9.0 PROVISIONAL PROCESS PLANT ADDITION FOR THE PRODUCTION OF DIMETHYL ETHER (DME)

9.1 BACKGROUND

A part of the stated technical objectives of the proposed LPMEOH™ demonstration is to install equipment in order to produce a dimethyl ether (DME) and methanol co-product. Although the final design for this equipment will not be done until Air Products has sufficient data on the reactor/catalyst system, and after market studies have been conducted, a 'best guess' process design case has been prepared for this EIV.

DME is a gas at ambient conditions with properties similar to propane. It is currently manufactured by the catalytic dehydration of methanol. The production of DME from synthesis gas is a natural extension of the LPMEOH™ process in that three reactions occur concurrently in a single liquid phase reactor; these reactions are methanol synthesis, methanol dehydration, and water-gas shift. This can significantly improve the overall conversion of coal-derived synthesis gas to a storable blend of methanol and DME.

DME has several potential commercial uses. In a storable blend with methanol the mixture can be used as a peaking fuel in IGCC electric power generating facilities. A small amount of DME can also be used to increase the vapor pressure of methanol being used as a diesel engine fuel. The resulting higher volatility is expected to provide beneficial "cold-start" properties to the methanol fuel. Blends of methanol and DME can also be used as a chemical feedstock for the synthesis of chemicals or new, oxygenate fuel additives.

For this project Air Products proposes to demonstrate the slurry reactor's capability to produce DME as a mixed co-product with methanol in a commercial size reactor.

Design Verification Testing (DVT) is required to provide additional data for the engineering design and to understand the economics of DME production. The DVT plan will be coordinated with and utilize the resources of the DOE's Liquid Fuels Program as technology experts. The essential DVT steps required for project decision making regarding the methanol/DME enhancement are:

1. Confirm catalyst activity and stability in the lab. A DME program decision point will follow this work to be completed in July 1996.

2a. Develop Engineering data in the lab. This data will be needed to proceed with designs to developing process economics.

2b. Confirm markets and economics. This includes tests as a replacement for M100 in diesel engines and marketplace acceptance, IGCC energy storage economics, and chemical feedstock process economics.

The above activities will be funded under the proposed LPMEOH™ Process Demonstration Program.

Based on the technology status determined in Step 1 and the market and economic data from the above, a decision on the continuation of the DME Program will be made. This decision will be made by December 1996.

3. Run Proof-of-Concept tests in the LaPorte AFDU. This work will be done in late 1996 and in 1997; it will be funded under the proposed LPMEOH™ Process Demonstration Program. Following this work and assimulation of the data, a final decision will be made by March 1998 on whether the DME demonstration at Kingsport will be implemented.

The decisions shown above will be made jointly by the Partnership and the DOE. The go/no-go implementation decision must be made in time such that the necessary design, procurement, construction and commissioning of the additional equipment can be completed in time for (Phase 3, Task 2) operation at the end of the primary LPMEOH™ Process demonstration period.

9.2 PROCESS DESCRIPTION

The Simplified Process Flow Diagram, Fig. 9.2-1 shows the major equipment in the synthesis loop and product separation train. Fig. 9.2-2 shows the composition and flowrates for both the Design Methanol Production Case as well as the anticipated DME Case. For the DME Case selected, the reactor feed rate (Stream 1) is 93% of the Design Methanol Case; methanol in the Raw Methanol Stream (Stream 3) drops from 266 TPD to 198 TPD and a net 27 TPD of DME (Stream 2-Stream 1) is produced in the reactor.

By adding up to 5 wt% alumina (dehydration catalyst) to the methanol catalyst already in the reactor, we will produce an outlet stream which is approximately 0.4 DME/methanol on the molar basis. When this stream is cooled the liquid which condenses (Stream 3) contains 8.8 lbs DME/91.2 lbs methanol; or 8.8 wt% DME on a total DME and methanol basis. This approximates the 8 wt% target that was set in the joint objectives.

Most of the unreacted synthesis gas, now containing most of the DME, will be recycled back to the reactor while a purge gas (Stream 4) containing approximately 7 TPD of DME will be sent to the boilers as fuel.

The reactor loop will be operated in a very similar manner as in the methanol operating period. Additional equipment, probably an additional stripping column, will need to be added to the crude methanol purification; this equipment will be needed to separate the DME from the methanol product. Some modifications to the analytical equipment will be needed to record the Liquid Phase DME (LPDME) Process performance.

