322f Modeling of Catalytic Partial Oxidation of Methane to Syngas in Short Contact Time Packed Bed Reactors

Ramaswamy C. Ramaswamy, P. A. Ramachandran, and Dudukovic M.P.

Syngas (a mixture of carbon mono-oxide and hydrogen) is an important feedstock for the production of variety of chemicals ranging from methanol and its derivatives to the synthetic automotive fuels and the hydrogen gas for fuel cell applications. Syngas is produced from various hydrocarbons such as natural gas (mostly methane), coal etc. by reforming and partial oxidation routes. The conversion of methane to synthesis gas by catalytic partial oxidation route is gaining momentum these days due to the availability of pollutant free natural gas and the ability of this process to produce desired ratio of CO/H2 in the product. The interaction of the exothermic combustion reaction and the endothermic reforming reactions in an adiabatic reactor exhibits several non-intuitive interesting steady state and dynamic behavior. In this work, we have used heterogeneous plug flow and axial dispersion models for the short contact time packed bed reactors to investigate the steady state and dynamic behavior exhibited by this process.

A parametric analysis is carried out to understand the steady state behavior of this process. The effect of addition of steam in the feed, operating pressure, the space velocity etc on the product yield and on the hot-spot is discussed. The product pattern obtained at thermodynamic equilibrium (long contact time) and non-equilibrium (short contact time) conditions are investigated. Some of the key transient behavior, including the wrong way phenomenon, obtained by sudden increase or decrease in the feed temperature (from a steady state profile) at the reactor inlet is analyzed. The effect of time scales of exothermic and endothermic reactions on the temperature profile during the start-up of the reactor is also presented.