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Fischer-Tropsch Synthesis: Towards understanding.

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ABSTRACT

A series of experiments in different types of reactors were performed with TiO_2 supported cobalt catalyst to gain a better understanding of the phenomena related to Fischer-Tropsch Synthesis (FTS) reaction. The performance of FTS was investigated during unsteady state and steady state. The experiments were conducted firstly to investigate the effect of external mass transfer on the performance of FTS, and the results suggested that it has effects only in short term but not long term. During the beginning period of the experiment conducted in the CSTR, two steady stages in terms of reaction rate and product selectivity could be observed and large changes were found in-between them. In order to reveal the precise reason(s) for causing these observed phenomena, flushing experiments were designed after the reactor system reached the secondary steady stage by means of changing the feed from synthesis gas to inert gas, argon. By comparing the results in the reactions before and after flushing, we can conclude that those observed large changes were mainly caused by the deposit of liquid phase products on the catalyst. The information of the materials in the stream out of reactor during flushing was also collected. The dynamic concentration of C_1-C_8 in the flushed out gas suggested that reaction among the light products might take place under a moderate FT reaction condition. To present another way to look at the reaction behaviour of FTS, a number of experiments were conducted in a batch reactor with different reaction durations. An unusual behaviour of the product distribution when compared to the typical ASF model was observed. The pressure in the reactor during the reaction was monitored, and the comparison of the pressure readings of the reactor system at different reaction durations with the pressure derived from the mass balance suggested that a considerable proportion of the water produced was in the liquid phase under reaction conditions. The study of FTS under steady state was carried out in a tubular fixed bed reactor. The olefin

to paraffin ratios for different carbon numbers and the relationship of C_2 and C_3 both in olefins and total amount under various reaction conditions were mainly investigated. A detailed explanation was presented to describe the behaviour of olefin to paraffin ratios with the change of the space velocity. The relationships of C_3H_6/C_2H_4 and C_3/C_2 were also summarised respectively. On the analysis of the experimental data both from CSTR and PFR, we found that the ratios of neighbouring light olefins kept constant although there were large alterations on the ratio of olefin to paraffin. Based on the implication from flushing experiments that light hydrocarbons may react with each other, an equilibrium was proposed for the olefin product distribution of FTS.