OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

INDUSTRIAL CHEMICALS FROM INDIGENOUS CARBOHYDRATE IN INDONESIA

——FINAL REPORT OF THE STUDY——

July 1989

JGC CORPORATION

TOKYO, JAPAN

UNIDO CONTRACT NO. 89/22/CW

(Project No. DP/INS/86/003)

INDUSTRIAL CHEMICALS FROM INDIGENOUS CARBOHYDRATE IN INDONESIA

—— FINAL REPORT OF THE STUDY ——

July 1989

JGC CORPORATION

TOKYO, JAPAN

PREFACE

In response to the award by UNIDO of the UNIDO Contract No.89/22/CW, "Study on Industrial Chemicals from Indigenous Carbohydrate in Indonesia", the Consultant, JGC Corporation, dispatched a field study team of three experts to Indonesia. Prior to the arrival of the team at Jakarta, Mr. Mizuho Kitamura, the team leader, visited UNIDO Headquarters in Vienna for briefing on 3 March. The field study team started its work in Indonesia on 6 March, 1989.

At the start of the field study, the study team and the Indonesian Government agreed upon eleven "Candidate Chemicals" to be studied. The initial phase of the field study consisted mostly of the analysis of published Government statistics of Indonesia. Data on the availability of molasses and information concerning the Government's policy for the development of agro-industry of Indonesia were provided to the team by the Sugar Council, Department of Agriculture. And data on production capacities and actual production records in 1988 of candidate chemicals presently produced in Indonesia were provided by the Department of Industry. In addition, the team conducted a number of interviews with private companies which handled industrial chemicals to collect supplemental information.

The data and information thus collected were such as to enable the team to make assumptions which can form a basis to fulfil the aim of the present study, whereas the detailed historical data on demand/supply of industrical chemicals which the team had originally intended to collect were unavailable. And the team could draw up a concept for a complex for the manufacture of six industrial chemicals selected by use of the data and information collected.

Then the team moved to Pasuruan, East jawa and discussed the results of the study so far performed with the Indonesian counterpart at the Sugar Research Institute there. The team also visited manufacturers of ethanol, MSG, and acetic acid and its derivatives in and around Surabaya and Solo.

In the last week of the field study, the team returned to Jakarta, and completed the Interim Report of the study. Meanwhile, the outline of the Interim Report was presented together with most of the data included in the Report at a seminar held on 10 April under the auspice of the Sugar Council. A number of questions and comments were raised by the Indonesian audience of the seminer. The basis for the home office study was also confirmed.

The field study team submitted its Interim Report on 14 April, 1989 to the S.I.D.F.A. of UNIDO in Jakarta and left Indonesia on that evening. The team leader visited UNIDO Headquarters again for consultation on 17 April and submitted the Interim Report.

In the home office, the study team re-examined the result of the field study and made necessary modification and addition. Particularly, the questions and comments raised at the seminar in Jakarta on 10 April and advice given to the team leader on the consultation at UNIDO Headquarters were taken into consideration. The Draft Final Report which incorporated the above modification and addition was submitted to UNIDO Headquarters on 16 June 1989.

The team leader visited UNIDO Headquarters on 26 June for de-briefing, on which the Draft Final Report was accepted by UNIDO on condition that some correction were to be made to complete this Final Report.

The Consultant believes that this Final Report can provide the Indonesian Government with a basis for its desision on the manufacture of industrial chemicals from the country's indigenous carbohydrate resources.

The Consultant would like to expresses its gratitude to Governmental and private organizations of Indonesia for their assistance and also to S.I.D.F.A., UNIDO in Jakarta for his kind guidance and support, which enabled the field study team to accomplish its task in the field. Thanks are also due to the staff of UNIDO Headquarters whose guidance and advice were invaluable for the completion of this study.

July 1989
JGC Corporation

CONTENTS

LIST OF TABLES

(LIST OF TABLES)

LIST OF FIGURES

Chapter 1. INTRODUCTION

The purpose of this study is to provide the Government of Indonesia with a basis for decision making on the production of industrial chemicals from indigenous carbohydrate raw material, particularly molasses.

Since Indonesia is basically an agricultural country and sugar cane is one of the country's major crops, and since Indonesia is in the process of industrializatiuon and the demand for industrial chemicals is bound to increase, it is quite reasonable for the country to consider the manufacture of industrial chemicals from sugar by-products. Molasses is the most important sugar by-product but it is not fully utilized in Indonesia and is exported to such countries as Japan, Taiwan, and South Korea mainly as a fermentation raw material.

At the start of the present study, eleven kinds of "candidate chemicals" were identified. They were : ethanol, acetone, n-butanol, acetic acid, acetic anhydride, ethyl acetate, butyl acetate, fructose, citric acid, monosodium glutamate (MSG), and L- lysine. All of the candidate chemicals can be made, theoretically, from carbohydrate raw material by fermentation, or as derivatives of fermentation products.

It cannot be said, however, that Indonesia has an advantage in the production of these chemicals by fermentation simply because Indonesia has a fermentation raw material and because these chemicals can be made by fermentation.

Some of the candidate chemicals are manufactured almost exclusively by way of fermentation and other biochemical processes worldwide. Fructose, citric acid, MSG, and L- lysine can be classified in this group and, except L- lysine, they have already been manufactured in Indonesia, and most are established as export commodities.

On the other hand, the situation is different for the rest of the candidate chemicals, namely, acetone, n-butanol, acetic acid, acetic anhydride, ethyl acetate, and butyl acetate. These organic chemicals were manufactured in the past as fermentation products or their derivatives, but nowadays the fermentation has almost completely given way to petrochemical processes because of the lower cost of the latter. Ethanol can be regarded as in between the two groups, it is made by both fermentation and petrochemical processes.

These chemicals are produced in huge scale mostly by petrochemical manufacturers in industrialized countries who dominate the world export market. The manufacturers seem to be producing these chemicals primarily for consumption in their respective domestic markets (in case of European producers, Europe is regarded as one common market), and exporting only a marginal portion of the products. It can be said, therefore, that for these manufacturers the need for making profit by product export is not very strong. They can set their export price so as to recover only variable costs of the products when necessary.

In this situation, it will not be wise for Indonesia to plan manufacture of these chemicals mainly for export. If Indonesia is to manufacture these chemicals, they will have to be targeted primarily to the domestic market of Indonesia to replace the chemicals hitherto imported.

This study is carried out with the above fundamental consideration in mind. The products to be manufactured should be those which are not produced in Indonesia, or, even if they are produced, the domestic production is not sufficient to fulfil the domestic demand. They should be made as fermentation products from molasses or their derivatives, and they should be cost-competitive with the products imported.

In this report, the economy and industry of Indonesia in general are surveyed in the first place (Chapter 2.), and an overview is made on the availability of the raw material, molasses (Chapter 3.). Then the situation in Indonesia of each candidate chemical is examined. Reference is also made to the world market of the chemicals (Chapter 4.). Against the above background, those chemicals which seem to be suitable for production in Indonesia are selected (Chapter 5.), and their production scheme is worked out (Chapter 6.). Then the economy of the project is evaluated (Chapter 7.). And, in the last part of the report (Chapter 8.), discussion is made on a number of problems which will have to be considered prior to the implementation of the project, and conceivable steps to be taken for a successful implementation of the project are recommended.

The main features of the project is summarized in the following page.

PROJECT SUMMARY

1. PRODUCT AND PRODUCTION QUANTITY

(1) Acetic Acid	15,800	ton/year
(2) Ethyl Acetate	18,700	
(3) Butyl Acetate	8,000	
(4) Acetone	8,000	
(5) n-Butanol	2,200	
(6) Octanol (2-Ethyl Hexanol)	9,600	
(7) Crude Ethanol	2,700	

2. RAW MATERIAL

(1) Molasses	250,000	ton/year
(2) Ethanol	20,000	

3. PRODUCTION CAPACITY OF MAIN PROCESS UNIT

(1) Ethanol	23,000	ton/year
(2) Acetaldehyde	35,000	
(3) Acetic Acid	20,000	
(4) Ethyl Acetate	19,000	
(5) Butyl Acetate	8,000	
(6) Acetone/Butanol	27,000	
(7) Octanol	10,000	

4. LOCATION — East Jawa

5. PLANT CONSTRUCTION COST — US$ 120 Million

6. CONSTRUCTION PERIOD — 2 Years

7. EMPLOYMENT — 200 Persons

8. ECONOMY

(1) Annual Sales Revenue	US$	62.7	Million
(2) Internal Rate of Return (IRR)		17.1	%
(3) Payout Period		6.7	Years
(4) Cummulative Surplus Cash*	US$	196	Million
(5) Foreign Currency Saving *	US$	319	Million

(* in 15 years)

CHAPTER 2. ECONOMY AND INDUSTRY OF INDONESIA

2.1. Economic Growth

In 1987, gross domestic product (GDP) of Indonesia at current price amounted to 114,518.5 billion Rupiahs, which is bigger than that of the previous year, 1986, by 19.51 % (Table 2.1.). At constant 1983 price, the growth rate of GDP in 1987 against 1986 was 3.59 %. Real growth rates of GDP at constant 1983 price during recent four years, namely 1983/84, 84/85, 85/86 and 86/87 were 6.03, 2.53, 3.99 and 3.59 %, respectively, indicating that the economy of Indonesia is on a path of steady growth.

As a consequence, per capita GDP has also recorded a growth of more than 2.1 % per year in real terms during past four years, amounting to 674,074 Rupiahs in 1987 at current price.

2.2. Population and Employment

Population of Indonesia counted at 164,630 thousand according to 1985 census (Table 2.2.). It is forecasted that the population is to increase to 216 116 thousand in the year 2000. The average annual rate of population growth, which is estimated at 2.1 % during 1985 - 1990 period, is expected to decrease to 1.6 % in 1995 - 2000 period.

The ratio in the whole population of younger people aged 14 years and under is expected to drop from 38.8 % in 1985 to 31.6 % in 2000. The share of Jawa Island in the whole population of Indonesia, which was 60.87 % in 1985, is expected to decrease to 59.82 % in 1990. Correspondingly, shares of Sumatra and Kalimantan Islands are expected to increase from 19.87 to 20.80 % and 4.71 to 4.86 %, respectively, during the same five year period, whereas the share of Sulawesi Island is to decrease slightly from 7.04 to 7.02 %.

Concentration of population into Jakarta, the capital of the country, is forecasted to continue, the share of the city in the whole population of Indonesia increasing to 5.23 % in 1990 from 4.81 % in 1985.

Among 122,547 thousand of population aged 10 and over in 1986, 70,193 thousand are economically active, of which 68,338 thousand (97.4 %) are actually working, ratio of the people looking for work among economically active population is as low as 2.6 %. However, the picture is somewhat different in Jakarta, where the ratio of people looking for work is 10.3 % of the economically active population (Table 2.3.).

Among working population of 68,338 thousand, 37,664 thousand (55.1 %) engage in agriculture, forestry, hunting and fishery sector, indicating that Indonesia is basically an agricultural country.

A sector which absorbs most working population next to agriculture etc. is public services, which accounts for 14.7 % of the total working population, then comes commercial sector including restaurant. Manufacturing industry employs only 8.2 % of the working population.

2.3. Agriculture

Agriculture, livestock, forestry and fishery sector contributes to 23.44 % of GDP in 1987 (Table 2.4.), being the biggest economic sector in the national economy of Indonesia. However, this ratio of agricultural sector in whole GDP has decreased from 23.59 % in 1983. The cummulative growth rate of agricultural sector from 1983 to 1987 was 14.32 %, which is lower than the growth rate of 17.11 % for the whole GDP during the same period.

Agriculture of Indonesia is supported mainly by smallholder farmers. Even for such commercial crops as rubber, sugar cane, and coffee, planted areas by smallholders exceed those by estates (Table 2.5.).

2.4. Manufacturing Industry

The share of manufacturing industry sector in GDP in 1987 is 13.97 % (Table 2.4.), which is less than those of agriculture (23.44 %) and mining (16.33 %) sectors. This figure, as well as the manufacturing sector's share in employment as aforementioned, indicates that manufacturing in Indonesia is still a lesser sector in the national economy compared to agriculture or mining.

However, manufacturing is the highest growing sector in the national economy of Indonesia. The cummulative growth rate of this sector from 1983 to 1987 is 46.79 % (Table. 2.4.), which by far exceeds the growth rate of whole GDP during the same period.

The structure of the manufacturing industry in Indonesia in 1979 is summarized in Table 2.6. More than 99 % of manufacturing establishments were of "small" and "household" scale, employing less than 20 persons, and these small factories employed more than 80 % of persons in the manufacturing sector. However, these small manufacturers contributed to only about 20 % of gross output and value added of the whole manufacturing industry.

Food and beverage sector accounted for more than 40 % of manufacturing establishment, person engaged, gross output, and value added of the whole manufacturing industry. Chemical industry sector (including such related subsectors as paint, match, tyre and tube, and plastics), which accounted for only 0.2 % of the manufacturing establishments and 2.7 % of the employees, contributed to 15.3 and 12.8 % of the gross output and value added, respectively, of the whole manufacturing industry. Chemical industry is also remarkable in that the sector is dominated by "large and medium" firms, which create 85.7 % of employment, 97.5 % of gross output, and 96.8 % of value added of the whole sector.

Basic chemical industry has grown keeping pace with the growth of whole manufacturing industry. From 1979 to 1985, gross output of basic chemical industry increased by 5.06 times, whereas the output of the whole industry increased by 4.97 times (Table 2.7.). However, if looked into more detail, this growth of basic chemical industry has so far been generated by the growth of fertilizer industry. From 1975 to 1984 and 1984 to 1986, average annual growth rates of fertilizer industry were 24.25 and 14.77 %, respectively, whereas the corresponding figures for basic chemical industry excluding fertilizer were 4.37 and 2.35 %, respectively (Table 2.8.). This growth rates of basic chemical industry excluding fertilizer were lower than those of whole manufacturing industry sector which were 10.22 and 7.04 % for the corresponding period.

2.5. Government's Policy

Indonesian Government's policy on the agro-industry seems to be that of "industrialization at the village level", that is, promotion of small or household type industry utilizing local agricultural products as raw materials, which is expected to add value to the agricultural products, to widen the use of the products, and eventually to improve and stabilize the living standard of the farmer families.