9.3 ENVIRONMENTAL IMPACTS

9.3.1 Air Pollution Emissions and Controls

9.3.1.1 Waste Gas Flows

Since we are burning the net DME product produced, the gas streams to the boilers have increased compared to the base methanol case from a total of 48 MMBTU/hr (HHV) to 66 MMBTU/hr. These streams are the sum of streams 4 and 6 shown in Fig. 9.2-2. These streams will be going to Boiler #30 or #31 which have design input heat duties of 780 MMBTU/hr and 880 MMBTU/hr, respectively. The net effect here will be to reduce coal firing compared to the base methanol case by an additional 21 MMBTU/hr (approximately 21 TPD of coal).

Total air emissions should decrease with the cleaner fuel.

9.3.1.2 Storage Tank Emissions

These are shown in Table 6.1-2 and remain unchanged for the DME Demonstration.

9.3.1.3 Equipment Leak Emissions

These emissions are calculated based on the number of valves, flanges, etc. in the process. These in turn are estimated based on the number of pieces process equipment. Our estimate for the DME case for these emissions is based on using ratio of the reactor feed compositions (Fig. 9.3-1). An MSDS for DME is found at the end of this section. DME is nontoxic.

The DME production case is expected to be run for up to six months at the very end of the four-year demonstration period as a substitution for the base methanol operation (Phase 3, Task 2.1).

9.3.1.4 Fugitive Dust

The DME equipment construction will involve no major excavation work and no dust emissions are expected.

9.3.2 Operational Impacts

Storm water will remain unchanged from the base methanol case described in Paragraph 6.32.

The process stream described in Paragraph 6.3.2 as the under flow from Eastman's distillation will be further increased from the base methanol case. The increase adds an additional 0.4 gpm to the 0.8 gpm increase of the base methanol case and an additional 2100 lb/day of BOD compared to the 4180 lb/day increase in the base methanol case.

The oil waste stream will remain the same as described in Paragraph 6.4.2. The existing (prior to the LPMEOH™ Process Demonstration) liquid waste stream also referred to in Paragraph 6.4.2 will decrease compared to the base methanol case. Our estimate for this decrease is 84,000 lb/year. The DME case would produce 240,000 lb/yr of additional waste for energy recovery in the onsite boilers compared to 324,000 lb/yr additional waste for the base methanol case.

The solid waste streams generated will remain unchanged from those shown in Paragraph 6.4.2.

9.3.3 Ecology

Remains the same as described in Paragraph 6.5

9.3.4 Community Resources

Remains the same as described in Paragraph 6.6.

9.3.5 Energy Resources

Remains the same as described in Paragraph 6.7.

9.3.6 Bidiversity

Remains the same as described in Paragraph 6.8.

9.3.7 Pollution Prevention

Remains the same as described in Paragraph 6.9.

9.3.8 Other Impacts

During the DME Process Demonstration, Eastman will have to import additional methanol onto the site. In the base methanol case there was also an increase required, this was 30 TPD. For DME this will increase by 68 TPD bringing the total to 98 TPD.

9.3.9 Cumulative Impacts

Remains the same as described in Paragraph 6.10.

