H2MINES | USAGES

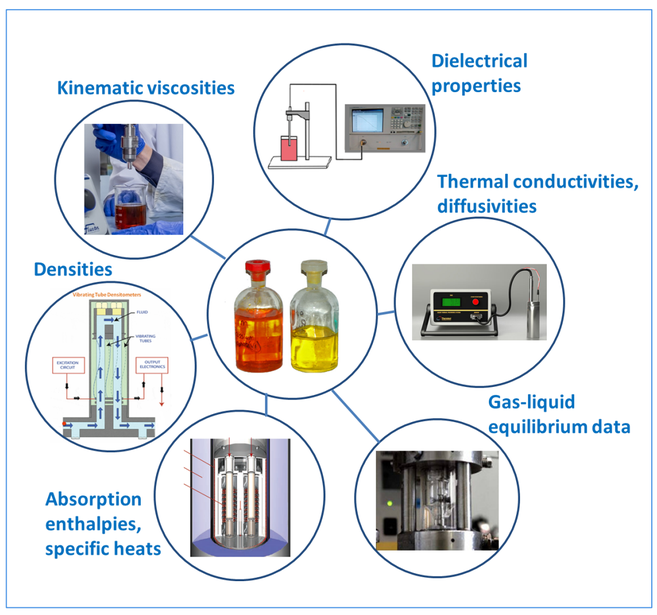
Intensification of amine-based CO_2 capture process in perspective of integration in a power to gas unit

Research aim

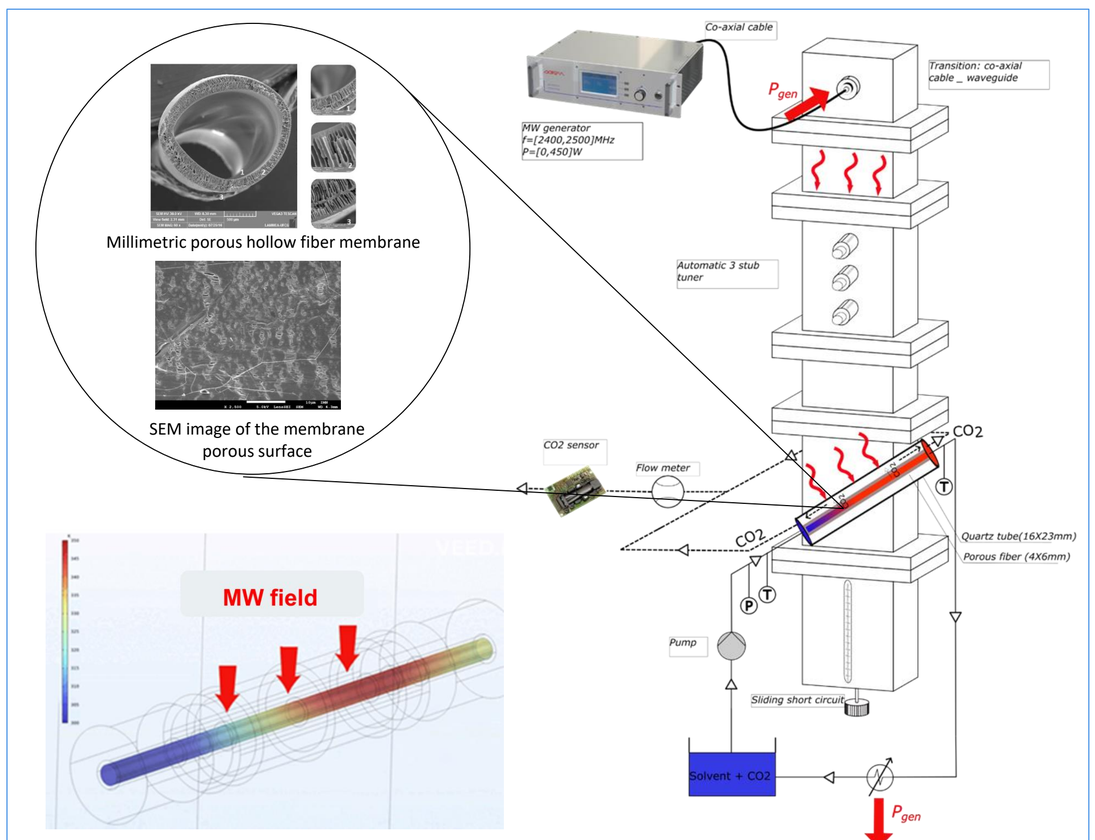
The WAVEINCORE project aims to develop new desorption technologies for the thermal regeneration of CO_2-enriched solvents, now considered as reference or promising for CO_2 capture. These technologies are based on the concept of regeneration of spent solvents by microwave irradiation (MW). The MW desorption technologies to be developed have the potential to drastically reduce energy consumption and solvent losses by working at temperatures below 100°C, with the possible use of renewable electricity. The drastic reduction in water requirements to operate the CO_2 desorption process, as well as the reduction in the size of the contactors should bring significant additional benefits.

