PROCESS DEVELOPMENT STUDY NO. 21

ALCOHOL FOR DIRECT SALE/BLEND

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ATTACHMENTS

PROCESS DEVELOPMENT STUDY NO. 21

ALCOHOL FOR DIRECT SALE/BLEND

I. Introduction

Tri-State Synfuels Co. proposes to construct and operate a coal liquefaction plant in Western Kentucky. The original feasibility study provided a chemical workup unit in which the feed stream (Fisher-Tropsch Synthol aqueous stream) was separated into a number of final products such as acetone, MEK, ethanol, propanol, butanol, etc.

This study evaluates an alternate product slate from the chemical workup unit which consists of acetone, MEK and a single dehydrated C_2+ alcohol stream. The alcohol stream can be either blended into fuels or sold as mixed alcohols.

II. Summary

Case 1 Feasibility Study: Chemical Separation and Recovery

C_2+ alcohols are separated into ethanol, n-propanol, butanol and C_5+ heavier alcohols.

Case 2 Single Product: Mixed C_2+ Alcohols

A single stream (mixed C_2+ alcohols) is produced,

a) for direct sale (Case 2a)
b) for blending into fuels (Case 2b)

The primary modification to the feasibility study plant is the deletion of the recovery columns in the chemical workup unit that separate the various alcohols.

III. Process Description

Case 1

The chemical workup unit processes the water-phase product from the Synthol unit. In a primary separation unit organic acids are separated from nonacid chemicals (NAC). NAC is further separated and recovered as carbonyls and alcohols. The primary products of the chemical workup unit are methyl ethyl ketone (MEK), acetone, methanol, ethanol, n-propanol, and butanol. For a detailed description of the process as well as the product specifications, see Volume II Section 1.2.2.12 "Chemical Workup Unit" of the feasibility study (Appendix 2).

Case 2

The process scheme is similar to Case 1, with the modifications as listed below:

- The aldehyde stream from the aldehyde tower overhead will be disposed of after biotreatment. Aldehyde hydrogenation equipment is not required.

PROCESS DEVELOPMENT STUDY NO. 21 (Continued)

- Higher ketones from the MEK product column bottoms will be disposed of after biotreatment.
- Columns that separate ethanol, propanol and butanol are not required.

Case 2a

The mixed alcohol stream from the ketone hydrogenerator will be sent to storage facilities for direct sale.

Case 2b

The mixed alcohol stream from the ketone hydrogenerator will be used for fuel blending. No additional equipment is needed, as blending can be performed by existing facilities.

IV. Discussion

The following comments identify areas of interest with respect to this study.

- Cost of operating labor will be the same for Case 1 and Case 2. The utilities consumption will be lower in Case 2 as compared to Case 1.
- Capital investment is lower in Case 2 as compared to Case 1 due to elimination of alcohol separation columns.
- There may be a limited number of buyers for mixed alcohol products (Case 2) as compared to pure alcohol products (Case 1).
- Case 2a requires extra marketing efforts to sell mixed alcohol as compared to fuel blending in Case 2b.

Table 1 lists comparative data for process streams to and from the chemical workup unit for each case. The composition of the mixed C_2+ alcohol stream is given in Table 2.

PROCESS DEVELOPMENT STUDY NO. 21 (Continued)

Table 1

Comparative Data

		Case 1 Lbs/hr.*	Case 2 Lbs/hr.*
A.	Feed	SAME FOR BOTH CASES	
B.	Products		
	Acetone	4424	4424
	MEK	1445	1445
	Methanol to Rectisol make-up	328	328
	Ethanol	9971	-
	n-Propanol	2876	-
	Butanol	1495	-
	Mixed Alcohols, C_5+	1425	-
	Mixed Alcohols, C_2+	-	15385
C.	To Biotreatment		
	Ketones	56	56
	Aldehydes	-	403
	Water	391220	391201

*Multiply quantities shown by 8160 to obtain annual production rates.

