PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

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ATTACHMENTS

PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

1.0 INTRODUCTION

In the original feasibility study for the Tri-State Synfuels Project, cresols and creosotes were to be sold as final products. This study develops process and cost information for hydrocracking these cresols and creosotes to gasoline and diesel fuel.

The capital and operating costs of the cresols/creosotes hydrocracking case were developed and incremental costs over the original feasibility study are given.

2.0 PROCESS DESCRIPTION

2.1 Cresols/Creosotes Hydrocracking

The Cresols/Creosotes Hydrocracking Process employed in this study is licensed by Union Oil Company of California. The process is based upon Unicracking technology. World-wide capacity of the Unicracking process is more than 850,000 B/D.

Feed to the unit consists of medium and heavy Creosote from Tar Distillation and Cresols from Phenosolvan. The main purpose of the unit is to produce maximum yield of middle distillate. The unit hydrogenates the feed to produce mainly diesel and naphtha. Sulfur, nitrogen, and oxygen compounds are also hydrogenated and removed. The high purity hydrogen (99.5%) for the process is provided from the PSA Units.

The small amount of gas produced by the unit is routed to fuel gas. The light naphtha, which is approximately 1 percent of the total gasoline pool, is routed directly to gasoline blending. The heavy naphtha, consisting mainly of cyclohexane and cyclopentane is upgraded for octane improvement in the Naphtha Hydrotreater/ Reformer. In order to meet distillation and pour point specifications, the material from the hydrocracker heavier than naphtha is fractionated into a diesel and fuel oil cut. The diesel cut is routed directly for grade 1-D diesel blending with the light diesel from the DHT/DSC Unit.

2.2 Mass Balance

The material balance for the Creosote Hydrocracker is shown in Table 1.

2.3 Product Properties

Following is the preliminary estimate of the product properties from the Creosote Hydrocracker.

Light Naphtha (C_5/185 °F)

Gravity, °API	54.0
Sulfur, wppm	<1.0
Nitrogen, wppm	<1.0
RON, clear	83
MON, clear	76

Heavy Naphtha (185/325 °F)

Gravity, °API	49.0
Boiling Range, D-86	194-329 °F
Sulfur, wppm	<1.0
Nitrogen, wppm	<1.0
RON, clear	68

Diesel + Fuel Oil (325 °F+)

Gravity, °API	31.3
Boiling Range, D-86	347-725 °F
Sulfur, wppm	< 5
Nitrogen, wppm	< 2
Cetane, number	45
Pour Point, °F	+28

2.4 Utility Requirements

The Cresol/Creosote Hydrocracker will require the following utilities on a stream hour basis:

600 psig, 750°F superheated steam, lbs/hr	3630
600 psig saturated steam, lbs/hr	1340
120 psig saturated steam, lbs/hr	600
Electricity, kw	3500
Fuel gas, MM BTU/HR	11.7

Significant utilities incurred in the PSA, NHT/Reformer, Fuel Gas System, Tankage, and Shipping are:

Electricity, kw	350
Fuel gas, MM BTU/HR	18.2

The small amount of waste water will be processed along with the gas liquor.

2.5 Environmental Considerations

There are no significant emissions forseen for the addition of the Cresol/Creosote Hydrocracker. The sour water, containing H_2S and NH_3, will be added to the gas liquor in the Phenosolvan plant.

The small amount of fuel gas contains H_2S and will be amine treated in the Oil Workup Section.

3.0 ECONOMICS

3.1 Capital Cost Estimate

The capital cost for the Cresol/Creosote Hydrocracker, including fractionation, rundown tankage and royalties is 23.28 million dollars. Costs are tabulated in Table 2.

Incremental capital costs for the NHT/Reformer, PSA Unit, Sour Water treating, diesel blend tank, shipping facilities is 6.00 million dollars.

The total capital cost increase is 29.13 million dollars.

3.2 Operating Cost Estimate

The operating labor requirement is estimated at 15 people to give full shift coverage on an annual basis.

Using an average labor cost consistent with the feasibility study, of $29,000/man/year that includes 35 percent overburdens and an allowance for shift differential and overtime, the overall operating labor cost is calculated as follows:

15 men x $29,000/year = $435,000 per year

The maintenance costs of the Cresol/Creosotes Hydrocracking Unit are estimated at:

Maintenance Labor = $ 800,000
Maintenance Material = $ 530,000

Utility costs are tabulated in Table 3.

