

Fischer-Tropsch Synthesis on supported cobalt catalysts – Effects of gas space velocity and activation procedure

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Due to high activity of cobalt metal in syngas conversion to higher hydrocarbons, supported cobalt catalysts have been widely used for Fischer-Tropsch synthesis (FTS) reaction. Cobalt catalyst is very active to produce long chain normal paraffin and also it shows high resistance to deactivation.

The effect of gas space velocity on catalytic performance of Co/Al₂O₃ catalyst was studied in a fixed bed reactor at the following conditions: 220 °C, 300 psig, H₂/CO = 2 and gas space velocities of 2.8, 3.0, 3.75 and 6.0 NL/g-cat/h. The catalyst (60-100 mesh) was activated in situ with hydrogen at 375 °C for 12 h.

CO conversion varied from 92% at the lowest space velocity (2.8 NL/g-cat/h) to about 35% at the highest space velocity (6 NL/g-cat/h). Selectivities of light hydrocarbon products (C₁ to C₄) increased with increase in space velocity, whereas selectivity of liquid and wax (C₅⁺ hydrocarbons) decreased. Olefin content of gaseous hydrocarbons (C₂ to C₅) increased slightly with decrease in conversion. This was even more pronounced for 1-olefins, which are the primary products of FTS. Total olefin and 1-olefin selectivities decreased with increase in carbon number (C₃-C₅ hydrocarbons), whereas ethylene selectivity was lower than that of propene.

We have also studied the effect of activation procedure on performance of 10 wt% Co/ZnO catalyst. The catalyst was activated in situ at ambient pressure, 1000 h⁻¹ with either H₂ (320 °C, 10 h), or CO (250 °C, 3 h) or CO (250 °C, 3 h) plus syngas containing 20% N₂ (420 psig, 250 °C, 1 h). During testing at 205 °C the H₂-activated sample achieved slightly higher CO conversion (19%) relative to the sample activated in CO (17.5%). However, methane selectivity on H₂-activated catalyst was much lower than on the CO-activated catalyst (6.3% vs. 12.1%), moreover, C₅⁺ selectivities were higher (83.4% for H₂-activated and 78.7% on CO-activated). Hydrocarbon products were more olefinic on the H₂-activated catalyst relative to the CO-activated one. Both activity and selectivity were higher following additional syngas pretreatment after the CO-activation (CO conversion and C₅⁺ selectivities were: 28.3% and 82.8% at 205 °C and 36.6% and 79.2% at 215 °C, respectively).

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