Table 2

Mixed C_2+ Alcohols Product Composition

	wt%
Ketones	0.1
Ethanol	55.2
Propanol	22.9
Butanol	11.5
Pentanol	6.7
Hexanol	1.2
Others	2.4
Total	100.0

PROCESS DEVELOPMENT STUDY NO. 21 (Continued)

V. Cost Estimates

Using the Feasibility Study as the primary data base, costs were adjusted to estimate the capital as well as the operating and maintenance cost requirements for Case 2. These estimates are based on instantaneous January 1980 dollars.

Capital Costs

The capital cost for Case 2a or 2b is estimated to be $16.8 million lower than for Case 1. This is due to the deletion of the alcohol recovery columns in the chemical workup unit.

Operating and Maintenance Costs

a. Reduction in annual operating costs for Case 2a or 2b as compared to Case 1 is estimated at:

   1. Utilities consumption = $700,000
   2. Operating labor = -0-

b. Reduction in annual maintenance cost for Case 2a or 2b as compared to Case 1 is estimated to be $350,000.

APPENDIX 1

PROCESS DEVELOPMENT STUDY NO. 21

ALCOHOL FOR DIRECT SALE/BLEND

SCOPE OF STUDY

PROCESS STUDY

Alcohol Recovery for Direct Sale or for use as a fuel blend component

1.0 GENERAL

This study will provide the data needed to perform economic analysis for selling the Acetone and MEK produced in the Synthol unit and purified to meet ASTM specifications. Also, the mixed C_2 + alcohols will either be blended into fuels or the mixed stream will be sold after it is dehydrated.

2.0 WORK DEFINITION

For the feasibility study, the alcohols were recovered in an impure state in the same manner as they were for Sasol II.

2.1 Modify the Chemical Workup units sized for the feasibility study in a manner that will produce a single mixed C_2 + alcohol stream.

2.2 Perform heat and material balances for the modified Chemical Workup.

2.3 Provide an estimating basis for the Chemical Workup.

2.4 Estimate capital and operating costs.

3.0 DELIVERABLES TO TRI-STATE

A formal report that contains the following:

3.1 Capital cost estimates.

3.2 Operating cost estimates.

3.3 The capital and operating costs will be provided for both alternate - either selling the alcohols or blending them into fuels.

3.4 Block Flow Diagram, material balance and process description for each of the two alternates.

4.0 SCHEDULE

It is estimated that the above work will be completed in eight weeks after the work is started by Fluor.

APPENDIX 2

FEASIBILITY STUDY VOL. II, SEC. 1.2.2.12

1.2.2.12 CHEMICAL WORKUP UNIT (Drawing No. 473604-00-R-0014)

The Chemical Workup Unit processes the water-phase product from the Synthol Unit and consists of the following primary functions:

1. Primary Separation
2. Carbonyls Recovery
3. Alcohols Recovery

The primary purpose of the Chemical Workup Unit is to recover methyl ethyl ketone (MEK), acetone, methanol, ethanol, propanol, butanol, pentanol, and hexanol from the water phase produced in Synthol.

The secondary purpose of this unit is to produce an acid wastewater stream suitable for biological treatment. This wastewater stream contains about 1.5 percent organic acids (acetic, propionic, butyric, and valeric).

The Chemical Workup Unit is comprised of the following individual operating systems:

1. The Primary Separation Storage system, which provides storage and surge capacity between the Synthol Unit and the Chemical Workup Unit.
2. The Primary Distillation Tower system, which separates non-acid chemical (NAC) from acid water.
3. The Carbonyl Stripper Tower system, which separates crude carbonyls from crude alcohols by distillation.
4. The Aldehyde Tower system, which separates aldehydes from ketones and alcohols by extractive distillation with water.
5. The Ketone Tower system, which separates ketones from alcohols by extractive distillation with water.
6. The Alcohol - Water Splitter Tower system, which separates alcohols from water. The water is recycled as an extractive agent to the aldehyde tower system and to the ketone tower system.
7. The Methanol Tower system, which recovers methanol product from heavier alcohols and water. The methanol produced is used to satisfy part of the methanol makeup for the Rectisol Unit.
8. The MEK Dehydration Tower system, which separates MEK from acetone and water.

