Kinetic modeling of Fischer-Tropsch synthesis using simplified reactions and Anderson-Shulz-Flory distribution

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In Fischer-Tropsch Synthesis (FTS), hydrocarbons with different carbon lengths are produced from syngas. Since a wide range of products can be produced, it is very important to optimize the reaction system (e.g., catalyst used, reaction temperature) so as to maximize the productivity and selectivity of target hydrocarbons. To perform such optimization, a kinetic model needs to be developed, which can explain the concentration changes of various chemical species in the reactor with high accuracy. However, due to the complexity of FTS, such a model is typically very complex and difficult to develop, while a simpler model can be beneficial for model-based optimization and control. To this end, in this study, a kinetic model for FTS is constructed, which is simple yet effective. Specifically, complex FT reactions are lumped into a single reaction whose stoichiometry coefficients are determined by analyzing the experimental data. Then, to predict the concentration changes of individual hydrocarbons, ASF distribution with triple alpha values is exploited. The effectiveness of the overall model is illustrated through a case study.