Section 7

CURRENT STATUS OF H-COAL® COMMERCIALIZATION

by

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A B S T R A C T

H-Coal® is a direct catalytic hydroliquefaction process for converting coal into high quality, clean liquids. The process uses the commercially proven ebullating-bed reactor to achieve superior distillate yields in the range of 40 to 50 weight percent from a wide variety of coals. The process has been thoroughly and successfully tested in laboratory equipment at coal capacities up to 3.5 tons per day. Over recent months, H-Coal operating experience has been obtained at the 600 ton-per-day plant at Catlettsburg, Kentucky.

Two major commercial plant design studies are underway for potential operators both in the U. S. and abroad, and additional feasibility studies are being proposed. HRI's experience with H-Coal extends to nearly 20 coals, and economic studies suggest that the H-Coal syncrude mode operation is a front-runner in terms of lowest liquefaction product cost.

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BACKGROUND

H-Coal® is a direct catalytic hydroliquefaction process developed by Hydrocarbon Research, Inc. for conversion of coal to high quality, clean liquids. The process can be modified to produce a variety of liquid fuels ranging from an all distillate synfuel to a heavy fuel oil. The novelty of H-Coal® (U. S. Patent 3,321,393) resides in its use of the commercially proven ebullating-bed reactor in combination with other process steps to achieve C4/975°F distillate yields in the range of 40 to 50 weight percent on dry coal. (Slide 1)

H-Coal® has been under development at HRI for more than fifteen years. Eighteen coal types have been evaluated in over 54,000 hours of operation. Development and demonstration have been carried out on bench-scale units processing up to 25 pounds of coal per day and in a Process Development Unit (PDU) handling 3.5 tons of coal per day. The bench-scale units are utilized for process improvement studies, catalyst evaluation and to test new coals, while the PDU studies have concentrated on confirming the design basis, operating conditions and modes of operation for the Large Pilot Plant and commercial plant projects.

The feasibility of the process is currently being demonstrated on a large scale at the 600 ton/day H-Coal® Pilot Plant in Catlettsburg, Kentucky. The projected two-year evaluation at Catlettsburg will provide the experience necessary for scale-up to commercial plants. Performance and product yields will be confirmed during the plant operations, and a firm foundation will be established for designing and constructing full-scale, commercial H-Coal® facilities. The design of a commercial H-Coal® plant has been initiated under the sponsorship of the Department of Energy. Other commercial plant designs are in the feasibility stage.

H-COAL PERFORMANCE

Hydrocarbon Research has experience with a large number of coal feeds over a wide range of operating conditions. Slide 6 presents a summary of some of the coals run in the H-Coal Process. The Eastern U. S. coals processed include Illinois No. 6, Indiana 5, Kentucky 9, 11, and 14, and Pittsburgh seam coal, all of which are bituminous coals.

The Western U. S. coals include both bituminous and sub-bituminous coals. Of these coals our experience is most extensive with Wyodak coal. This coal has presented difficulties to other direct coal liquefaction processes due to the formation of calcium carbonate deposits in the liquefaction reactor. This has not been a problem in our well-mixed catalytic H-Coal reactor system.

A second major PDU run of 40 days has recently been completed on Wyodak coal. This run used a new Amoco catalyst and demonstrated high yields and activity maintenance while operating free of calcium carbonate deposition.

Lignities have been successfully processed as have the Australian Brown coal and German "Steinkohle".

Slide 7 summarizes some typical H-Coal yields on the basis of pounds per 100 pounds of dry coal. The first two columns compare yields from an Illinois No. 6 coal for two different modes of operation, the Syncrude and the Fuel Oil modes. In the Syncrude mode, high yields of distillate liquids are achieved, in this case 47.8 wt% C4/975 F liquid products. The yield of bottoms material is adequate to meet hydrogen requirements if they are processed in partial oxidation to produce hydrogen.

In the Fuel Oil mode, operating conditions are less severe to produce a heavier product slate. The heavy fuel oil is recovered using a solids-liquid separation technique such as the Lummus Anti-Solvent Deashing or Kerr-McGee Critical Solvent Deashing process. Hydrogen consumption is also much lower than in the Syncrude mode. Other product slates intermediate to those presented may be produced to meet the particular market needs.

