DOE/PC/90027--T12

DVORSCAK

U.S. Department of Energy
Pittsburgh Energy Technology Center

Baseline Design/Economics
for
Advanced Fischer-Tropsch Technology

Contract No. DE-AC22-91PC90027

Quarterly Report

July – September 1994

We have no objection from a patent standpoint to the publication or dissemination of this material.

Mark Dvorscak 4-25-95

Office of Intellectual Property Counsel
DOE Field Office, Chicago

Date

93-3504b.001 p3

DISCLAIMER

Tables

Figures

Section 1

Introduction and Summary

This report is Bechtel's twelfth quarterly technical progress report and covers the period of July through September, 1994.

All major tasks associated with the contract study have essentially been completed. Effort is under way in preparing various topical reports for publication.

1.1 Introduction

Bechtel, with Amoco as the main subcontractor, initiated a study on September 26, 1991, for the U.S. Department of Energy's (DOE's) Pittsburgh Energy Technology Center (PETC) to develop a baseline design and computer model for advanced Fischer-Tropsch (F-T) technology. This study, with an approved budget of $2.3 million, is being performed under DOE Contract Number DE-AC22-91PC90027.

The objectives of the study are to:

- Develop a baseline design and two alternative designs for indirect liquefaction using advanced F-T technology. The baseline design uses Illinois No. 6 Eastern Coal and conventional refining. There is an alternative refining case using ZSM-5 treatment of the vapor stream from the slurry F-T reactor and an alternative coal case using Western coal from the Powder River Basin.

- Prepare the capital and operating costs for the baseline design and the alternatives. Individual plant costs for the alternative cases will be prorated on capacity, wherever possible, from the baseline case.

- Develop a process flowsheet simulation (PFS) model.

The baseline design, the economic analysis and computer model will be major research planning tools that PETC will use to plan, guide and evaluate its ongoing and future research and commercialization programs relating to indirect coal liquefaction for the manufacture of synthetic liquid fuels from coal.

The study has been divided into seven major tasks:

- Task 1: Establish the baseline design and alternatives.

- Task 2: Evaluate baseline and alternative economics.

- Task 3: Develop engineering design criteria.

- Task 4: Develop a process flowsheet simulation (PFS) model.

- o Task 5: Perform sensitivity studies using the PFS model.
- o Task 6: Document the PFS model and develop a DOE training session on its use.
- o Task 7: Perform project management, technical coordination and other miscellaneous support functions.

1.2 Summary

Tasks 1, 2, 3 and 5 have essentially been completed. Effort is under way in preparing topical reports for publication. During the current reporting period, work progressed on Tasks 4, 6 and 7. This report covers work done during this period and consists of four sections:

- o Introduction and Summary.
- o Task 4 - Process Flowsheet Simulation (PFS) Model and Conversion to ASPEN PLUS.
- o Task 6 - Document the PFS model and develop a DOE training session on its use.
- o Project Management and Staffing Report.

Under Task 4, process simulation models for 1) the Baseline design, 2) the Alternate (ZSM-5) Upgrading case, and 3) the Western Coal case have all been completed. These models were originally constructed using ASPEN/SP, and they have been converted to run under the latest version of ASPEN/PLUS. The converted models give essentially the same results as the original ones but execute significantly faster under ASPEN/PLUS.

Several enhancements were made to the discounted-cash flow economic spreadsheet model. The model was modified to allow different means of relating the F-T product, n-butane and propane prices to the reference crude oil price. These product prices were also allowed to escalate at the same rate as that of the crude oil price. The effect of all these changes on the economic analysis and comparison of the three F-T indirect coal liquefaction designs were presented to DOE/PETC.

Under Task 7, cost & schedule control and project reporting were the primary activities. A technical progress meeting was held at Bechtel San Francisco office, on July 1, 1994. During which, an overall comparison between the Baseline design and the two alternative cases was reviewed with DOE/PETC, in terms of their key design differences, capital cost, process performance and economics.

A paper entitled "Process Simulation Model for Indirect Coal Liquefaction Using Slurry Reactor Fischer-Tropsch Technology' was presented at the ACS Symposium on Alternate Routes for the Production of Fuels, held at Washington DC on August 22-25, 1994. The paper presented the results from Task 5, Sensitivity Study, using the ASPEN process simulation model for the Baseline design.

A paper entitled "Process Design/Simulation Models for Advanced Fischer-Tropsch Technology" was presented at the DOE Contractors' Review Conference, held at Pittsburgh, Pennsylvania on September 7-8, 1994.

Section 2

Task 4 - ASPEN Simulation Model Development

Previous quarterly progress reports described the development of ASPEN/SP process simulation models for each of the individual plants in the indirect coal liquefaction complex and their integration into three complete process simulation models for

1. The Baseline design case which processes Illinois No. 6 coal at a plant located in southern Illinois
2. An alternate refining case in which the vapor products from the slurry bed Fischer-Tropsch reactors are upgraded in a close-coupled reactor containing ZSM-5 catalyst
3. A Western coal case processing Powder River Basin coal in a plant located in Wyoming.

