



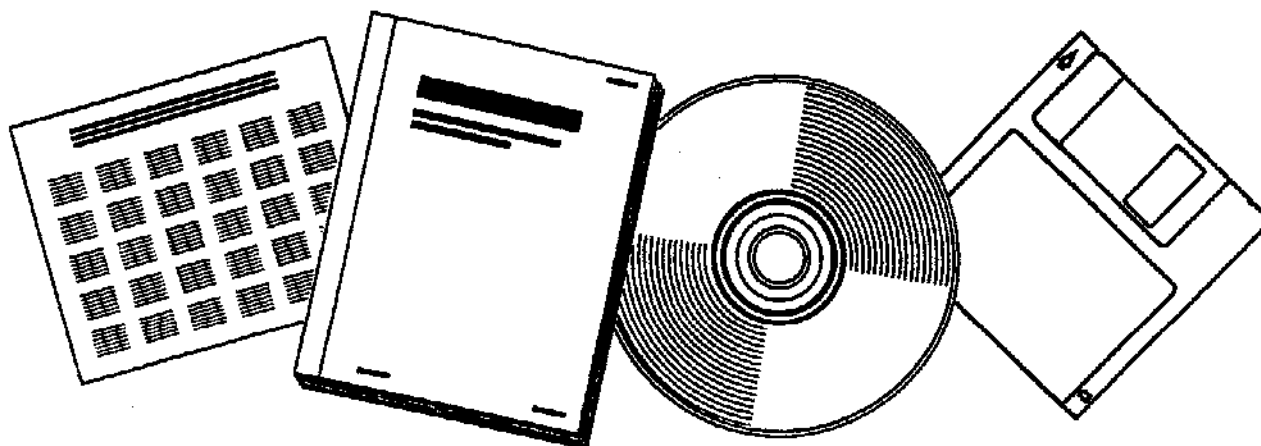
PB81169237

NTIS[®]
Information is our business.

METHANOL FROM COAL: PROSPECTS AND PERFORMANCE AS A FUEL AND AS A FEEDSTOCK

ICF, INC.
WASHINGTON, DC

DEC 1980



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

METHANOL FROM COAL: PROSPECTS AND PERFORMANCE AS A FUEL AND AS A FEEDSTOCK

Prepared for
The National Alcohol Fuels Commission

December 1980

ICF INCORPORATED 1850 K Street, Northwest,
Suite 950, Washington, D. C. 20006

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

REPORT DOCUMENTATION PAGE	1. REPORT NO. NAFC/80-23	2.	3. Recipient's Accession No. PB81 169237
4. Title and Subtitle Methanol from Coal: Prospects and Performance as a Fuel and as a Feedstock			5. Report Date October 1980
7. Author(s)			6.
9. Performing Organization Name and Address ICF Incorporated 1850 K Street, N.W. Suite 950 Washington, D.C. 20006			8. Performing Organization Rept. No.
12. Sponsoring Organization Name and Address U.S. National Alcohol Fuels Commission 412 First Street, S.E. Washington, D.C. 20003			10. Project/Task/Work Unit No.
15. Supplementary Notes			11. Contract(C) or Grant(G) No. (C) (G)
16. Abstract (Limit: 200 words) <p>The purpose of this report is to provide some background information for determining a role for methanol in a U.S. synfuel strategy. To that end and as instructed by the National Alcohol Fuels Commission, ICF compared methanol from coal with other, selected coal-based synthetic liquids as fuels for automobiles and electric utilities. In addition, methanol from coal is considered as a substitute for the methanol from natural gas now used by the petrochemical industry.</p> <p>In this first section, the plantgate product cost estimates used throughout the report are presented and explained. Each of the next three sections consider one of the energy uses studied herein: automobile fuels; fuels for electric utilities; and petrochemical feedstocks. A final section outlines the remainder of the report.</p>			13. Type of Report & Period Covered
			14.
17. Document Analysis a. Descriptors b. Identifiers/Open-Ended Terms c. COSATI Field/Group			
18. Availability Statement: Release Unlimited	19. Security Class (This Report) Unclassified	21. No. of Pages	
	20. Security Class (This Page) Unclassified	22. Price	

PREFACE

This report was prepared for the National Alcohol Fuels Commission. However, some of the work reflected here was funded by the U.S. Department of Energy and, with additional material and detail, will at a later date be presented in a report to that agency. The assumptions, judgements, and findings presented here are those of ICF and do not necessarily reflect the views of either client.

