

Oleochemicals

99/00S12

May 2001

TABLE OF CONTENTS

	Page
I EXECUTIVE SUMMARY	1
A. NATURAL FEEDSTOCKS FOR OLEOCHEMICALS	1
B. OLEOCHEMICALS FROM NATURAL FEEDSTOCKS	6
C. ECONOMICS OF ALCOHOL PROCESSES	10
D. SUPPLY	11
E. DEMAND	12
II INTRODUCTION	13
III COMMERCIAL PROCESSES	18
A. FATS AND OILS PRODUCTION	18
B. NATURAL FEEDSTOCKS FOR OLEOCHEMICALS	22
C. OLEOCHEMICALS FROM NATURAL FEEDSTOCKS	33
1. General Background	33
2. Natural Detergent Alcohol Processes	36
(a) Natural Oil Feedstocks	38
(b) Process Descriptions	38
(1) Methyl Ester Route (Methanolysis)	39
(2) Fatty Acid Route (Hydrolysis)	44
(3) Hydrogenolysis of Methyl Esters or Fatty Acids	50
3. Fatty Acid Distillation and Fractionation	56
4. Fatty Nitrogen Compounds	60
(a) Chemistry	60
(b) Process Design	60
D. DETERGENT RANGE ALCOHOLS FROM PETROCHEMICAL FEEDSTOCKS	65
1. Oligomerization/Hydroformylation Approach	65
2. Oligomerization/Oxidation/Hydrolysis Approach	65
IV ECONOMICS	66
A. BASIS	66
1. Pricing Basis	66
2. Investment Basis	67
3. Cost of Production Basis	67

**TABLE OF CONTENTS
(Continued)**

	Page
B. NATURAL ROUTES	68
C. SYNTHETIC ROUTES	76
D. COMPARISON OF ALCOHOL PROCESSES	82
V COMMERCIAL ANALYSIS	86
A. END USE APPLICATIONS	86
1. Natural Fatty Acids	86
(a) Fatty Acids for Medium Chain Triglycerides	87
(b) Fatty Acids in Rubber Processing	87
(c) Fatty Acids for Candles	87
(d) Fatty Acids for Cosmetic Products	87
(e) Fatty Acids for Soaps	87
(f) Fatty Acids for the Production of Metallic Soaps	88
2. Fatty Esters	88
(a) Fatty Esters for Fatty Alcohols	88
(b) Fatty Esters for Soap Production	89
(c) Alpha-Sulfonated Methyl Esters for Detergents	89
(d) Methyl Esters as a Diesel Substitute	89
3. Fatty Nitrogen Compounds	89
4. Glycerol	89
B. OLEOCHEMICAL RAW MATERIALS	90
C. SUPPLY	93
D. DEMAND	95
APPENDIX	96
PERP TITLE INDEX	101

TABLES

		Page
Table I.A.1	Natural Fatty Acids: Chain Length and Common Sources	5
Table I.C.1	Comparison of Detergent-Range Alcohol Processes	10
Table I.D.1	Estimated Capacities of Leading Global Oleochemical Producers, 2000	11
Table I.E.1	Estimate of World Oleochemicals Production/Demand	12
Table II.1	World Production of 17 Major Fats and Oils, 1995-2000	14
Table II.2	Average Annual Yields of Selected Vegetable Oils	15
Table III.B.1	Natural Fatty Acids: Chain Length and Common Sources	26
Table III.B.2	Typical Tall Oil Compositions from Common Pine Wood Sources	28
Table III.B.3	Average Fatty Acid Composition of Common Fats and Oils	29-31
Table III.C.1	Disposition of Fatty Acid Fractions in Distillation	56
Table IV.A.1	Prices of Raw Materials, By-Products and Other Inputs	66
Table IV.B.1	Cost of Production Estimate for Fatty Acids Process: Natural Ex PKO via Hydrolysis	69
Table IV.B.2	Cost of Production Estimate for: Lauric/Myristic Acids Process: Batch Distil. Of Natural C ₁₂ -C ₁₈ Cut	71
Table IV.B.3	Cost of Production Estimate for: C ₁₂ Fatty Amine Process: Natural via Amination of C ₁₂ Fatty Acid	72
Table IV.B.4	Cost of Production Estimate for: Mixed Fatty Alcohols Process: Natural via Fatty Acids	73
Table IV.B.5	Cost of Production Estimate for: Linear Alcohols Process: Natural Ex PKO via Methyl Ester	75
Table IV.C.1	Cost of Production Estimate for: Linear Alpha Olefins Process: Shell SHOP	77
Table IV.C.2	Cost of Production Estimate for: Linear Internal Olefins Process: Shell Metathesis	78
Table IV.C.3	Cost of Production Estimate for: Detergent Alcohols Process: High Pressure Hydroformylation	79
Table IV.C.4	Cost of Production Estimate for: Linear Olefins Process: Ziegler	81
Table IV.D.1	Comparison of Detergent-Range Alcohol Processes	82

**TABLES
(Continued)**

		Page
Table V.A.1	Fatty Acid Overview and End-Use Applications	86
Table V.C.1	Estimated Capacities of Leading Global Oleochemical Producers, 2000	93
Table V.C.2	Asian Oleochemical Capacities	94
Table V.D.1	Estimate of World Oleochemicals Production/Demand	95

FIGURES

	Page	
Figure I.A.1	Overview of Oleochemicals Industry	2
Figure I.A.2	Selected Chemical Reactions of Oils and Fats	3
Figure III.B.1	Overview of Oleochemicals Industry	23
Figure III.B.2	Selected Chemical Reactions of Oils and Fats	24
Figure III.B.3	Commercial Fats and Oils Compared	32
Figure III.C.1	Methyl Esters via Methanolysis of Coconut Oil	40
Figure III.C.2	Fatty Acids via Hydrolysis of Coconut Oil	45
Figure III.C.3	Continuous Catalytic Hydrogenation of Fatty Acids	49
Figure III.C.4	Fatty Alcohols via Hydrogenolysis of Fatty Acids	54
Figure III.C.5	Fatty Acid Distillation	58
Figure III.C.6	Fatty Acid Fractionation	59
Figure III.C.7	Fatty Acid Nitrile via Ammonolysis of C ₁₂ Fatty Acids	62
Figure III.C.8	Linear Fatty C ₁₂ Dimethylamine via Linear Fatty Nitriles	64
Figure IV.D.1	USGC Pricing for Detergent Alcohol Feedstocks	84
Figure IV.D.2	Detergent Alcohol Price Sensitivity	85
Figure V.B.1	Oleochemical Industry Raw Materials	91
Figure V.B.2	Oleochemical Sources	92