The third column shows yields achieved from Wyoming subbituminous coal in the Syncrude mode. The hydrogen consumption for this case was higher than the Illinois coal due to the increased yield of water with this high oxygen content coal. Distillate liquid (C4/975 F) yields of 44.4 weight percent are achieved. Less severe conditions again could be utilized to obtain a heavier product slate and lower hydrogen requirements.

Some typical H-Coal product qualities are presented in Slide 8. The analyses are for coal liquids produced from Illinois coal and Wyoming coal in the Syncrude operating mode. These qualities were achieved at lined out operating conditions on HRI's 3.5 T/D Process Development Unit during the current H-Coal process development program. Note that these H-Coal liquids are very low in sulfur compared to typical petroleum fractions. The oxygen and nitrogen contents, however, are higher. Unlike petroleum crudes and products from some other direct coal liquefaction technologies, no residual oil products (975°F Plus Boiling Range) are produced.

H-COAL® REACTOR DESCRIPTION

Slide 5 is a simplified sketch of the H-Coal® reactor. The reactor feed and recycle stream from the ebullating pump enter the bottom of the reactor. The liquid flow causes the catalyst bed to expand and fluidize. The catalyst remains in the bed. The reactor products, including the unconverted coal and ash solids, leave the bed and are separated in a vapor-liquid separator for further processing. Because the catalyst is constantly in motion, a portion of the catalyst can be withdrawn and replaced with fresh catalyst to maintain high catalyst activity. On a daily basis, about one or two percent of the catalyst inventory is removed for this purpose. The ebullating-bed reactor system has over 27 unit-years of commercial operations in our H-Oil® petroleum residuum hydroconversion process. The current H-Coal catalyst has also been demonstrated commercially in H-Oil operations.

The ebullated bed reactor allows intimate contact between catalyst particles, hydrogen, and the coal-oil slurry and thus achieves essentially isothermal reaction conditions and provides low and constant reactor differential pressure. Other major advantages of the H-Coal reactor system are:

- High liquid yields and qualities are achieved in the presence of a synthetic catalyst and are not dependent on the catalytic effect of coal ash.
- Continuous catalyst replacement controls deactivation, provides constant product quality, allows the possibility of continuous catalyst regeneration, and provides for high unit service factors.
- Operating conditions can be varied to meet flexible product slate requirements.
- Direct catalytic hydrogenation of coal offers the potential for use of different and improved catalysts in the future as product requirements change.
- The ebullated bed assures good temperature control throughout the reactor, using the energy of the reaction to heat the feed slurry to reaction temperatures. The continuous liquid phase in this well-mixed system provides an excellent heat sink to assure reactor stability and a high degree of operability.

Fluid dynamics of the H-Coal reactor system is a critical element of scaleup, and has been studied extensively in the PDU and in cold-model simulations of both the PDU and the Large Pilot Plant. Significant improvements in design of reactor internals have been made, and transient responses of the system under upset conditions have been quantified.

LARGE PILOT PLANT PROJECT

The H-Coal® Process has been thoroughly tested on bench and PDU size equipment and is now being demonstrated in commercial-size equipment at the Catlettsburg Pilot Plant. This plant is the largest Coal Liquefaction Pilot Plant ever built in the U. S. It is designed to feed up to 600 tons of coal per day to produce up to 1,800 barrels per day of liquid product. Ashland Oil is responsible for Pilot Plant operations. The Pilot Plant has several major objectives which are not obtainable on laboratory-scale equipment. These objectives include:

- Demonstrate the mechanical operability and reliability of commercial scale equipment.
- Provide products for commercial testing at rates of 100 to 300 tons per day.
- Verify yields in commercial size equipment.
- Collect scale-up and engineering data.
- Determine appropriate materials for construction.
- Establish maintenance requirements for key items of equipment.

Two operating configurations have been designed into the plant, and a two-year demonstration program is planned, encompassing syncrude and boiler-fuel mode operations and using three different coals. Plans for the first year include syncrude operations with Kentucky No. 11 and Illinois No. 6 coals. The schedule for the second year calls for boiler fuel operations with those two coals and a return to the syncrude mode using Wyodak coal.

Operations of the plant are currently underway. Oil was first fed to the reactor system on February 26, 1980. A series of scheduled oil operations were then carried out processing first a light gas oil, then a heavy gas oil, and finally a residual fuel oil to eliminate any deficiencies of the operating equipment and to provide operator training.