3.3 Thermal Efficiency

The energy remaining in the products produced by this process divided by the net energy contained in the feed streams to this unit is 87%.

3.4 Conclusions

Since the economic evaluation will be made by others, no conclusions have been reached other than the data presented in the body of this study.

Table 1

MATERIAL BALANCE FOR THE CRESOL/CREOSOTE HYDROCRACKER

FEEDS

	lbs/hr	API	B/CD
Medium Creosote	17,694		
Heavy Creosote	13,673	7.5	2,395
Cresols	4,223		
Hydrogen	2,124		
Wash Water	1,196		
Total Input	38,910		

PRODUCTS

	lbs/hr	API	B/CD
Sour Fuel Gas	802		
Light Naphtha*	1,758	54.0	158
Heavy Naphtha*	8,218	49.0	718
Diesel Fuel (1-D)	19,700	34.0	1,581
Fuel Oil	4,608	19.9	338
Sour Water	3,824		
Total Output	38,910		2,795

Notes:
1. *Increase in total gasoline pool = 158 + 752 = 910 B/CD (Light + Heavy Naphtha).
2. The 718 B/CD heavy naphtha is reformed to produce 752 B/CD of reformate that is added to the gasoline pool.
3. The increase in heavy naphtha yield over that shown above is due to increased reformer yield at the same severity (RON clear) with the easier to reform Naphthenic hydrocracker naphtha as partial reformer feedstock.
4. To convert the above rates to stream day basis, multiply by the fraction 365/340.

TABLE 2

CAPITAL COST ADDITION FOR CRESOL/CREOSOTE HYDROCRACKING

	$ MM (January 1980)
Hydrocracker - Onsite	21.84
- Initial charge of catalyst	0.45
- Intermediate storage tank	0.84
Sub-total	23.13
Associated Units - (NHT/Reformer, PSA Unit etc.)	6.00
Total Incremental Capital Cost	29.13

License and royalties (by client) 0.15$MM

TABLE 3

ADDITIONAL OPERATING AND MAINTENANCE COSTS SUMMARY

	$MM/Year
Coal Supply	No Change
Electricity @ $0.055/kw	1.729
Fuel Gas @ $5.00/MM BTU	1.221
High Pressure Steam @ $3.25/1000 lb	0.132
Low Pressure Steam @ $2.45/1000 lb	0.012
Water Supply @ $0.50/1000 lb	No Change
Labor	
Operating	0.435
Maintenance	0.800
Materials and Supplies	0.530
Chemicals and Catalysts	0.250
Ash Disposal	No Change
Incremental increase in Operating and Maintenance Costs	5.109

Note: Utility unit costs above are as recommended by Fluor. They are included in the preliminary Process Design Criteria Manual. The preliminary version of this manual is nearing completion.

APPENDIX 1

PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

SCOPE OF STUDY

PROCESS STUDY

EVALUATE THE UTILIZATION OF TAR ACIDS AS PLANT FUEL

1.0 GENERAL

Eliminate creosote, cresols and phenols from the product slate developed for the feasibility study by using these materials as in-plant fuel oils.

2.0 WORK DEFINITION

2.1 The composition and yield of creosotes, creosols and phenols will be the same as in the feasibility study.

2.2 The fuel value for these materials will be determined.

2.3 Calculate the quantity of coal which would be saved by these fuel oils.

2.4 Determine the revised capital and operating costs.

3.0 DELIVERABLES TO TRI-STATE

A formal report that contains the following:

3.1 Revised block flow diagram.

3.2 Revised capital cost.

3.3 Revised operating costs.

3.4 Thermal efficiency calculation.

3.5 A formal report that gives the scope of work and all conclusions that were reached.

4.0 SCHEDULE

It is estimated that the above work will be completed about 8 weeks after Tri-State authorizes Fluor to proceed.