In case of sucro-based chemical industry, it seems that its aim is primarily to improve the economic status of sugar cane farmers by adding value to sugar cane and sugar by-products and to make a new field of demand for sugar cane.

For this purpose, close coordination is being established between Agricultural, Industrial, and other Govermental Departments concerned.

From 19 to 20 January this year, an Integrated National Workshop between Department of Agriculture and Department of Industry was held. As a result of the Integrated Workshop, a decision concerning the development of Agro-industry was made, which reads as follows:

"In consideration of the potential market opportunities, the agro-industry should be developed in the following way.

1. Priority should be laid on the increase of added value for the society which has low-income group in rural area, particularly farmers and small-scale industries, etc.

2. In the selection of the agro-industry to be developed, creation of labor-intensive business should be emphasized.

3. To push the agro-industry to spread to agricultural production centers in rural areas.

4. To push foreward the change of export structure from agricultural commodities to finished or semi-finished products.

Table 2.1. ECONOMIC GROWTH OF INDONESIA

		Gross Domestic Product	Per Capita GDP
at current price		(billion Rp)	(Rp)
1986		95,823.1	575,950
1987		114,518.5	674,074
Growth rate 86/87		(%)	(%)
at current price		19.51	17.04
at constant 1983 price		3.59	2.11
Growth rate at constant 1983 price	83/84	6.03	2.16
	84/85	2.53	2.14
	85/86	3.99	2.13
	86/87	3.59	2.11

source : National Income of Indonesia, Main Table, 1984 - 1987

Table 2.2. POPULATION PROJECTION OF INDONESIA

Year	Population (thousand)	Average annual growth rate (%)	Age 14 & under (thousand)	Share in population (%)
1985	164,630		63,938	38.8
		2.1		
1990	182,650		66,566	36.4
		1.8		
1995	199,647		67,137	33.6
		1.6		
2000	216,116		68,278	31.6

Distribution of Population by Island (%)

Island	1980	1985	1990
Sumatra	19.00	19.87	20.80
Jawa	61.88	60.87	59.82
(Jakarta)	(4.11)	(4.81)	(5.23)
Kalimantan	4.56	4.71	4.86
Sulawesi	7.05	7.04	7.02

source : STATISTIK INDONESIA 1987

Table 2.3-a. EMPLOYMENT IN INDONESIA, 1986

Status	Whole Indonesia thousand (%)	Jakarta thousand (%)
Aged 10 and over	122 547	
Economically active	70 193 (100.0)	2 568 (100.0)
Working	68 338 (97.4)	2 303 (89.7)
Looking for work	1 855 (2.6)	265 (10.3)
Never worked	1 376 (2.0)	213 (8.3)

source : STATISTIK INDONESIA, 1987

Table 2.3.-b. EMPLOYMENT BY SECTOR

Sector	Employment thousand (%)
Total Working Population	68 338 (100.0)
Agriculture, Forestry, Hunting and Fishery	37 644 (55.1)
Manufacturing Industry	5 606 (8.2)
Commerce including Restaurant	9 756 (14.3)
Public Service	10 018 (14.7)
Others	5 182 (7.6)

source : STATISTIK INDONESIA. 1987

Table 2.4. GDP OF INDONESIA BY INDUSTRIAL ORIGIN

Sector	Cummulative Growth Rate of GDP from 1983 to 1987 at constant 1983 price (%)	Change of Share in GDP 1983 (%)	Change of Share in GDP 1987 (%)
Whole GDP	17.11	100.00	100.00
High Growth Sectors			
Manufacturing Industry	46.79	12.50	13.97
Electricity, Gas, Water	36.41	0.70	0.83
Banking & Other Finance	31.36	3.10	3.10
Low Growth Sectors			
Mining	0.88	18.93	16.33
Construction	4.47	5.62	5.56
Agriculture, Livestock etc.	14.32	23.59	23.44
Trade, Hotel, Restaurant	14.69	15.56	15.96
Selected Industrial Sub-sectors			
Non-Oil & Gas Manufacturing	26.53	8.44	9.11
Petroleum Refining	7.16 (times)	0.49	1.07
LNG	74.67	3.57	3.79
Communication	88.21	0.56	0.62
Petroleum and Natural Gas	0.35	18.18	15.52
Forestry	(-) 0.66	1.15	1.14

source : National Income of Indonesia, Main Table, 1984 - 1987

Table 2.5. PLANTED AREA FOR SELECTED CROPS
Estate vs. Smallholder, 1986

Crop	Estate (1000 ha)	Smallholder (1000 ha)
Rubber	513.0	2 369.8
Palm Oil	463.9	129.9
Sugar Cane	87.2	235.7
(1983)	59	315.6
Tea	69.7	65.3
Coffee	46.2	766.1
Cocoa	36.6	53.4

source : STATISTIK INDONESIA, 1987

Table 2.6. MANUFACTURING INDUSTRY OF INDONESIA. 1979

INDUSTRY	SIZE *	NO. OF ESTABLISHMENT	NO. OF PERSONS	GROSS OUTPUT (10^6 Rp)	VALUE ADDED (10^6 Rp)
31 FOOD & BEVERAGE	Large/Medium	2 420	294 441	1 614 688	674 109
	Small	57 280	403 517	344 684	82 489
	Household	617 668	1 362 762	440 637	133 172
	Total	677 368	2 060 720	2 400 009	889 700
32 TEXTILE	Large/Medium	2 147	227 787	669 277	207 104
	Small	9 692	91 402	73 930	27 684
	Household	177 246	293 198	50 089	20 623
	Total	189 085	612 387	794 196	255 411
33 WOOD PRODUCTS	Large/Medium	633	51 221	189 274	62 704
	Small	15 144	110 932	71 395	29 258
	Household	434 376	735 816	105 861	58 020
	Total	450 153	897 969	366 530	149 982
34 PAPER & PRODUCTS	Large/Medium	358	29 876	127 813	49 277
	Small	1 263	11 931	11 082	4 660
	Household	-	-	-	-
	Total	1 621	41 807	138 895	53 937
35 CHEMICALS	Large/Medium	823	103 803	890 898	264 481
	Small	1 786	17 363	22 864	8 756
	Household	-	-	-	-
	Total	2 609	121 166	913 762	273 237
36 GLASS & CEMENT	Large/Medium	675	43 000	207 536	115 037
	Small	19 814	133 687	37 648	18 549
	Household	104 997	221 113	44 754	26 948
	Total	125 486	397 800	289 938	160 534
37 IRON & STEEL	Large/Medium	22	8 247	215 154	59 145
	Small	-	-	-	-
	Household	-	-	-	-
	Total	22	8 247	215 154	59 145
38 METAL PRODUCTS	Large/Medium	796	105 686	696 257	223 688
	Small	6 814	49 527	34 918	14 151
	Household	32 009	79 447	42 724	23 079
	Total	39 619	234 660	773 899	260 918
39 OTHERS	Large/Medium	86	5 958	19 717	4 914
	Small	1 231	8 676	4 410	1 776
	Household	51 506	102 497	62 577	29 600
	Total	52 823	117 131	86 704	36 290
TOTAL	Large/Medium	7 960	870 019	4 630 614	1 660 459
	Small	113 024	827 035	600 931	187 323
	Household	1 417 802	2 794 833	747 542	291 442
	Total	1 538 786	4 491 887	5 979 087	2 139 224

* note : the size of establishment

Large	:	employees 100 and more
Medium	:	20 - 99
Small	:	5 - 19
Household	:	1 - 4

Table 2.7. DEVELOPMENT OF BASIC CHEMICAL INDUSTRY IN INDONESIA
Large and Medium Scale (1979 - 1985)

Industry		Number of Establishment	Person Employed	Value of Output (million Rp)
Whole Industry	('79)	7,960	870,019	4,630,614
	('84)	8,006	1,197,799	14,613,834
	('85)	12,909	1,684,726	23,027,322
	('85/'79)			4.97
Basic Chemical	('79)	823	103,803	890,898
	('84)	973	146,848	2,520,220
	('85)	1,626	248,631	4,506,623
	('85/'79)			5.06
Basic Chemical/		(%)	(%)	(%)
Whole Industry	('79)	10.3	11.9	19.2
	('84)	12.2	12.3	17.2
	('85)	12.6	14.8	19.6

		Person/ Establishment	Output/ Establishment	Output/ Person
Whole Industry	('79)	109	581.7	5.32
	('84)	150	1,825.4	12.20
	('85)	131	1,783.8	13.67
Basic Chemical	('79)	126	1,082.4	8.58
	('84)	151	2,590.2	17.16
	('85)	153	2,771.6	18.13

source : STATISTIK INDONESIA, 1987.

Table 2.8. GROWTH OF SELECTED INDUSTRIAL SECTORS IN INDONESIA, Large and Medium Scale (1975 - 1984 and 1984 - 1986)

Industry Code	Sector	Average Annual Growth Rate (calculated from production index) 1975 - 1984 (%)	1984 - 1986 (%)
	General Index	10.22	7.04
35110	Basic Chemical Excluding Fertilizer	4.37	2.35
35120	Fertilizer	24.25	14.77
35232	Match	13.91	10.59
36310	Cement	22.39	11.59
37110	Iron and Steel	31.37	8.01
38440	Motor Cycle & Three Wheel Vehicles	(-) 0.80	17.32
38430	Motor Vehicles	6.68	8.57
35210	Paint, Varnish & Lacquer	5.65	10.16
34111	Paper	5.65	11.80
31420	Clove Cigarettes	9.37	8.97
31330	Malt Liquers and Malts	0.75	8.08
33113	Plywood	17.22	1.31
35510	Tyre and Tube	12.98	4.72
38312	Dry Cell and Battery	13.64	6.44
38320	Radio, TV, etc.	12.08	(-)11.81

source : STATISTIK INDONESIA, 1987

CHAPTER 3. AVAILABILITY OF MOLASSES

3.1. Molasses Production

Production of molasses in Indonesia during the past decade has been increasing with an average annual rate of 11.2 % (Table 3.1.) in line with the increase in sugar production. However, the rate is expected to drop in future, and according to a projection, molasses production in 1993 is estimated at 1,323,100 tons (Table 3.2.).

In the same projection, the share of Jawa Island in 1989 in whole molasses production of Indonesia is estimated to be about 74 %. The Government is promoting the sugar cane cultivation outside Jawa, while restraining that in Jawa, so that Jawa's share in molasses production in Indonesia in 1993 is projected to drop to less than 70 %. But Jawa still hold the position of the largest molasses producer in Indonesia which produces more than two thirds of molasses production of the country (Table 3.2.). The reason of Jawa's superiority in molasses production to other islands is twofold: one is the cultivated area under sugar cane, and the other is the productivity of land. This position of Jawa will be maintained in near future as shown in Table 3.3.

Within Jawa, East Jawa is the largest molasses producing region which produces almost two-thirds of molasses in Jawa (Table 3.4.).

Production of molasses is dispersed to many sugar refineries, annual molasses production of one sugar factory being in the range of 4,000 to 40,000 tons and averaged at about 13,000 tons in PTP-XXIV-XXV (East Jawa) for example (Table 3.5-a.). Outside of Jawa, the scale of molasses production per one sugar factory is bigger and is in the range of 20,000 to 65,000 tons (Table 3.5-b.).

According to the trade stsatistics, out of 737,512 tons of molasses exported in 1987, 457,226 tons were exported from the port of Surabaya, indicating that East Jawa, particularly the vicinity of Surabaya, is the place where molasses is produced and gathered most in the country (Table 3.6.).

It can be said from the above recent situation that among about 908,000 tons of molasses to be produced in Jawa in 1993, around 600,000 tons will be produced in East Jawa.

Analysis of typical molasses produced in Indonesia is as shown in Table 3.7.

3.2. Use of Molasses

Production, export, and domestic consumption of molasses in Indonesia and the breakdown of domestic consumption are summarized in Tables 3.1. and 3.8., respectively.

Domestic consumption of molasses has been increasing, but the consumption in recent years is about 25 to 30 % of the production and the rest is exported. Overall balance of molasses has been tending to surplus as seen in Table 3.1.

Manufacture of monosodium glutamate (MSG) and ethanol are two major use of molasses in Indonesia. MSG manufacture consumed about 212,000tons of molassses in 1987, which is nearly two-thirds of molasses consumed domestically. Ethanol production consumed around 90,000 tons, and around 18,000 tons of molasses was used for other purposes (Table 3.8.).

According to the information from the Department of Industry, production capacity of MSG in Indonesia, which was 68,800 tons in 1987/88, increased to 111,500 tons in 1988/89

(62.5 % increase), and is projected to increase to 171,100 tons in 1990/91 (53.5 % increase), and again to 272,100 tons in 1991/92 (59 % increase). Actual production of MSG in 1988 was 59,674 tons, the operating ratio being about 54 % . As to ethanol, annual production capacity in Indonesia in 1988 was totaled at 85,355 kl and no increase in production capacity is anticipated up to 1992. Actual production in 1988 was 52,226 kl, operating ratio being 61.2 %.

According to a projection on the future molasses consumption made by the Department of Industry in January 1989, total domestic consumption of molasses, which was 463,595 tons in 1988 is, to increase by 2.7 times to 1,247,900 tons in 1992 (Table 3.9.). MSG manufacture is projected to consume 874,000 tons of molasses in 1992, which is a increase by more than 3.6 times from 240,000tons of 1988. During the same period, consumption by ethanol manufacture is expected to increase by 1.7 times (196,800 tons to 341,400 tons), whereas the increase of consumption for other uses is by only 1.2 times (27,155 tons to 32,500 tons).

If this projection becomes to reality, total domestic consumption of molasses in 1992 (1,247,900 tons) will use up almost 97 % of the molasses produced in the country which is projected to be 1,292,900 tons, and no room will remain for new uses. In Jawa, particularly, almost all molasses produced in the Island (projected at 904,100 tons) is to be consumed by the manufacture of one single commodity, MSG (the projected consumption is 874,000 tons).

