Poster 21

The impact of transport properties on a selective catalytic reactor: Preferential Oxidation of CO

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The reforming of complex fuels via O2 and H2O has become important for a variety of applications such as remote and portable power production via PEMFC and SOFC, ICE combustion enhancement with syngas and biofuel conditioning. A thorough understanding of the process is constrained by the large number of chemical species and reactions involved, coupled with mass and heat transfer processes and masked by various catalyst deactivation modes. This research attempts to gain insight into Autothermal reforming (ATR) of hydrocarbons by investigating the Preferential Oxidation of CO (in the presence of H2, H2O and CO2). The comparison is based on the knowledge that both processes involve oxidation reactions taking place in the front of the catalyst bed, followed by the endothermic reactions. For this research 5% Pt on -Al2O3 was washcoated on monoliths and wire-gauze screens. Results and model calculations indicate that the CO oxidation reaction is mass and heat transfer limited. This behavior is confirmed by test results at high space velocities and low CO inlet concentrations (300 ppm). Additional direct comparisons between monolith and wire mesh supports show different O2 consumption kinetics: for the monolith reactor, CO conversion levels off at the same temperature at which the O2 is fully converted, while for the wire mesh reactor, O2 is still available after CO conversion levels off, reflecting a decrease in CO selectivity, suggesting that wire mesh screens enhance the CO oxidation mass transfer rate. Tests have been conducted in the absence of O2 in the feed, in order to elucidate the reverse water gas shift (rWGS) kinetics, suggesting a Langmuir-Hinshelwood mechanism with competitive adsorption of CO, H2 and CO2. Comparison of these results with the PROX data (illustrated in Figure 1) indicates that the CO conversion drop is attributed to the rWGS reaction and that the product CO concentration is far from thermodynamic equilibrium. Additionally PROX data was compared with ATR data, exhibiting similar reaction zones and behavior with respect to space velocity.

Figure 1: Monolith–wire mesh support comparison: Reactor CO exit concentration vs. reactor temperature. PROX reactor data is superimposed to reverse WGS test data and thermodynamic equilibrium.