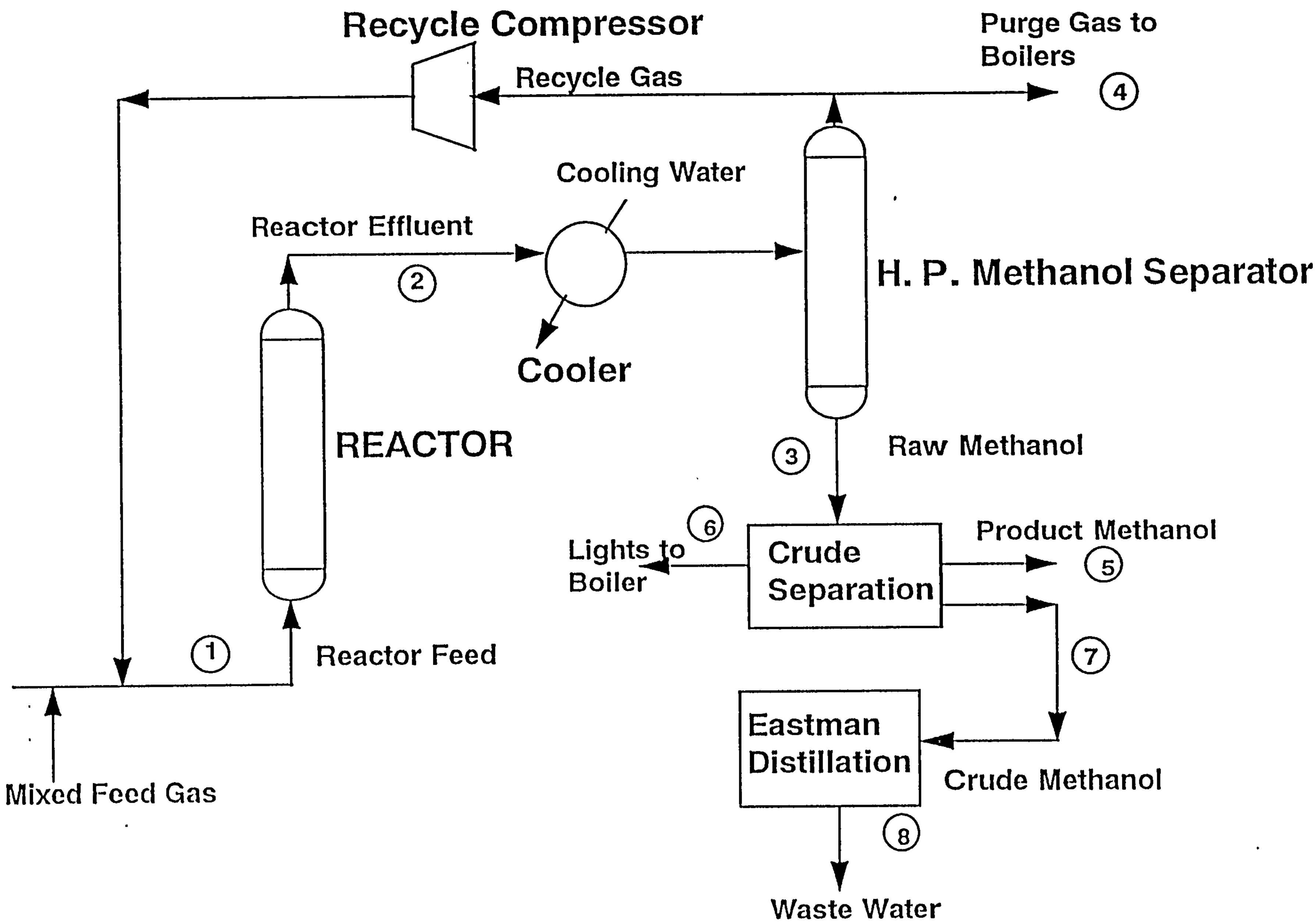


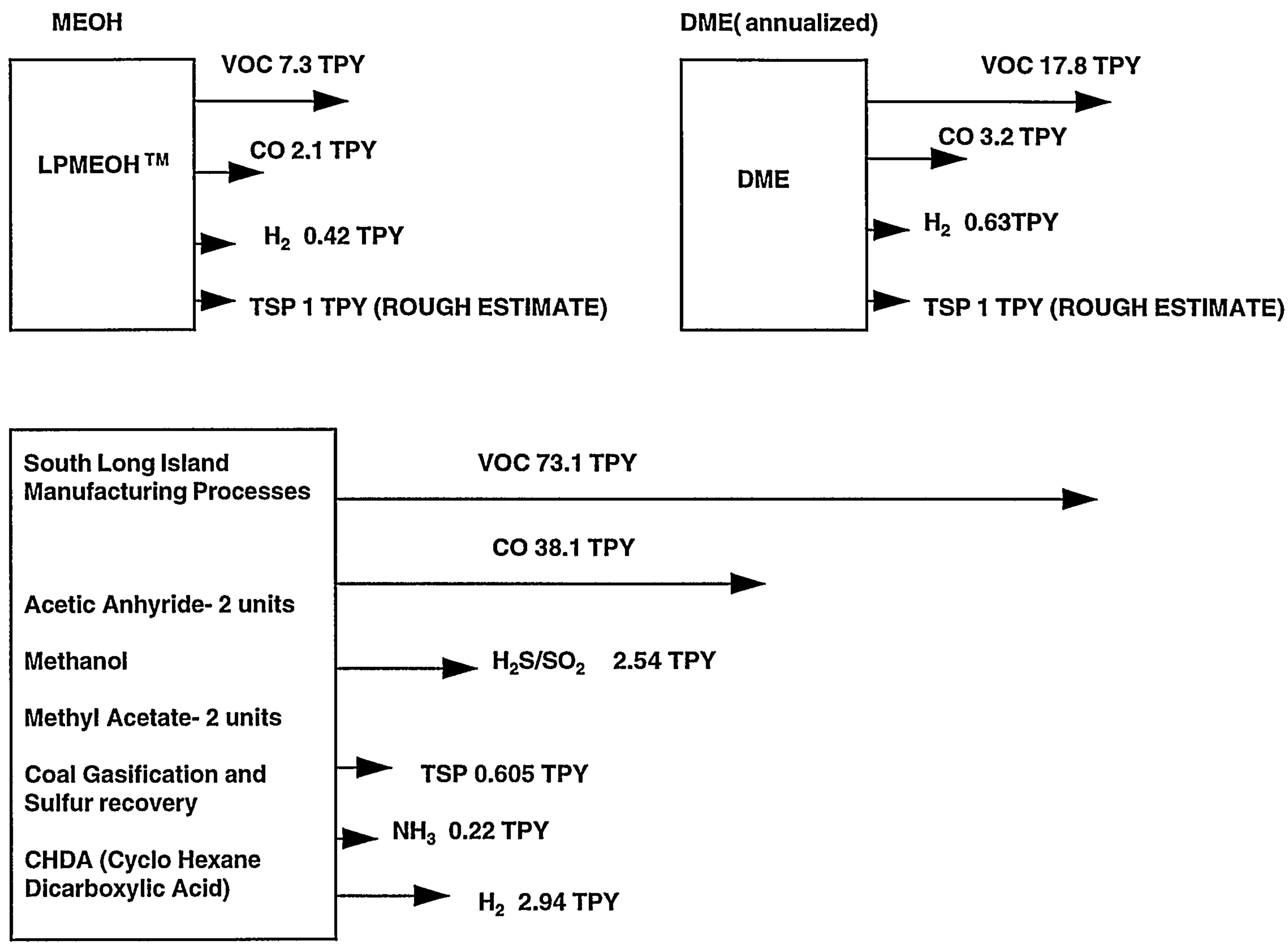
Fig. 9.2-1 Simplified Flow Diagram

Comparison of DME Case With Design Methanol Case

Stream Number	1	1	2	2	3	3	4	4
Stream	Reactor Feed	Reactor Feed	Reactor Effluent	Reactor Effluent	Raw Methanol	Raw Methanol	Purge Gas to Boilers	Purge Gas to Boilers
Case	DME	MEOH	DME	MEOH	DME	MEOH	DME	MEOH
(volume %)								
H2 %	61	60	52	50	0	0	59	58
CO %	19	25	12	20	0	0	14	22
CO2%	12	9	15	11	4	4	16	13
DME %	2	0	4	0	6	0	3	0
MEOH %	0	1	10	13	83	92	0	1
Water %	0	0	1	<1	7	3	0	<1
Moles/Hr	6729	7235	5494	5829	625	753	383	438
DME T/D	80		107		20	0	7	0
MEOH T/D					198	266	1	2
MMBTU(HHV)/Hr							42	45

Stream Number	5	5	6	6	7	7	8	8
Stream	Product Methanol	Product Methanol	Lights to Boiler	Lights to Boiler	Crude Methanol	Crude Methanol	Waste Water	Waste Water
Case	DME	MEOH	DME	MEOH	DME	MEOH	DME	MEOH
(volume %)								
H2 %	0	0	3	8	0	0		
CO %	0	0	3	7	0	0		
CO2%	0	0	34	63	0	0		
DME %	0	0	56	0	0	0		
MEOH %	99.9	99.9	2	12	73	89		
Water %	0	0	0	0	27	11		
MeAc %	0	0	<1	1	0	0		
MeFormate %	0	0	2	4	0	0		
Moles/hr	388	520	66	42	171	190		
DME T/D	0	0	20	0	0	0		
MEOH T/D	149	200	0	0	48	65		
MMBTU(HHV)/Hr			24	3				

FIG. 9.2-2



**EQUIPMENT LEAK AND OTHER FUGITIVE EMISSIONS
MANUFACTURING PROCESSES- SOUTH LONG ISLAND**

Fig. 9.3-1

FSF 5/15/96