TRI-STATE SYNFUELS COMPANY Indirect Coal Liquefaction Plant Western Kentucky

FLUOR ENGINEERS AND CONSTRUCTORS, INC. Contract 835504

PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

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PROCESS DEVELOPMENT STUDY NO. 13

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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 DET/DSC Unit.

2.2 Mass Balance

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

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2.3 Product Properties

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

Light Naphtha (C5/185 °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	۷1.0
Nitrogen, wppm	<1.0
RON, clear	68

Diesel + Puel Oil (325 °F+)

Gravity, *API	31.3
Boiling Range, D-86	347-725 °F
Sulfur, wppm	45
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,	lew	350
Fuel gas, MM	BTU/HR	18.2

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

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2.5 Environmental Considerations

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

The small amount of fuel gas contains ${\rm H}_2{\rm S}$ 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 \times \$29,000/year = \$435,000 per year

The maintenance costs of the Cresol/Creosotes Bydrocracking 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%.

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Contract 835504

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.

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Table 1

MATERIAL BALANCE FOR THE CRESOL/CREOSOTE HYDROCRACKER

FEEDS

	lbs/hr	API	B/CD
Medium Creosote Heavy Creosote Cresols Hydrogen	17,6947 13,673 (4,223 2,124	7. 5	2,395
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.

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TABLE 2

CAPITAL COST ADDITION FOR CRESOL/CREOSOTE HYDROCRACKING

	\$ MM	(January	1980)
Hydrocracker - Onsite - Initial charge of catalyst - Intermediate storage tank		21.84 0.45 0.84	
Sub-total		23.13	
Associated Units - (NHT/Reformer, PSA Unit etc.)	6.00	
Total Incremental Capital Cost		29.13	
Licensc and royalties (by client)		0.15	SMM

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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.

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FLUOR ENGINEERS AND CONSTRUCTORS, INC. Contract 835504

APPENDIX 1

PROCESS DEVELOPMENT STUDY NO. 13

UPGRADE CREOSOTE TO DIESEL

SCOPE OF STUDY

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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.

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APPENDIX 2

PROCESS DEVELOPMENT STUDY NO. 13

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20-00	Structural Steel	 				 	<u> </u>	ļ	ļ	—
30-00	Buildings	<u> </u>				├	<u> </u>	ļ	 	ļ
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40-00	Machinery & Equipment	 				<u> </u>	<u> </u>	<u> </u>		
50-00	Piping	<u> </u>				ļ				↓
60-00	Electrical		 _					ļ	<u>L</u>	<u> </u>
70-00	Instruments	ļ								<u> </u>
80-00						1				
85-00	Insulation					<u> </u>	ļ	<u> </u>		
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90-00		1 .					·		i	
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93-00									!	
94-00	Craft Benefits, Payroll Burdens & Insur.					1			†	$\overline{}$
95-10	Equipment Rental	i				\vdash			i	\vdash
95-50	Small Tools					 				
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		1	 						1	344
	TOTAL FIELD COSTS								2	792
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96-00	Home Office Construction	 				 			<u> </u>	
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97-00		 				<u> </u>				<u> </u>
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99-50	Office Overhead Costs	 								ļ
77-30	Office Overnedd Costs								<u> </u>	
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99-10	Escalation									
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	TOTAL	1								
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C LIENT_	TRI-STATE SYNFUELS						_ PRO	DP. NO				
		SPLITTER STUDY"					_ w.o	W.O. NO				
LOCATION WESTERN KENTUCKY		CREOSOTE HYDROCRACKING RUNDOWN					N co	CONT. NO. 835504				
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20-00	Structural Steel	 		-	<u> </u>					+		
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40-00	Machinery & Equipment	╌				-				+		
50-00	Piping	 		├		\longrightarrow				——		
60-00		 إ		<u> </u>		 				├ ─		
	Instruments	 			-					<u> </u>		
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85-00	Painting & Scaffolding									1		
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L				<u> </u>								
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90-00									,	†		
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99-50	Office Overhead Costs								1	1		
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30-00	Structural Steel Buildings	ļ!	 		 	4		 _	 	┼		
40-00	Machinery & Equipment	 	 '	 -	 	₩,		لـــــا	 	╄╼┥		
50-00	Piping	 	 '		 	├ ──		Щ,	 	┼─┤		
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92-00			<u> </u>	<u> </u>	<u> </u>	↓ !	ļ	ئــــا	<u> </u>	 		
93-00	Field Staff, Subsistence & Expense		<u> </u>	<u> </u>	ļ				<u> </u>	1		
94-00	Craft Benefits, Payroll Burdens & Insur.	<u> </u>				<u> </u>			<u> </u>	1		
95-10	Equipment Rental							لا		\perp		
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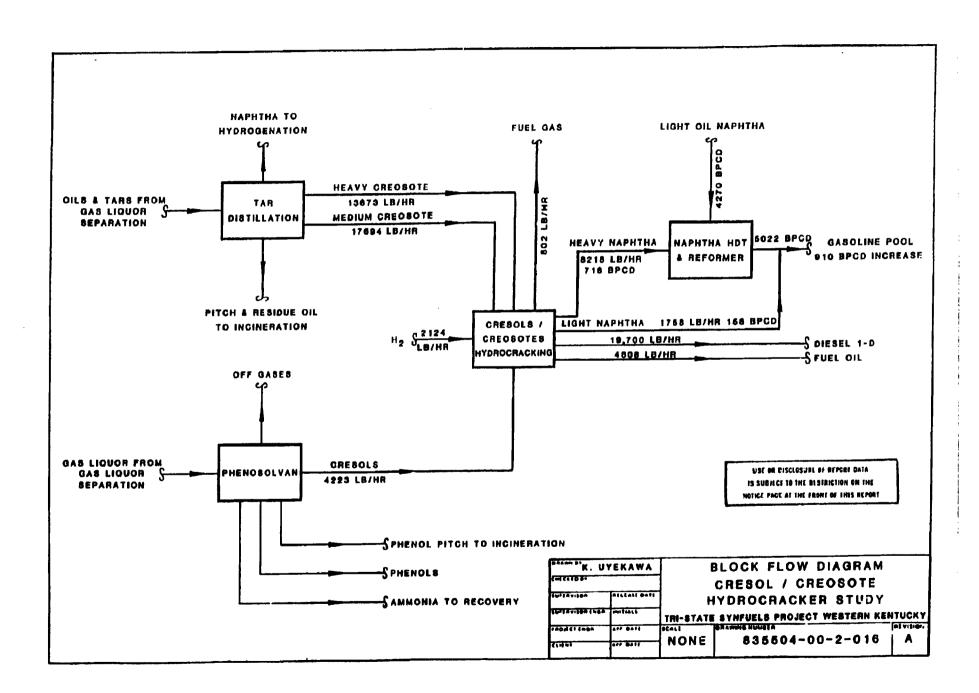
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