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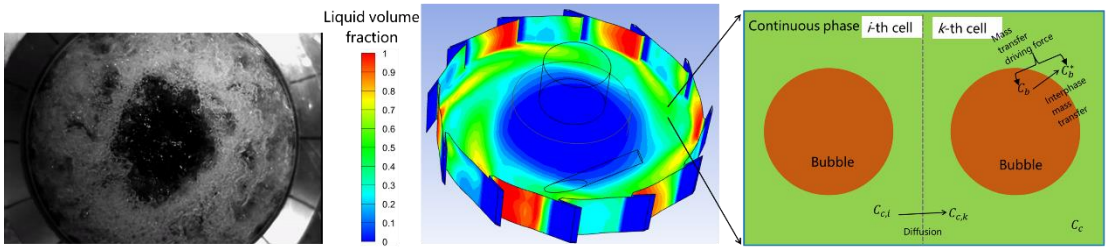
Gas-liquid hydrodynamics and mass transfer in a gas-liquid vortex reactor for CO_2 capture

Aim

The thesis aims to investigate the gas-liquid flow characteristics and interphase mass transfer on CO_2 capture within the gas-liquid vortex reactor (GLVR) by the experimental method and computational fluid dynamics (CFD) simulation.

Justification

Carbon dioxide (CO_2) is the main contributor to global warming. Chemical absorption using amine-based solvents has attracted considerable attention in the field of CO_2 capture due to its advantages, e.g. high efficiency and low cost, etc. However, process intensification and performance improvement of the gas-liquid mass transfer process still face some challenges, particularly caused by mass transfer limitations that hinder CO_2 capture efficiency. Recent experimental results on gas-liquid flow and mass transfer have shown that GLVR has tremendous potential for enhancing gas-liquid interphase mass transfer and micromixing[1-2].



• CO_2 capture in the GLVR • Gas-liquid flow • Interphase mass transfer

The main focus of this project is to investigate the intensification mechanism and performance of the GLVR on CO_2 capture. The research encompasses both the experimental aspect and CFD simulation. At the first stage of the project, experiments will be performed to evaluate the CO_2 capture efficiency in GLVR. Besides, solvent regeneration in the GLVR through direct steam stripping will be studied using a CO_2-rich aqueous amine flow. Then, the multiphase simulation with the mass transfer model will be established and validated by the experimental results.

Program

1. Literature study on CO_2 capture and relevant amine-based solvents.
2. Performing experiments on CO_2 capture within GLVR using amine-based solvents and solvent regeneration.
3. Validating the CFD model against the experiment data.
4. Development of a simulation model for CO_2 absorbed into amine solvent.

Reference

1. Ouyang Y, Manzano M N, Beirnaert K, Heynderickx G J, Van Geem K M. Micromixing in a gas-liquid vortex reactor. AIChE J. 2021;67:e17264.
2. Ouyang Y , Manzano M N , Wetzels R , et al. Liquid hydrodynamics in a gas-liquid vortex reactor. Chemical Engineering Science, 2021:116970.

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