TABLE OF CONTENTS

	<u>Page</u>
 PART I:	
CHAPTER 1: Introduction and Summary	1-1
Product Cost Estimates	1-1
Synthetic Fuels for Automobiles	1-6
Electric Utilities	1-11
Petrochemicals	1-14
Outline of the Report	1-15
 PART II: PRODUCTION COSTS FOR METHANOL FROM COAL AND FOR COMPETING ENERGY TECHNOLOGIES	
CHAPTER 2: Introduction to Part II	2-1
CHAPTER 3: Assumptions Common to All the Estimates	3-1
Raw Cost Data	3-1
Product Cost Estimates	3-6
Synfuel Transportation	3-12
CHAPTER 4: Product Cost Estimates	4-1
Product Cost Estimates	4-1
The Effect of Changing Assumptions	4-7
 PART III: METHANOL AS A FUEL IN AUTOMOBILES	
CHAPTER 5: Introduction to Part III	5-1
CHAPTER 6: Methanol and Gasoline: A Comparison of Technical and Environmental Performance	6-1
Engine and Fuel Delivery Modifications for Methanol Use	6-1
Environmental and Health Considerations	6-5
Fuel Economy and Specific Power	6-8
CHAPTER 7: Cost Comparisons of Synthetic Fuels for Automobiles	7-1
Extent of Methanol Use	7-2
Prices for Retail Services	7-10
Location	7-14
Construction	7-14

TABLE OF CONTENTS (Continued)

	<u>Page</u>
CHAPTER 8: Automotive Fleets and Fuel Use	8-1
Fleet Car Characteristics	8-2
Fleet Car Fuel Use	8-6
PART IV: METHANOL AS A FUEL FOR ELECTRIC UTILITIES	
CHAPTER 9: Introduction to Part IV	9-1
Fuels Now Used in Utilities	9-2
Utility Technologies Suitable for Methanol Use	9-2
CHAPTER 10: Technical and Environmental Performance of Methanol in Electric Utility Equipment	10-1
Performance of Methanol in Boilers	10-1
Performance of Methanol in Gas Turbines	10-5
CHAPTER 11: Cost Comparisons of Methanol in Utilities	11-1
Methanol Versus Other Liquid and Gaseous Fuels	11-1
Liquid and Gas Technologies Versus Coal	11-13
CHAPTER 12: Market Projections for Electric Utilities	12-1
CEUM Projections	12-1
Environmental Regulations and Methanol	12-5
PART V: METHANOL AS A FEEDSTOCK IN THE PETROCHEMICAL INDUSTRIES	
CHAPTER 13: Introduction to Part V	13-1
Current Production	13-1
Current Uses	13-2
Current Capacity	13-3
CHAPTER 14: Cost Comparisons of Methanol from Coal and Natural Gas	14-1
CHAPTER 15: Market Potential for Methanol as a Petrochemical Feedstock	15-1

TABLE OF CONTENTS (Continued)

	<u>Page</u>
APPENDICES	
APPENDIX A: Indirect Coal Liquefaction	A-1
Methanol From Coal	A-1
Mobil Gasoline From Coal	A-11
Methanol From Natural Gas	A-14
APPENDIX B: Direct Coal Liquefaction	B-1
H-Coal Process Description	B-3
Exxon Donor Solvent	B-5
SRC-11 Process Description	B-11
Refining Needs and Product Prices	B-15

LIST OF FIGURES

	<u>Page</u>
CHAPTER EIGHT	
8-1 Map of Census Regions	8-8
CHAPTER NINE	
9-1 Boiler-Fired Power Plant	9-4
9-2 Gas Turbine	9-6
9-3 Combined-Cycle Gas Turbine	9-8
APPENDIX A	
A-1 Block Flow Diagram - Production of Methanol and Gasoline From Coal	A-2
A-2 Block Flow Diagram - Production of Methanol From Natural Gas	A-15
APPENDIX B	
B-1 H-Coal Process: Principal Steps in the Process	B-4
B-2 Block Flow Diagram - Exxon Donor Solvent Process	B-10
B-3 Block Flow Diagram - SRC II Process	B-14