1.2.2.12 (Continued)

9. The MEK Product Column system, which separates MEK from heavier ketones.

10. The Acetone Lights Column system, which separates lower boiling impurities from acetone.

11. The Acetone Product Column system, which separates acetone product from high boiling impurities.

12. The Aldehyde Hydrogenation system, which converts aldehydes to alcohols by catalytic hydrogenation.

13. The Alcohol Dehydration system, which separates alcohols from water by azeotropic distillation using benzene.

14. The Ethanol Tower system, which recovers ethanol product from heavier alcohols.

15. The Propanol Tower system, which recovers propanol product from heavier alcohols.

16. The Butanol Tower system, which recovers butanol product from heavier alcohols.

17. The Ketone Hydrogenation system, which converts ketones and trace aldehydes in the hydrogenator feed into alcohols by catalytic hydrogenation.

Air emissions from vents and emergency reliefs are routed to a flare for combustion of any organic compounds. This unit does not contain any fired heaters since steam is used as a heat medium for process heat.

Wastewater effluent from this unit is an organic acid stream that is routed to the Effluent Treatment Unit.

Spent catalyst and solid wastes generated from construction and maintenance activities are addressed in Section 1.3.3.

Unusual noise attenuation methods are not anticipated for this unit since the pressures and velocities within the piping system are sufficiently low to avoid excessive noise from depressurizing and material transfer. The rotating equipment, such as pumps and air fans, will not be exceptionally large.

APPENDIX 3

PROCESS DEVELOPMENT STUDY NO. 21

ALCOHOL FOR DIRECT SALE/BLEND

ESTIMATE DETAILS

COST ESTIMATE

FLUOR

CLIENT TRI-STATE SYNFUELS

DESCRIPTION "BLEND TO GASOLINE OR SELL ALCOHOLS STUDY" UNIT 36

PROP. NO.

W.O. NO.

CONT. NO. 835504

MADE BY BSC

APPROVED

LOCATION HENDERSON, KY

PROJECT TRI-STATE SYNFUELS

JAN 1980 INSTANTANEOUS

A/C NO.	ITEM & DESCRIPTION	MANHOURS x 10^3	ESTIMATED COST U.S. $ x 10^3 LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
	DIRECT FIELD COSTS	[34]	[408]		[526]	[934]
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					[512]
	TOTAL FIELD COSTS					[1446]
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					[169]
	TOTAL FIELD & OFFICE COSTS					[1615]
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					[1773]

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DATE 9-10-81 REVISION NO. REVISION DATE PAGE NO.

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COST ESTIMATE

FLUOR

CLIENT TRI-STATE SYNFUELS
DESCRIPTION "BLEND TO GASOLINE OR SELL ALCOHOLS STUDY"
PROP. NO.
W.O. NO.
LOCATION HENDERSON, KY
CONT. NO. 835504
UNIT 37
MADE BY BSC
PROJECT TRI-STATE SYNFUELS
APPROVED
JAN 1980 INSTANTANEOUS

A/C NO.	ITEM & DESCRIPTION	MANHOURS x10^3	ESTIMATED COST U.S. $ x 10^3 LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
	DIRECT FIELD COSTS	[22]	[264]		[349]	[613]
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					[333]
	TOTAL FIELD COSTS					[946]
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					[110]
	TOTAL FIELD & OFFICE COSTS					[1056]
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					[103]
	TOTAL					
99-60	Fee					
	TOTAL PROJECT					[1159]

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REV. 1/80

COST ESTIMATE

FLUOR

CLIENT TRI-STATE SYNFUELS
DESCRIPTION "BLEND TO GASOLINE OR SELL ALCOHOLS STUDY"
PROP. NO.
W.O. NO.
LOCATION HENDERSON, KY
CONT. NO. 835504
UNIT 38
MADE BY BSC
PROJECT TRI-STATE SYNFUELS
APPROVED
JAN 1980 INSTANTANEOUS

