subsequent cooling stage.

FUNCTION IN CCU VALUE CHAIN

Flue gas pressurization ensures that the gas stream is at the required pressure for effective CO_2 capture. Without proper pressurization, the efficiency of capture technologies such as absorption (hot potassium carbonate), adsorption (pressure swing adsorption), and membrane separation would be significantly reduced, leading to lower CO_2 capture rates and higher operational costs.

LIMITATIONS

- High energy consumption for compression to high pressures.
- Potential for increased wear and maintenance of equipment.
- Efficiency is dependent on gas composition and temperature.

ENERGY

Electricity is primarily used to power the blowers or compressors. The energy requirement varies based on the volume and pressure of the flue gas.

CONSUMABLES

- Cooling water is used to cool the flue gas after each compression stage. It is generally recycled and not consumed.
- No significant consumables are required for the pressurization process itself, apart from regular maintenance materials for the equipment.

Energy and consumables

Parameter	Value
Electricity (kWh/m^3 flue gas)	Equation[1]
Cooling water (ton/ton flue gas)	-NA-

$$P_B = \frac{\gamma}{\gamma - 1} \frac{Q_1 \cdot P_1}{\eta_B} \left[\left(\frac{P_2}{P_1} \right)^{\frac{(\gamma-1)}{\gamma}} - 1 \right]$$

$$P_C = \frac{P_B}{\eta_M}$$

P_B – brake power, Q_1 – volumetric flowrate, P_1 – inlet pressure, P_2 – outlet pressure, η_B – isentropic efficiency, γ – specific heat ratio, ideal gas assumption, P_C – consumed power, η_M – motor efficiency.

COSTS

The cost of flue gas pressurization varies based on the type of equipment (blower or compressor), the required pressure, and the volume of gas. Typical CAPEX calculation for blower and compressor can be calculated using the equations below.[1] The OPEX is estimated by calculating the electricity requirement.

Equipment purchase cost (EPC) of blower:

$$EPC = F_M \cdot C_B$$

F_M is the factor for materials, considered 1 for carbon steel.

$$C_B = exp\left[a + b \cdot ln(P_C) + c \cdot \left(ln(P_C)\right)^2\right]$$

- *for centrifugal (turbo) blower (valid from P_C 5 to 1000 HP): a=6.8929, b=0.79, c=0*
- *for rotary straight-lobe blower (valid from P_C 1 to 1000 HP): a=7.59176, b=0.79320, and c=-0.012900*

Equipment purchase cost (EPC) compressor:

$$EPC = F_D \cdot F_M \cdot C_B$$

F_D is the factor for drives, considered 1 for electric drives. F_M and C_B are the factors for materials and the expression of the base cost, the same as for blowers.

- *for centrifugal compressors (valid from P_C 200 to 30000 Hp): a=7.5800, b=0.8, c=0*
- *for reciprocating compressors (valid from P_C 100 to 20000 Hp): a=7.9661, b=0.8, c=0*
- *for screw compressors (valid from P_C 10 to 750 Hp): a=8.1238, b=0.7243, c=0*

TECHNOLOGY PROVIDERS

- Gas compressors and blowers by **Ingersoll Rand**, United States.
- Gas compressors and blowers by **Elmo Rietschle**, Germany.
- Gas compressors and blowers by **Atlas Copco**, Sweden.

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ACKNOWLEDGEMENT

This infosheet was prepared as part of the MAP-IT CCU project funded by VLAIO (grant no. HBC.2023.0544).

REFERENCES

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