PROJECT FACTS

UNIVERSITY OF KENTUCKY CENTER FOR APPLIED ENERGY RESEARCH

CLEAN FUELS & CHEMICALS

Kinetics of Slurry Phase Fischer-Tropsch Synthesis on a Cobalt Catalyst

The specific goal of the project will be to determine kinetic parameters of Fischer-Tropsch synthesis (FTS) from experimental data in a stirred tank slurry reactor (STSR) under well defined conditions and over a wide range of process conditions. The STSR is an ideal choice of bench-scale reactor for catalyst testing, as it essentially mimics the slurry phase performance characteristics of the commercial-scale slurry bubble column reactor (SBCR), which is the current design being used by Sasol in Qatar for the gas-to-liquids (GTL) process.

Kinetic models will be based on mechanistic studies from the literature and take into account adsorption-desorption rates of reactants and product species, and include concepts of the rate determining step and pseudo-steady state hypothesis for reactive surface intermediates. Rigorous data reduction procedures and statistical methods will be employed to discriminate between various rival kinetic models and determine optimal values of kinetic parameters for each promoted catalyst investigated. Quantum mechanics calculations will be used to provide initial estimates of the pre-exponential factor and activation energies to be used in the selected kinetic models that will be evaluated. The kinetic model developed in this study, coupled with the appropriate conservation equations and transport properties for a given reactor configuration (fixed bed or slurry bubble column reactor), would be useful for optimizing product yield, simulating the process in plant design, and evaluating the economic cost benefits.

Alumina supported cobalt (Co) catalysts, promoted with reduction promoters (Pt, Pd, Re, and Ru), will be used in this study, as these catalysts are often employed in SBCR reactors for GTL processing. The impact of the reduction promoters on cobalt FT kinetics (reaction rates and product distribution) remains largely unknown. Catalyst characterization studies will provide insight on interactions between cobalt and promoters and alumina support. Interactions between reduction promoter and cobalt will be studied using synchrotron methods (e.g., EXAFS, XANES), temperature programmed methods, and adsorption techniques, such as hydrogen chemisorption with pulse reoxidation. Particular effort will be made to determine which, if any, of the reduction promoters form alloys with cobalt, and whether such alloying benefits catalyst performance in the STSR.

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