A/C NO.	ITEM & DESCRIPTION	MANHOURS x 10^3	ESTIMATED COST U.S. $x10^3$ LABOR	SUB-CONTRACTS	MATERIALS	TOTAL
	DIRECT FIELD COSTS	[282]	[3384]		[3804]	[7188]
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					[4152]
	TOTAL FIELD COSTS					[11340]
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					[1295]
	TOTAL FIELD & OFFICE COSTS					[12635]
99-30	Sales Tax					
99-10	Escalation					
99-20	Contingency					
	TOTAL					[1233]
99-60	Fee					
	TOTAL PROJECT					[13858]

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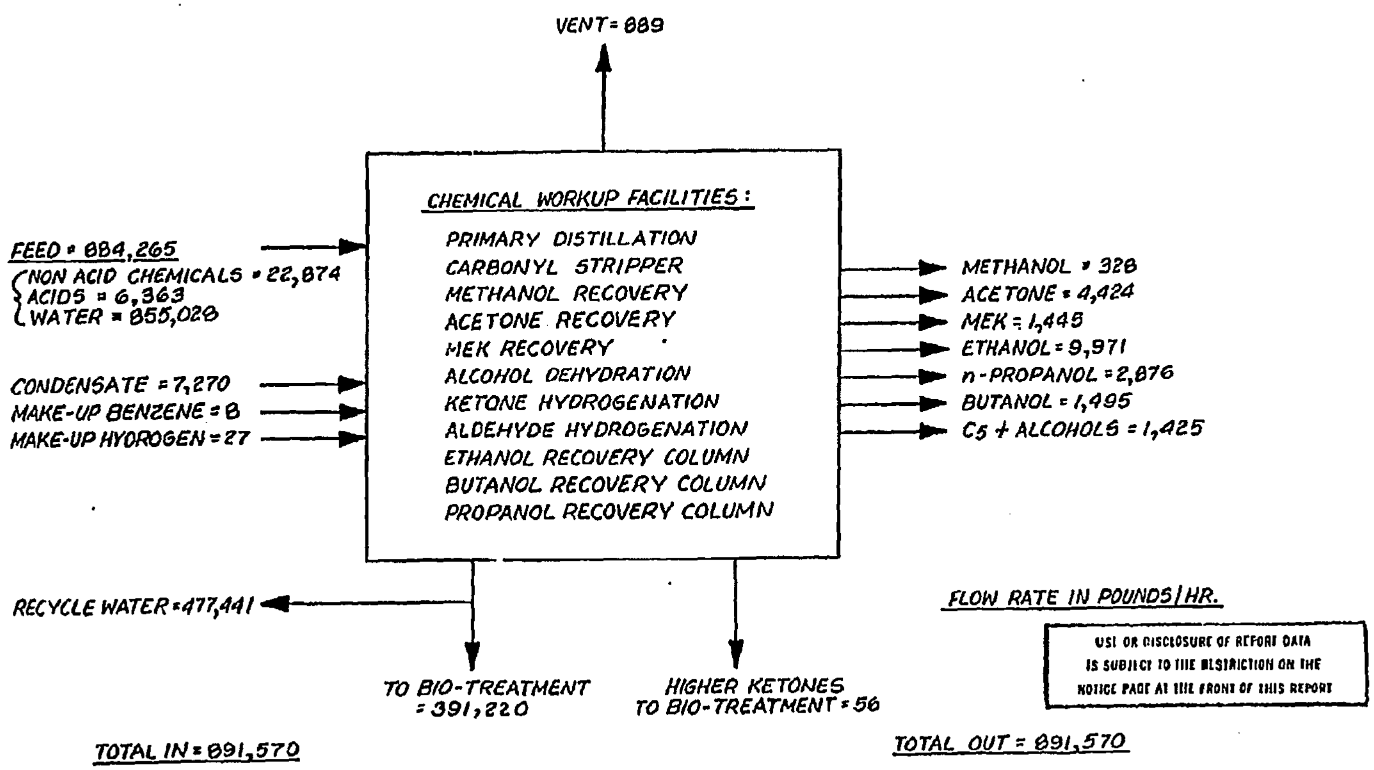


