Engineering Demonstration of a Modular Fischer Tropsch for Wyoming Coal to Liquid Fuels

Executive Summary Report to: **School of Energy Resources University of Wyoming**

Clean Coal Technologies Research Program

Category: Engineering scale-up of demonstrated technologies

Topic: H. Coal-to-liquids/coal-to-natural gas/coal-to-hydrogen technologies

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EXECUTIVE SUMMARY REPORT – FINAL

Project Objectives

The primary objective of the program was to develop a modular, cost effective, road transportable FT reactor system design that could be used for conversion of Wyoming coal to FT liquids. The primary objective required addressing issues related to heat transfer in fixed bed FT reactors and evaluation of catalysts that could minimize downstream treatment of the FT products. The design would be tested in realistic environments to assure that implementation of the technology was possible. Proof of technical and economic feasibility would be demonstrated by the testing and industrial interest in the technology.

Testing and research conducted

Two different heat transfer mechanisms to control the heat generated in a Fischer Tropsch reactor were tested. The first was a design for an aluminum extrusion insert that was developed using geometric optimization coupled heat transfer modeling. The resultant structure was tested with various catalysts. This structure appears to have good heat transfer characteristics under moderate catalyst loading and synthesis gas flows. It has low costs and appears as a viable technical and commercial alternative under certain circumstances. The second approach was a heat transfer insert based on IntraMicron's microfibrous entrapped catalyst (MFEC) approach. The MFEC uses micron sized copper fibers to conduct the heat to the walls of reactor tubes. The catalyst particles are held in place in the copper fiber matrix, which was formed by sintering the fibers. The MFEC provides superior heat transfer, the ability to use smaller catalyst particles (i.e. better surface area resulting in reaction intensification), resistance to upset conditions, and good

fluid mixing. Offsetting these advantages are the issues of potentially higher cost for materials and processing. Each type of heat transfer media appears to have its preferred commercial application.

The testing validated both heat transfer approaches and the general design of the Ceramatec modular FT reactor and the 4" diameter reactor element. Based on the tests conducted, sufficient data has been developed to design, fabricate, and operate larger facilities. The use of the extruded aluminum fin insert shows promise in situations where low capital cost is a primary consideration. While product production is lower because of operating constraints with the fin insert compared to the MFEC, the cost reduction may be driving in particular circumstances. The MFEC ability to control the thermal output of highly active FT Co catalysts has been demonstrated and validates the viability of 4" FT reactor tubes with high loadings of highly active catalyst. The operation on synthesis gas derived from both natural gas (i.e. primarily methane) and simulated synthesis gas from coal has been demonstrated. The calculations and simulations conducted by Ceramatec have received empirical verification.

Commercialization

Ceramatec has identified potential commercial applications and is actively bidding additional research work and potential commercial projects. Current applications of interest to commercial entities seem to center on feedstock options that include at least some biomass. The only alternative applications currently being pursued involve co-produced natural gas that is currently being vented or flared. There is some interest from current coal mines that are being forced to close as demand for coal drops with increased environmental regulation.

Ceramatec is pursuing research with production of FT liquids from combinations of coal and biomass under funding provided by the USAF (US Air Force) and managed by the DOE (Department of Energy). The objective of this program is to produce synthetic jet fuel from coal with carbon emissions that does not exceed or is lower than those emissions from fuel derived from natural petroleum. Simulations indicate that inclusion of biomass feedstock with a contribution exceeding 30% of total input can meet the desired objective.

The key determination resulting from the project is Ceramatec's commitment to continued development of the technology based on the demonstrated success achieved due to Wyoming ACT support of this project. The ability to develop and commercialize a technology that will provide valuable future energy options is important to the country. Coal is the predominant energy resource in the United States and at some point in the future will become very important option to produce liquid fuels. The FT technology under development will provide a method for producing transportation fuels and energy options from an abundant, indigenous energy source. Proving the ability to combine coal with biomass will increase the environmental acceptability of this important United States resource and increase its utilization. Ceramatec appreciates the valuable support from the State of Wyoming that has facilitated the development of this technology.