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CFD investigation on the design optimization of the internal configuration in a gas-solid vortex reactor

Aim

To optimize the design of the internal configuration in a gas-solid vortex reactor by means of CFD simulations using ANSYS Fluent and Workbench.

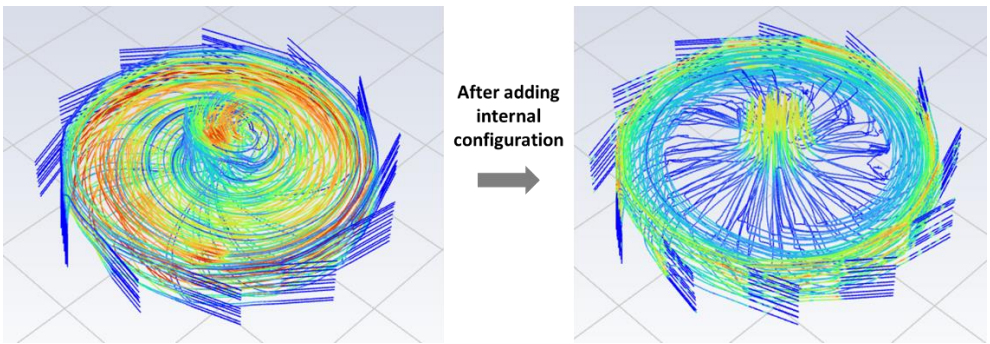
Justification

The vortex reactor developed at the Laboratory for Chemical Technology (LCT) emerges as a promising reactor technology for many applications such as oxidative coupling of methane (OCM) [1], fast pyrolysis [2]and CO_2 capture [3], etc. However, the current design of the gas-solid vortex reactor (GSVR) still suffers from (1) low solid loading, (2) bed non-uniformity due to gravity effect and (3) short residence time of the gas phase. These issues could be addressed by optimizing the design of the internal configuration of the GSVR.

An efficient way to justify a design concept is to employ computational fluid dynamics (CFD) for low-cost and fast assessment. Adding new internal configurations in the GSVR chamber will significantly affect the gas-solid hydrodynamics, which will be the focus of this project. Euler-Euler simulation and Discrete Element Method (DEM) simulation will be performed in ANSYS Fluent to study the velocity fields, pressure drop, solids loading, and bed uniformity, etc. The optimization methods integrated in ANSYS Workbench, e.g. genetic algorithm, will be employed for dynamic geometrical parameter study.

Program

- Literature study on the novel gas-solid reactor designs.
- Perform Euler-Euler simulation and Discrete Element Method (DEM) simulation using ANSYS Fluent, and validate the simulation based on literature data.
- Perform geometric parameter optimization using ANSYS Workbench.
- Evaluate reactor performance based on the simulation data of gas-solid hydrodynamics.



1. Vandewalle, L. A., Marin, G. B. & Van Geem, K. M. *Chem. Eng. Process. - Process Intensif.* 165, 108434 (2021).
2. Gonzalez-Quiroga, A. *et al. Chem. Eng. J.* 329, 198–210 (2017).
3. Ouyang, Y. *et al. AIChE J.* e17608, (2022).

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