ALTERNATIVE FUELS AND CHEMICALS FROM SYNTHESIS GAS

FINAL

Technical Progress Report No. 25

For the Period 1 October - 31 December 2000

Contractor

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Prepared for the United States Department of Energy
Under Contract No. DE-FC22-95PC93052
Contract Period 29 December 1994 – 31 July 2002

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Contract Objectives

The overall objectives of this program are to investigate potential technologies for the conversion of synthesis gas to oxygenated and hydrocarbon fuels and industrial chemicals, and to demonstrate the most promising technologies at DOE's LaPorte, Texas, Slurry Phase Alternative Fuels Development Unit (AFDU). The program will involve a continuation of the work performed under the Alternative Fuels from Coal-Derived Synthesis Gas Program and will draw upon information and technologies generated in parallel current and future DOE-funded contracts.

RESULTS AND DISCUSSION

TASK 1: ENGINEERING AND MODIFICATIONS - no activity this quarter

TASK 2: AFDU SHAKEDOWN, OPERATIONS, DEACTIVATION AND DISPOSAL - no activity this quarter

TASK 3: RESEARCH AND DEVELOPMENT

LPMEOH^{TM} Kinetics–Water Injection

- More LPMEOH^{TM} experiments with water injection were conducted. In contrast to the results from Shell feed gas reported last quarter, little enhancement in productivity was observed when Texaco gas and a feed gas with H_2:CO ratio of 1:1 were used as the major feed. The variation in productivity enhancement by water injection appears to be related to the concentration of water in the reactor.

- Water injection under Kingsport feed gas was conducted. No suppression of methanol catalyst activity was observed, even when the water concentration in the reactor effluent was high. This is contrary to our previous observations using a different H_2-rich feed and a different methanol catalyst.

- A life test was conducted under the best conditions selected from the water injection experiments. The catalyst showed very good stability (0.04%/hr).

- Summarizing the kinetic data from all water injection experiments shows that there is considerable variation in the methanol synthesis rate constant, indicating the lack of robustness in our methanol synthesis kinetic model. The water gas shift reaction model appears to be adequate.

LPDME™ Stability: Catalysts, Conditions and Mechanistic Study

- Spent LPDME catalyst samples from stable and unstable runs were analyzed using SEM/EDS. More copper was observed on the cross section of the spent dehydration catalyst from the unstable runs than from the stable runs. A trend between the copper accumulation rate and the catalyst-aging rate has been observed. Three more samples will be analyzed to verify this observation.

- The correlation between catalyst activity and copper crystallite size, observed previously from the samples of stable LPDME experiments, was further confirmed by more data from LPMEOH experiments. This correlation ("sintering curve") can be used to distinguish non-sintering-related catalyst aging mechanisms.

Investigation of Lab Reactor Artifacts

- High Fe level has been observed recently in the spent catalysts from Lab 17. Elemental analysis shows that this is most likely due to the breakthrough of Fe carbonyls in the carbon trap, which can have significant effects on stability test results. The lifetime of the carbon traps could be as short as two months on syngas streams. More timely carbon trap replacement will be practiced.

- Efforts were continued to achieve a lower baseline rate for catalyst aging in 300 cc lab autoclaves. Using Squalane as the slurry fluid did not give better results. However, two experiments using Drakeol 34 showed aging rates between 0.02 and 0.03%/hr, significantly lower than the nominal baseline aging rate using Drakeol 10 (0.05%/hr). A control experiment using Drakeol 10 will be conducted to confirm the superiority of Drakeol 34.

PROJECT MANAGEMENT

DOE Topical Report

- A draft of a DOE topical report has been finished. It covers Air Products' work on developing aluminum phosphate as the dehydration catalyst for the LPDME™ process. The focus is on the relationship between performance and preparation. The other major part of Air Products' work with this catalyst system, i.e., understanding the dependence of catalyst deactivation on the reaction conditions, will be covered in a separate report.