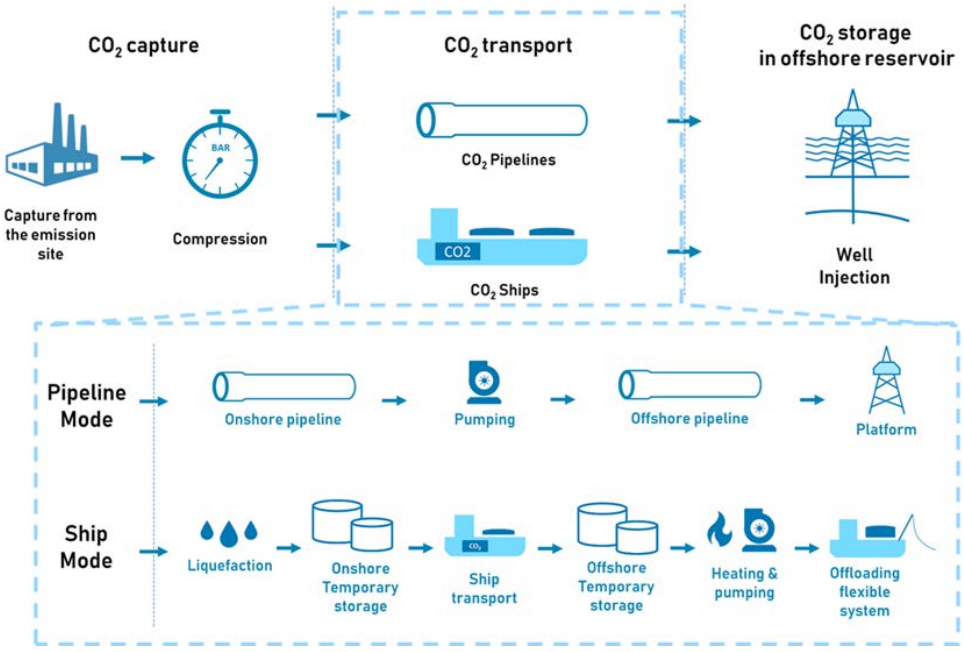
Project Newsletter #1

Safe and reliable CO_2 transport solutions are essential to achieve full-scale carbon capture and storage (CCS) deployment. However, knowledge gaps exist about the effect of dense phase CO_2 on the non-metallic materials which may be used in CO_2 transport infrastructure; the CO_2 EPOC project focuses on analysing the compatibility between polymeric materials and dense phase CO_2 to close some of these knowledge gaps.



CO_2 EPOC focusses on the polymer materials used in the transport of CO_2 from capture to storage.

A wide range of polymers are used in the CO_2 transport network, including elastomeric seals and thermoplastic pipe liners. CO_2 is a good solvent for many polymers, and therefore the compatibility of polymers used in CO_2 transport must be carefully assessed.

The work performed in the first phase of the CO_2 EPOC project has focussed on mapping which polymers are particularly relevant for use in CO_2 transport, starting with those that are currently used in the transport of oil and gas products, and expanding to other polymers which may have potential for use with CO_2.

A wide range of both commercially available and experimentally produced elastomers have been received and characterised to build up a basis for compatibility studies with CO_2, such as nitrile rubber (HNBR), EPDM, fluorinated rubbers and, butyl and natural rubbers. A selection of thermoplastics is also being investigated for use for example as pipe liners and in valve seats, such as polyethylene, PEEK and various fluorinated thermoplastics (PTFE, PVDF etc).

