



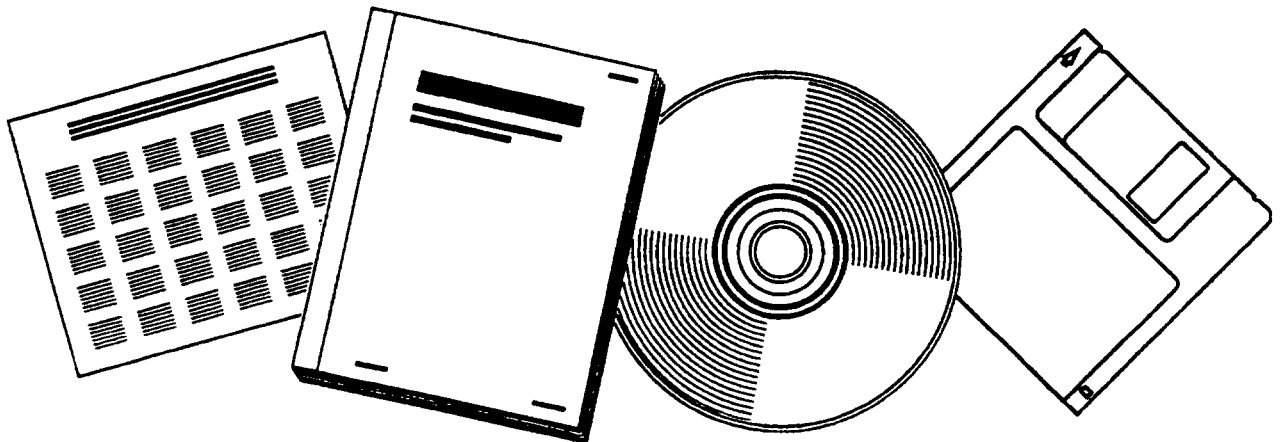
DE82017677

NTIS[®]
Information is our business.

FURTHER STUDIES ON DEVELOPING TECHNOLOGY FOR INDIRECT LIQUEFACTION

MITRE CORP., MCLEAN, VA. METREK DIV

MAR 1982



U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

Further Studies on Developing Technology for Indirect Liquefaction

David Gray
Martin B. Neuworth
Glen Tomlinson

March 1982

MTR-82W32

SPONSOR: Department of Energy
CONTRACT NO.: DE-AC01-77ET10280

The MIT Corporation
Met
1820 Dolley M. ...vard
McLean, Virg. ...102

ABSTRACT

This report is a companion volume to MTR-80W326 (now published by NTIS as DOE/ET/10280 T1 and T2) which quantified the impact of developing gasification and synthesis technology on a conventional SASOL-type indirect liquefaction plant. This volume extends the previous analyses to include an agglomerating-ash fluid-bed gasifier and the use of Illinois #6 seam coal as feedstock.

TABLE OF CONTENTS

	Page
LIST OF ILLUSTRATIONS	vii
LIST OF TABLES	viii
1.0 INTRODUCTION	1
2.0 EXECUTIVE SUMMARY	5
2.1 Westinghouse Gasifier Performance with Western Coal	5
2.2 Indirect Liquefaction of Illinois #6 Coal	12
2.3 Conclusions and Recommendations	19
2.3.1 Westinghouse Gasification	19
2.3.2 Indirect Liquefaction of Illinois #6 Coal	20
3.0 INDIRECT LIQUEFACTION USING WESTINGHOUSE FLUID BED GASIFICATION	23
3.1 Introduction	23
3.2 Plant Configuration	24
3.3 Westinghouse Gasification	26
3.3.1 Gasifier Operation	26
3.3.2 Gasifier Performance	29
3.4 Synthesis Gas Preparation	32
3.5 Product Synthesis and Upgrading	34
3.5.1 Introduction	34
3.5.2 Performance of Plant Employing Synthol Synthesis	38
3.5.3 Performance of Plants Employing Kolbel Synthesis	42
3.6 Economic Comparisons	45
3.6.1 Plant Construction Costs	45
3.6.2 Product Costs	49
3.7 Environmental Considerations	56
4.0 INDIRECT LIQUEFACTION USING FIXED BED GASIFICATION OF ILLINOIS #6 COAL	59
4.1 Introduction	59
4.2 Data Sources Used for Process Evaluation	61
4.2.1 Lurgi Dry-Ash	61
4.2.2 BGC Slagging Lurgi	64