APPENDIX 2

PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

ESTIMATE DETAILS

COST ESTIMATE

CLIENT TRI-STATE SYNFUELS DESCRIPTION "CREOSOTE SPLITTER STUDY" UNIT 25 HYDROGEN PURIFICATION JAN 1980 INSTANTANEOUS PROP. NO. W.O. NO. CONT. NO. 835504 MADE BY APPROVED

LOCATION WESTERN KENTUCKY

PROJECT TRI-STATE SYNFUELS

A/C NO.	ITEM & DESCRIPTION	MANHOURS X 10^3	ESTIMATED COST U.S. $ 10^3			
			LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
00-00	Excavation					
10-00	Concrete					
20-00	Structural Steel					
30-00	Buildings					
40-00	Machinery & Equipment					
50-00	Piping					
60-00	Electrical					
70-00	Instruments					
80-00	Painting & Scaffolding					
85-00	Insulation					
	DIRECT FIELD COSTS	33	396		835	1 231
90-00	International Expense					
91-00	Temporary Construction Facilities					
92-00	Constr. Services, Supplies & Expense					
93-00	Field Staff, Subsistence & Expense					
94-00	Craft Benefits, Payroll Burdens & Insur.					
95-10	Equipment Rental					
95-50	Small Tools					
99-40	Field Staff Overhead Costs					
	INDIRECT FIELD COSTS					548
	TOTAL FIELD COSTS					1 779
96-00	Home Office Construction					
	Project Engineering					
	Process Engineering					
	Design					
	Purchasing					
	Business Services					
97-00	Office Expense					
98-00	Office Payroll Burdens					
99-50	Office Overhead Costs					
	TOTAL OFFICE COSTS					223
	TOTAL FIELD & OFFICE COSTS					2 002
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					195
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					2 197

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COST ESTIMATE

CLIENT TRI-STATE SYNFUELS
LOCATION WESTERN KENTUCKY
PROJECT TRI-STATE SYNFUELS

DESCRIPTION "CREOSOTE SPLITTER STUDY" UNIT 28 - CREOSOTE HYDROGENERATOR & CREOSOTE DIESEL SPLITTER JAN 1980 INSTANTANEOUS

PROP. NO.
W.O. NO.
CONT. NO. 835504
MADE BY
APPROVED

A/C NO.	ITEM & DESCRIPTION	MANHOURS x 10^3	ESTIMATED COST U.S. $ x 10^3 LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
00-00	Excavation					
10-00	Concrete					
20-00	Structural Steel					
30-00	Buildings					
40-00	Machinery & Equipment					
50-00	Piping					
60-00	Electrical					
70-00	Instruments					
80-00	Painting & Scaffolding					
85-00	Insulation					
	DIRECT FIELD COSTS	212	2 545		10 607	13 152
90-00	International Expense					
91-00	Temporary Construction Facilities					
92-00	Constr. Services, Supplies & Expense					
93-00	Field Staff, Subsistence & Expense					
94-00	Craft Benefits, Payroll Burdens & Insur.					
95-10	Equipment Rental					
95-50	Small Tools					
99-40	Field Staff Overhead Costs					
	INDIRECT FIELD COSTS					4 342
	TOTAL FIELD COSTS					17 504
96-00	Home Office Construction					
	Project Engineering					
	Process Engineering					
	Design					
	Purchasing					
	Business Services					
97-00	Office Expense					
98-00	Office Payroll Burdens					
99-50	Office Overhead Costs					
	TOTAL OFFICE COSTS					2 409
	TOTAL FIELD & OFFICE COSTS					19 913
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					1 942
	TOTAL					
98-60	Fee					
	TOTAL PROJECT					21 845

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COST ESTIMATE

CLIENT TRI-STATE SYNFUELS
DESCRIPTION "CREOSOTE SPLITTER STUDY" UNITS 30/31 NAPHTHA HYDROTREATER & CATALYTIC REFORMER JAN 1980 INSTANTANEOUS
PROP. NO.
W.O. NO.
CONT. NO. 835504
MADE BY
APPROVED
LOCATION WESTERN KENTUCKY
PROJECT TRI-STATE SYNFUELS

A/C NO.	ITEM & DESCRIPTION	MANHOURS x 10^3	ESTIMATED COST U.S. $ x 10^3 LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
00-00	Excavation					
10-00	Concrete					
20-00	Structural Steel					
30-00	Buildings					
40-00	Machinery & Equipment					
50-00	Piping					
60-00	Electrical					
70-00	Instruments					
80-00	Painting & Scaffolding					
85-00	Insulation					
	DIRECT FIELD COSTS	61	732		1 116	1 848
90-00	International Expense					
91-00	Temporary Construction Facilities					
92-00	Constr. Services, Supplies & Expense					
93-00	Field Staff, Subsistence & Expense					
94-00	Craft Benefits, Payroll Burdens & Insur.					
95-10	Equipment Rental					
95-50	Small Tools					
99-40	Field Staff Overhead Costs					
	INDIRECT FIELD COSTS					944
	TOTAL FIELD COSTS					2 792
96-00	Home Office Construction					
	Project Engineering					
	Process Engineering					
	Design					
	Purchasing					
	Business Services					
97-00	Office Expense					
98-00	Office Payroll Burdens					
99-50	Office Overhead Costs					
	TOTAL OFFICE COSTS					334
	TOTAL FIELD & OFFICE COSTS					3 126
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					305
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					3 431