Figure 1. The compatibility of a range of elastomer and thermoplastic materials are being analysed in the CO_2 EPOC project

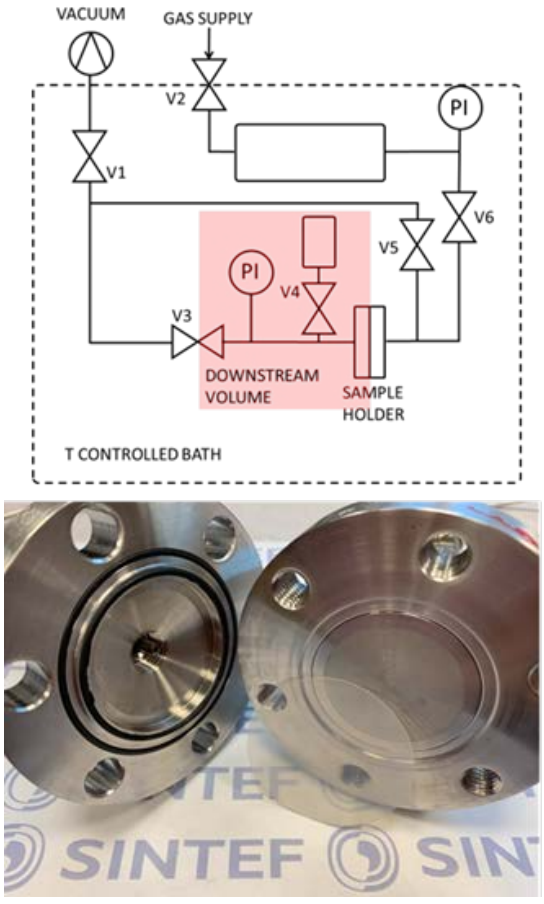


Figure 2. Gas permeation equipment to measure the CO_2 transport properties up to 25 bars, in the temperature range of 5 to 70 °C.

Measurement of CO_2 permeation through polymers

Equipment is used to measure gas permeation through polymers at constant volume and variable pressure (ASTM D1434-82, manometric, procedure M) – Figure 2. The initial characterization of CO_2 transport properties of selected polymers focused on performing gas permeation tests under standard conditions (3 pressures: 5, 15 and 25 bar, 3 temperatures: 5, 25 and 45°C), aiming at creating a database where different polymer families and different grades within these families could be easily compared. The purpose of this exercise was to bridge the current literature gap related performance evaluation under similar conditions. The tests were performed using a constant volume, variable pressure setup, that allows the measurement of permeability and diffusivity coefficients. The solubility coefficient can then be calculated through the solution diffusion mechanism.

During the first phase of the project, an advanced permeation setup was also built – Figure 3. This system is based on a constant pressure method, where a GC is used to determine the amount of CO_2 permeated through the sample. Argon is used as a sweep gas to collect the permeated gas. The sample holder is placed inside a thermostatic bath which can span a wide range of temperature, relevant for the both the pipeline and ship CO_2 transport scenarios. Tests will focus first on the ship transport scenario (cryo-compressed conditions) for thermoplastic materials.