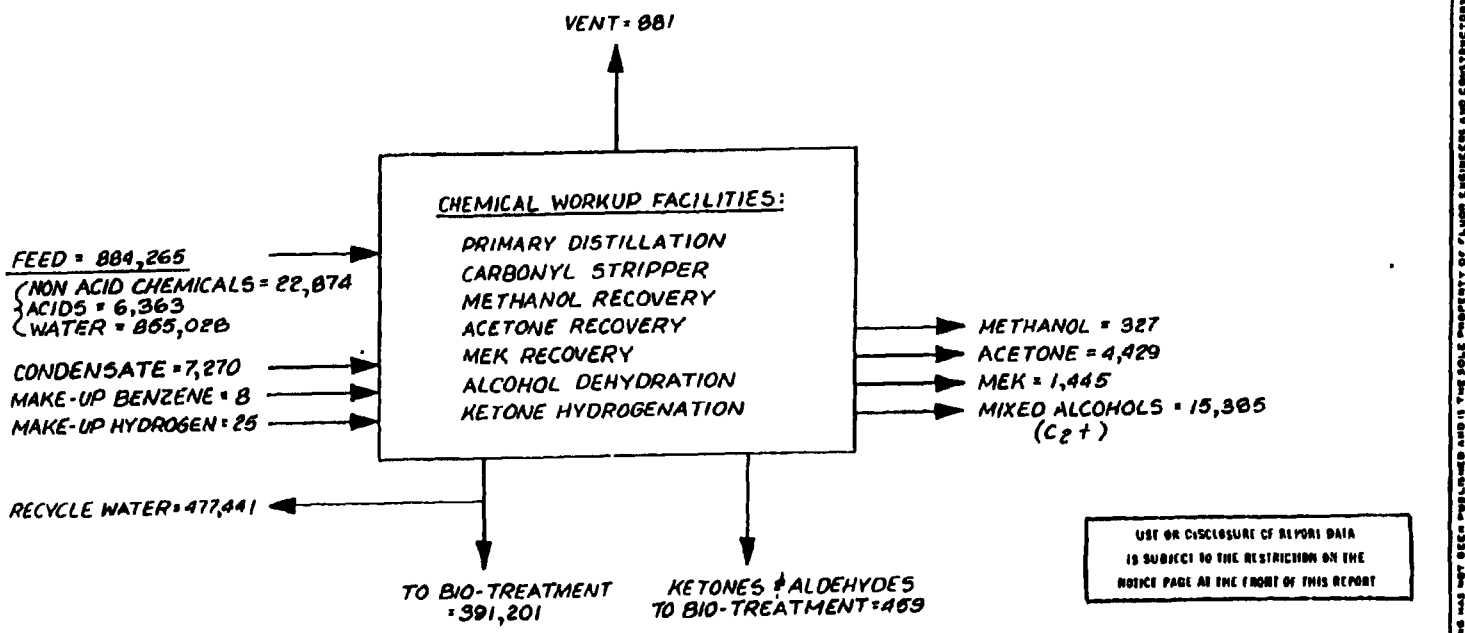
FLUOR

DRAWN BY: T. KING
CHECKED BY: D. CRACKNELL

BLOCK FLOW DIAGRAM
ALCOHOL FOR DIRECT SALE/BLEND STUDY
(CASE-1)

SCALE: NONE
DRAWING NUMBER: 835504-00-2-014
REVISION: A

REV. | DATE | REVISION DESCRIPTION | DRAWN / CHECK | DATE



TOTAL IN = 891,568

TOTAL OUT = 891,568

FLOW RATE IN POUNDS/HR

FLUOR

T. KING

O. CRACKNELL

BLOCK FLOW DIAGRAM
ALCOHOL FOR DIRECT SALE/BLEND STUDY
(CASE-2)

NONE | 895504-00-2-015 | A | 11-13-81