Coal was first fed to the H-Coal® Reactor on May 29, 1980. Currently, operations are with Kentucky No. 11 coal at a feed rate target of 220 tons per day in the syncrude operating mode. Coal conversions as high as 95 percent have been achieved. Onstream days, to date, have been somewhat limited because of maintenance requirements associated with the pressure let-down valves.

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The coal liquids produced in the H-Coal process may require some further upgrading prior to their ultimate utilization. The naphtha cut requires hydrotreating to remove sulfur, nitrogen and oxygen contaminants. The hydrotreated naphtha then makes an excellent quality feedstock for catalytic reforming to produce a high octane gasoline blend stock. The reformate can also be used for production of chemicals such as benzene, toluene and xylenes.

The mid-distillate material can be used as home heating oil, diesel fuel, jet fuel, or turbine fuel after some mild to severe hydrotreating. The heavy fuel oil material can be used directly as boiler fuel or may be upgraded to meet specific customer requirements. Extensive upgrading and end-use testing has been carried out and more is planned as part of the current H-Coal Large Pilot Plant project.

H-COAL PROCESS DEVELOPMENT UNIT EXPERIENCE

The H-Coal Process Development Unit (PDU) has been operated intermittently over the last 14 years to demonstrate scaleup of yield data, to demonstrate equipment operability, and to obtain products for downstream testing. Nine PDU runs, typically of about 30 days duration, have been carried out under the current H-Coal development program and some of the major accomplishments are summarized below.

- Illinois No. 6, Kentucky No. 11 and Wyodak coals successfully processed.
- Equilibrium catalyst conditions simulated using continuous catalyst addition and withdrawal.
- Syncrude, Fuel Oil and Intermediate Modes of Operation Demonstrated.
- Emergency operating procedures for Pilot Plant were tested while providing operator training.
- Critical operating limits such as maximum gas velocity were evaluated.
- Two-stage slurry letdown system designed for Pilot Plant demonstrated.
- Irradiated catalyst used to test ebullated-bed mixing and catalyst deactivation.
- Demonstration run on Illinois No. 6 Coal used as basis for H-Coal® Commercial Plant.

FUTURE PROSPECTS FOR H-COAL

The cost of coal liquids by direct hydroliquefaction is generally considered to fall in the range of 25 to 45 $/B (1979 $). The wide range of cost estimates derives from the great variations in basic assumptions made and level of detail incorporated in the calculations. These costs are presently about equal to the average cost of products from imported oil at OPEC prices. In addition, the balance-of-payments and security-of-supply issues have led the U. S. Government to act further to stimulate commercialization of a coal liquids industry.

In part because of the wide variation in product costs calculated for coal liquefaction, comparisons of the various processes are difficult to make, and infrequently reported. One such comparison, though, was made in July, 1979, by the Engineering Societies Commission on Energy (ESCOE), under Department of Energy Contract No. EF-77-C-01-2468. Product costs estimated by ESCOE (SLIDE 11) are summarized for various coal liquefaction processes. These costs are calculated by two alternate methods. The first column lists costs of producing coal liquids for the various technologies on an energy basis in terms of dollars per million BTU's of energy produced. Since different products and product qualities are produced from each process, it is necessary to adjust the product costs to reflect the value of the products in the market place. In the second column, the individual products are assigned value factors, based on current market price relationships. These factors provide a basis for determine an effective cost for the multi-product slate, to simulate the cost incurred if all products were transformed to gasoline product.

The H-Coal syncrude mode appears to produce products at the lowest estimated cost for all processes reported by ESCOE. While these data are not conclusive, H-Coal would appear to be a front-runner in terms of lowest-cost product. Low costs for H-Coal reflect the superior liquid yields demonstrated in the development to date.

The H-Coal process as studied by ESCOE and now being commercialized represents a translation to large equipment of the reactor operations and process configurations as designed in the early 1970's. Improvements and variations are now being evaluated by use of our new H-Coal Commercial Plant LP Model. These studies, supported by our ongoing experimental and engineering R&D program, offer promise of even lower H-Coal product costs. Staged operations, further catalyst improvements, and superior dispositions of bottoms and gas are of particular interest. Combined with the inherent flexibility of a direct-catalytic process, and the proven capability to handle a full range of coal types, this assessment suggests a bright future indeed for the H-Coal Process.

ACKNOWLEDGEMENTS. The authors acknowledge the contributions to this paper by Alfred G. Comolli, James B. MacArthur, Harold H. Stotler, and others of the HRI staff.

