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Design of Stable Catalysts for Oxidative Coupling of Methane (OCM) in a Gas-Solid Vortex Reactor (GSVR) and stator-rotor vortex chamber (STARVOC)

Aim

Designing of novel attrition resistance OCM catalysts to improve their stability in GSVR and STARVOC reactors

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 are a perfect match for OCM reaction. However, the GSVR operates under higher shear forces compared to traditional fluidized bed reactors. Materials with a low attrition index are expected to withstand the high shear forces in the GSVR. Hence, a critical step towards realizing this process is the development of a stable-attrition resistant OCM catalyst. At the Laboratory for Chemical Technology, a novel, attrition resistant and high-performance catalyst was therefore developed. First OCM experiments in GSVR showed that the time for stable operation was limited due to the catalyst deterioration. The aim of this master thesis will be improving the stability of the developed catalyst at LCT via coating of the supported La_2O_3 based catalysts. The synthesized material will be characterized using XRD, XPS, and attrition analysis techniques, and their performance under OCM condition will be studied in the fixed bed reactor. Then, the new attrition resistance and OCM active catalysts will be tested in a GSVR under hot flow conditions. The characterization of the spent catalyst will be carried out to understand the catalyst deterioration mechanism. Attrition can possibly also be reduced in a novel reactor recently developed and patented by the LCT: the stator-rotor vortex chamber (STARVOC) reactor. The STARVOC reactor is a special type of GSVR, with a central rotating element instead of static inlet slots. It has some important advantages over a GSVR, namely a lower energy consumption, higher rotation velocities, less particle entrainment and potentially lower attrition rates. Therefore, the attrition resistance of the new catalysts will also be tested in the STARVOC reactor and compared with the attrition resistance in the GSVR.

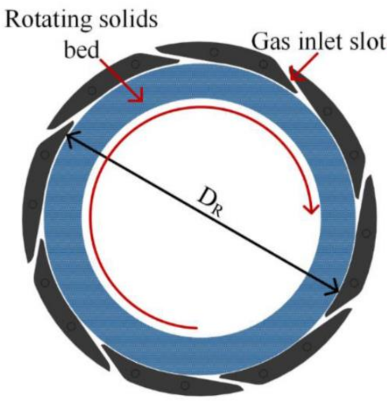

Figure 1: Schematic of a gas-solid vortex reactor.

Program

1. Literature study: Studying the state of the art synthesis techniques to improve the stability of the catalyst for fluidized bed reactors.
2. Synthesis of novel and stable OCM catalysts for GSVR.
3. Kinetic study of the new catalysts in fixed bed reactor.
4. Characterization of the developed catalysts.
5. Hot flow stability test in the GSVR and STARVOC reactor.
6. Unravelling the catalyst deterioration mechanisms.

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