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Synthesis gas conversion into dimethyl ether and light hydrocarbons via methanol over a hybrid gold-based catalyst

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ABSTRACT

Dimethyl ether (DME) has attracted an increasing amount of attention in recent years because its properties are similar to those of transportation fuels and it can be used as a substitute for diesel. The two-step process required to produce DME is a proven technology that has already been commercialised. However its capital and operating costs remain high because two different reactors are required for methanol synthesis and methanol dehydration, and a number of recycles are needed to improve the overall CO conversion in the methanol synthesis step.

A number of researchers have proposed a new process design named synthesis gas-to-DME (STD) process to overcome the limitations of the current technology for producing DME. This innovation uses one reactor for both methanol and DME synthesis, and a hybrid catalyst that leads to higher conversions of synthesis gas to DME. Both of these features reduce the capital and operating costs of the process.

In this dissertation we record the results of thermodynamic research into the STD process, which confirm that it offers more advantages than the two-step process. The system remains pressure-sensitive, as the methanol synthesis is the most active component of the process. The experimental results also matched the trends of thermodynamic predictions of selectivities.

For the experimental work we used a gold-based catalyst to convert synthesis gas to DME and by-products (light hydrocarbons C_1 to C_5). The results showed that DME selectivity is high at a low temperature (340^{o}–380^{o}C), but that under these conditions the catalyst exhibited a low level of activity. An increase in temperature increased the production of hydrocarbons but imposed kinetic limits on the conversion of MeOH to DME. Deactivation of the catalyst occurred at 460^{o}C because of carbon deposits on its surface.