Table 3.1. PRODUCTION AND USE OF MOLASSES, 1978 - 1987

(ton)

Year	Production	Export	Domestic Consumption	Balance
1978	424 762	105 490	240 594	78 678
1979	470 262	239 895	252 942	- 22 575
1980	491 294	224 020	274 320	- 7 046
1981	493 824	255 873	120 075	117 876
1982	659 405	481 326	178 079	0
1983	718 192	513 760	244 170	- 39 738
1984	785 020	590 528	207 287	- 12 795
1985	869 995	577 022	224 009	68 964
1986	918 992	714 712	268 988	- 64 708
1987	1 105 560	624 780	324 187	156 593

average rate of increase of production 1978 - 1987 : 11.2 %
1978 - 1981 : 5.0 %
1981 - 1984 : 16.7 %
1984 - 1987 : 12.1 %

source : Sugar Council

Table 3.2. PROJECTION OF MOLASSES PRODUCTION, 1989 - 1993

(ton)

Year	Java	Others	Total
1989	864 000	306 900	1 170 900
1990	888 400	343 900	1 232 300
1991	899 800	361 500	1 261 300
1992	904 100	388 800	1 292 900
1993	907 900	415 200	1 323 100

average rate of increase of production Java : 1.2 %
Others : 7.8 %
Total : 3.1 %

source : Sugar Council

Table 3.3. PLANTED AREA AND LAND PRODUCTIVITY FOR SUGAR

Region			1987/88	1992/93
Java	Planted Area	(ha)	258 113	287 212
	Refined Sugar Production	(t)	1 597 732	2 120 042
	Land Productivity	(t/ha)	6.19	7.38
Others	Planted Area	(ha)	83 922	113 636
	Refined Sugar Production	(t)	351 125	632 123
	Land Productivity	(t/ha)	4.18	5.56
Whole Indonesia	Planted Area	(ha)	342 037	400 848
	Refined Sugar Production	(t)	1 948 857	2 752 165
	Land Productivity	(t/ha)	5.70	6.87

source : Sugar Council

Table 3.4. MOLASSES PRODUCTION IN JAWA, 1987

(ton)

East Jawa		
PTP-XXIV-XXV	(12 factories)	155 287
PTP-XXI-XXII	(12 factories)	220 209
PTP-XX	(5 factories)	70 785
Private	(5 factories)	107 492
Subtotal		553 773
Central Jawa		
PTP-XV-XVI	(13 factories)	142 009
Private	(3 factories)	54 709
Subtotsl		196 718
West Jawa		
PTP-XIV	(8 factories)	89 334
JAWA TOTAL		839 825

source : Sugar Research Institute

Table 3.5-a. MOLASSES PRODUCTION OF SUGAR FACTORIES OF PTP-XXIV-XXV 1987 (ton)

Factory	Cane Crushed	Molasses Production	Molasses/Cane(%)
Asembagus	313 924	12 871	4.1
Panji	197 169	7 098	3.6
Olean	115 143	4 375	3.8
Wringinanom	146 465	5 126	3.5
Prajekan	432 168	17 287	4.0
De Maas	101 074	4 043	4.0
Semboro	801 282	29 647	3.7
Pejarakan	142 782	5 283	3.7
Gending	183 814	6 617	3.6
Jatiroto	962 498	39 462	4.1
Wonolangan	170 497	6 308	3.7
Kedawung	408 768	17 168	4.2
Total	3 975 583	155 287	3.9

source : Sugar Research Institute

Table 3.5-b. MOLASSES PRODUCTION OUTSIDE JAWA BY FACTORY Projection (ton/y)

Sugar Factory	Production
Bunga Mayang (Lampung)	39 600
Gunung Madu (Lampung)	56 200
Gula Putih Mataram (Lampung)	64 800
Cinta Manis (Sumatra Selatan)	33 000
PTP-IX (Sumatra Utara)	78 000
Palaihari (Kalimantsan Selatan)	29 000
Takalar (Sulawesi Selatan)	22 000
Camming (Sulawesi Selatan)	22 000

source : Sugar Council

Table 3.6. EXPORT OF MOLASSES, 1987 (ton)

Total Export	737 512
of which destination	
Japan	217 462
Taiwan	210 137
South Korea	80 726
Netherland	79 775
West Germany	72 800
others	76 612
of which exporting port	
Surabaya	457 226
Tegal	135 282
Panjang	74 408
others	70 596

source : Indonesia Foreign Trade Statistics, 1987, Exports

Table 3.7. ANALYSIS OF TYPICAL MOLASSES, 1987

	Sulfite Process	Carbonate Process
Brix	91.4	90.3
H.K.Pol	32.0	31.9
% Sucrose	34.2	34.3
H.K.Sucrose	37.5	37.8
% Reducing Sugar	23.3	23.1
% Total Sugar	57.5	57.4
% Ash	11.1	11.3
% Dry Substance	81.9	81.6

source : Sugar Council

Table 3.8. DOMESTIC USE OF MOLASSES IN INDONESIA, 1978 - 1987

(ton)

Year	Domestic Consumption			
	Total	Ethanol	MSG	Others
1978	240 594	121 400	109 276	9 918
1979	252 942	130 000	115 000	7 942
1980	274 320	134 600	123 250	16 470
1981	120 075	54 300	65 439	336
1982	178 079	117 000	56 680	4 399
1983	244 170	120 000	120 000	4 170
1984	207 287	60 300	141 000	5 987
1985	224 009	84 050	134 847	5 113
1986	268 988	89 300	161 300	18 388
1987	324 187	94 100	211 910	18 176

source : Sugar Council

Table 3.9. Position and Projection of Supply Demand of Molasses Locally
(POSISI & PROYEKSI SUPPLY DEMAND TETES DALAM NEGERI)

ORGANIKI.BU:SUPPLY1
18.01.1989-TR/vs

YEAR	SUPPLY (ton)	INDUSTRY REQUIREMENT (ton) GA/MSG	Alcohol	Pellet	Ketchup	Yeast	Others	Total
1984		141,000	60,300	3,000	2,484	0	508	207,292
1985		134,847	84,050	1,385	1,888	1,400	1,400	224,970
1986		161,300	89,300	3,290	10,408	3,190	1,500	268,988
1987		220,160	94,100	5,150	5,966	3,600	3,460	332,436
1988		240,000	196,800	5,590	10,205	4,400	6,600	463,595
1989	1,170,900 (864,000)*	360,000	278,600	5,900	10,700	4,600	6,900	666,700
1990	1,232,300 (868,400)*	547,200	341,400	6,200	11,200	4,800	7,300	918,100
1991	1,261,300 (899,800)*	770,000	341,400	6,500	11,800	5,100	7,600	1,142,400
1992	1,292,900 (904,100)*	874,000	341,400	6,800	12,400	5,300	8,000	1,247,900

Note: 1) Data of molasses supply received from Min. of Agriculture.
2) Requirement data from 1989 thru 1992 for Alcohol and MSG is counted based on national capacity installed.

( )* Figures in parentheses are supply in Java.

source : Department of Industry

CHAPTER 4. MARKET SITUATION FOR CANDIDATE CHEMICALS

4.1. World Market

(1) Ethanol

According to a United Nations statistics, world production of ethanol in 1983 was over 15 million kiloliters, of which about 8 million kiloliter is produced in Latin America and 4 million kiloliters in Eastern Europe. Asia, Western Europe, and North America produce slightly more than 1 million kiloliters each. It is noted that some developing countries such as Brazil, India, and Mexico are among the leading ethanol producers.

The amount of ethanol traded internationally is estimated to be less than one million kiloliters, indicating that most countries manufacture ethanol to consume domestically.

Japan is one of big importer of ethanol. In 1986, Japan's production of ethanol was 171,491 kiloliters of which fermentation and petrochemical processes produced 99,491 and 72,000 kiloliters, respectively. Out of the fermentation ethanol, 77,019 kiloliters, or 77 %, was made by re-distillation of crude ethanol imported mainly from Brazil.

Biggest use of ethanol in industrialized countries is as a raw material for other organic chemicals such as esters and ethers. Next is as additives for cosmetics, pharmaceuticals, and detergents.

(2) Acetone

Acetone is produced almost exclusively by industrialized nations. The U.S. has a total production capacity of slightly over one million tons per year, whereas the production capacity in West Europe in total is about 0.7 million tons, and Japan's total capacity is about 0.3 million tons per year.

Other than the above, East European contries produce about 0.4 million tons annually, and Peru, Mexico, Argentine and India have small production plants.

Main uses of aceton are as solvent and as a raw-material for the synthesis of such organic chemicals as methyl metacrylate and MIBK. Export is less than 10 % of production for the U.S. and Japan.

(3) Normal Butanol

Production capacity of n-butanol in the U.S. is about 0.5 million tons per year and actual annual production is less than 0.4 million tons. In Japan, production in 1987 was about 93,000 tons, whereas existing capacity was 108,000 tons per year.

N-butanol is mainly used as solvent and raw material for organic synthesis. Export is less than 5 % of production.

(4) Acetic Acid

World production of acetic acid in 1981 was about 2.5 million tons according to a United Nations statistics. The U.S. is the world biggest producer who have a total production capacity of about 1.6 million tons per year and make about a half of the world production, 1.3 milion tons. Next comes Japan and West Germany. Japan's annual production capacity is about 0.5 million tons, actual production being less than 0.4 million tons. Among developing countries, India, Taiwan, Mexico, Argentine, and Chile produce acetic acid.

Major uses of acetic acid are for manufacture of vinyl acetate, cellulose acetate and other organic chemicals. Acetic acid is also important as a reaction solvent for the synthesis of terephthalic acid. Export is less than 10 % of production for both Japan and the U.S.

(5) Acetic Anhydride

In Japan, out of 152,400 tons of acetic anhydride produced in 1987, 133,900 tons (88%) was used by the producers themselves mostly to make acetyl cellulose. Export was nil. This situation seems to be almost similar to other acetic anhydride manufacturers in the world. Production capacity in the U.S. is around 0.9 million tons per year, actual annual production is slightly over 0.7 million tons, of which 80 % is used for acetyl cellulose manufacture and only 4 % is exported.

(6) Ethyl Acetate

Ethyl acetate is manufactured almost exclusively in industrialized countries. The U.S. have a total annual production capacity of about 100,000 tons, which is almost fully utilized. Japan's existing annual production capacity is about 143,000tons, and actual production in 1987 was aboout 126,000 tons, of which about 12,000 tons was exported.

Major use of ethyl acetate is solvent for paint, ink and adhesives.

(7) Butyl Acetate

Butyl acetate is mainly used, like ethyl acetate, as solvent for paint and ink, and is manufactured almost exclusively in industrialized nations.

The U.S. have an annual production capacity of about

77,000 tons, which is almost fully utilized. Japan's annual production is around 30,000 tons against existing production capacity of 65,600 tons per year.

(8) Fructose

Fructose is manufactured from sucrose by hydrolysis, or from starch by hydrolysis and enzymatic inversion. The product is a mixture of glucose and fructose in both processes. These processes can be operated in a relatively small scale, so that there are many small producers in many countries and exact amount of procuction is difficult to grasp. The product is used as a sweetner for food and fermaceuticals and the use is increasing since fructose is a low calorie sweetner.

Pure fructose is produced in very small amounts and is used for medicinal and other specific purposes.

(9) Citric Acid

World production capacity of citric acid is said to be approximately corresponds to its world demand which is about 400,000 tons per year, but the figure is somewhat questionable since the capacity may include the plants making refined citric acid from crude product or citrate salt imported. For example, out of Japan's annual production capacity of 13,400 tons, 3,800 tons are for making citric acid from calcium citrate.

Annual production capacities in the U.S. and West Europe are about 150,000 tons and 220,000 tons, respectively, and there are production of citric acid or its salt in such countries as Israel, India, China, Turkey, Pakistan, and Indonesia, etc. Demands for citric acid are: 125,000 tons in the U.S. and Canada; 108,000 tons in West Europe, 44,000 tons in East Europe, 35,000 tons in the Far East including Japan, and 30,000 tons in Latin America, etc.

Major use of citric acid is for fruit juice and other beverage, and as an additive to other food products. Some is used for cleaning of boilers and other industrial purposes.

(10) Monosodium Glutamate (MSG)

World annual production capacity of MSG in 1987 is estimated to be about 463,000 tons, excluding China that is said to have about 200 factories with a total capacity of 70,000 tons.

Asian countries lead the world MSG industry. Japan is the biggest MSG producing country with a total annual production capacity of 107,000 tons, followed by Taiwan (86,000 tons), South Korea (61,000 tons), Indonesia (44,000 tons), and Thailand (42,000 tons). Other Asian countries such as the Philippines, Malaysia, Viet Nam, Hong Kong and Burma have production capacity of about 20,000 tons in total.

West Europe and Latin America have production capacity of 62,000 and 41,000 tons, respectively. The U.S. has no production of MSG, importing around 30,000 tons annualy.

(11) L- Lysine

The use of L-lysine is increasing very rapidly in recent years as an additive for poultry and livestock feed, average annual growth rate of consumption in Western Europe from 1981 to 1985 being more than 29 %.

Japan is the biggest supplier of L-lysine in the world who produced 20,000 tons and exported 15,500 tons in 1985. In the same year, West European nations in total produced 23,500 tons and consumed 25,000 tons, while the U.S. produced 5,800 tons and imported 10,500 tons. In addition to the above countries, South Korea, Mexico, Czechoslovakia, etc. have some L-lysine production.

4.2. Market in Indonesia

(1) General Situation of Industrial Chemicals

It is pointed out in Chapter 2 that the past growth of the basic chemical industry excluding fertilizer has not been remarkable in Indonesia. However, this does not mean that the industry is dormant. There are a number of indications that the market for industrial chemicals has been changing its structure drastically.

Trade statistics is one of such indications. Records of import of candidate and related chemicals in the years 1981, 1984, 1987 and a part of 1988 are summarized in Table 4.1.

Import of some chemicals listed has increased enormously. From 1981 to 1987, for example, import of normal butanol increased by neary three times and the increase is accerelated in 1988. Import of octyl alcohols in 1988 was more than 20 times of that in 1987. Similar remarkable increase of import is also recorded for acetic acid, its salts and its esters.

