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Catalyst and Reactor Development for a Liquid Phase Fischer-Tropsch Process

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ABSTRACT

This report describes work carried out in the fifth quarter of a three year contract, begun October 1980, between Air Products and Chemicals, Inc. and the DOE: "Catalyst and Reactor Development for a Liquid Phase Fischer-Tropsch Process". The program contains four major tasks: (1) Project Work Plan, (2) Slurry Catalyst Development, (3) Slurry Reactor Design Studies, and (4) Pilot Facility Design.

In Task 2, five modified "conventional" catalysts were prepared, and six gas phase screening tests were carried out. One of these catalysts gave an excellent diesel fuel type product distribution, with a low CH_4 yield and good stability.

Two slurry tests were run. The first used a 19 wt% slurry of ammonia synthesis catalyst as a "baseline" F-T case, and incorporated the slurry reactor mass transfer tests by varying stirring rates and space velocities as a function of temperature. Product distributions were straight line Schulz-Flory, as expected with this type of catalyst. The data is currently being analyzed to separate mass transfer and chemical rate effects. The second utilized a slurry of a coprecipitated catalyst, activated in the slurry phase. The pressure and temperature required for activation and reaction were found to be higher than for the gas phase screening tests, and deviations from the standard hydrocarbon product distribution were small. The usage and feed ratios were equal for 1:1 syngas.

Seven supported cluster catalysts were synthesized and eight were screened in the gas phase. One of these produced a high selectivity to 1-butene and n-pentane.

In Task 3, measurements of gas hold-up and solids dispersion in the 5" column were completed for the 45-53 μm and 90-106 μm iron oxide/isoparaffin systems. Contrary to the silica slurry results, an increase in gas hold-up was observed with a positive slurry velocity. No dependence of gas hold-up on distributor type was observed, however. With the 45-53 μm slurry, the solids concentration profiles were uniform under all conditions studied, but with the 90-106 μm slurry, a decrease in solids concentration with column height was observed at zero slurry velocity .

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The 12" column experimental plan was approved by the DOE. Additional work to the 5" column program includes the measurement of slurry heat transfer coefficients, and variation of heat transfer internals and distributor hole size.

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