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COST ESTIMATE

CLIENT TRI-STATE SYNFUELS
DESCRIPTION "CREOSOTE SPLITTER STUDY"
PROP. NO.
W.O. NO.
LOCATION WESTERN KENTUCKY
CREOSOTE HYDROCRACKING RUNDOWN TANKS
CONT. NO. 835504
MADE BY
PROJECT TRI-STATE SYNFUELS
JAN 1980 INSTANTANEOUS
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A/C NO.	ITEM & DESCRIPTION	MANHOURS x 10^3	ESTIMATED COST U.S. $ 10^3			
			LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
00-00	Excavation					
10-00	Concrete					
20-00	Structural Steel					
30-00	Buildings					
40-00	Machinery & Equipment					
50-00	Piping					
60-00	Electrical					
70-00	Instruments					
80-00	Painting & Scaffolding					
85-00	Insulation					
	DIRECT FIELD COSTS	20		240	170	410
90-00	International Expense					
91-00	Temporary Construction Facilities					
92-00	Constr. Services, Supplies & Expense					
93-00	Field Staff, Subsistence & Expense					
94-00	Craft Benefits, Payroll Burdens & Insur.					
95-10	Equipment Rental					
95-50	Small Tools					
99-40	Field Staff Overhead Costs					
	INDIRECT FIELD COSTS					279
	TOTAL FIELD COSTS					689
96-00	Home Office Construction					
	Project Engineering					
	Process Engineering					
	Design					
	Purchasing					
	Business Services					
97-00	Office Expense					
98-00	Office Payroll Burdens					
99-50	Office Overhead Costs					
	TOTAL OFFICE COSTS					74
	TOTAL FIELD & OFFICE COSTS					763
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					74
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					837

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COST ESTIMATE

CLIENT TRI-STATE SYNFUELS
DESCRIPTION "CREOSOTE SPLITTER STUDY" ADDITIONAL BLEND TANK JAN 1980 INSTANTANEOUS
PROP. NO.
W.O. NO.
CONT. NO. 835504
MADE BY
APPROVED
LOCATION WESTERN KENTUCKY
PROJECT TRI-STATE SYNFUELS

A/C NO.	ITEM & DESCRIPTION	MANHOURS x10^3	ESTIMATED COST U.S. $ x 10^3 LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
00-00	Excavation					
10-00	Concrete					
20-00	Structural Steel					
30-00	Buildings					
40-00	Machinery & Equipment					
50-00	Piping					
60-00	Electrical					
70-00	Instruments					
80-00	Painting & Scaffolding					
85-00	Insulation					
	DIRECT FIELD COSTS	4	48		172	220
90-00	International Expense					
91-00	Temporary Construction Facilities					
92-00	Constr. Services, Supplies & Expense					
93-00	Field Staff, Subsistence & Expense					
94-00	Craft Benefits, Payroll Burdens & Insur.					
95-10	Equipment Rental					
95-50	Small Tools					
99-40	Field Staff Overhead Costs					
	INDIRECT FIELD COSTS					77
	TOTAL FIELD COSTS					297
96-00	Home Office Construction					
	Project Engineering					
	Process Engineering					
	Design					
	Purchasing					
	Business Services					
97-00	Office Expense					
98-00	Office Payroll Burdens					
99-50	Office Overhead Costs					
	TOTAL OFFICE COSTS					40
	TOTAL FIELD & OFFICE COSTS					337
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					33
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					370

