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A novel approach to the design of stable OCM catalysts for Gas-Solid Vortex Reactor (GSVR)

Aim

Designing novel OCM catalysts with improved stability for GSVR.

Justification

Oxidative coupling of methane (OCM) is an innovative process to convert abundant natural gas to light olefins, the building blocks of the chemical industry, thereby expanding the use of natural gas as a feedstock for the chemical industry. Within the H2020 ADREM project, the gas-solid vortex reactor (GSVR) was proposed for OCM. Simulations indicated that the fast heat and mass transfer and the short residence times in the GSVR provide a perfect match with the OCM reaction. First OCM experiments in the GSVR showed however that the time of stable operation was limited due to catalyst deterioration. The catalyst particles experience impact against the walls or other particles in the fluidized bed or during their pneumatic transport. As a result, the particles rapidly become very small under high shear forces in GSVR, i.e. their Stoke's number begins to decrease and the particles are removed by the gas streamlines. Materials with high mechanical strength are expected to withstand the high shear forces in the GSVR. Hence, a critical step towards realizing this process is the development of a mechanically stable OCM catalyst. This requires the catalyst support particles to be mechanically strong to resist degradation, deformation and breakage during their lifetime in the unit.

In this master thesis, we will study the catalyst support particle properties with a focus on their mechanical strength. The aim is to improve the stability of the catalyst developed at LCT, having La_2O_3 as active site, via synthesis of a new catalyst support. The synthesized material will be characterized using XRD, their mechanical properties will be evaluated using Young's modulus, hardness, fracture toughness and attrition analysis techniques, and their performance under OCM conditions will be studied in the fixed bed reactor. Eventually, the new stable and active OCM catalysts will be tested in a GSVR under OCM conditions.

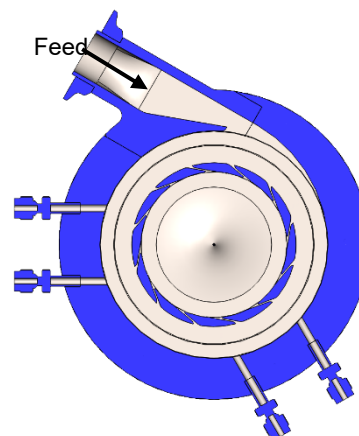


Figure 1: Schematic of a gas-solid vortex reactor.

Program

1. Literature study: an introduction on mechanical properties of solid catalysts such as Young's modulus, hardness and fracture toughness.
2. Literature study: Studying the state of the art synthesis techniques to improve the stability of the catalyst for fluidized bed reactors.
3. Synthesis of novel and stable OCM catalysts for GSVR.
4. Catalytic experiments in the fixed bed reactor.
5. Characterization of the developed catalysts.
6. Catalytic experiments in the GSVR.