### RESEARCH GUIDANCE STUDIES TO ASSESS GASOLINE FROM COAL BY METHANOL-TO-GASOLINE AND SASOL-TYPE FISCHER-TROPSCH TECHNOLOGIES

#### FINAL REPORT

#### MAX SCHREINER

# MOBIL RESEARCH AND DEVELOPMENT CORPORATION PRINCETON, New Jersey 08540

#### CONTRIBUTORS:

AMERICAN LURGI CORPORATION

P. R. GAMBARO

A. M. PESKIN

R. WEISS

LURGI KOHLE UND MINERALOELTECHNIK GMBH

H. FRITZSCHE

MOBIL RESEARCH AND DEVELOPMENT CORPORATION

A. J. DIMATTIO

A. H. JORGENSEN

J. M. Kuo

DATE PUBLISHED - AUGUST 1978

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY

UNDER CONTRACT No. EF-76-C-01-2447

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

#### NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

This report has been reproduced directly from the best available copy.

Available from the National Technical Information Service, U. S. Department of Commerce, Springfield, Virginia 22161.

#### NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.

#### TABLE OF CONTENTS

		Page
ABSTRA	CT	1
SUMMARY		2
1. ST	UDY SCOPE	9
2. ŞT	UDY DESIGN BASES	14
3. BA	SE CASE I: MOBIL METHANOL CONVERSION TECHNOLOGY	20
3. 3. 3. 3.	1 Material Balance 2 Product Yields and Quality 3 Thermal Efficiency 4 Process Descriptions 5 Offsite Units 6 Utility Requirements and Steam/EFW Balance 7 Train Philosophy	21 22 28 30 75 89 91
4. BA	SE CASE II: FISCHER-TROPSCH TECHNOLOGY	94
4. 4. 4. 4.	Material Balance Product Yields and Quality Thermal Efficiency Process Descriptions Offsite Units Utility Requirements and Steam/BFW Balance Train Philosophy	95 96 104 106 142 148 150
5. SE	NSITIVITY CASES	151
5. 5. 5.	1 Case I-A: Methanol and SNG Coproduction 2 Case I-B: Gasoline Only Production 3 Case I-C: Mobil Fluid-Bed Technology 4 Case I-D: Second Generation Gasifier 5 Case II-A: Mobil Direct Syngas Conversion	152 160 167 176 177
6. C	OST ESTIMATION	187
6. 6.	1 Investment 2 Working Capital 3 Coal and Operating Costs 4 Byproduct Credits	188 197 200

## TABLE OF CONTENTS (Continued)

		Page
7.	ECONOMIC EVALUATION	207
	7.1 Bases	208
	7.2 Inter-Study Comparisons	212
	7.3 Base Cases	213
	7.4 Inter-Study Comparison Sub-Case	217
	7.5 Base Case I Economic Sensitivities	218
	7.6 Sensitivity Cases	226
8.	CONCLUSIONS	228
9.	REFERENCES	229
	APPENDICES	
	A. Base Case I Material Balance	
	B. Base Case II Material Balance	
	C. Sensitivity Cases Material Balances (Partial)	
	D. SNG Only Sensitivity Case	

### TABLE OF CONTENTS (Continued)

		Page
TABLES		
2.1	Study Coal Properties	15
3.2.1	Comparison of Principal Unleaded Gasoline	
	Specifications with Estimated Methanol-to-	
	Gasoline Gasoline Properties (Case I)	25
3.2.2	Principal Unleaded Gasoline Specifications	26
3.2.3	Comparison of Principal LPG Specifications	
	with Estimated Methanol-to-Gasoline LPG	
	Properties (Case I)	27
3.3.1		29
3.4.1	Methanol Conversion Unit 150-Process Design	
	Conditions for Fixed-Bed	48
3.4.2	Methanol Conversion Unit 150-Base Feed and	
	Product Composition	50
3.4.3	Methanol Conversion Unit 150-Catalyst Properties	52
4.2.1	Comparison of Principal Unleaded Gasoline	
	Specifications with Estimated Fischer-	
	Tropsch Gasoline Properties (Case II)	98
4.2.2	Comparison of Principal Diesel Fuel Specifications	
	with Estimated Fischer-Tropsch Diesel Fuel	
	Properties (Case II)	100
4.2.3	Comparison of Principal Fuel Oil and Gas Turbine	
	Fuel Oil Specifications with Estimation Fischer-	
	Tropsch Heavy Fuel Oil Properties (Case II)	101
4.2.4		
	with Estimated Fischer-Tropsch LPG	
	Properties (Case II)	103
4.3.1	• · · · · · · · · · · · · · · · · · · ·	105
4.4.1		
	Product Composition	114
5.1.1		156
5.2.1	Sensitivity Case I-B - Thermal Efficiency	163
5.3.1		
	Case I-C	170
5.3.2	Sensitivity Case I-C - Thermal Efficiency	172
5.5.1		
	Case II-A	180
5.5.2	Sensitivity Case II-A - Thermal Efficiency	182
6.1.1		191
6.1.2	Plant Investment Breakdown - Base Case II	192
6.1.3		193
6.1.4	Unit Investment Breakdown - Base Case II	194
6.1.5	Investments for Sensitivity Cases	196
6.2.1	Working Capital Breakdown for Base Cases	199
6.3.1	Operating Manpower for Base Cases	201
6.3.2	Breakdown of Operating Costs for Base Cases	204
6.4.1		206
7.3.1		214
7.3.2	Equity Cash Flow for Base Case I	215
7.3,3	Equity Cash Flow for Base Case II	216
7.5.1	Sensitivities for Base Case I-Equity Financing	219
7.5.2	Sensitivities for Base Case I-Utility Financing	220
7.5.3		224
7.6.1		227

## TABLE OF CONTENTS (Continued)

	(,	Page
FIGURE	S	
3.4	Block Flow Diagram - Base Case I (ZO-GEM-6894)	58
3.4	Process Flow Diagrams - Base Case I	59-74
3.5		87-88
3.6	Steam/BFW Balance - Base Case I (ZO-GEM-6910)	90
4.4	Block Flow Diagram - Base Case 11 (ZO-GEM-6988)	128
4.4		129-141
4.6	Steam/BFW Balance - Base Case II (ZO-GEM-6986)	149
5.1	Block Flow Diagram - Sensitivity Case I-A	
	(ZO-GEM-7037)	159
5.2	Block Flow Diagram - Sensitivity Case I-B	
	(ZO-GEM-7036)	166
5.3	Block Flow Diagram - Sensitivity Case I-C	_00
	(ZO-GEM-7038)	175
5.5	Block Flow Diagram - Sensitivity Case II-A	•
	(ZO-GEM-7040)	186
7.5.1	Effect of DCF Rate of Return on Unit Costs	221
	Effect of SNG Price on Gasoline Unit Cost	222