Objectives & methodologies

(1) Generation of property data for a selected panel of gas-loaded solvent systems



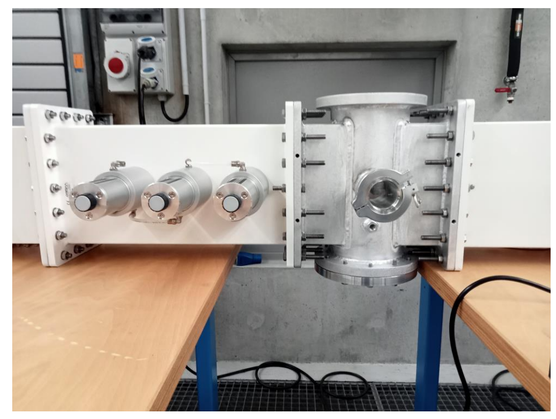
(2) Local scale kinetic studies : transfer-reaction phenomena troughout the porous membrane of a single hollow fiber (HF) exposed to monomode MW irradiation



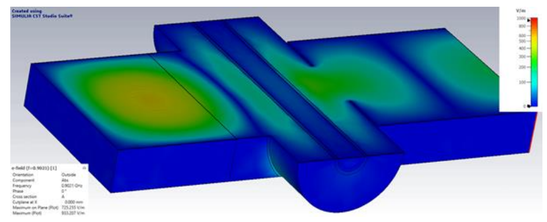
Simulated temperature profile of the flowing solvent under MW field at the scale of hollow fiber with a porous membrane.

MW assisted regeneration of CO2 rich solvents at the scale of a single hollow fiber

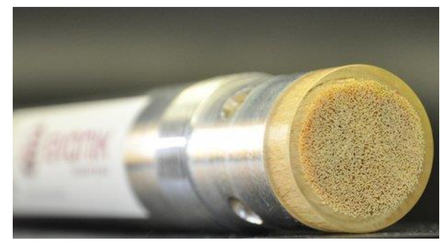
(3) Design of lab-scale prototypes- investigation of CO_2 desorption performances using HF membrane modules placed in a multimode MW cavity



Experimental MW equipment : solid state generator (multimode, 915 MHz) coupled with a cavity able to host membrane contactors of different sizes