DEVELOPMENT PLAN FOR COMMERCIALIZATION

The development path for commercialization of H-Coal is similar to that used by HRI for scale-up of the commercial H-Oil® residuum and heavy crude hydroconversion process. The H-Oil Reactor system was scaled-up from the bench, through the PDU, followed by a large Pilot Plant demonstration unit and finally to the commercial scale plant. The reactor diameters are shown below.

	H-Oil Reactor Diameter	H-Coal Reactor Diameter
Bench Unit	3/4"	3/4"
Process Development Unit	8-1/2"	6 & 8-1/2"
Large Pilot Plant	4'6"	5'
Commercial Plant	13"	10-13"

Likewise, the H-Coal commercialization steps follow the same reactor scaleup criteria. The 5-foot diameter H-Coal reactor is currently in operation at Catlettsburg while the commercial-scale reactors are being designed as part of the Phase Zero H-Coal Commercial Plant Project. An H-Coal commercial plant would have several reactors in parallel, depending on the economy of scale desired by the operator and the availability of capital. In terms of the individual reactor train, the commercial scale reactor would have about ten times the throughput as the Catlettsburg Pilot Plant with a diameter scaleup of 2 to 3 times.

The Department of Energy has authorized work to begin on the design of a commercial scale H-Coal liquefaction plant. This plant is to be located in Breckinridge County, Kentucky and will be designed to feed about 23,000 tons per day of run-of-mine Illinois #6 coal to produce a nominal 50,000 B/D of hydrocarbon liquid products and about 30 MSCF/D of SNG. The Phase Zero program includes:

- Commercial Plant Design
- Cost Estimate & Economic Evaluation
- Detailed Plans for Construction & Operation

Phase Zero is a 9-million-dollar cooperative effort between DOE, Ashland Oil, and AIRCO extending through April, 1981. The schedule calls for follow-on phases for detailed engineering, procurement, and construction leading to startup of the commercial plant about mid-1986. (Slide 10)

HRI is currently involved in feasibility studies for other commercial H-Coal liquefaction facilities. This includes a major program for an overseas client involving several coals which extend the H-Coal data base significantly. Several bench unit runs have been undertaken to optimize process parameters and depth of coal cleaning, and to establish variability of the clients coal resource. A PDU program to confirm the engineering design basis is in progress.

Continuing research and development on the H-Coal Process has led to the discovery of better catalysts, to improvements in modes of operation and has demonstrated versatility of the ebullated-bed reactor in processing various coals. The current H-Coal Development Program consists of Laboratory R&D Studies and PDU Operations; Engineering Process Development and Economic Studies; Product Testing, Upgrading, and End Use Studies; and the Large Pilot Plant Construction and Operation. It is scheduled to run through the end of 1982 and cost a total of 296 million dollars. (Slide 2)

Initially, Dynalectron Corporation, HRI's parent company, supported the development program and, as the process advanced, funding became available through other companies. Currently, the sponsors are the U. S. Department of Energy, the Electric Power Research Institute, Ashland Oil, Inc., Standard Oil Company of Indiana, Conoco Coal Development Company, Mobil Oil Corporation, the Commonwealth of Kentucky, and Ruhrkohle, AG.

H-COAL® PROCESS DESCRIPTION

Slide 3 presents a schematic of the H-Coal® Process. Coal is crushed, dried and slurried with a process-derived oil, pumped to reactor pressure, mixed with hydrogen and fed to the reactor. There, the coal, recycle oil, and hydrogen react in the presence of a catalyst. The reactor typically operates at a temperature of about 850°F and 3000 psig pressure. Depending on the process severity selected, the net product yield can be all-distillate material, or at low severities, a distillate and a heavy fuel oil. The reactor effluent slurry is processed through hydroclones to reduce its solids content. Low solid content oil is recycled as a slurry oil for the feed coal. The balance of the liquid is fractionated to produce an all-distillate product. The vacuum residuum, containing non-distillate oils, unconverted coal, and ash, can be fed to a partial oxidation unit to produce the hydrogen for the process as shown or used for plant fuel.