All three process simulation models have been completed. They were sent to ASPEN Technology for conversion to the PC version of ASPEN/PLUS.

2.1 Conversion to ASPEN/PLUS

During this period, consultations were provided to Paul Gallier of ASPEN Technology on the conversion of the process simulation models to ASPEN/PLUS.

All three process simulation models have been successfully converted into ASPEN/PLUS code. The converted models give essentially the same results as the original ASPEN/SP models, but execute significantly faster on the version 9 of ASPEN/PLUS. Documentation of the model conversion to ASPEN/PLUS will be issued as a topical report.

Section 3

Task 6 - ASPEN Simulation Model Documentation

3.1 ASPEN model documentation

The Topical Report for Task IV documenting the ASPEN process simulation models was finalized for publication. This report documents the three process simulation models, presents their results with detailed designs, provides users' instructions for running them on ASPEN/SP, and contains an overview of the LOTUS spreadsheet economics model. As instructed by DOE/PETC, the details of the LOTUS spreadsheet economics model will be issued as a separate restricted addendum.

A separate topical report will be issued to document the conversion of the simulation models to ASPEN/PLUS code.

3-2 Training

A three day training session on ASPEN/PLUS, the process simulation models and LOTUS spreadsheet economics model was held at the Pittsburgh Energy Technology Center on September 27-29, 1994.

ASPEN Technology presented an overview of ASPEN/PLUS in both the DOS and ModelManger modes. This participatory session emphasized the graphical ModelManager interface and showed the ease with which process simulation models can be constructed and executed. Because the coal liquefaction models for the complete processing plant are large ones, the use of ASPEN/PLUS in the DOS mode was covered as well as a brief overview of the relevant portions of the ASPEN/PLUS input language. The Fischer-Tropsch synthesis plant model and the complete Baseline simulation model were used as teaching tools.

Following this, a presentation describing the details and inner workings of the models was given. This presentation covered the spectrum from the general philosophy used to develop the models through a detailed description of the input parameters of each of the user FORTRAN models. Class exercises were performed examining the effects of some process variables on the performance of the Fischer-Tropsch synthesis reactor model and studying the effect of capacity on the ZSM-5 alternate refining design.

The training session concluded with a hands-on session on the use of the LOTUS spreadsheet economics model. This spreadsheet is a detailed discounted-cash flow model for analyzing the economics of the entire coal liquefaction project covering a 29 year period. A class exercise involved looking at the implications of various economic

assumptions and parameters on the crude oil equivalent price required for a 15% return on investment.

Each student received a copy of the slides used during the presentations along with a draft copy of the Topical Report for Task IV, most of its appendices, and the restricted addendum covering the LOTUS spreadsheet economics model.

Documentation of this three-day training session, including all presentation slides, will be issued as a topical report.

Section 4

Project Management & Staffing Report

4.1 Task 7 - Project management

During this reporting period, cost & schedule control and project reporting were the primary activities. A technical progress meeting was held at Bechtel San Francisco office, on July 1, 1994. During which, an overall comparison between the Baseline design and the two alternative cases was reviewed with DOE/PETC, in terms of their key design differences, capital cost, process performance and economics.

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4.2 key personnel staffing report

The key personnel staffing report for this reporting period as required by DOE/PETC is shown below:

Name	Function	% Time Spent(a)
Bechtel		
Samuel S. Tam	Project Manager	15
Gerald N. Choi	Process Engineer	60
Amoco		
R.D. Kaplan	Subcontract Manager	0
S. S. Kramer	Process Model/Simulation	26

(a) Number of hours spent divided by the total available working hours in the period and expressed as a percentage.

Figure 4-1

Overall Milestone Schedule
(as of September 25, 1994)

DOE F1332.3
(11-84)

□ PLAN ■ STATUS REPORT

FORM APPROVED
OMB NO 1901-1400

1. TITLE	Baseline Design/Economics for Advanced Fischer-Tropsch Technology	2. REPORTING PERIOD	8/15/94 to 9/25/94	3. IDENTIFICATION NUMBER	DE-AC22-91PC90027
4. PARTICIPANT NAME AND ADDRESS	Bechtel Corporation 50 Beale Street San Francisco, CA 94105	5. START DATE	9/26/91		
		6. COMPLETION DATE	10/31/94		

7. ELEMENT CODE	8. REPORTING ELEMENT	DURATION FY 93 / FY 94 (D J F M A M J J A S O N D J F M A M J J A S O N)	10. PERCENT COMPLETE a. Plan	b. Actual
Task 1	Baseline Design	② ③	100	100
Task 2	Economic Evaluation		100	100
Task 3	Engineering Design Criteria		100	100
Task 4	Process Flowsheet Simulation Model		100	100
Task 5	Sensitivity Studies		100	100
Task 6	Documentation and Training		100	32
Task 7	Project Management & Administration	① ① ①	94	94

△ Completion
① Progress meetings
② Baseline case design complete
③ Baseline case equipment list transmitted to Cost Estimating

11. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE Samuel S. Tam