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Solvent assessment in vortex technology-based carbon capture

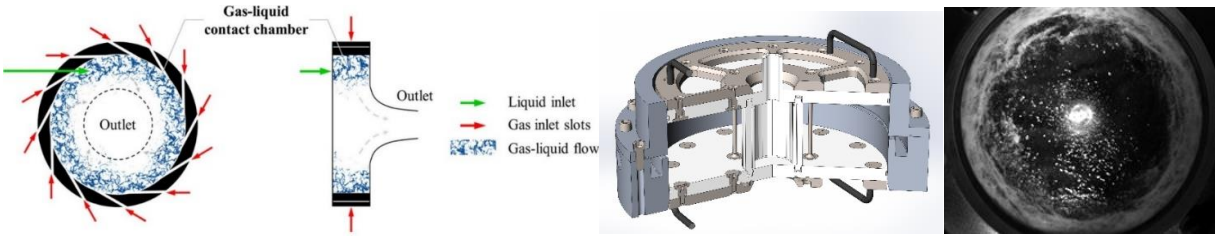
Aim

The objective of this work is to evaluate the CO_2 absorption performance of the gas-liquid vortex reactor (GLVR) for carbon capture (CC) application by assessing various types of liquid solvents.

Justification

Despite all recent efforts to mitigate climate change, in 2021 the largest annual increase in emissions related to energy ever was recorded [1]. While various emerging technologies strive for zero emissions, this transition will take time, especially for sectors facing significant challenges in decarbonizing. Therefore, it is imperative to develop technologies that can efficiently **capture CO_2 either from the air or from point source gases**. Among different CC technologies, chemical absorption is the most commonly used on an industrial scale. However, substantial barriers are associated with the high capital expenditure (CAPEX) linked to large columns used and high operational expenditure (OPEX) due to the **elevated energy required for solvent regeneration**. The choice of solvent directly affects the OPEX of the process, and while amines are prevalent, novel solvents or blends are constantly being developed. The need to overcome these barriers led to the conception of this project which is based on the Gas Liquid Vortex Reactor (GLVR) technology.

GLVR is an **intensified reactor** developed at the LCT (UGent), designed for gas-liquid applications. It consists of a static fluidization chamber in which the gas is injected tangentially through multiple inlet slots inducing the rotation and therefore the heat and mass transfer between the gas and liquid phase. Previous studies have already been confirmed the potential of GLVR for process intensification due to its favorable gas-liquid hydrodynamics and micromixing efficiency [2]. The potential of processing large gas flow rates in a relatively small reactor volume can lead to a reduced CAPEX. On top of this, a variety of solvents (or mixture of solvents) can be used in the vortex reactor, which can be further associated with the energy requirements in the regeneration section. Thus, this work involves a detailed study of different solvents under various operating conditions, enhancing the absorption performance of the vortex reactor while aiming at **reducing the CAPEX and OPEX of the carbon capture process**.



Program

- Literature study on the CCU technologies emphasizing on (novel) solvents for process intensification.
- Evaluate and screen solvent based on the literature review.
- Perform the absorption experiments on the GLVR based on the solvents screened and compare their performance.
- Develop a validated 1D model of GLVR and embed it in a process simulation in Aspen Plus.

[1] IEA, World energy outlook 2022, IEA Paris, France, 2022.
[2] Y. Ouyang, M.N. Manzano, R. Wetzels, S. Chen, X. Lang, G.J. Heynderickx, K.M. Van Geem, Liquid hydrodynamics in a gas-liquid vortex reactor, Chemical Engineering Science 246 (2021) 116970.

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