LIST OF TABLES

		<u>Page</u>
 CHAPTER 1		
1-1	Product Cost Estimates	1-2
1-2	Crude Oil Equivalent Costs	1-4
1-3	Product Yields for Direct Liquefaction Technologies With Refining	1-5
1-4	Methanol and Synthetic Gasoline Powered Cars: Range of Differences in Annual Operation Cost	1-9
1-5	Total Fuel Used by Fleet Cars in Terms of Methanol Consumption	1-11
1-6	Methanol and Synthetic Distillate and Residual Oil: Differences in Delivered Fuel Costs	1-12
1-7	Projections of Utility Demand for Liquid Fuels in Peak-Load Service	1-13
1-8	Natural Gas Prices Necessary to Make Gas-Based Methanol and Coal-Based Methanol Equal in Cost	1-15
 CHAPTER 2		
2-1	Product Yields for Direct Liquefaction With Refining	2-3
 CHAPTER 3		
3-1	Assumed Construction Schedules	3-2
3-2	Annual Maintenance Cost Estimates	3-5
3-3	Procedure for the Calculation of Product Costs	3-8
3-4	Illustration of the Adjustment Factor Calculation	3-10
3-5	Capital Adjustment Factors for Large Plants	3-11
3-6	Key Financial Assumptions for the Capital Charge Rate	3-13

LIST OF TABLES (Cont'd.)

	<u>Page</u>
CHAPTER 4	
4-1 Estimates of Instantaneous Investment	4-2
4-2 1990 Annual Costs of Production with a 15 Percent Capital Charge Rate	4-3
4-3 Plantgate Product Cost Estimates with 15 Percent Capital Charge Rate	4-5
4-4 Crude Oil Equivalent Cost with 15 Percent Capital Charge Rate	4-6
4-5 Product Cost Estimates With 21 Percent Capital Charge Rate	4-8
4-6 Crude Oil Equivalent Cost with 21 Percent Capital Charge Rate	4-9
4-7 Plantgate Product Cost Estimates with a five-year Delay in Construction	4-10
4-8 Plantgate Product Cost Estimates with a 70% Utilization	4-12
CHAPTER 7	
7-1 Fleet Auto Cost Comparison in 1990 for Small Scale Synfuel Distribution to Chicago	7-4
7-2 Fleet Auto Cost Comparison in 1990 for Large Scale Synfuel Distribution to Chicago	7-5
7-3 Summary of Fleet Cost Comparisons in 1990 for Both Small and Large Scale Distributions to Chicago	7-6
7-4 Non-Fleet Auto Cost Comparison in 1990 for Small Scale Synfuel Distribution to Chicago	7-7
7-5 Non-Fleet Auto Cost Comparison in 1990 for Large Scale Synfuel Distribution to Chicago	7-8
7-6 Summary of Non-Fleet Cost Comparison in 1990 for Both Small and Large Scale Distributions to Chicago	7-9
7-7 Non-Fleet Auto Cost Comparison in 1990 for Small Scale Synfuel Distribution to Chicago with Low Retail Costs	7-11
7-8 Non-Fleet Auto Cost Comparison in 1990 for Large Scale Synfuel Distribution to Chicago with Low Retail Costs	7-12
7-9 Summary of Non-Fleet Cost Comparisons in 1990 for Large Scale Synfuel Distribution to Chicago With Low Retail Costs	7-13

LIST OF TABLES (Cont'd.)