TABLE OF CONTENTS (Concluded)

	<u>Page</u>
4.3 General Plant Assumptions	69
4.4 System Description and Analyses	71
4.4.1 Dry-Ash Lurgi/Synthol	71
4.4.2 Plant Construction Cost	77
4.4.3 Product Costs	79
4.4.4 BGC Slagging Lurgi Systems	82
4.4.5 Plant Construction Cost	88
4.4.6 Product Costs	91
5.0 INDIRECT LIQUEFACTION USING ENTRAINED GASIFICATION OF ILLINOIS #6 COAL	 93
5.1 Introduction	93
5.2 Data Sources Used for Process Evaluation	93
5.2.1 Texaco	93
5.2.2 Shell-Koppers	94
5.3 Systems Descriptions and Analyses	94
5.3.1 Texaco	94
5.3.2 Plant Construction Costs	100
5.3.3 Product Costs	102
5.3.4 Shell Koppers	104
5.3.5 Plant Construction Costs	108
5.3.6 Product Costs	111
APPENDIX A Plant Steam Coal Requirements	113
APPENDIX B Shift Analysis	115
APPENDIX C Computation of Entrained Gasifiers Product Gas Output	 116
APPENDIX D Gasoline Cost Computations	117
REFERENCES	121

LIST OF ILLUSTRATIONS

<u>Figure Number</u>		<u>Page</u>
2-1	Comparison of Reactor Types	6
2-2	Plant Construction Cost Comparisons	8
3-1	Schematic of Indirect Liquefaction Plant Employing Westinghouse Gasification	25
3-2	Westinghouse Pressurized Fluidized Bed Gasifier	27
3-3	Synthesis Gas Preparation Using Westinghouse Gasification	33

LIST OF TABLES

Table Number	Page
1-1 Coal Analyses	2
2-1 Gasifier Performance Comparisons (Wyoming Sub-bituminous Coal)	7
2-2 Summary Data for Plants Using Synthol Synthesis and Advanced Gasifiers (All-Liquid Output) Wyoming Sub-bituminous Coal	10
2-3 Summary Data for Plants Using Kolbel Synthesis and Advanced Gasifiers (All-Liquid Output) Wyoming Sub-bituminous Coal	11
2-4 Summary Data for Plants Using Synthol Synthesis and Advanced Gasifiers (All-Liquid Output) Illinois #6 Coal	13
2-5 Summary Data for Plants Using Kolbel Synthesis and Advanced Gasifiers (All-Liquid Output) Illinois #6 Coal	14
2-6 Comparison of Gasoline Costs from Indirect Liquefaction Plants (All-Liquid Output)	15
2-7 Gasoline Cost Computations (Synthol Synthesis)	18
3-1 Summary Data for Westinghouse Coal Gasification for Illinois #6 and Wyoming Sub-C Coals	30
3-2 Material and Energy Flux in Synthesis Gas Preparation Units for Westinghouse/Synthol System (Wyoming Coal)	35
3-3 Material and Energy Flux in Synthesis Gas Preparation Units for Westinghouse/Synthol System (Illinois #6 Coal)	36
3-4 Product Selectivity for Synthol and Kolbel Fischer-Tropsch Synthesis Reactors	37
3-5 Product Upgrading Units Following F-T Synthesis	39
3-6 Plant Output--Westinghouse/Synthol (Wyoming Coal)	40
3-7 Plant Output--Westinghouse/Synthol (Illinois #6 Coal)	41
3-8 Plant Output--Westinghouse/Kolbel (Wyoming Coal)	43
3-9 Plant Output--Westinghouse/Kolbel (Illinois #6 Coal)	44
3-10 Construction Costs of Plants Employing Westinghouse Gasification (Wyoming Coal)	46
3-11 Construction Cost Data for Indirect Liquefaction Plants Using Synthol Synthesis and Wyoming Coal	47
3-12 Construction Cost of Plants Employing Westinghouse Gasification (Illinois #6 Coal)	48
3-13 Construction Cost Data for Indirect Liquefaction Plants Using Synthol Synthesis and Illinois #6 Coal	50