Slide 4 lists some of the main features of the H-Coal Process. High yields of distilled low sulfur liquids have been demonstrated with bituminous and sub-bituminous coals and lignites. The presence of the catalyst in the coal liquefaction reactor significantly improves conversion of heavy coal liquids to distillate boiling range products. Typically 2.8 to 3.5 barrels of C_3/975°F oil is produced per ton of dry coal fed to liquefaction. The catalytic ebullating bed reactor combines coal liquefaction, solvent hydrogenation, and product upgrading in a single reactor. This reduces the number of process steps as compared to some of the other coal liquefaction technologies. This simplified flow scheme helps to reduce plant costs, increase process efficiency, and improve plant service factor.

Hydroclones are used to recover a high residuum content recycle oil (to maximize distillate liquid yields and improve unit operability) while minimizing solids recycled to the H-Coal reactor. Liquid products are recovered by conventional atmospheric and vacuum distillation. Process hydrogen requirements can be met by Partial Oxidation of liquefaction bottoms and by Steam Reforming of light hydrocarbons produced in the H-Coal Process. Some further product upgrading is required to produce high quality transportation fuels such as gasoline, diesel, or jet fuel.

SLIDE 1

BACKGROUND OF THE H-COAL PROCESS

- H-COAL® IS A PATENTED CATALYTIC HYDROLIQUEFACTION PROCESS DEVELOPED BY HRI.
- THE PROCESS PRODUCES C_4-975°F DISTILLATES IN THE RANGE OF 40-50 W % OF FEED COAL.
- MORE THAN 15 YEARS OF DEVELOPMENT
- OVER 54,000 HOURS OF OPERATION IN BENCH-SCALE AND PROCESS DEVELOPMENT UNITS
- BENCH SCALE OPERATIONS
  - PROCESS OPTIMIZATION
  - CATALYST EVALUATION
  - NEW COAL EVALUATION
- PDU OPERATIONS
  - CONFIRM DESIGN BASIS
- THE FEASIBILITY OF THIS PROCESS WILL BE DEMONSTRATED IN A 600 T/D PILOT PLANT IN CATLETTSBURG, KENTUCKY

SLIDE 2

H-COAL© LARGE PILOT PLANT PROJECT

CURRENTLY SPONSORED BY

U. S. DEPARTMENT OF ENERGY
ELECTRIC POWER RESEARCH INSTITUTE
ASHLAND OIL, INC.
STANDARD OIL (INDIANA)
CONOCO COAL DEVELOPMENT COMPANY
MOBIL OIL COMPANY
COMMONWEALTH OF KENTUCKY
RUHRKOHLE AG

