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Coach	**Supervisor(s)**	**Funding**
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Design of stable OCM catalysts for fluidized bed reactors by encapsulating the active sites in an attrition resistant support

Aim

Developing a new synthesis protocol to improve the mechanical stability of lanthanum oxide based OCM catalysts.

Justification

One of the significant challenges in the operation of fluidized bed reactors is catalyst attrition and loss of activity and/or selectivity with time on stream. The aim of this master thesis is to develop a universal synthesis protocol for the design of mechanically stable catalysts by evaluating a case study: performance of catalysts based on lanthanum oxides in a gas-solid vortex reactor (GSVR) under oxidative coupling of methane (OCM) conditions.

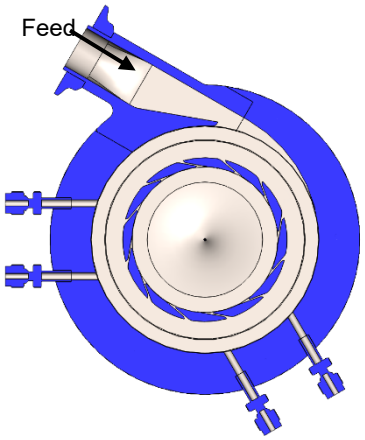

Figure 1: Schematic of a gas-solid vortex reactor.

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. Within the European ADREM project, the 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 of other particles in the fluidized bed or during their pneumatic transport. As a result, they rapidly become very small under the high shear forces in the GSVR, i.e. their Stoke's number decreases and the particles are removed by the gas streams.

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 to be mechanically strong to resist degradation, deformation and breakage during their lifetime in the unit. Within the European H2020 ERC OPTIMA project, the mechanical stability of different catalyst supports is identified based on Young's modulus and attrition index analysis.

In this master thesis, we will develop synthesis protocols to encapsulate lanthanum oxide in the available mechanically stable support in our laboratory. The synthesized material will be characterized using XRD, their mechanical properties will be evaluated using Young's modulus and attrition analysis techniques, and their performance under OCM conditions will be studied in a fixed bed reactor. Eventually, the new stable and active OCM catalysts will be tested in a GSVR under OCM conditions.

Program

1. Literature study: different encapsulation techniques employed for controlling catalyst deactivation.
2. Synthesis of novel and mechanically stable OCM catalysts for fixed bed reactor and GSVR.
3. Characterization of the developed catalysts.
4. Catalytic experiments in the fixed bed reactor.
5. Catalytic experiments in the GSVR.

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