	<u>Page</u>
 CHAPTER 7 (Cont'd.)	
7-10 Non-Fleet Auto Cost Comparison in 1990 for Small Scale Synfuel Distribution to New York with Low Retail Costs	7-15
7-11 Non-Fleet Auto Cost Comparison in 1990 for Large Scale Synfuel Distribution to New York with Low Retail Costs	7-16
7-12 Summary of Non-Fleet Cost Comparisons in 1990 for Both Small and Large Scale Distributions to New York and with Low Retail Costs	7-17
7-13 Fleet Auto Cost Comparison in 2000 for Small Scale Synfuel Distribution to Chicago	7-18
7-14 Fleet Auto Cost Comparison in 2000 for Large Scale Synfuel Distribution to Chicago	7-19
7-15 Summary of Fleet Cost Comparisons in 2000 for Both Small and Large Scale Distribution in Chicago	7-20
7-16 Non-Fleet Auto Cost Comparison in 2000 for Small Scale Synfuel Distribution to Chicago with Low Retail Costs	7-21
7-17 Non-Fleet Auto Cost Comparisons in 2000 for Large Scale Synfuel Distribution to Chicago with Low Retail Costs	7-22
7-18 Summary of Non-Fleet Cost Comparisons in 2000 for Both Small and Large Scale Distributions to Chicago With Low Retail Costs	7-23
 CHAPTER 8	
8-1 New Car Sales for Fleets of Ten or More	8-2
8-2 Cars by Type of Use in Fleets of Ten or More	8-3
8-3 Annual Miles Driven and Average Size of Fleets by Type of Use	8-4
8-4 Needed Driving Range Capability	8-5
8-5 Garaging Information	8-5
8-6 Geographic Distribution of Fleet Cars	8-7
8-7 Projected Stock of Fleet Cars	8-9
8-8 Projected Gasoline Use by Fleet Cars	8-9
8-9 Projected Fuel Use by Fleet Cars in Terms of Methanol Consumption	8-10
8-10 Projected Fuel Use with Higher Fuel Efficiency	8-11
8-11 New Car Sales for Fleets of Ten or More	8-11

LIST OF TABLES (Cont'd.)

	<u>Page</u>
CHAPTER 11	
11-1 Utility Cost Comparisons: Methanol and Synthetic Residual or Distillates in 1990 to Chicago Using Rail For Transporting All Fuels	11-3
11-2 Utility Cost Comparisons: Methanol and Synthetic Residual or Distillate in 1990 to Chicago Using Pipeline for Transporting Methanol and Distillate, and Rail for Transporting Residual Oil	11-4
11-3 Summary of Utility Cost Comparisons Between Methanol and Synthetic Residual or Distillate to Chicago in 1990	11-5
11-4 Utility Cost Comparison: Methanol and Synthetic Residual or Distillate in 1990 to New York Using Rail for Transporting All Fuels	11-7
11-5 Utility Cost Comparison: Methanol and Synthetic Residual or Distillate in 1990 to New York Using Pipeline for Transporting Methanol and Distillate, and Rail for Transporting Residual Oil	11-8
11-6 Summary of Utility Cost Comparisons Between Methanol and Synthetic Residual or Distillate to New York in 1990	11-9
11-7 Utility Cost Comparison: Methanol and Synthetic Residual or Distillate in 2000 to Chicago Using Rail for Transporting All Fuels	11-10
11-8 Utility Cost Comparison: Methanol and Synthetic Residual or Distillate in 2000 to Chicago Using Pipeline for Transporting Methanol and Distillate, and Rail for Transporting Residual Oil	11-11
11-9 Summary of Utility Cost Comparisons between Methanol and Synthetic Residual or Distillate to Chicago in 2000	11-12
11-10 Cost Comparison of New Liquids and Coal-Fired Boilers/Steam Turbine	11-14
11-11 Cost Comparison of Existing Liquids-Fired and New Coal-Fired Boiler/Steam Turbines	11-15
11-12 Cost Comparison of a New Liquids-Fired Combined Cycle Unit Versus a New Coal-Fired Boiler/Steam Turbine	11-17
11-13 Cost Comparison of Liquids and Coal in a Coal-Capable Boiler/Steam Turbine	11-18

LIST OF TABLES (Cont'd.)