DEVELOPMENT PROGRAM

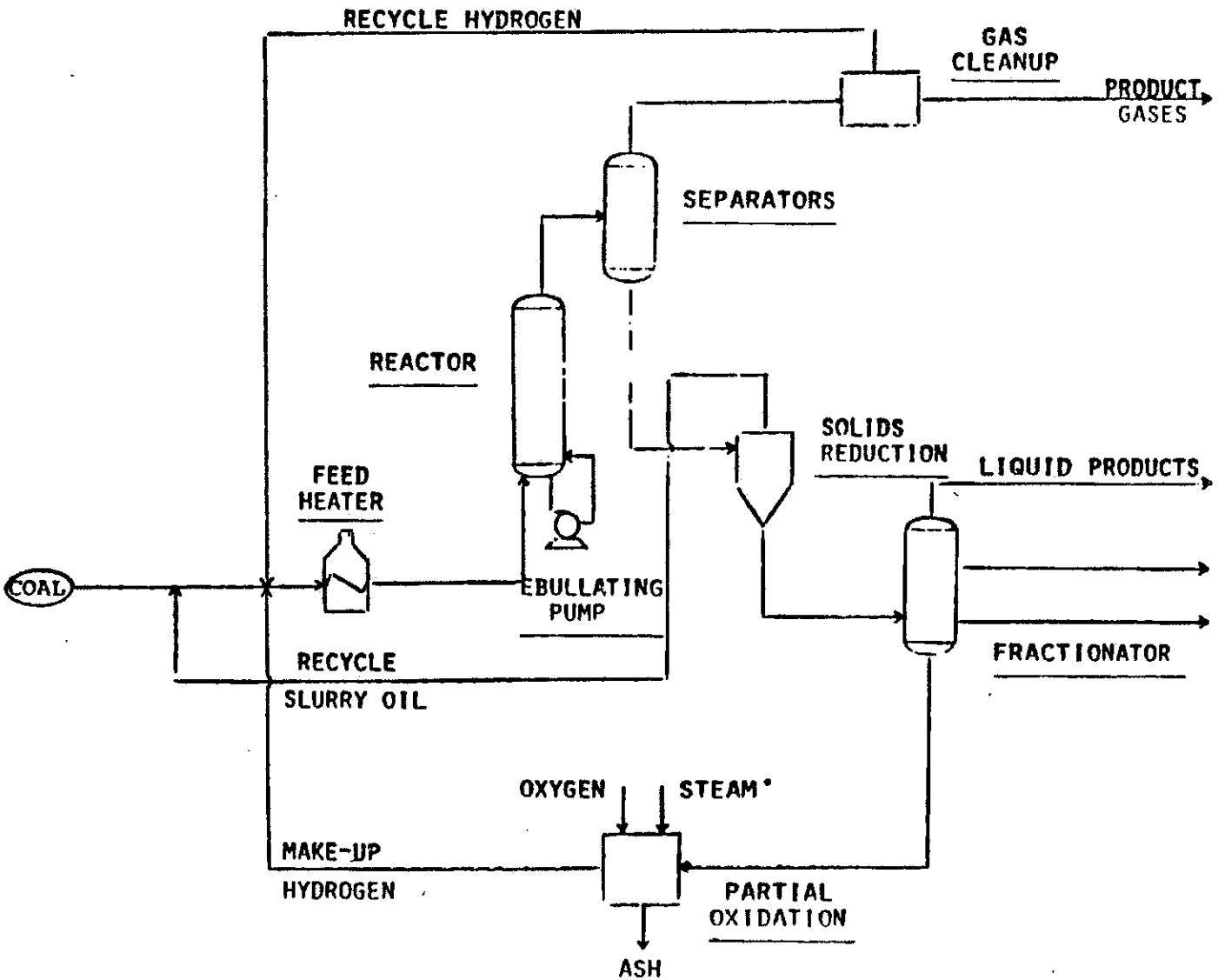
- LABORATORY R&D STUDIES AND PDU OPERATIONS
- ENGINEERING PROCESS DEVELOPMENT AND ECONOMICS STUDIES
- PRODUCT TESTING, UPGRADING AND END USE STUDIES
- LARGE PILOT PLANT CONSTRUCTION AND OPERATION