In contrast, there are some chemicals of which import has markedly decreased. Dioctyl phthalate (DOP) is one example : its import, which amounted to 25,000 tons in the past, decreased to less than one thousand tons in 1987 and 1988. This reflects the fact that manufacture of this chemical, an important plasticizer for PVC processing, in Indonesia started between 1984 and 1987. In 1988, one more newcomer entered into the manufacture of DOP in Indonesia.

Another example of import replacement is acetic acid. Import of this chemical has been increasing as mentioned earlier. One big user of acetic acid in Indonesia is PERTAMINA's terephthalic acid manufacturing plant, which has been consuming a substantial amount of imported acetic acid as a reaction solvent. To replace this import by the indigenous product, a company has built a new plant in Solo to make acetic acid from molasses as starting raw-material. At this plant, molasses is fermented to make ethanol, from which acetic acid is synthesized via acetaldehyde. This company is also planning to manufacture ethyl acetate, of which import has been increasing and which can be synthesized from acetic acid and ethanol.

Domestic production of DOP has caused the decreased import of DOP, and, in its place, increased import of octyl alcohol, a raw material for DOP synthesis.

Industrial chemicals are chemicals that are used as raw-material or auxiliary material for other industry, including the chemical industry itself. As seen from the above examples, development of manufacturing industry in Indonesia is creating new and increasing demand for industrial chemicals. And, correspondingly, the industrial chemicals industry in Indonesia is changing its structure drastically.

At a time of such a drastic change of industrial structure, it is not possible to predict the future of the indusry by simply extrapolating the past.

Presently, six out of eleven candidate chemicals are produced in Indonesia and others are imported. The situation is summarized in Table 4.2. Import and export of the candidate chemicals are summarized in Tables 4.3 and 4.4., respectively.

And, in Table 4.5., production capacities and actual production records in 1988 are shown for the candidate chemicals presently produced in Indonesia.

(2) Ethanol

In Indonesia, there are thirteen companies manufacturing ethanol of 95 % purity from molasses. Their annual production capacity and actual production in 1988 are totaled at 85,000 kl and 52,000 kl, respectively, average operating ratio being about 61 % (Table 4.6.).

Domestic demand for ethanol is fully satisfied by the product of existing producers and the surplus is exported. All of the producers have no plan of expanding their production capacities up to 1992 (Table 4.7.)

(3) Acetone

There is no domestic production of acetone in Indonesia and this chemical is wholly supplied by import. The import of acetone has been increasing rapidly from 1,740 tons in 1981 to 5,330 tons in 1987, and is estimated to further increase to 1,740 tons in 1988.

(4) n-Butanol

All domestic demand for n-butanol is met by import. The import, which was only 260 tons in 1981, increased to 700 ton in 1987, and is expected to more than double to 1,750 tons in 1988. Adding iso-butanol and other butanols, total import of all butanols in 1988 is estimated at 3,500 tons.

(5) Acetic Acid

In indonesia, a company named P.T. Yudo Acidatama is going to produce acetic acid starting from ethanol fermentation. The plant is located at Solo in Central Jawa and its production capacity is 12,000 kl per year. However, even this plant comes into operation, domestic demand for acetic acid is not fulfilled by domestic production. Import of acetic acid to Indonesia in 1988 is estimated at 12,000 tons.

(6) Acetic Anhydride

Acetic Anhydride is not produced in Indonesia and domestic demand is supposedly met by imported product. However, reliable data concerning the demand or consumption of this chemical cannot be obtained .

(7) Ethyl Acetate/Butyl Acetate

Ethyl acetate is to be manufactured, with an annual production capacity of 4,500 kl, by P.T. Yudo Acidatama as a downstream operation of the company's acetic acid production. Butyl acetate is not produced domestically. In 1988, import of ethyl and butyl acetates in total is estimated to be about 21,000 tons.

(8) Fructose

In Indonesia, at least one company named P.T. Punchak Gunung Mas is manufacturing "High Fructose Syrup (HFS)", which is actually a mixed water solution of glucose and fructose made by hydrolysis of starch into glucose followed by enzymatic inversion. The daily production capacity of the plant is 45 tons as HFS (35 tons as dry substance) and actual production in 1988 is 6,000 tons. This production seems to be sufficient to meet the domestic demand.

(9) Citric Acid

In Indonesia there are five manufacturers of citric acid and their total production capacity is 16,570 tons for calcium citrate and 8,250 tons for citric acid. Actual production rerdsin 1988 for these two products are 5,233 tons and 4,235 tons, respectively (Table 4.8.).

This production is more than sufficient to fulfil the domestic demsand and about 1,700 tons of citric acid is exported in 1987.

(10) Monosodium Glutamate (MSG)

There are ten producer of MSG of which five are said to have production capacities for glutamic acid (GA) as shown in Table 4.9. For MSG, their total production capacity and actual production record in 1988 are 111,500 and 59,676 tons, respectively, apparent operating ratio being 54 %.

The domestic demand for MSG can be covered by this production and about 8,000tons of MSG was exported in 1988.

(11) L- Lysine

At present there is no domestic production of L- lysine in Indonesia, and it is recorded that cattle feed manufacturers in Indonesia consumed 225 tons of imported L- lysine as a raw material in 1986

A company named P.T. Cheil Samsung Astra, reportedly, is now constructing a plant for the production of this amino acid at Pasuruan in East Jawa with an annual capacity of 20,000 tons. After this plant is put into commercial operation, 20 % of its product is to be supplied to domestic market and 80 % is to be exported. It seems that demand in Indonesia for L-lysine for foreseeable future will certainly be covered by the product of this plant.

Table 4.1. IMPORT OF CANDIDATE AND RELATED INDUSTRIAL CHEMICALS
(Note : Commodity name in bold letter indicates "Candidate Chemicals".
1988 * is cummulative of Jsanuary - October 1988.)

CCCN CODE	COMMODITY	YEAR	NET WEIGHT (kg)	VALUE CIF (US$)
1702220	**FRUCTOSE**	1981	441	3 863
		1984	201	2 320
		1987	13 775	35 868
		1988*	6 710	33 051
2208100	**ETHYL ALCOHOL UNDENATURED OF A STRENGTH OF >80% PROOF**	1981	12 297	25 421
		1984	28 793	76 371
		1987	35 505	353 405
		1988*	13 871	38 054
2208900	**OTHER ETHYL QLCOHOL/NATURAL SPIRITS OF A STRENGTH OF >80% PROOF**	1981	4 450	21 090
		1984	56 699	86 756
		1987	3 169	6 185
		1988*	10 122	25 780
2904100	METHYL ALCOHOL	1981	93 843 888	20 112 772
		1984		
		1987	76 162 402	13 416 618
		1988*	13 534 221	5 177 208
2904200	PROPYL OR ISOPROPYL ALCOHOL	1981	3 166 235	1 884 568
		1984	1 676 702	888 047
		1987	2 734 630	1 260 268
		1988*	4 850 110	1 382 984
2904310	NORMAL BUTANOL	1981	258 439	226 046
		1984	50 100	32 359
		1987	703 376	495 816
		1988*	1 456 463	940 172
2904320	ISO BUTANOL	1981	2 972 005	1 316 081
		1984	3 017 870	1 104 863
		1987	925 767	437 989
		1988*	1 157 495	852 575

(continued)

(Table 4.1. page 2)

2904390	OTHER BUTYL ALCOHOLS	1981	1 492 585	681 491
		1984	130 293	140 287
		1987	99 505	217 713
		1988*	336 063	384 827
2904400	OCTYL ALCOHOLS	1981	2 174	19 494
		1984	500	2 870
		1987	28 470	51 633
		1988*	573 461	636 229
2913100	ACETONE	1981	1 743 914	869 098
		1984	558 093	528 659
		1987	5 326 845	2 220 138
		1988*	5 221 522	2 683 695
2913200	ETHYL METHYL KETONE	1981	2 785 410	1 397 088
		1984	1 051 494	684 834
		1987	6 179 969	2 641 927
		1988*	2 607 066	2 463 225
2913910	ISOBUTYL METHYL KETONE	1981	322 683	237 198
		1984	483 393	368 478
		1987	2 396 593	1 714 015
		1988*	2 201 125	1 554 302
2914100	ACETIC ACID AND ITS SALTS	1981	4 709 018	2 488 462
		1984	3 869 625	3 058 654
		1987	24 569 123	11 615 137
		1988*	10 327 465	7 073 525
2914200	ESTERS OF ACETIC ACIDS	1981	389 980	275 251
		1984	129 918	105 951
		1987	17 996 578	10 531 654
		1988*	17 439 339	16 975 999
2914990	OTHER MONOCARBOXYLIC ACIDS & THEIR ANHYDRIDES HALIDES	1981	22 715 927	23 139 238
		1984	16 916 315	19 490 395
		1987	16 598 958	24 301 080
		1988*	13 510 079	27 391 124

(continued)

(Table 4.1. page 3)

2915100	DIOCTYL PHTHALATE & THE LIKE USED FOR PLASTICIZER (DHP DIOP)	1981	24 869 990	18 477 396
		1984	25 861 961	15 114 011
		1987	992 759	947 693
		1988*	825 969	905 907
2915900	OTHER POLYCARBOXYLIC ACIDS AND THEIR ANHYDRIDES	1981	95 898 228	68 606 010
		1984	85 956 891	68 781 237
		1987	16 499 761	15 879 052
		1988*	13 671 557	13 243 139
2916200	CALCIUM CITRATED	1981	650	2 179
		1984	21 818	56 223
		1987	2 100	8 597
		1988*	311	195
2916300	CITRIC ACID	1981	n.a.	n.a.
		1984	n.a.	n.a.
		1987	222 072	369 145
		1988*	106 308	170 222
2923110	GLUTAMIC ACID	1981	136 454	241 078
		1984	2 363 458	3 446 886
		1987	7 997	48 997
		1988*	3 586	23 873
2923191	MONOSODIUM GLUTAMATE (MSG)	1981	n.a.	n.a.
		1984	n.a.	n.a.
		1987	16 420	13 731
		1988*	864	1 068
2923199	OTHER SALTS OR DELIVATIVES OF GLUTAMIC ACID	1981	208 885	551 999
		1984	132 356	570 225
		1987	15 814	157 790
		1988*	14 269	188 794

source : INDONESIA FOREIGN TRADE STATISTICS, IMPORTS, 1987.

Table 4.2. Situation of Candidate Chemicals

Product	Domestic Production	Import	Export
1. Ethanol	Yes	n.s	Yes
2. Acetone	No	Yes	No
3. n-Butanol	No	Yes	No
4. Acetic Acid	Yes	Yes	No
5. Acetic Anhydride	No	n.a	No
6. Ethyl Acetate	Yes	Yes	No
7. Butyl Acetate	No	Yes	No
8. Fructose	Yes	No	Yes
9. Citric Acid	Yes	n.s	Yes
Calcium Citrate	Yes	n.s	Yes
10. Mono Sodium Glutamate			
(MSG)	Yes	n.s	Yes
Glutamic Acid	Yes	n.s	Yes
11. L-Lysine	No*1)	Yes	No

Note *1) L-Lysine plant having the capacity of 20,000 t/y is under construction.

Table 4.3. Export of Candidate Chemicals in 1987

Products	Export Quantity (t/y)	Export Value (FOB 10^3 US$/y)
1. Ethanol		
(1) Undenatured	11	85
(2) Neutral spirits	865	252
2. Citric Acid	1,687	2,007
Calcium Citrate	1,278	562
3. MSG	7,047	8,032
Gultamic Acid	3,039	3,377
Other Salts on Derivative of Glutamic Acid	3,101	3,507

6557D

Table 4.4. Import of Candidate Chemicals

Products	Import Quantity (t/y)				Import Value (CIF 10^3 US$/y)			
	1981	1984	1987	1988 (Estimated)	1981	1984	1987	1988 (Estimated)
1. Acetone	1,744	558	5,327	6,266	869	529	2,220	3,220
2. n-Butanol	258	50	703	1,747	226	32	496	1,128
3. Acetic Acid and its Salts	4,709	3,870	24,569	12,392	2,488	3,059	11,615	10,888
4. Esters of Acetic Acid	390	130	17,997	20,927	275	106	10,531	20,370
Total	7,101	4,608	48,596	41,332	3,858	3,726	24,862	35,606

Note: Import quantities and values for L-Lysine in 1986 is 225 t/y and 737 x 10^6 Rp./y respectively. L-Lysine is used for manufacturing of cattle feed.

Table 4.5. Situation of Domestic Production in 1988

Products	Production Capacity	Actual Production	Operation Ratio	Number of Producer	Average Shipping Price
1. Ethanol	85,355 kl/y	52,264 kl/y	61%	13	507,000 Rp/Kl
2. Acetic Acid	12,000 kl/y	n.a	n.a	1	n.a
3. Ethyl Acetate	4,500 kl/y	n.a	n.a	1	n.a
4. Fructose	10,000 t/y	6,000 t/y	60%	1	600-700 Rp/kg 300 US$/t (export)
5. Citric Acid	8,250 t/y	4,235 t/y	51%	5	2.31×10^6 Rp/t
Calcium Citrate	16,570 t/y	5,233 t/y	32%	6	0.68×10^6 Rp/t
6. MSG	111,500 t/y	59,674 t/y	54%	10	2.95×10^6 Rp/t
Glutamic Acid	102,700 t/y	53,696 t/y	52%	5	n.a

Table 4.6. Ethanol Production Record in 1988

Association	Producer	Capacity (Kl/y)	Production (Kl/y)	Value (1,000 Rp)
BKS Alkohol	PT. Basis Indah	5,500	3,000	1,268,000
	PT. Madubaru	4,000	2,500	1,883,000
	PT. Aneka Kimia	16,000	12,785	5,866,635
	PT. Starsaco	3,600	1,575	983,850
	PT. Permata Sakti	5,220	4,850	2,555,000
	PT. Molindo Raya	4,000	2,615	1,446,000
	PT. Palimanan	4,925	3,350	1,174,774
	PT. Madusari Murni	5,850	6,276	3,470,000
	PT. Comal	5,700	4,600	2,198,000
	PT. Jatiroto	7,500	7,658	4,166,000
	PT. Nabati Sarana	1,800	-	-
	PT. Padaharija	2,000	-	-
	PT. Indo Acidatama	19,260	3,057	1,530,048
	Total	85,355	52,266	26,541,307

Table 4.7. Future Production Capacity for Ethanol

No.	Producer	Location	Installed Capacity (Kl)				
			1988	1989	1990	1991	1992
1.	PT. Basis Indah	Ujung Pandang	5,500	5,500	5,500	5,500	5,500
2.	PT. Madubaru	Jogjakarta	4,000	4,000	4,000	4,000	4,000
3.	PT. Aneka Kimia	Mojokerto	16,000	16,000	16,000	16,000	16,000
4.	PT. Starsaco	Langsa	3,600	3,600	3,600	3,600	3,600
5.	PT. Permata Sakti	Medan	5,220	5,220	5,220	5,220	5,220
6.	PT. Molindo Raya	Lawang	4,000	4,000	4,000	4,000	4,000
7.	PT. Palimanan	Cirebon	4,925	4,925	4,925	4,925	4,925
8.	PT. Madusari Murni	Lawang	5,850	5,850	5,850	5,850	5,850
9.	PT. Comal	Satang	5,700	5,700	5,700	5,700	5,700
10.	PT. Jatiroto	Lumajang	7,500	7,500	7,500	7,500	7,500
11.	PT. Nabati Sarana *1)	Cirebon	1,800	1,800	1,800	1,800	1,800
12.	PT. Padahardja *1)	Tegal	2,000	2,000	2,000	2,000	2,000
13.	PT. Indo Acidatama *2)	Solo	19,260	19,260	19,260	19,260	19,260
	Total		85,355	85,355	85,355	85,355	85,355

Note *1) No production.
*2) 13,500 Kl of ethanol is used to produce acetic acid and ethyl acetate.

