UCRA2019 – International Conference on Unconventional Catalysis, Reactors and Applications, Zaragoza, October 16-18, 2019

CATALYST DESIGN FOR OXIDATIVE COUPLING OF METHANE IN A GAS-SOLID VORTEX REACTOR

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Keywords: Catalyst design, Oxidative coupling of methane, gas-solid vortex reactor, process intensification

Oxidative coupling of methane (OCM) is a promising route for the direct synthesis of C_2 hydrocarbons from methane according to the following reactions[1].

$$2CH_4 + O_2 \rightarrow C_2H_4 + 2H_2O \quad \Delta H_r^0 = -282 \text{ kJ mol}^{-1} \quad (1)$$

$$2CH_4 + 0.5O_2 \rightarrow C_2H_6 + H_2O \quad \Delta H_r^0 = -177 \text{ kJ mol}^{-1} \quad (2)$$

The presence of O_2 and the high reaction temperatures limit C_2 yields to 25% for most catalysts[2]. In the gas-solid vortex reactor (GSVR), a rotating fluidized bed is obtained by tangential injection of gas at high velocities (**Fig. 1**)[3], creating a dense bed and high gas-solid slip velocities, resulting in increased heat, mass and momentum transfer and a decrease in gas phase residence time. Recently, Vandewalle et al. showed that the good thermal back mixing combined with limited species back mixing in the GSVR can potentially improve C_2 yields[4]. The high temperatures, the high solids velocity and the limited space times require the design of highly active, thermally and mechanically stable catalysts. This work focusses on the development of such a supported catalyst. Cold flow experiments show that a stable catalyst bed can be formed and less than 1% of the catalyst is entrained over a 1 hour experiment. Experiments with conventional Sr/La_2O_3 catalyst pellets show instantaneous pulverization and entrainment. Fixed bed experiments at GSVR conditions of temperature and space time show a reasonable methane conversion of 5-10% with 50% C_2 selectivity under intrinsic kinetic regime. First proof-of-concept OCM experiments in the GSVR will be reported. Microkinetic simulations indicate a methane conversion of 10% and a C_2 selectivity above 50%.

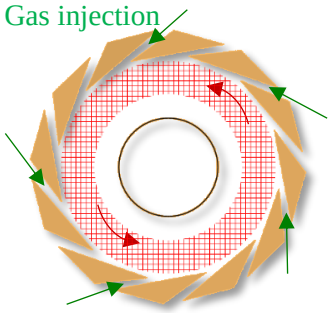

Fig. 1 Top view of GSVR showing gas injection and rotating fluidized bed.

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