

Report No. 24A2

Interim

ACETALDEHYDE

by JAMES J. L. MA

December 1976

A private report by the

PROCESS ECONOMICS PROGRAM



STANFORD RESEARCH INSTITUTE

MENLO PARK, CALIFORNIA

For detailed marketing data and information, the reader is referred to one of the SRI programs specializing in marketing research. The CHEMICAL ECONOMICS HANDBOOK Program covers most major chemicals and chemical products produced in the United States and the WORLD HYDROCARBONS Program covers major hydrocarbons and their derivatives on a worldwide basis. In addition, the SRI DIRECTORY OF CHEMICAL PRODUCERS services provide detailed lists of chemical producers by company, product, and plant for the United States and Western Europe.

CONTENTS

1	INTRODUCTION	1
2	SUMMARY	3
	General Aspects	3
	Economics	4
	Technical Aspects	7
	One-Step Process	7
	Two-Step Process	8
3	INDUSTRY STATUS	11
4	CHEMISTRY	15
	Reactions	15
	Reaction Mechanism	16
	Kinetics	17
	Side Reactions and By-Products	19
5	REVIEW OF PROCESS INFORMATION	21
	Patents	21
	Commercial Processes	29
6	ACETALDEHYDE BY ONE-STEP ETHYLENE OXIDATION PROCESS	33
	Process Description	33
	Reaction	33
	Purification	36
	Process Discussion	43
	Cost Estimates	46
	Capital Cost	46
	Production Cost	46
7	ACETALDEHYDE BY TWO-STEP ETHYLENE OXIDATION PROCESS	55
	Process Description	55
	Reaction	55
	Purification	57
	Process Discussion	66
	Cost Estimates	68
	Capital Cost	68
	Production Cost	68

CONTENTS

8	ACETALDEHYDE BY OTHER PROCESSES	77
	Acetylene Hydration	77
	Ethanol Dehydrogenation and Ethanol Oxidation	79
	Paraffin Oxidation	80
	Methanol Conversion	81
	Oxidative Cracking of Propylene	82
APPENDIX A	DESIGN AND COST BASIS	83
APPENDIX B	PHYSICAL AND THERMOCHEMICAL PROPERTIES OF ACETALDEHYDE	87
APPENDIX C	TYPICAL PRODUCT SPECIFICATION OF ACETALDEHYDE	89
APPENDIX D	HANDLING AND SAFETY OF ACETALDEHYDE	91
CITED REFERENCES	93
PATENT REFERENCES BY COMPANY	97

ILLUSTRATIONS

4.1	Acetaldehyde by Ethylene Oxidation Relationship Between Ethylene Absorption Rate and Operating Variables	18
6.1	Acetaldehyde by One-Step Ethylene Oxidation Process Flow Plan	99
6.2	Acetaldehyde by One-Step Ethylene Oxidation Process Effect of Plant Capacity on Total Fixed Capital Cost	49
6.3	Acetaldehyde by One-Step Ethylene Oxidation Process Effect of Operating Level and Plant Capacity on Production Cost	52
6.4	Acetaldehyde by One-Step Ethylene Oxidation Process Effect of Ethylene and Oxygen Prices on Net Production Cost	53
7.1	Acetaldehyde by Two-Step Ethylene Oxidation Process Flow Plan	101
7.2	Acetaldehyde by Two-Step Ethylene Oxidation Process Effect of Plant Capacity on Total Fixed Capital Cost	71
7.3	Acetaldehyde by Two-Step Ethylene Oxidation Process Effect of Operating Level and Plant Capacity on Production Cost	74
7.4	Acetaldehyde by Two-Step Ethylene Oxidation Process Effect of Ethylene Price on Net Production Cost	75

Tables

2.1	Acetaldehyde by Ethylene Oxidation Processes Summary of Costs	5
3.1	Acetaldehyde Plant Capacities	13
5.1	Acetaldehyde by Ethylene Oxidation Patent Summary	22
6.1	Acetaldehyde by One-Step Ethylene Oxidation Process Major Equipment and Utilities Summary	38
6.2	Acetaldehyde by One-Step Ethylene Oxidation Process Stream Flows	40
6.3	Acetaldehyde by One-Step Ethylene Oxidation Process Summary of Waste Products	41
6.4	Acetaldehyde by One-Step Ethylene Oxidation Process Design Bases and Assumptions	42
6.5	Acetaldehyde by One-Step Ethylene Oxidation Process Total Capital Investment	48
6.6	Acetaldehyde by One-Step Ethylene Oxidation Process Production Costs	50
7.1	Acetaldehyde by Two-Step Ethylene Oxidation Process Major Equipment and Utilities Summary	60
7.2	Acetaldehyde by Two-Step Ethylene Oxidation Process Stream Flows	62
7.3	Acetaldehyde by Two-Step Ethylene Oxidation Process Summary of Waste Products	64
7.4	Acetaldehyde by Two-Step Ethylene Oxidation Process Design Bases and Assumptions	65
7.5	Acetaldehyde by Two-Step Ethylene Oxidation Process Total Capital Investment	70
7.6	Acetaldehyde by Two-Step Ethylene Oxidation Process Production Costs	72