Table 4.8. Production Capacity and Record for Citric Acid in 1988

Association	Producer	Capacity (Ton/y)	Production (Ton/y)	Value (1,000 Rp)
ASCAC				
- Calcium Citrate	PT. Semarang Diamond Chem.	3,000	3,583	2,771,718
	PT. Budi Alam Kencana	6,000	-	-
	PT. Inti Rasa Jaya	3,600	-	-
	PT. Budi Acid Jaya	2,160	1,650	825,000
	PT. Sari Idaman	370	-	-
	PT. Kancing Mas Jaya	1,440	-	-
	Total	16,570	5,233	3,596,718
- Citric Acid	PT. Budi Alam Kencana	3,000	3,000	6,782,000
	PT. Inti Rasa Jaya	1,200	1,028	2,319,209
	PT. Budi Acid Jaya	2,730	87	208,800
	PT. Sari Idaman	1,200	-	-
	PT. Kancing Mas	120	120	252,000
	Total	8,250	4,235	9,762,009

Table 4.9. Production Capacity and Record for MSG in 1988

Association	Producer	Capacity (ton)	Production (ton)	Value (1,000 Rp)
P2MI				
- Monosodium Glutamate (MSG)	PT. Indo Vetsin	1,200	1,200	3,054,000
	PT. Palur Raya	12,000	3,250	7,921,875
	PT. Foomaco	1,800	1,500	4,880,000
	PT. Sasa Inti	24,100	17,500	58,127,175
	PT. Sasa Permentasi	3,600	4,592	14,924,000
	PT. Ajinomoto	18,400	13,032	40,961,519
	PT. Miwon Indo.	24,000	15,600	36,549,000
	PT. Indo Miki	4,800	3,000	9,750,000
	PT. Rena Jaya	3,600	-	-
	PT. Ajinex Int.	18,000	-	-
	Total	111,500	59,676	176,167,570
- Glutamic Acid (GA)	PT. Palur Raya	12,700	2,826	-
	PT. Sasa Inti	24,000	19,210	-
	PT. Ajinomoto	24,000	16,290	-
	PT. Miwon Indo	24,000	15,600	4,138,000
	PT. Ajinex Int.	18,000	-	-
	Total	102,700	53,696	4,138,000

Chapter 5. PRODUCT SELECTION AND DETERMINATION OF PRODUCTION QUANTITY

5.1. Product Selection

Eleven candidate chemicals can be classified into the following two major groups:

Group (A) : Ethanol. Fructose, Citric Acid, MSG, L- Lysine.

Group (B) : Acetone, n-Butanol, Acetic Acid, Acetic Anhydride, Ethyl Acetate, Butyl Acetate.

The chemicals in the Group (A) are the chemicals that are manufactured worldwidely by way of fermentation or other biochemical processes, or as derivatives of biochemical products, although ethanol is also produced by a petrochemical process.

The Group (B) includes organic chemicals that had been manufactured in the past as fermentation products or derivatives thereof, but were mostly replaced by the petrochemical products nowadays because the lower production costs of the petrochemical processes.

In Indonesia, manufacture of chemicals in the Group (A) except L- lysine has already well developed and these products have established themselves as export commodities. Regarding L-lysine, a production facility is to be constructed in near future with a prospect of exporting 80 % of its product.

On the other hand, most of the chemicals in Group (B) are not produced in Idonesia and have been imported in substantial amounts. These chemicals still may be produced by way of fermentation in Indonesia, but it is highly questionable if they are competitive to the petrochemical products in the export market. Therefore, if the production of these chemicals by fermentation is to be planned in Indonesia, they will have to be aimed primarily at the domestic market to replace the imported products.

Keeping the above situation of candidate chemicals in Indonesia in mind, they are screened by use of the following two criteria, namely,

(1) Whether the chemical is already produced in Indonesia and is established as an export product. Or whether its production in Indonesia in near future is planned.

(2) Whether the chemical is imported in an amount sufficient to justify its domestic production.

The screening process is schematically illustrated in Fig. 5.1. And, as a result, five industrial chemicals are selected as the subject of further study. They are : acetone, n-butanol, acetic acid, ethyl acetate, and butyl acetate.

In addition to the above, one industrial chemical that has not been included in the original candidate chemicals, octanol, is found to meet the criteria for product selection. As already mentioned in the previous chapter, import of octanol has been increasing rapidly since the domestic production of DOP started, and there is no domestic production of octanol in Indonesia. Therefore, octanol is added to the list of selected products, making the total number of industrial chemicals for further study six.

5.2. Determination of the Production Quantity

There is no domestic production in Indonesia of the six industrial chemicals selected. Although a plant to manufacture acetic acid and ethyl acetate has been completed recently, it is still under test operation and there is no record of actual commercial production. The data concerning the consumption of the selected chemicals are not sufficient to allow demand forcast by conventional methods. Even if the historical data are available, it is not realistic to make forecast by conventional method since the structure of the market for industrial chemicals in Indonesia has been changing drastically. In consideration of this situation, the production quantity of each industrial chemical selected is determined on the basis of the following assumptions.

Firstly, the amount of import of each chemical is to be regarded as representing the allowable production amount. This assumption seems reasonable since the production of the chemical is aimed primarily at the replacement of the product hitherto imported.

Secondly, import of each chemical is assumed to increase at an annual rate of 5 % for coming five years. This assumption seems acceptable in consideration of the growth of manufacturing industry in Indonesia. Average annual growth rates from 1984 to 1986 were: 7% for whole industry, 10.2 % for the paint, varnish and lacquer industry, and 2.3 % for the basic chemical industry.

Accordingly, the production quantity of each chemical selected, except octanol, is set around the amount of its forcasted import after five years from 1988. As for octanol, it is used as a raw material to make DOP, of which Indonesia has an annual production capacity of 30,000 tons. This means that there is a potential demand of about 20,000 tons per year for octanol. Therefore, 20,000 tons will be regarded as an allowable upper limit for the production quantity of octanol.

Actual production quantity is to be decided in consideration of the balance with other products. The production quantities of industrial chemicals determined in this way is summarized in Table 5.1.

1. Candidate Chemicals

Ethanol, Acetone, n-Butanol, Acetic Acid, Acetic Anhydride, Ethyl Acetate, Butyl Acetate, Fructose, Citric Acid, MSG, L-Lysine. (11 Chemicals)

↓

2. Screening (Criteria)

(1) Already produced in Indonesia and established as export products, or near future production plan

(2) Imported in an amount sufficient to justify domestic production

Ethanol, Fructose, Citric Acid, MSG, L-Lysine. (5 Chemicals)

↓

3. Selected Industrial Chemicals (Note)

Acetone, n-Butanol, Acetic Acid, Ethyl Acetate, Butyl Acetate, Octanol (6 Chemicals)

Note (1) Acetic Anhydride is excluded, because sufficient data is not available.

(2) Octanol(2 ethyl-hexanol) is added to the selected industrial chemicals. Because octanol is imported in substantial amount as a raw material for domestically producing Dioctyl phthalate (DOP) in Indonesia and it can be produced from n-butanol.

Fig 5.1. Screening of Candidate Chemicals

6557D

Table 5.1. Production Quantity Based on Product Import Quantity

(Unit: ton/y)

	Product	1981	1984	1987	1988 (Estimated)	After 5 years (Prospected)	Annual Increase Rate
(1)	Acetic Acid	4,709	3,869	24,569	12,392	15,800	5%
(2)	Ethyl Acetate	389	129	17,996	20,927	(18,700)	5%
(3)	Butyl Acetate					26,700 *1) (8,000)	
(4)	Acetone	1,743	558	5,326	6,265	8,000	5%
(5)	n-Butanol	258	50	703	1,747	2,200	5%

Note *1) Production ratio of ethyl acetate and butyl acetate is assumed to be 70% and 30% respectively.

(1) Maximum production capacity of Octanol is assumed to be 20,000 t/y, which is estimated based on the 30,000 t/y capacity of DOP plant operating in Indonesia.

Chapter 6. PROJECT DESCRIPTION

6.1. Production Scheme

The production scheme of a sucro-based chemical complex is worked out to make six industrial chemicals selected in Chapter 5. The production quantities of the products are also as determined. As for octanol, which is derived from n-butanol, the production quantity is set at 9,600 tons per year in consideration of the balance with the production quantities of acetone and n-butanol. The scheme is illustrated in Fig. 6.1. together with overall material balance for the raw materials, products, and by-products.

All of the six chemicals can be manufactured basically from molasses as a starting raw materials. However, one of the primary products in the scheme, ethanol, is already produced from molasses in Indonesia and is exported in a substantial amount. Therefore, it is assumed that 20,000 tons per year of 95 % ethanol is to be supplied by existing ethanol factories to the complex, so that the amount of molasses to be supplied is 250,000 tons per year. Requirement for raw materials and production quantity of all products are summarized in Table 6.1.

This sucro-based chemical complex is composed of seven process plants whose respective descriptions are given in the following paragraph.

The location of the complex is assumed to be in East Jawa.

6.2. Process Description

(1) Ethanol

Molasses is diluted with water to a sugar content of 14 to 18 % and pumped into a fermenter. About 5 % by volume of active fermenting yeast mash is also added. The yeast starts to multiply immediately.

The fermenter is cooled and the pH of the fermenting mash is controlled to maintain the optimum condition of fermentation. In some case, a small amount of nutrient solution is added to help the growth of the yeast.

Fermentation is completed in 36 - 37 hours.

$$\underset{\text{sucrose}}{C_{12}H_{22}O_{11}} + H_2O \longrightarrow \underset{\text{glucose + fructose}}{2\,C_6H_{12}O_6}$$

$$\xrightarrow{\text{yeast}} \underset{\text{ethanol}}{4\,C_2H_5OH} + \underset{\text{carbon dioxide}}{4\,CO_2}$$

The fermented mash is then transferred to the distillation section to recover and concentrate ethanol.

(2) Acetaldehyde

Acetaldehyde is an intermediate to make acetic acid and ethyl acetate from ethanol.

To make acetaldehyde from ethanol, a catalytic dehydrogenation reaction is employed. Ethanol is firstly evaporated and passed over a catalyst.

$$\underset{\text{ethanol}}{C_2H_5OH} \xrightarrow{\text{Cat.}} \underset{\text{acetaldehyde}}{CH_3CHO} + \underset{\text{hydrogen}}{H_2}$$

Acetaldehyde is separated from condensed liquid by distillation.

Unused ethanol is also recovered and returned to the process. Separated gas contains by-product hydrogen which is satisfactorily pure to be used for other process.

(3) Acetic acid

Acetic acid is made from acetaldehyde by catalytic oxidation. Acetaldehyde is mixed with air as the oxidant and introduced into a catalytic reactor.

$$\underset{\text{acetaldehyde}}{CH_3CHO} + \underset{\text{air}}{1/2\,O_2} \xrightarrow{\text{Cat.}} \underset{\text{acetic acid}}{CH_3COOH}$$

The reacted gas is scrubbed with refrigerated water to remove uncondensed gas.

Condensed raw acid is sent to the refining system, where water is removed to yield acetic acid.

(4) Ethyl acetate

Ethyl acetate is produced by a condensation reaction of acetaldehyde, so-called Tischenko reaction.

$$\underset{\text{acetaldehyde}}{2\,CH_3CHO} \xrightarrow{\text{Cat.}} \underset{\text{ethyl acetate}}{CH_3COOC_2H_5}$$

The reaction takes place at low temperature in a reactor equipped with a cooling system.

Nonvolatile substances contained in the reactor effluent is separated at an evaporator and ethyl acetate is purified by distillation.

(5) Butyl Acetate

Butyl acetate is produced by a condensation reaction of acetic acid with n-butanol in the presence of a catalyst.

$$\underset{\text{acetic acid}}{CH_3COOH} + \underset{\text{n-butanol}}{C_4H_9OH} \xrightarrow{\text{Cat.}} \underset{\text{butyl acetate}}{CH_3COOC_4H_9} + \underset{\text{water}}{H_2O}$$

Acetic acid and n-butanol are continuously fed to a reactor in which a catalytic solution is held. The reactor is heated by steam to maintain the temperature and the product is evaporated. The reactor is combined with a distillation column.

The product evaporated from the reactor is neutralized and washed with water. Unreacted n-butanol and water are removed from butyl acetate by distillation.

(6) Acetone/n-butanol

Acetone and n-butanol are produced simultaneously by a fermentation process using a bacterium.

Molasses is diluted with water to a carbohydrate concentration of 5 - 7 %, and supplemented with nitrgenous and phosphatic nutrients to make the mash, which is sterilized and transferred to a fermenter.