SCHEDULE AND COST

1974 THROUGH 1982
$ 296 MILLION

SLIDE 3

H-COAL® PROCESS



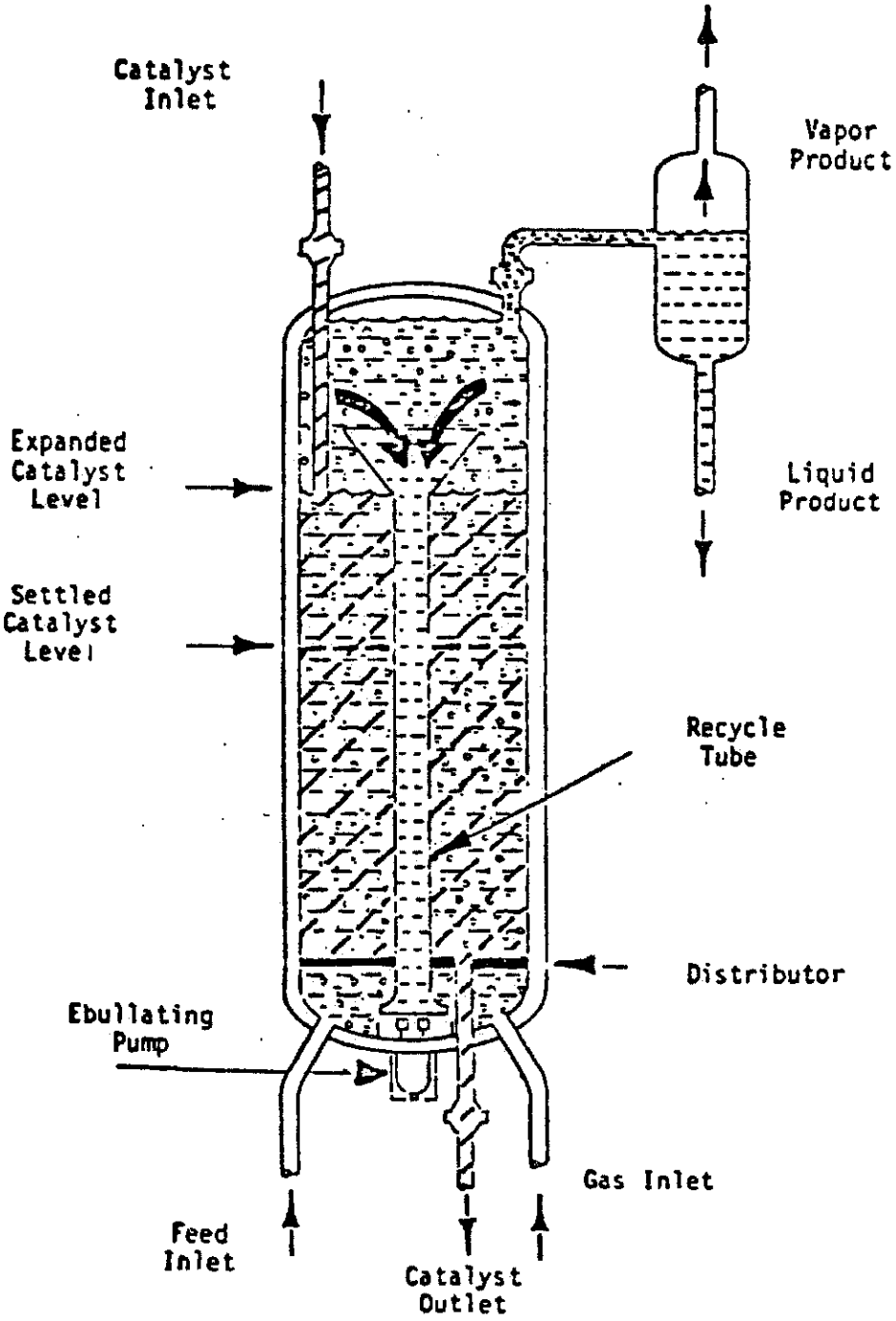
SLIDE 4

H-COAL® PROCESS FEATURES

- HIGH YIELDS OF DISTILLED, LOW SULFUR LIQUIDS FROM BITUMINOUS AND SUB-BITUMINOUS COALS AND LIGNITES
  - 40 TO 50 WT% C_4/975°F LIQUID YIELD ON DRY COAL
- CATALYTIC EBULLATED BED COMBINES COAL LIQUEFACTION, SOLVENT HYDROGENATION AND PRODUCT UPGRADING IN A SINGLE REACTOR
- HYDROCLONES USED TO RECOVER LOW SOLIDS RESIDUUM OIL STREAM TO SLURRY COAL FEED
- LIQUEFACTION EFFLUENT SEPARATED BY DISTILLATION
- LIQUEFACTION BOTTOMS CAN BE FED TO PARTIAL OXIDATION FOR HYDROGEN PRODUCTION

SLIDE 5

EBULLATED BED REACTOR



SLIDE 6

COALS RUN IN H-COAL® PROCESS

EASTERN U.S.

ILLINOIS NO. 6
INDIANA NO. 5
KENTUCKY 9/14
KENTUCKY 11
PITTSBURGH SEAM (CONSOL NO. 8)

WESTERN U.S.

WYODAK
UTAH D.
BIG HORN
COLORADO
BLACK MESA

LIGNITES (U.S.)

TEXAS
N. DAKOTA

FOREIGN

AUSTRALIAN BROWN
GERMAN "STEINKOHLE"
OTHERS

SLIDE 7

TYPICAL H-COAL® YIELDS(1)

YIELDS, LBS/100 LBS DRY COAL	ILLINOIS BITUMINOUS (BURNING STAR) SYNCRUDE	ILLINOIS BITUMINOUS (BURNING STAR) FUEL OIL	WYOMING SUB-BITUMINOUS (WYODAK) SYNCRUDE
H_2	(5.3)	(3.4)	(6.2)
H_2O, CO, CO_2	7.1	6.5	20.0
H_2S, NH_3	3.6	2.2	1.6
C_1-C_3	11.2	6.8	12.3
C_4-400°F NAPHTHA	18.7	13.4	25.8
400-975°F FUEL OIL	29.1	20.8	18.6
975°F+ BOTTOMS (INCL. ASH)	35.6	53.7	27.9
	100.0	100.0	100.0

(1) BASED ON LINED OUT OPERATION IN THE 3 TON/DAY PROCESS DEVELOPMENT UNIT (PDU) AT HYDROCARBON RESEARCH, INC.'S TRENTON LABORATORY.

