Onboard Carbon Capture

Ecospray is continuously working on **decarbonization** with **three carbon capture technologies tailored to maritime applications**:

- **Amine-based chemical absorption**
- **Calcium Hydroxide-based absorption**
- **Molten Carbonate Fuel Cells (MCFC)**

Two systems–Amine and Calcium Hydroxide–are already developed and tested specifically for onboard integration. The MCFC solution is under development within CapLab, Ecospray's joint R&D lab with the University of Genoa. Our diversified approach allows customization based on vessel type, size, route, and space availability–supporting shipowners in meeting decarbonization targets with optimal efficiency.

Scrubbing with Amine

The post-combustion CO_2 capture technology **based on chemical absorption with amines** is considered one of the most effective and mature solutions, especially for marine applications. The main goal is to reduce the system's size and complexity while **optimizing energy consumption by using the thermal energy already available on board**. The process involves absorbing CO_2 from exhaust gases using an amine solution, which is then regenerated through the combined action of heat and vacuum to be reused. The released CO_2 is liquefied and temporarily stored in cryogenic tanks on board for later discharge at port. The main operational cost lies in the thermal regeneration of the amine solution. Ecospray addresses this with a low pressure and low temperature regeneration.
This approach saves energy, as the heat can be recovered from the engine's cooling system without burning additional fuel.
Extended tests at pilot scale in combination with process modelling has allowed Ecospray to reduce the space requirements of the system and optimize the thermal requirements, thus allowing for increased carbon capture capacity.

Onboard Carbon Capture System

Effective power	NET capture rate	NET CO_2 reduced	Liquefied CO_2	Absorption tower Ø	Absorption tower height	Stripping tower Ø	Stripping tower height	El. Power consumption
MW	*%*	*ton/h*	*ton/h*	*m*	*m*	*m*	*m*	*kWe*
6	**>25**	1,15	1,55	2,1	11	1,1	11	720
9	**>25**	1,65	2,20	2,4	11	1,4	11	1.000
12	**>25**	2,10	2,85	2,8	11	1,6	11	1.267
16	**>25**	2,75	3,70	3,0	11	1,8	11	1.670
20	**>25**	3,40	4,55	3,3	11	2,0	11	2.040

Data are referred to HFO fueled engines with DeSOx EGCS

Calcium Hydroxide

An alternative **CO_2 capture method uses lime milk** (a suspension of calcium hydroxide) **to chemically bind CO_2 as solid calcium carbonate**. Exhaust gases flow counter-current to the lime milk in the scrubber, with an additional bubbling vessel enhancing CO_2 absorption.
This eco-friendly process produces a solid by product and eliminates the need for onboard CO_2 storage. It is particularly attractive for bulk carriers due to favorable capital and operational costs and compatibility with bulk chemical storage.

Molten Carbonate Fuel Cells

MCFCs offer simultaneous **high-efficiency power generation and CO_2 capture in a single unit**, with low maintenance due to the absence of moving parts. They can integrate with other environmental systems like DeSOx, particle filters, and oxidation catalysts. Powered by fuels such as LNG, bio-LNG, hydrogen, ammonia, or syngas, MCFCs can capture up to 90% of CO_2 from exhaust gases, which is then easily separated and liquefied. Their compact design, fuel flexibility, and effectiveness even at low CO_2 concentrations make them ideal for all ship types, especially when combined with biofuels.

CapLab
ELECTROCHEMICAL CELLS

CapLab is a joint initiative by Ecospray and the University of Genoa, driving the development of decarbonization technologies through a strong industry-academia partnership.
Focused on **Molten Carbonate Fuel Cells (MCFCs),** CapLab advances both research and training in numerical modeling and experimental development. The goal: scale lab innovations into sustainable industrial solutions.