The inoculum, which is 2 - 4 % of the medium by volume, is built up in 24 hours' stage for the production stage fermentor.

The fermentation temperature is 30 - 35 °C, and the fermentation period is 40 - 45 hours.

The products are recovered from the fermented mixture by steam stripping. Acetone, n-butanol, and crude ethanol are separated from each other by fractional distillation.

(7) Octanol (2-ethylhexanol)

Octanol is produced from n-butanol. n-Butanol is converted in the first step to butyl aldehyde by a catalytic dehydrogenation.

$$\underset{\text{n-butanol}}{CH_3CH_2CH_2CH_2OH} \xrightarrow[-H_2]{\text{Cat.}} \underset{\text{butyl aldehyde}}{CH_3CH_2CH_2CHO}$$

Butyl aldehyde is converted to ethylhexenal by aldol condensation and dehydration reaction. The ethylhexenal formed is recovered and concentrated by distillation.

$$\underset{\text{n-butyl aldehyde}}{2CH_3CH_2CH_2CHO} \xrightarrow[-H_2O]{} \underset{\text{2-ethylhexenal}}{CH_3CH_2CH_2CH=C(C_2H_5)CHO}$$

2-Ethylhexenal is converted to 2-ethylhexanol by hydrogenation.

$CH_3CH_2CH_2CH=C(C_2H_5)CHO$

2-ethylhexenal

$$\longrightarrow CH_3CH_2CH_2CH_2CH(C_2H_5)CH_2OH$$

$+ H_2$ 2-ethylhexanol

Crude product is purified and concentrated by distillation.

6.3. Outline of Major Facilities

(1) Process unit

Seven process units are installed in the complex. Respective capacities of the process units are shown in Table 6.2.

(2) Utility facility

It is assumed that electricity and fuel oil are supplied from outside of the complex, and the raw water for cooling and other uses can be taken from the river.

Other utilities are provided in the complex to meet respective requirements.

(a) Steam generation facility

Three package boilers, one of which is for stand-by, are to be installed to supply steam. The capacity of each boiler is as follows:

Capacity : 60 t/hr x 20 kg/cm^2 G

(b) Power receiving facility

A power receiving facility with the following capacity is installed to supply the electricity required.

Capacity : 2,500 kW

(c) Water supply facility

A water intake facility and cooling towers with the following capacity are installed.

Capacity : 2,000 t/h x 3 sets

(d) Other utility facilities

- Instrument and plant air supply facility
- Fuel oil supply facility

(3) Storage facility

The capacities of the storage tanks for raw material, intermediate products, and products are listed in Table 6.3.

(4) Other facilities

The following facilities are to be installed:

- Raw material receiving and product shipping facilities by tank trucks
- Waste water treating facility (activated sludge)
- Firefighting facility
- Buildings including control room

6.4. Manning Plan

The total number of personnel required in the complex is estimated to be about 200 persons.

6.5. Construction Period

The complex is supp sed to be constructed in two years.

Table 6.1. Raw Material and Product

Item	Quantity (t/y)
1. Raw Material	
(1) Molasses	250,000 *1)
(2) Ethanol	20,000
2. Product	
(1) Acetic Acid	15,800
(2) Ethyl Acetate	18,700
(3) Butyl Acetate	8,000
(4) Acetone	8,000
(5) n-Butanol	2,200
(6) Octanol (2-Ethyl Hexanol)	9,600
(7) Crude Ethanol	2,700

Note *1): Sugar content is assumed to be 57%.

Table 6.2. Summary of Process Unit

	Process	Capacity (t/y) (As product)
(1)	Ethanol	23,000
(2)	Acetaldehyde	35,000
(3)	Acetic Acid	20,000
(4)	Ethyl Acetate	19,000
(5)	Butyl Acetate	8,000
(6)	Acetone/Butanol	27,000
(7)	Octanol	10,000

Table 6.3. Storage Facility

	Item	Storage Capacity	Tank
(1)	Molasses	Half year	50,000 kl x 3
(2)	Ethanol	30 days	4,000 kl x 1
(3)	Acetaldehyde	7 days	1,000 kl x 1
(4)	Ethyl acetate	30 days	2,000 kl x 1
(5)	Acetic Acid	30 days	2,000 kl x 1
(6)	Butyl Acetate	30 days	1,000 kl x 1
(7)	Acetone	30 days	1,000 kl x 1
(8)	n-Butanol	30 days	2,000 kl x 1
(9)	Octanol	30 days	1,000 kl x 1
(10)	Crude Ethanol	30 days	300 kl x 1

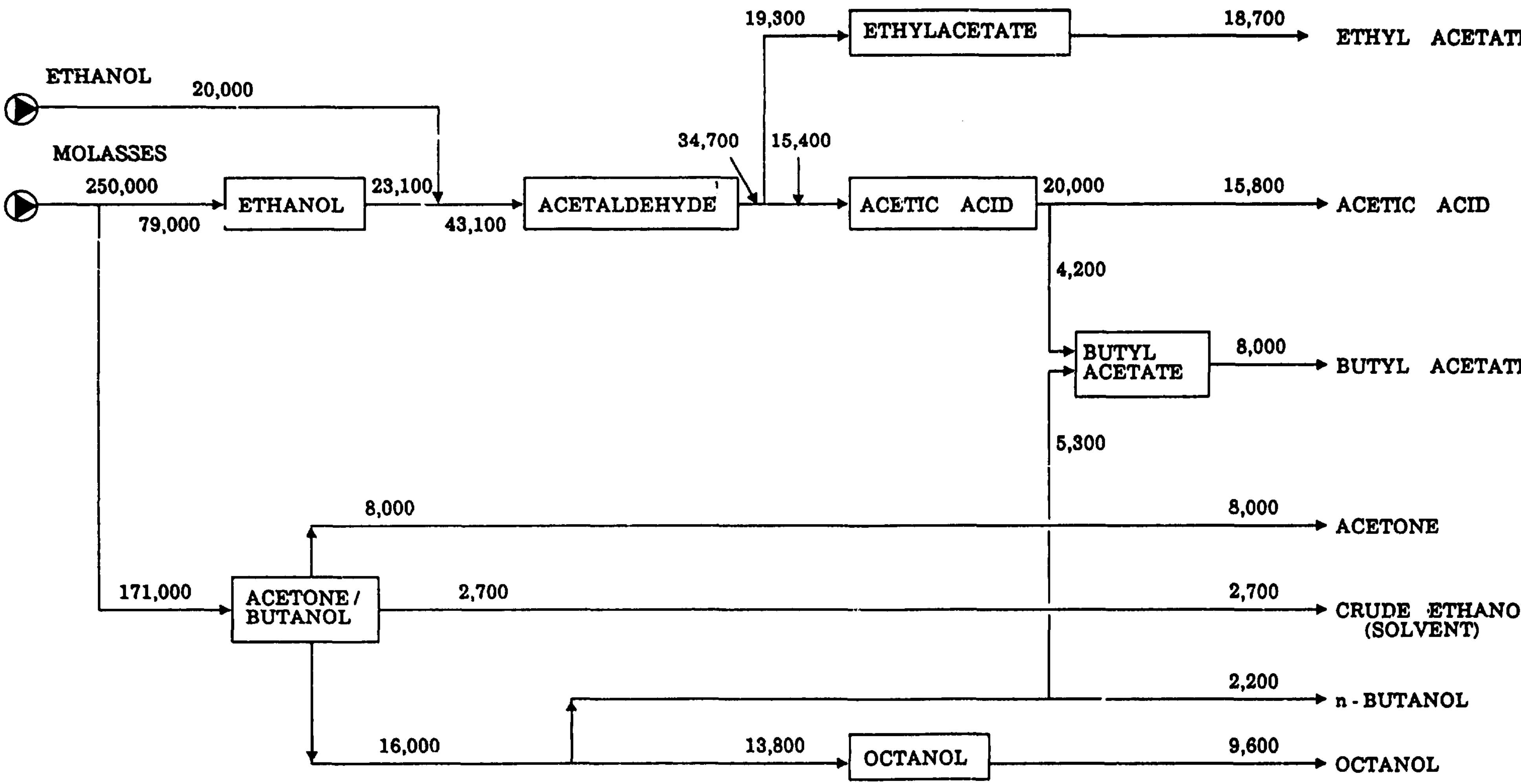


Fig.6.1 Production Scheme for Sucro - based Chemical Complex
(Unit : Ton / year)

