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Autothermal oxidative coupling of methane (OCM) operation in a fixed bed reactor with ambient feed temperature

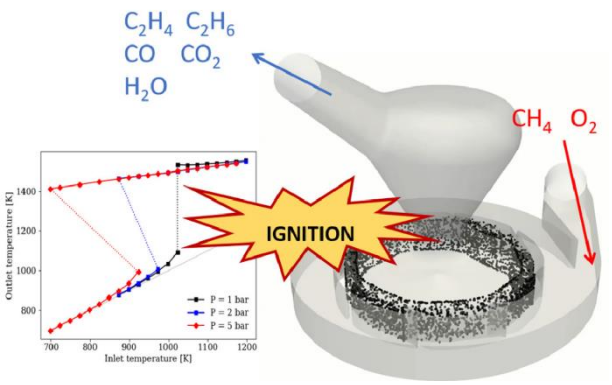
Aim

To operate oxidative coupling of methane (OCM) at auto-thermal conditions for the first time at LCT and identify the ignition-extinction behaviour of novel LCT materials

Justification

OCM is an innovative process that converts abundant natural gas to light olefins, the building blocks of the chemical industry, thereby expanding the use of natural gas as a feedstock. A significant challenge to operating OCM at an industrial scale is dealing with the high exothermic nature of the involved reactions. One solution is to use the heat of the reaction to maintain the reactor temperature above 800°C, so that no other means of external heating is required and the reaction feed acts as a coolant. This master thesis aims to demonstrate the feasibility of using novel LCT materials in an adiabatic autothermal fixed bed reactor and operating them under ignited OCM conditions.

Within the European projects ADREM and OPTIMA, the gas-solid vortex reactor (GSVR) and novel LCT catalysts were proposed for OCM. Simulations indicate that the fast heat and mass transfer and the short residence times in the GSVR provide a perfect match with the OCM reaction. The autothermal operation of OCM in the GSVR theoretically proved to reach 37% methane conversion and 72% selectivity to C2 hydrocarbons.



Materials with high activity are required for autothermal OCM operation. The activity of the LCT materials is three times higher than that reported for La_2O_3-based catalysts, and their performance remains stable for more than 60 h. However, using these materials directly in the GSVR is challenging and requires scale-up of the catalyst synthesis methods and producing catalyst pellets. In addition, an experimental protocol needs to be developed, including feed composition and continuous adaptation of reaction conditions in a fixed bed reactor to reach the ignited conditions, before aiming for actual operation in the GSVR as a more challenging stage.

In this master thesis, we will identify the feasible region of autothermal operation with an ambient feed temperature. LCT materials will be the basis of investigations, and catalysts with new formulations will be designed when needed. The synthesized materials and spent catalysts will be characterized using XRD and TPD/R/O. Eventually, a receipt will be developed to design the experiments for autothermal OCM operation in the GSVR.

Program

1. Literature study: Autothermal OCM: requirements on catalyst properties and reactor design.
2. Synthesis of OCM catalyst with high activity.
3. Catalytic experiments in the fixed bed reactor.
4. Characterization of the developed catalysts, fresh and spent.

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