

Report No. 12

LINEAR ALPHA OLEFINS

by ROBERT G. MULLER

contributions by SHIGEYOSHI TAKAOKA
and DONALD B. MILLER

JUNE 1966

A private report by the

PROCESS ECONOMICS PROGRAM



STANFORD RESEARCH INSTITUTE

MENLO PARK, CALIFORNIA

CONTENTS

I	INTRODUCTION	1
II	SUMMARY	3
III	INDUSTRY STATUS	7
IV	ALPHA OLEFINS BY CRACKING PARAFFIN WAX	15
	Introduction	15
	Chemistry	15
	Thermal Decomposition of Paraffins	16
	Secondary Reactions	20
	Catalytic Cracking	22
	Kinetics of Thermal Cracking	22
	Review of Processes	26
	Thermal Cracking	26
	Catalytic Cracking	33
	Process Description	33
	Raw Materials	42
	Materials of Construction	42
	Process Discussion	43
	Cost Estimates	46
	Capital Investment	46
	Production Costs	46
V	ALPHA OLEFINS BY ETHYLENE POLYMERIZATION	51
	Introduction	51
	Chemistry	51
	Preparation of Triethylaluminum	51
	Ethylene Polymerization	53
	Aluminum Alkyl Recovery	62
	Review of Processes	65
	Low Temperature Polymerization	66
	High Temperature Polymerization	70
	Triethylaluminum Recovery	73
	High Temperature Polymerization Process	76
	Process Description	76
	Raw Materials	91
	Materials of Construction	92
	Process Discussion	92
	Capital Cost Estimate	96
	Production Cost Estimate	96

CONTENTS

V	(continued)	
	Low Temperature Polymerization Process	104
	Process Description	104
	Process Discussion	114
	Cost Estimates	116
VI	OTHER PROCESSES	119
	Dehydration of Alcohols	119
	Dehydrohalogenation of Alkyl Halides	120
	Dehydrogenation of Paraffins	121
	Olefin Isomerization	122
	Oligomerization	122
	Miscellaneous Processes	123
APPENDIX A	DESIGN AND COST BASIS	125
APPENDIX B	PHYSICAL DATA	129
APPENDIX C	RAW MATERIAL SPECIFICATIONS	131
REFERENCES	133

ILLUSTRATIONS

1	Effect of Temperature on Cracking Reaction Velocity of Various Paraffins	24
2	Alpha Olefins by Cracking Paraffin Wax	35
3	Distribution of C ₆ -C ₂₀ Olefins in Cracking Furnace Effluent . .	44
4	Theoretical Poisson Distribution of Alkyl Groups R-(C ₂ H ₄) _p , in Growth Reaction Product	55
5	Alpha Olefins by High Temperature Ethylene Polymerization . . .	81
6	Alpha Olefin Production Cost versus Ethylene Selectivity and Cost	103
7	Alpha Olefin Production Cost versus TEA Recovery and Cost . . .	103
8	Alpha Olefins by Low Temperature Ethylene Polymerization . . .	105
9	Vapor Pressure for Various Olefins and Paraffins	130

TABLES

1	Alpha Olefins--Plant Capacities United States and Foreign	11
2	Alpha Olefins by Thermal Cracking Summary of Processes	29
3	Alpha Olefins by Cracking Paraffin Wax Major Process Equipment and Utilities Summary	34
4	Alpha Olefins by Cracking Paraffin Wax Stream Flows	37
5	Alpha Olefins by Cracking Paraffin Wax Process Unit and Utilities Investment	47
6	Alpha Olefins by Cracking Paraffin Wax Total Capital Investment	48
7	Alpha Olefins by Cracking Paraffin Wax Production Costs	49
8	Alpha Olefins by High Temperature Ethylene Polymerization Major Process Equipment and Utilities Summary	77
9	Alpha Olefins by High Temperature Ethylene Polymerization Stream Flows	85
10	Alpha Olefins by High Temperature Ethylene Polymerization Process Unit and Utilities Investment	97
11	Alpha Olefins by High Temperature Ethylene Polymerization Total Capital Investment	99
12	Alpha Olefins by High Temperature Ethylene Polymerization Production Costs	101
13	Alpha Olefins by Low Temperature Ethylene Polymerization Stream Flows	109