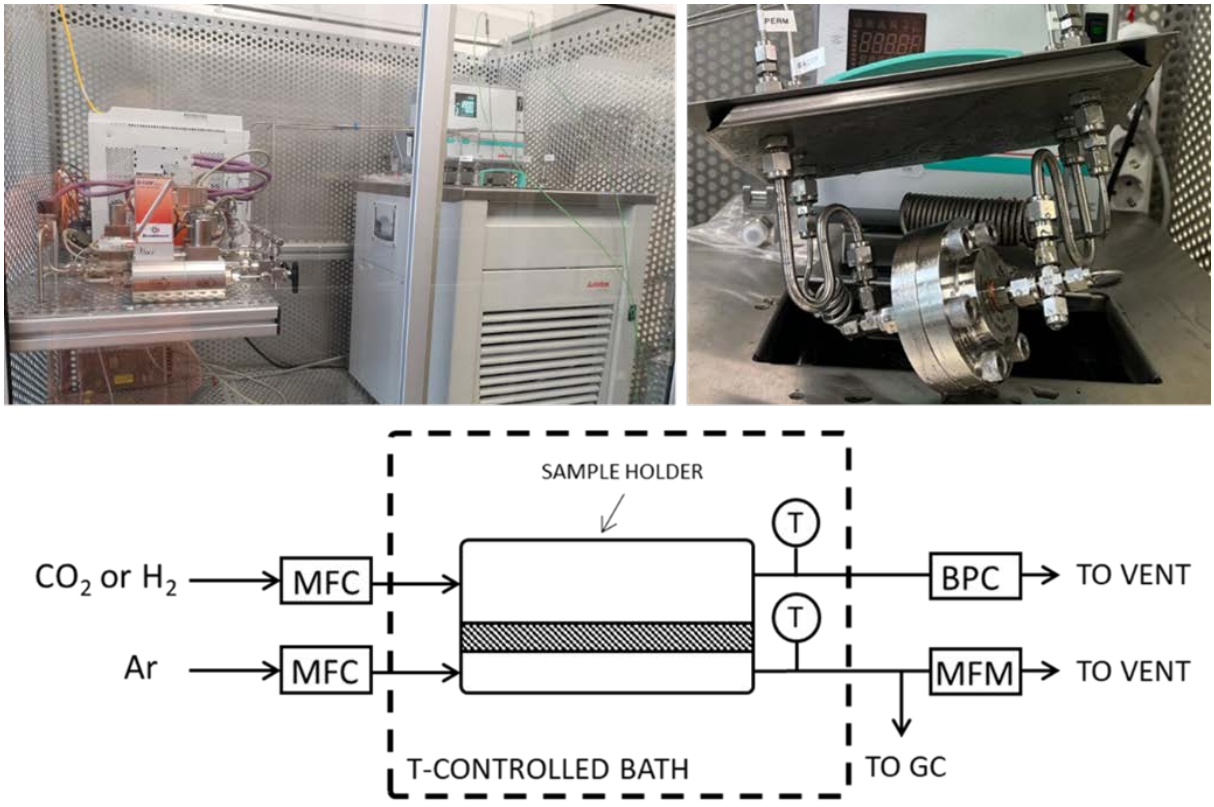


Figure 3. Gas permeation equipment (constant pressure method, analogue to ASTM D3985 – 17) to measure the CO_2 transport properties in extreme conditions (pressure: up to 200 bar, temperature: -50 to 200 °C).

New partner in CO_2 EPOC: Shell

In 2022, Shell joined the CO_2 EPOC project, together with our other industrial and academic partners.

Dissemination activities:

The CO_2 EPOC project has disseminated results the following events:

- CLIMIT SUMMIT 2023 – BEYOND LONGSHIP, which took place in Larvik (Norway) on the 7-9 February 2023. "CO2 EPOC: The effect of CO_2 on polymer materials used in the CO2 transport network"
- International Rubber Conference 2022, Bangalore (India) in November 2022. "Polymer materials for CO_2 transport applications"
- Euromembrane 2022, Sorrento (Italy) in November 2022. "CO_2 sorption and diffusion in fluorinated polymers for carbon capture and transport application".
- GHGT-15, which took place both in person (Abu-Dhabi) and online from 15-18 March 2021. "CO_2 EPOC project: effect of CO_2 on the polymeric materials present within the CO_2 transport chain". An extended abstract was also published in relationship to the conference: Ansaloni, L., Peters, T.A., Alcock, B., *CO_2 EPOC project: effect of CO_2 on the polymeric materials within the CO_2 transport chain*, SSRN Journal (2021) id=3816726.
- The 12th Trondheim Conference on CO_2 Capture, Transport and Storage (TCCS-12), June 19 - 21, 2023
- Journal paper: "*Characterization and modelling of CO_2 and H2 transport in fluorinated polymers potentially present in the CO_2 and H2 transport chain*" doi.org/10.1021/acsapm.3c02056

Relevant links:

- Project website
- Funding program
- Project Bank of Research Council of Norway

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