	<u>Page</u>
CHAPTER 12	
12-1 Projected Utility Generating Capacity	12-2
12-2 Projected Utility Fossil-Fuel Consumption	12-2
12-3 Utility Oil and Gas Capacity and Fuel Use in 1990 and 1995	12-4
CHAPTER 13	
13-1 U.S. Production of Methanol, 1965-1980	13-2
13-2 Chemical Uses of Methanol	13-3
13-3 U.S. Methanol Industry Plant Capacity	13-4
13-4 Announced Capacity Additions to the U.S. Methanol Industries	13-5
CHAPTER 14	
14-1 Petrochemical Cost Comparison: Methanol From Illinois in 1990 Delivered to Houston by Rail	14-2
14-2 Petrochemical Cost Comparison: Methanol From Illinois in 1990 Delivered to Houston by Pipeline	14-3
14-3 Petrochemical Cost Comparison: Methanol From Illinois in 2000 Delivered to Houston by Rail	14-4
14-4 Petrochemical Cost Comparison: Methanol from Illinois in 2000 Delivered to Houston by Pipeline	14-5
14-5 Natural Gas Prices Necessary to Make Gas-Based Methanol and Coal Based Methanol Equal in Cost	14-6
CHAPTER 15	
15-1 Celanese Projections of U.S. Methanol Demand	15-1
15-2 U.S. Acetic Acid Industry Plant Capacity	15-3
APPENDIX A	
A-1 Estimated Capital Costs for Production of Methanol From Illinois No. 6 Coal	A-4
A-2 Estimated Capital Costs for Production of Methanol From Illinois No. 6 Coal for Three Gasification Technologies	A-5

LIST OF TABLES (Cont'd.)

	<u>Page</u>
APPENDIX A (Cont'd.)	
A-3	Estimated Capital Costs for the Coproduction of SNG and Methanol from Wyoming Sub-bituminous Coal
A-4	Estimated Yields and Operating Requirements for the Production of Methanol from Illinois No. 6 Coal
A-5	Estimated Yields and Operating Requirements for the Production of Methanol from Illinois No. 6 Coal for Three Gasification Technologies
A-6	Estimated Yields and Operating Requirement for the Coproduction of SNG and Methanol from Wyoming Sub-bituminous Coal
A-7	Estimated Capital Costs for Production of Gasoline from Illinois No. 6 via Methanol
A-8	Estimated Yields and Operating Requirements for the Production of Gasoline from Illinois No. 6 via Methanol
A-9	Estimated Capital Costs for Production of Methanol by Steam Reforming Natural Gas
A-10	Estimated Yields and Operating Requirements for Production of Methanol by Steam Reforming Natural Gas

LIST OF TABLES (Cont'd.)

	<u>Page</u>
APPENDIX B	
B-1 Estimated Capital Costs for Production of Liquid Fuels by H-Coal From Illinois No. 6 Coal	B-6
B-2 Estimated Capital Costs for Production of Liquid Fuels by H. Coal From WYODAK Coal	B-7
B-3 Estimated Yields and Operating Requirements for the Production of Liquid Fuels by H-Coal From Illinois No. 6 Coal	B-8
B-4 Estimated Yields and Operating Requirements for the Production of Liquid Fuels by H-Coal from WYODAK Coal	B-9
B-5 Estimated Capital Costs for EDS Production of Liquid Fuels from Illinois No. 6 Coal	B-12
B-6 Estimated Yields and Operating Requirements for the EDS Production of Liquid Fuels from Illinois No. 6 Coal	B-13
B-7 Estimated Capital Costs for SRC-11 Production of Liquid Fuels from Illinois No. 6 Coal	B-16
B-8 Estimated Yields and Operating Requirements for the SRC-11 Production of Liquid Fuels from Illinois No. 6 Coal	B-17
B-9 Estimated Capital Costs for Refinery Upgrading of H-Coal Liquid Products	B-19
B-10 Estimated Yields and Operating Requirements for the Refinery Upgrading of H-Coal Liquid Fuels	B-20
B-11 Estimated Capital Costs for Refinery Upgrading of EDS Liquid Products	B-21
B-12 Estimated Yields and Operating Requirements for the Refinery Upgrading of EDS Liquid Products	B-22
B-13 Estimated Capital Costs for Refinery Upgrading of SRC-11 Liquid Products	B-23
B-14 Estimated Yields and Operating Requirements for the Refinery Upgrading of SRC-11 Products	B-24
B-15 Estimated Capital Costs for Refinery Upgrading of H-Coal Liquid Products from WYODAK Coal	B-25
B-16 Estimated Yields and Capital Costs for the Refinery Upgrading of WYODAK Coal	B-26