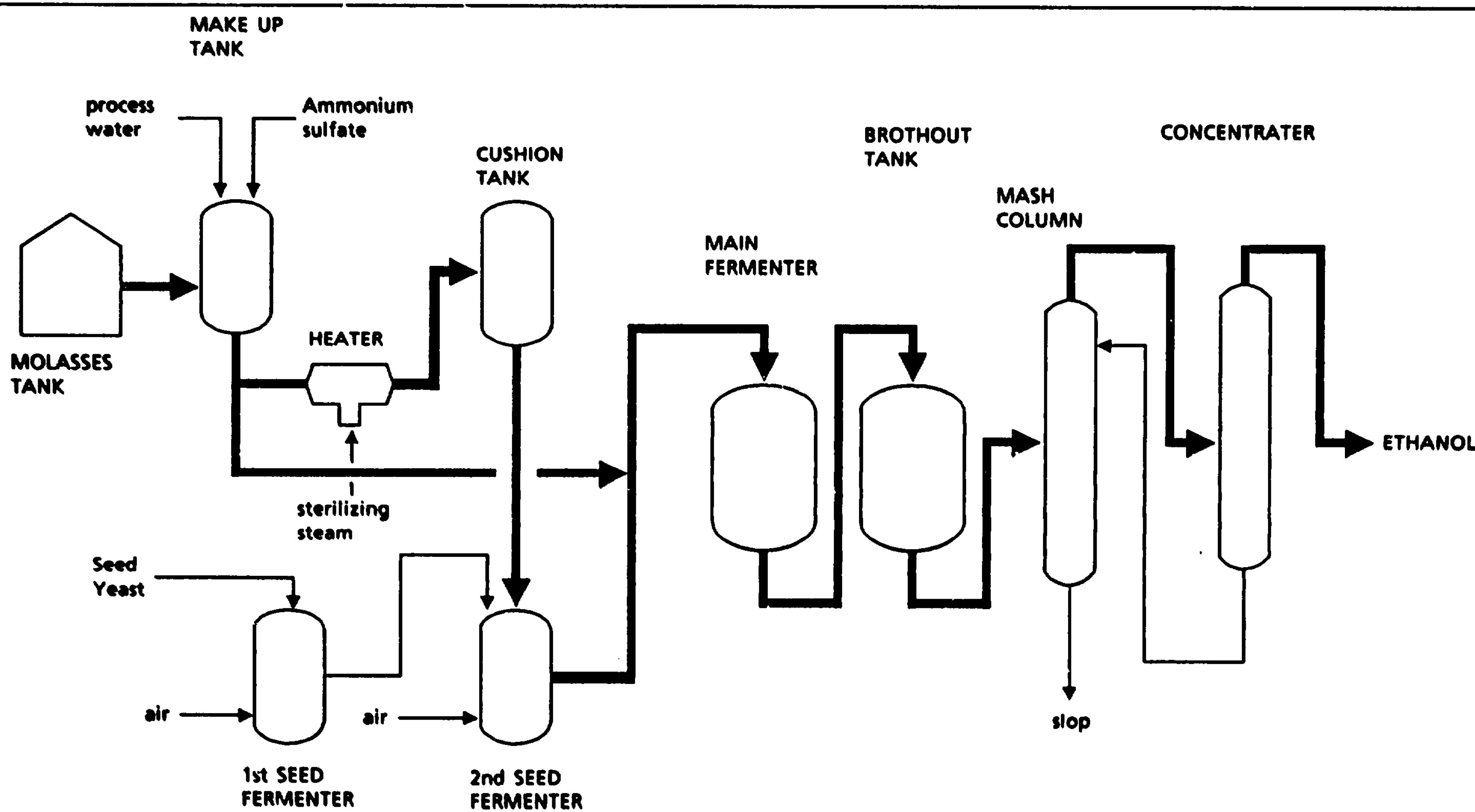


Fig.6.2. Molasses - based Ethanol Manufacturing Process

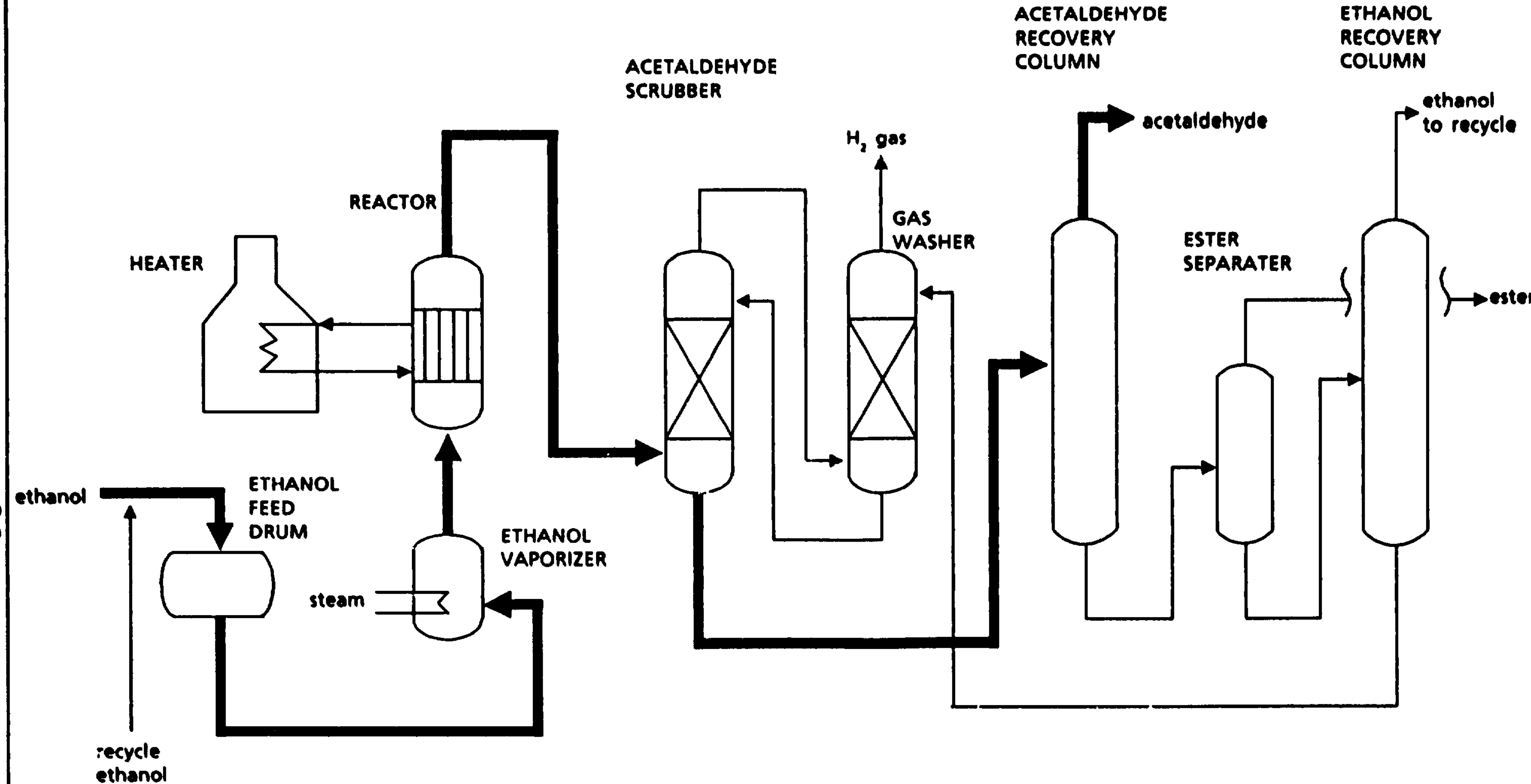


Fig.6.3. Ethanol - based Acetaldehyde Manufacturing Process

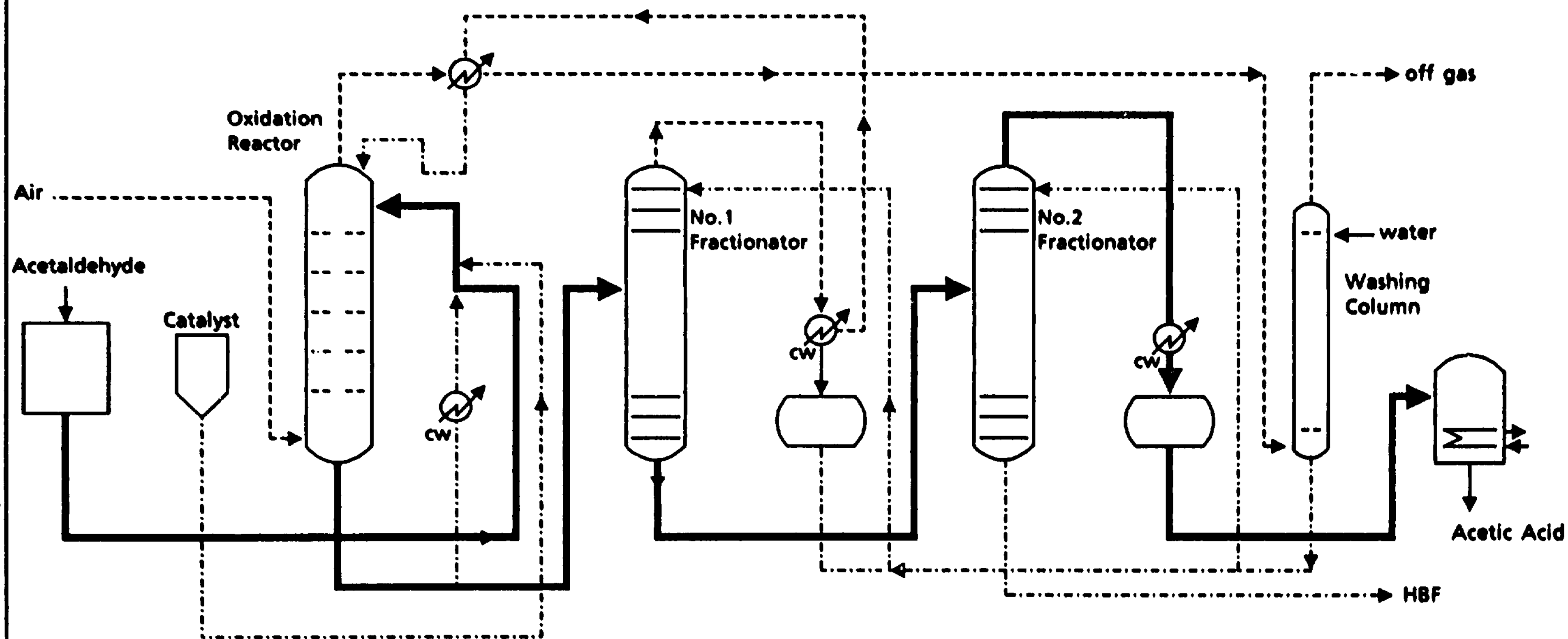


Fig.6.4. Acetic Acid Manufacturing Process

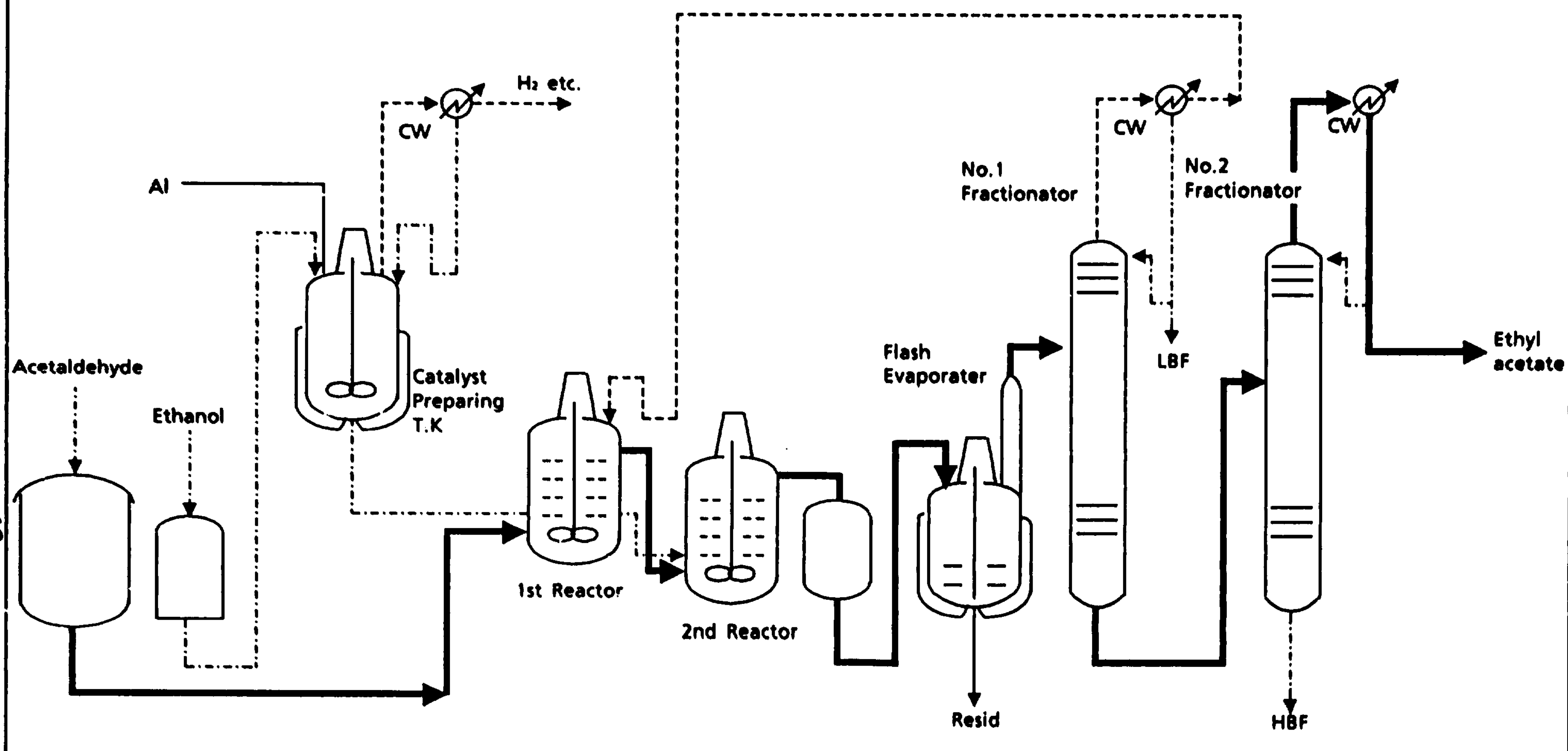


Fig.6.5. Acetaldehyde - Based Ethyl Acetate Process

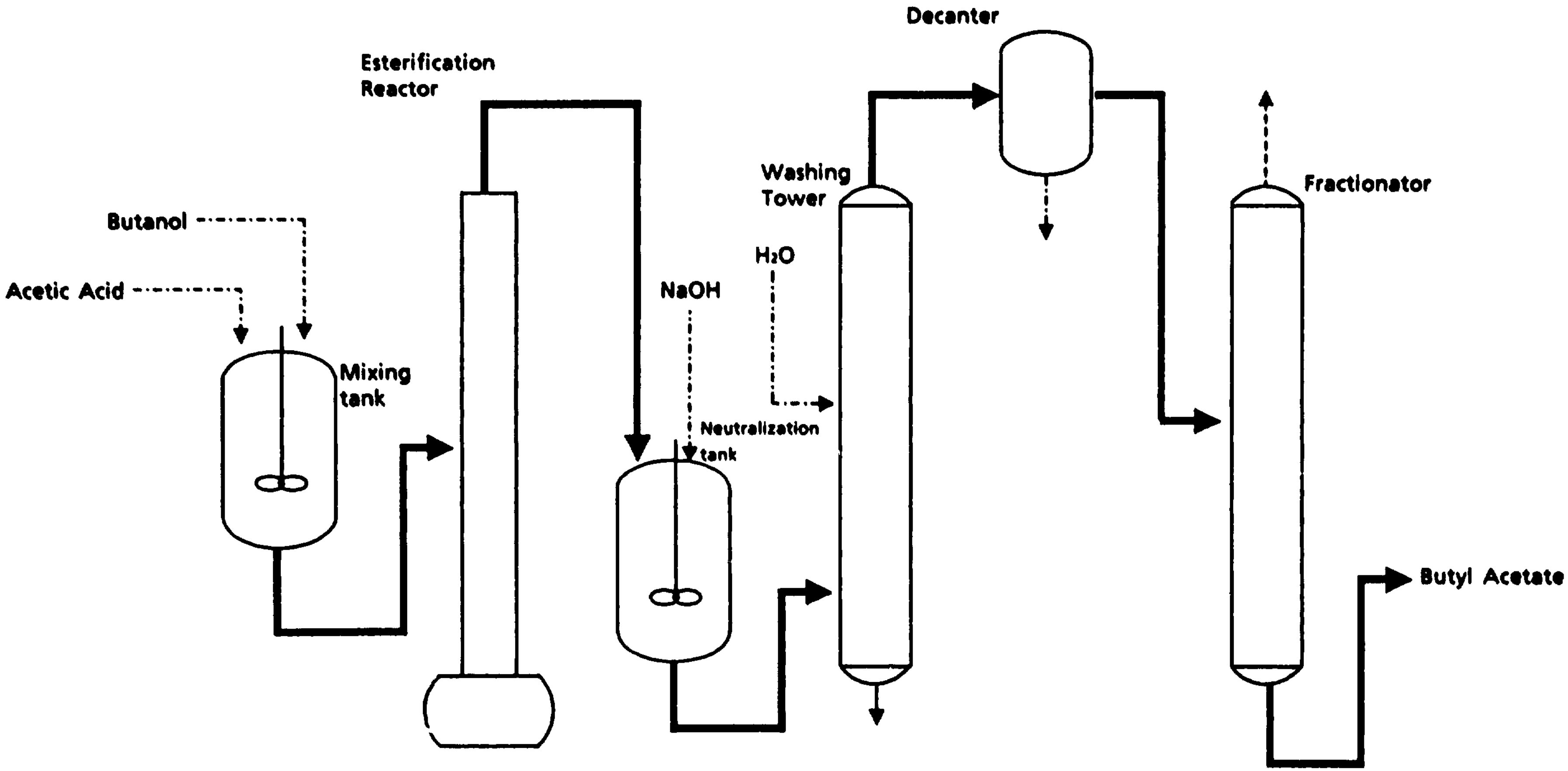


Fig.6.6. Butyl Acetate Manufacturing Process

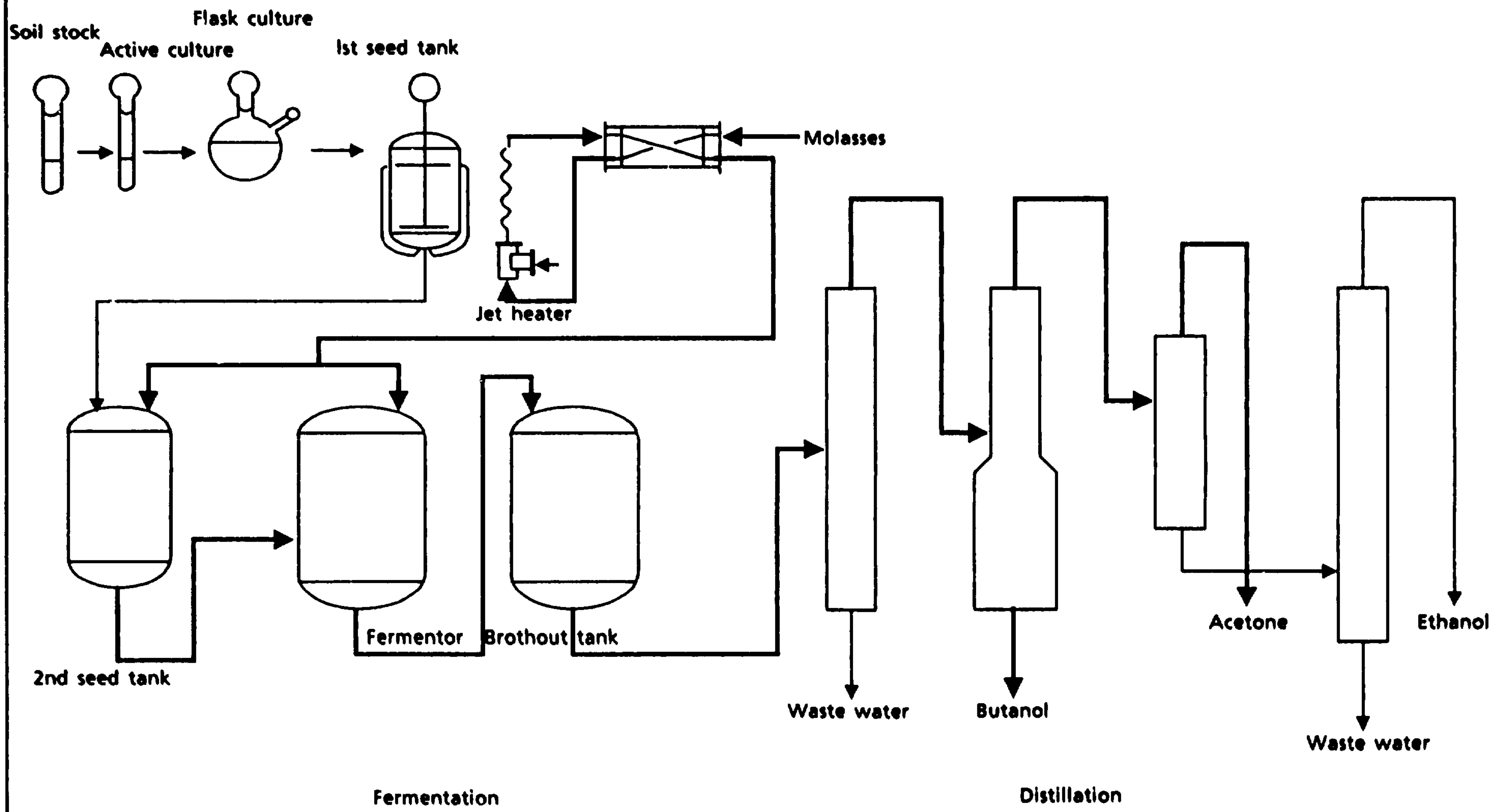


Fig.6.7. Acetone - Butanol Manufacturing Process

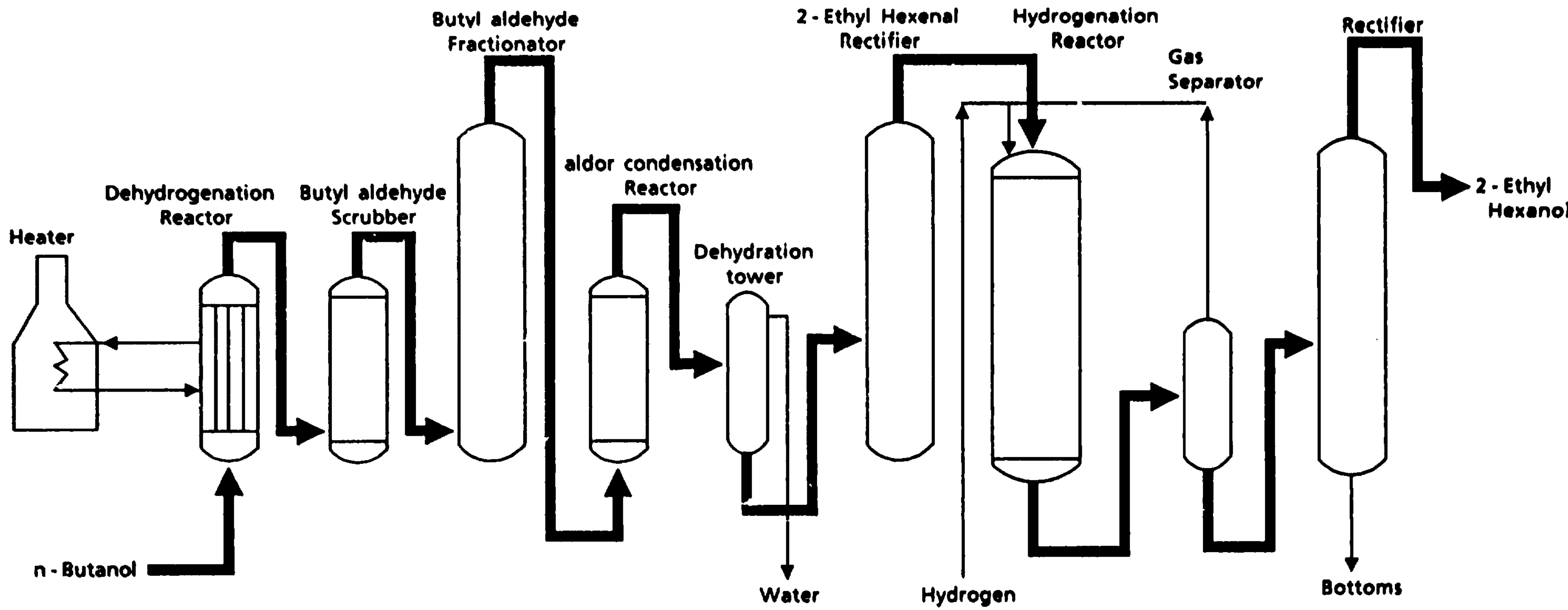


Fig.6.8. 2 - Ethyl Hexanol Manufacturing Process

CHAPTER 7. EVALUATION

7.1. Method of Study

The viability of the project presented in Chapter 6. is examined by an economic study. The study is made from the following two viewpoints:

(1) Profitability

The profitability of the project is evaluated by applying internal rate of return (IRR) as the criteria. The basis of calculation of IRR is described in the following paragraph 7.2.

IRR is the discount rate which makes the total sum of the present value of the net cash flow of the project equal to zero, that is, discount rate, r, in the following equation:

$$\sum_{i=0}^{n} \frac{CIF_i - COF_i}{(i+r)^i} = 0$$

where,

CIF_i : cash inflow in the i-th year,
profit after tax, but before depreciation and interest paid

COF_i : cash outflow in the i-th year,
investment cost excluding interest during construction

i : the i-th year of the study period

r : discount rate

In addition, sensitivity analysis is made to examine the effect on IRR of changes in cost and revenue factors, the range of the change of each factor is as shown below.

Factor	Range
Plant construction cost	± 20 %
Raw material cost	± 10 %
Product sales price	± 10 %

(2) Foreign currency saving

The project is expected to contribute to the foreign currency saving of Indonesia by reducing the dependence on import of industrial chemicals. This effect is examined by comparing the foreign currency requirements in the "with project" case and "without project" case. The difference in foreign currency requirements between the two cases, that is, foreign currency requirement in "without" case minus that in "with" case, is regarded as the foreign currency saving.

In "without" case, foreign currency is required to import the industrial chemicals to be produced by the project, but, on the other hand, foreign currency is earned by exporting the raw material, molasses and ethanol, to be consumed by the project. Therefore, the foreign currency requirement in this case is calculated by deducting the foreign currency earning by raw-material export from the foreign currency requirement for the product import. In the culculation of the foreign currency requirement and earning, FOB export prices of the raw materials and CIF import prices of the chemicals are used, respectively.

In the "with" case, foreign currency requirement is calculated by summing up the refund of loan and the interest payment.

7.2. Basis of Study

7.2.1. Study Period

The IRR of the project is calculated over a period of seventeen (17) years, of which initial two (2) years (1st and 2nd) are plant construction period and succeeding fifteen (15) years (from 3rd to 17th) are commercial operation. It is assumed that the commercial operation is started from the 3rd year with full capacity of the plant.

Foreign currency saving is calculated over the commercial operation period (3rd to 17th) only.

7.2.2. Investment Costs

The plant construction cost for the project is estimated to be US$ 120 millions including the construction costs of the facilities as described in Capter 6., and its payment schedule is assumed as below:

(unit : 10^6 US$)

Year	1st	2nd	Total
(1) Plant construction cost	36.0	84.0	120.0
(2) Interest during construction period	1.3	5.9	7.2
Total investment costs	37.3	89.9	127.2

7.2.3. Annual Sales Revenue

Sales prices of the products of the project are assumed to be their respective CIF import prices in 1988 added by import duty and handling charge at the customs and port. Import duties and handling charge are assumed at 15 % and 3 % of CIF price of each product, respectively.

Annual sales revenue of each product is calculated by multiplying the annual production amount by its sales price, and summarized in Table 7.1.

7.2.4. Annual Expenses

(1) Raw material cost

Prices of raw materials for the project, molasses and ethanol, are assumed to be equal to their respective FOB export prices in 1988. Annual raw material cost is calculated as shown in Table 7.2.

(2) Catalyst and chemicals

The annual cost of the catalyst and chemical is estimated to be about US$ 3 million.

(3) Utility cost