Mapping of the simulated electromagnetic field in the cavity



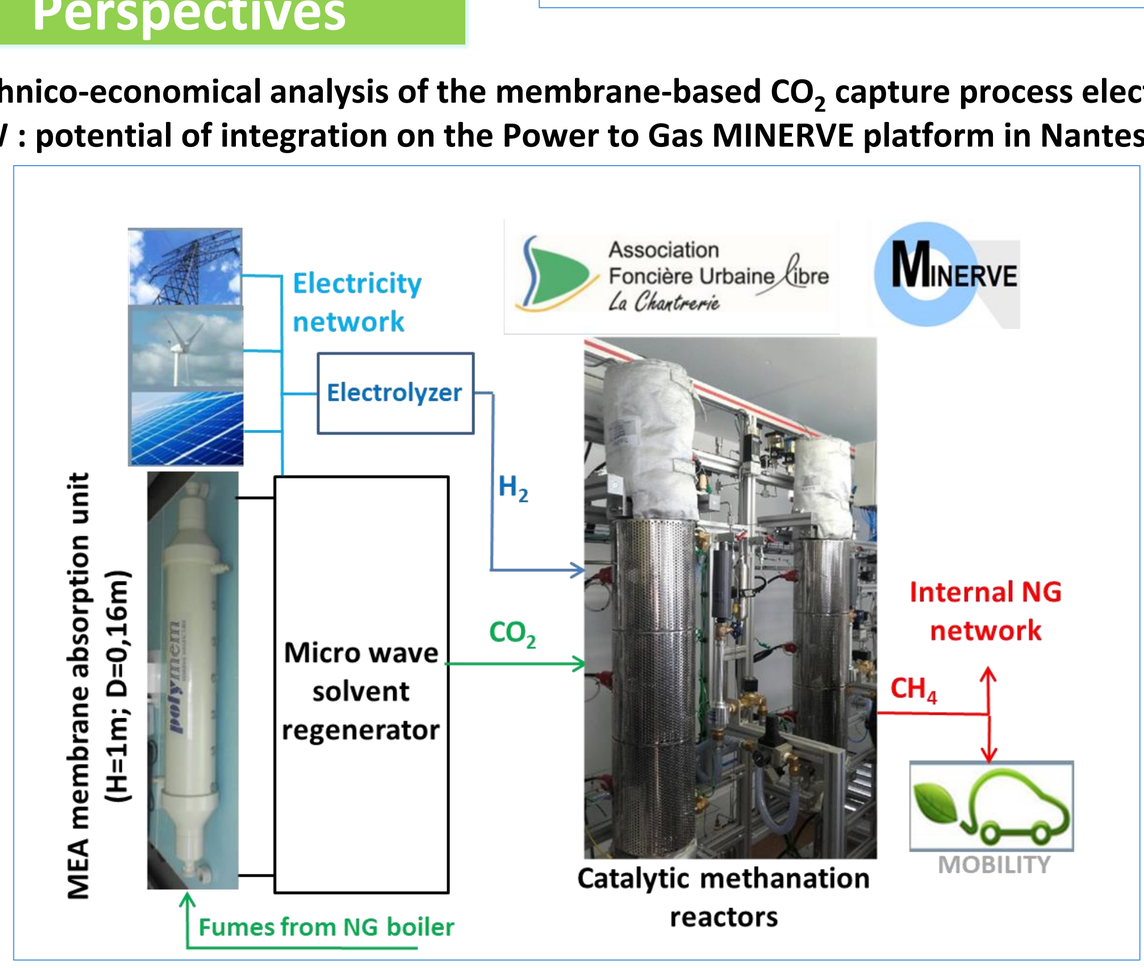
Tested hollow fiber membrane contactor: 40% porosity, surface area 0,7m²

Results

- Variations of the di-electrical properties of amine-based solvents with CO_2 loading were measured in the temperature range [20-80°C]
- Density, viscosity and speed of sound of 4 amine-based solvents were measured in the temperature range [15-70°C]
- Heat of absorption and solubility of CO_2 in 4 amine-based solvents were measured in the range [50-120°C] and in the pressure range [0.5-4 MPa].
- CO_2 desorption rates throughout a single HF membrane were measured as function of the solvent CO_2 loading, liquid flow velocity and MW power with minimal reflection.
- A 1D simulation model coupling propagation of electromagnetic fields with solvent flow hydrodynamics, heat and mass transfers and chemical desorption was developed.
- An experimental set-up was constructed to carry out CO_2 desorption tests by MW irradiation using in-house adapted gas-liquid contactors operating either in steady state or transient regime.
- Experimental validation of the developed simulation model is being achieved.

Perspectives

Technico-economical analysis of the membrane-based CO_2 capture process electrified with MW : potential of integration on the Power to Gas MINERVE platform in Nantes.



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