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Topics:
Synthetic fuels
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Coal gasification
H-Coal process
Lurgi methanol process

EPRI AP-3290
Project 1658-1
Final Report
November 1983

H-Coal and Coal-to-Methanol Liquefaction Processes: Process Engineering Evaluation

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Stone & Webster Engineering Corporation
New York, New York

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EPRI PERSPECTIVE

PROJECT DESCRIPTION

Although numerous isolated evaluations of coal liquefaction processes have been published, comparison between individual studies is difficult and often subject to considerable judgment. Generally the evaluations are developed on different or incompletely defined bases, cost estimating procedures are not necessarily consistent, and the detail of process design varies from study to study.

This study under RP1658-1 has undertaken consistent evaluations of the H-Coal process charging both Illinois No. 6 and Wyodak coals as examples of direct coal liquefaction and the Lurgi methanol process charging Illinois No. 6 coal as an example of indirect coal liquefaction.

The H-Coal process was developed by Hydrocarbon Research, Inc. (HRI). This study considers operation in the Syncrude mode in which coal is converted to clean distillate products by direct hydrogenation. The H-Coal conversion process was most recently demonstrated in a 200 to 600 ton/day pilot plant at Catlettsburg, Kentucky.

The Lurgi low-pressure methanol synthesis process has been in commercial operation for a number of years, and twenty-one plants are currently on stream or under construction. In this case, however, synthesis gas to the Lurgi plant is derived from a Texaco coal gasification plant. Several projects are now demonstrating the Texaco process or are presently under construction.

Based on technical information provided by HRI, Texaco, and Lurgi, the reaction sections of each plant were designed and the various effluent treating and offsite facilities necessary to provide for a completely self-contained project were also included. The H-Coal distillates were upgraded to marketable products as required. From estimates of capital and operating costs a detailed financial analysis was developed with the use of the Engineering and Economic Evaluations Department's discounted cash flow program.

PROJECT OBJECTIVES

The objectives of this project were to compare two approaches to coal liquefaction on a consistent design basis and to assess the effect of various financing methods on product costs. The project would also assist EPRI in making research choices by providing a financial basis for comparison with new developments and alternative processes.

PROJECT RESULTS

The results of this study are summarized in the table below.

Comparison of Illinois No. 6 and Wyodak Coals as H-Coal feedstocks indicates:

- The production of gasoline and heavier distillate products is approximately the same in each case, but Illinois No. 6 coal yields an additional quantity of propane and butane LPG products.

- The specific (per FOE bbl/sd gasoline and heavier products) quantity of Wyodak coal required is about 40% greater owing to its higher moisture and oxygen content.

- The specific capital requirement for the Wyodak case is about 24% higher since (1) additional reactor trains are required, (2) hydrogen consumption is higher (higher oxygen content), (3) hydrogen production by reforming of light hydrocarbons is required to supplement gasification of vacuum tower bottoms, and (4) supplemental drying facilities and fuel are required to handle the higher moisture content.

- The thermal efficiency of the Wyodak case is lower as a result of these factors.

Comparison of H-Coal and Methanol Synthesis from Illinois No. 6 coal indicates:

- Production of liquid products is about 4% greater for the methanol plant as designed, but, as above, the H-Coal plant produces additional fuel as propane and butane LPG.

- The specific coal requirement for the methanol plant is about 11% greater.

- The specific capital requirement for the methanol plant is about 6% greater.

- The thermal efficiency for methanol production is lower in part owing to the large hydrogen requirement and the use of a conservative coal slurry concentration (60% solids) to the gasifier. It is also estimated that the successful development of a high-temperature heat recovery system for the gasification unit would increase the methanol plant efficiency about 5 percentage points.

It is clear from the accompanying comparison table that none of the base cases would be economically attractive to the nonregulated producer. For these presently uneconomic processes, some form of financial incentive appears mandatory. The following table illustrates the effect of several financial incentives on Case HE:

Nonregulated Starting Price--Case HE

Financing Method	Mid-1982 $/10^6 Btu
100% Equity-Base Case	9.06
75% Debt Financing @ 12% Interest	6.50
Expensing of Investment During Construction	
--100% Equity	7.72
--50% Debt @ 12% Interest	6.01

For comparison, the market value of case HE products was estimated to be $6.80/10^6 Btu (mid-1982 prices).

The levelized prices calculated for a regulated utility producer are substantially lower than the starting price for the nonregulated producer and, indeed, would

COMPARISON OF PROCESSES

Case	HE	HW	CM
Process H-Coal	H-Coal	H-Coal	Lurgi Methanol
Coal Feed	Illinois No. 6	Wyodak	Illinois No. 6
st/sd[a] (As Received)	21,891	30,960	25,418
Gasoline and Heavier Liquid Product Yield, bbl/sd (FOE)[b]	50,031	50,396	52,209
Total Fuel Product Yield, bbl/sd (FOE)	58,154	50,396	52,209
Total Capital Requirement[c]			
--Mid-1982 10^6	2,813	3,524	3,122
--$/(FOE bbl Gasoline and Heavier Liquid Product/sd)	56,225	69,926	59,798
Thermal Efficiency, %	69.7	59.6	53.9
Nonregulated Producer-Base Case			
--Starting Price[d], Mid 1982 $/$10^6$Btu	9.06	10.46	10.94
Regulated Producer-Base Case			
--Levelized Price, Mid-1982 $/$10^6$ Btu	5.78	5.66	6.88
--Required Selling Price, Mid-1982 $/$10^6$ Btu			
First Year (1990)	9.55	11.26	11.54
Third Year (1992)	7.91	8.85	9.51
Thirtieth Year (2019)	4.53	3.73	5.36

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[a] Short tons/stream day (a day at design capacity).

[b] Fuel oil equivalent barrel = 5.85 x 10^6 Btu (HHV).

[c] Excluding AFDC. The estimates assume mature plant construction.

[d] The starting price escalated at the general inflation rate which gives the same return on investment as the calculated year-by-year or levelized revenue requirements.

represent a saving over the life of the plant. Nevertheless, the annual cost of production, as the table indicates, is substantially higher than the marketplace during the early years. Thus, the regulated utility owner may have a problem in recovering costs during this period.

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