SLIDE 8

TYPICAL H-COAL® LIQUID PRODUCT QUALITIES

	ILLINOIS BITUMINOUS (BURNING STAR)	WYOMING SUB-BITUMINOUS (WYODAK)
OPERATING MODE	SYNCRUDE	SYNCRUDE
NAPHTHA(IBP/350°F)		
°API	52.3	55.8
C	85.3	84.7
H	13.8	14.0
O	0.56	1.25
N	0.24	0.10
S	0.07	0.02
MID-DISTILLATE(350/600°F)		
°API	18.5	27.8
C	88.4	87.0
H	10.1	11.4
O	1.0	1.3
N	0.47	0.22
S	0.08	0.03
DISTILLATE BOILER FUEL(500/800°F)		
°API	4.9	10.9
C	89.4	88.4
H	8.6	9.4
O	1.3	1.7
N	0.63	0.46
S	0.08	0.03

SLIDE 9

PROBABLE DISPOSITION OF H-COAL® PRODUCTS

CUT	UPGRADING REQUIRED(1)	DISPOSITION(2)	COMMENTS
NAPHTHA C5/350°F	NAPHTHA HYDROTREATING, CATALYTIC REFORMING	MOTOR GASOLINE, AROMATICS PRODUCTION	SEVERE HYDROTREATING CONDITIONS, EXCELLENT REFORMER FEEDSTOCKS (88 LV% C5 PLUS, 3.4 WT% H_2 YIELDS @ 103 RON)
MID-DISTILLATE 350/650°F	MILD HYDROFINISHING TO SEVERE HYDROTREATING (FOR DIESEL)	HOME HEATING OIL, DIESEL FUEL, TURBINE FUEL	NITROGEN REMOVAL FOR STABILITY, CETANE INDEX IMPROVEMENT, GRAVITY IMPROVEMENT
FUEL OIL 350°F+ OR 650°F+	NONE TO MILD HYDROTREATING	LARGE STATIONARY COMBUSTION FUEL (STEAM BOILERS)	UPGRADING REQUIREMENTS, IF ANY, DEPEND ON CUSTOMER REQUIREMENTS

(1) UPGRADING STUDIES HAVE BEEN CARRIED OUT ON H-COAL PRODUCTS BY HRI, UOP, MOBIL, CHEVRON, EXXON AND OTHERS. STUDIES INCLUDE HYDROTREATING, HYDROCRACKING, CATALYTIC CRACKING, COKING, CATALYTIC REFORMING, PARTIAL OXIDATION, AND STORAGE STABILITY.

(2) END USE TESTING INCLUDES DEMONSTRATION OF H-COAL PRODUCTS IN GASOLINE, HOME HEATING OIL, NO. 2 FUEL OIL AND TURBINE FUEL.

SLIDE 10

ASHLAND COMMERCIAL PLANT PRODUCT SLATE

COAL FEED		
	RUN-OF-MINE ILLINOIS NO. 6	22,500 T/D
PRODUCTS		
	MOGAS BLEND STOCKS (C_5/360°F)(1)	16,000 B/D
	DISTILLATE FUEL OIL(360/950°F)	24,600 B/D
	BUTANE	3,800 B/D
	PROPANE	5,900 B/D
	C_3/950°F LIQUID PRODUCTS	50,300 B/D
BY PRODUCTS		
	SULFUR	520 LT/D
	AMMONIA	160 T/D
	SNG	25 MSCF/D

(1) ALTERNATE PETROCHEMICAL OUTLET TO BE EVALUATED

SLIDE 11

COAL LIQUEFACTION PROCESS COMPARISON

REFERENCE: COAL CONVERSION COMPARISONS BY K. A. ROGERS AND R. F. HILL, ENGINEERING SOCIETIES COMMISSION ON ENERGY INC., JULY 1979

	ENERGY COST $/MBTU	REFERENCE PRICE $/MBTU
DIRECT LIQUEFACTION-SOLID PRODUCT		
SRC-I	3.38	6.67
DIRECT LIQUEFACTION-LIQUID PRODUCT		
SRC-II	3.62	5.59
EDS	3.96	5.40
H-COAL FUEL OIL	3.30	5.09
H-COAL SYNCRUDE	3.58	4.81
INDIRECT LIQUEFACTION		
FISCHER-TROPSCH	4.99	5.52
M - GASOLINE	4.89	4.91
METHANOL	4.37	4.54