LIST OF TABLES (Continued)

Table Number		Page
3-14	Price of Fuels Other Than Gasoline	51
3-15	Comparison of Gasoline Costs from Indirect Liquefaction Plants (27.8 M Tons/Hour Coal Throughput)	52
4-1	Analysis of Illinois #6 Feedstock	60
4-2	Comparison of Parameters Used in Gasification of Illinois #6 Coal Using the Dry-Ash Lurgi	65
4-3	Performance Data from the Westfield Slagging Gasifier on a Variety of Coals	67
4-4	Material and Energy Flux in Synthesis Gas Preparation Units for Lurgi Dry-Ash/Synthol System (Illinois #6 Coal)	72
4-5	Product Slate for Lurgi Dry-Ash/Synthol System (Illinois #6 Coal)	75
4-6	Comparison of Gasification Efficiencies with Wyoming and Illinois #6 Coals Using Lurgi Dry-Ash Gasifier	76
4-7	Construction Cost for Lurgi Dry-Ash Systems	78
4-8	Cost Data for Lurgi Dry-Ash/Synthol System	81
4-9	Material and Energy Flux in Synthesis Gas Preparation Units for BGC-Lurgi/Synthol System (Illinois #6 Coal)	83
4-10	Comparison of Gasification Efficiencies of EGC-Lurgi Using Wyoming and Illinois #6 Coals	85
4-11	Product Slate for BGC-Lurgi/Synthol System (Illinois #6 Coal)	87
4-12	Product Slate for BGC-Lurgi/Kolbel System (Illinois #6 Coal)	89
4-13	Construction Cost for BGC-Lurgi Systems (Illinois #6 Coal)	90
4-14	Cost Data for BGC-Lurgi Systems (Illinois #6 Coal)	92
5-1	Material and Energy Flux in Synthesis Gas Preparation Units for Texaco/Synthol System (Illinois #6 Coal)	96
5-2	Product Slate for Texaco/Synthol System (Illinois #6 Coal)	98
5-3	Product Slate for Texaco/Kolbel System (Illinois #6 Coal)	99
5-4	Construction Cost for Texaco Systems (Illinois #6 Coal)	101
5-5	Cost Data for Texaco Systems with Illinois #6 Coal	103
5-6	Material and Energy Flux in Synthesis Gas Preparation Units for Shell-Koppers/Synthol System (Illinois #6 Coal)	105
5-7	Product Slate for Shell-Koppers/Synthol System (Illinois #6 Coal)	107

LIST OF TABLES (Concluded)

<u>Table Number</u>		<u>Page</u>
5-8	Product Slate for Shell-Koppers/Kolbel System (Illinois #6 Coal)	109
5-9	Construction Cost for Shell-Koppers Systems (Illinois #6 Coal)	110
5-10	Cost Data for Shell-Koppers Systems with Illinois #6 Coal	112
D-1	Gasoline Cost Computations, Synthol Synthesis (Wyoming Coal)	117
D-2	Gasoline Cost Computations, Synthol Synthesis (Illinois #6 Coal)	118
D-3	Gasoline Cost Computations, Kolbel Synthesis (Wyoming Coal)	119
D-4	Gasoline Cost Computations, Kolbel Synthesis (Illinois #6 Coal)	120