



Thesis proposal for a Doctoral position 2022-2025
Study of membrane separation for the recovery of solutes solubilized in supercritical CO₂

Laboratoire de Génie Chimique, UMR CNRS 5503

University of Toulouse, France

Research project description

Due to the need of sustainable processes development, the list of authorized solvents is being reduced from year to year. Among the alternative solvents for low hydrophilic substrates, pure supercritical CO₂ or its mixtures with a low proportion of ethanol appears to be an attractive candidate. One of the advantages of processes that use this solvent lies in the easy regeneration of CO₂ thanks to a decompression step, allowing CO₂ to return to its gaseous state, restoring a "clean" solute. However, this attractive simplicity induces a high-energy consumption of the process which essentially corresponds to the work of re-compression of CO₂ for its recycling after the solute recovery.

The french ANR MemScCO₂ research project (2019-2023) recently allowed to experimentally demonstrate the feasibility of implementing a membrane separation step to recover vegetable oil extracted by supercritical CO₂, while significantly reducing energy consumption (>80%) of the process. Membrane separation has been carried out using dense membranes based on cross-linked silicone or polyamide polymer. An original experimental set-up was built as part of this project that can be used to test any type of polymer membrane to assess its permeability, selectivity and stability, up to pressures of the order of 250 bar.

In the context of this PhD thesis, it is proposed to extend the process to a wider range of CO₂ + solute mixtures, exhibiting a large range of properties in terms of solubility in CO₂, volatility and hydrophobicity, which have influence on CO₂/solute/membrane interactions. The scientific purpose is to better understand the physical phenomena that govern the process. Full advantage of the experimental set-up and know-how acquired during the ANR project will be taken during the thesis. A methodology should be established in order to apply this kind of low energy solvent recycling loop on existing or new processes.

To achieve these objectives, the thesis work will focus on two complementary axes:

- Implementation of experiments after selection of CO₂ + solute(s) systems of interest,
- Modeling of the transport of the solvent and the solute(s) through the membrane.

Supervising research teams of the LGC will provide the PhD student with the necessary equipments and resources necessary for the successful completion of the project.

We are looking for a PhD student interested in both membrane and supercritical processes. A young high-level researcher capable of implementing concepts related to process engineering, materials, in particular polymeric materials, and thermodynamics is expected to be found for this multidisciplinary topic. Human personal qualities, dynamism and autonomy associated with a curious and thoughtful mind are also required.

Contact of PhD Supervisors :

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