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GRAPHICAL METHODS FOR THE REPRESENTATION OF THE FISCHER-TROSPCH REACTION:

Towards understanding the mixed iron-cobalt catalyst systems

Thierry Musanda Mukenz

ABSTRACT

Fischer-Tropsch is a process that converts synthesis gas (especially H_2 and CO) into hydrocarbons by the mean of metal catalysts (such as Fe, Co, Ru, and Ni). Its success depends strongly on the catalyst used for the reaction, the reactor where the reaction is taking place, and some parameters such as the operating temperature, the reactor pressure, and the gas purity, composition (ratio H_2:CO) and flow rate. Besides the above parameters, other factors, such as the degree of reduction of the catalyst, also play an important role for a successful FT reaction. Water can deactivate (by re-oxidation) the catalyst and carbon deposit can reduce the catalyst's activity.

It is well known that FT is a complex reaction because of the range of products that it produces as well as the reactions that occur during the process. A good choice or combination of catalysts, reactor and operating conditions can help to control the product spectrum.

In this thesis we develop a simple graphical technique to represent the mass, energy balance and thermodynamic constraints that affect both the catalyst and the reactor.

This graphic model is shown to be capable of opening up insights into reactor operations and indicating preferred operational regions. The diagrams make it possible to visualize operations and understand the interactions between the catalysts and the reactor. The mass and energy balances also provide information about the best possible region in which the FT reactor system can be designed and operated.

A few catalysts (Fe/TiO_2, Co/TiO_2 and $Fe:Co/TiO_2$) were prepared for the completion of this work. Some of them were tested separately and others were mixed in the same reactor.

The results showed that the physical mixture (of Fe/TiO_2 and Co/TiO_2) and bimetallic catalysts behave differently from one another. The addition of Fe Fe/TiO_2 to a constant amount of Co/TiO_2 results in an increase of CO hydrogenation activity, WGS activity and CH_4 selectivity. However, the position of the two catalysts in the reactor (one followed by another) shows little effect on the rate of hydrogenation of CO and the CO conversion.