

# CO<sub>2</sub> capture process

The M<sup>2</sup>ARE project is developing a **low-cost, low-carbon methanol** fuel for the shipping industry, synthesized from **biogenic CO<sub>2</sub>** and **renewable H<sub>2</sub>**. This fuel is essential for achieving a reduction in maritime CO<sub>2</sub> emissions. A foundational step in scaling this technology is securing a reliable, sustainable carbon feedstock.

## Monoethanolamine (MEA) – based capture process



Fig. 1. Monoethanolamine (MEA) chemical structure

Following the **pre-capture conditioning** process, CO<sub>2</sub> is prepared for **final capture** and subsequent **storage** or direct feeding into the **Bio-CO<sub>2</sub> stream**. The capture sequence begins inside the absorber, where the gas undergoes cooling and compression. Concurrently, **amine is introduced** from the top of the unit to establish counter-current contact with the flue gas flowing from the opposite direction. This interaction produces a reaction at the **MEA gas-liquid interface**, forming a soluble intermediate.

The flue gas carrying the MEA-CO<sub>2</sub> intermediate continues through the absorber and exits from the top. At this stage, **washing water** is introduced to capture MEA along with all degradation products. Finally, this water is reintroduced into the absorption unit to minimize process losses.



At this stage, the CO<sub>2</sub>-rich solvent is **collected** and **pumped** to the desorber. This passage is crucial, since all the CO<sub>2</sub> is released and recovered from the solution, preceded by an increase in temperature to facilitate the process.

### What a desorber is?

The desorber is typically a **packed column** equipped with a partial condenser at the top and a reboiler at the bottom.

## Why temperature is important?

### Breaking the Chemical Bond (Reaction Heat)

Energy is needed to **detach the CO<sub>2</sub> molecules from the solvent**. The amount of heat required depends on the specific solvent used and how much CO<sub>2</sub> remains in the liquid after processing.

### Generating Vapor (Stripping Heat)

Heat is used to **boil part of the liquid** and create **steam**, which helps carry the CO<sub>2</sub> gas out of the system. This relies on how easily water and CO<sub>2</sub> evaporate from the mixture.

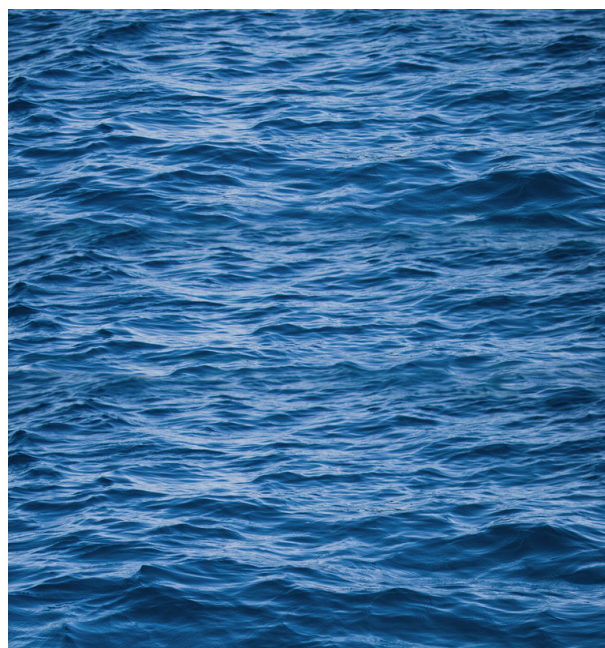
### Warming the Liquid (Sensible Heat)

Energy is required to **heat the entire liquid solvent** up to the high operating temperature of the reboiler. This depends directly on the total volume of liquid being pumped through the system.

## Optimizing System Pressure and Temperature

To lower the energy required to release captured CO<sub>2</sub>, the desorption column typically operates at **pressures slightly above atmospheric levels**, usually around 2 bar. Raising the operating pressure increases the internal temperature, which **speeds up CO<sub>2</sub> release** and reduces overall heating demand. Higher pressures also make it easier to generate the steam needed for the process and provide a helpful pressure boost for the downstream compression required to transport or store the captured gas.

However, operating at pressures and temperatures that are too high can cause the MEA solvent to break down permanently into unusable by-products. This degradation reduces the system's capture efficiency, increases chemical losses, and leads to a higher environmental impact. Research shows that MEA begins to degrade at around 110 °C, with the process accelerating rapidly at temperatures above 125 °C.



### Read our previous factsheets

1. [The Biogenic Solution for Maritime Decarbonization](#)
2. [Mapping and categorization of different bio-CO<sub>2</sub> sectors](#)
3. [In depth analysis of CO<sub>2</sub> pre-capture stream conditioning](#)



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