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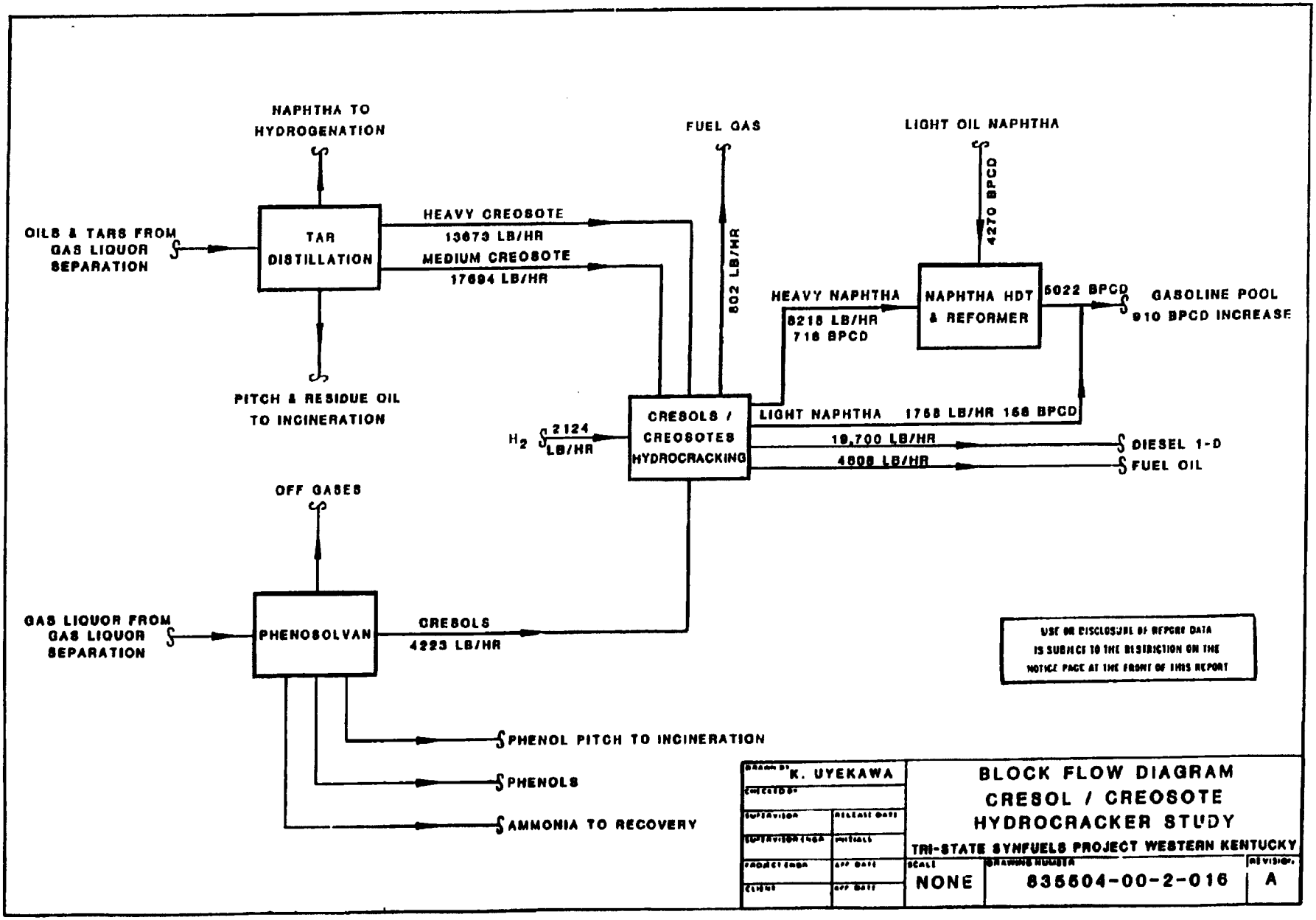
NAPHTHA TO HYDROGENATION
FUEL GAS
LIGHT OIL NAPHTHA
4270 BPCD
OILS & TARS FROM GAS LIQUOR SEPARATION
TAR DISTILLATION
HEAVY CREOSOTE
13673 LB/HR
MEDIUM CREOSOTE
17694 LB/HR
802 LB/HR
HEAVY NAPHTHA
8218 LB/HR
716 BPCD
NAPHTHA HDT & REFORMER
5022 BPCD
GASOLINE POOL
910 BPCD INCREASE
PITCH & RESIDUE OIL TO INCINERATION
CRESOLS / CREOSOTES HYDROCRACKING
LIGHT NAPHTHA 1758 LB/HR 166 BPCD
H_2 2124 LB/HR
19,700 LB/HR
DIESEL 1-D
4608 LB/HR
FUEL OIL
OFF GASES
GAS LIQUOR FROM GAS LIQUOR SEPARATION
PHENOSOLVAN
CRESOLS
4223 LB/HR
PHENOL PITCH TO INCINERATION
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TRI-STATE SYNFUELS PROJECT WESTERN KENTUCKY
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NONE
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