Electricity and fuel oil are regarded as utilities to be purchased and their consumption and unit costs are assumed, and annual costs calculated, as below.

Utility	Consumption	Unit cost	Annual cost (10^6 US$)
Electricity	23.8×10^6 kWh/y	US$ 0.09/kWh	2.1
Fuel oil	3,000 kl/y	US$ 100/kl	0.3

(4) Labor cost

Operating labor cost is calculated at US$ 0.5 million per year on the basis of the number of employees estimated at 200 persons and average labor cost assumed to be US$ 2,500 per man-year.

(5) Administration cost

Administration cost is assumed to be 100 % of the labor cost, namely US$ 0.5 million per year.

(6) Maintenance cost

Maintenance cost is asumed to be 3 % of the plant construction cost annualy.

(7) Insurance and miscellaneous costs

It is assumed that 2 % of the plant construction cost is required annually as insurance and miscellaneous costs.

(8) Depreciation

Fixed annual rate of 10 % is to be applied to depreciation.

7.2.5. Fund Arrangement

(1) Equity capital

It is supposed that equity capital which corresponds to 30 % of the plant construction cost is to be raised.

(2) Long term loan

It is supposed that the portion of the investment costs which surpass the equity capital is to be covered by long term loan. The condition of the loan is as below.

- -interest rate 10 % annually
- -repayment of principal uniform repayment in 10 years with no grace period

(3) Short term loan

It is supposed that in the case of shortfall the fund is to be covered by short term loan. The condition of the loan is as below.

- -interest rate 20 % annually
- -repayment of principal when fund is in excess

7.2.6. Corporate Tax

It is supposed that 35 % of income tax is to be incurred.

7.3. Result of Study

The result of the evaluation of the profitability of the project is summarized in Table 7.3. The following is some observations:

(1) IRR can be regarded as the profit rate of the total investment in the project. The IRR value of 17 % for this project is not very high but seems to be in an acceptable range.

(2) The payout period is the period required to recuperate the initial investment costs through the profit earned from the project. For this project, it is calculated to be about 6.7 years.

(3) It is generally said that 1.5 is a minimum acceptable value of the debt service coverage ratio. The calculated ratio

of 1.8 for this project indicates that the principal and the interest of initial loan is to be safely repaid by the revenue of the project.

(4) The income tax is paid to the government and the total amount throughout the project period of 15 years is calculated at US$ 86 million.

(5) Surplus cash generated by the project throughout the project period of 15 years is calculated to amount to US$ 196 million.

The result of the sensitivity analysis is summarized in Table 7.4. The profitability of the project in terms of IRR is much more sensitive to the variation in the product sales price compared with the variation in the raw material cost. The variation in the plant construction cost also affects the profitability considerably.

The foreign currency requirements for "without project" and "with project" cases are calculated to be US$ 456 million and 137 million, respectively, indicating that US$ 319 million of forreign currency saving can be expected throughout the 15 years of commercial operation of the project (Table 7.5.).

6557D

Table 7.1. Annual Sales Revenue

	Product	Price (US$/t)	Quantity (ton/y)	Value (10^6 US$)
(1)	Acetic Acid	800	15,800	12.6
(2)	Ethyl Acetate	1,145 *1)	18,700	21.4
(3)	Buthyl Acetate	1,145 *1)	8,000	9.2
(4)	Acetone	600	8,000	4.8
(5)	n-Butanol	770	2,200	1.7
(6)	Octanol	1,310	9,600	12.6
(7)	Crude Ethanol	150	2,700	0.4
	Total		65,000	62.7

Note *1) Average import price of esters of acetic acid.

Table 7.2. Raw Material Cost

	Raw Material	Price (US$/t)	Quantity (ton/y)	Value (10^6 US$)
(1)	Molasses	65	250,000	16.3
(2)	Ethanol	305	20,000	6.1
	Total		270,00	22.4

Table 7.3. Result of Evaluation

	Indicator	Value
(1)	Internal rate of return (IRR)	17.1%
(2)	Payout period	6.7 years
(3)	Debt service coverage ratio (average)	1.8
(4)	Cumulative tax payment	86 million US$
(5)	Cumulative surplus cash	196 million US$

Note: Financial statements are attached in Appendix-1.

Table 7.4. Results of Sensitivity Analysis (IRR%)

Raw Material Cost	Product Sales Price	Plant Construction Cost		
		Base	-20%	+20%
Base	Base	17.1	22.0	13.5
	-10%	13.1	17.4	9.3
	+10%	20.7	26.2	16.8
-10%	Base	18.4	23.5	14.7
	-10%	14.5	19.1	11.0
	+10%	22.0	27.6	17.9
+10%	Base	15.7	20.4	12.2
	-10%	11.4	15.8	7.6
	+10%	19.5	24.7	15.7

6557D

Table 7.5. Foreign Currency Saving (1/2)

(10^6 US$)

Operation Year	Without Project Case			With Project Case			Foreign Currency Saving ((3)-(6))
	(1) Requirement	(2) Earning	(3) Net Requirement	(4) Refund of Loan	(5) Interest Payment	(6) Total	
Year	(Product Import)	(Raw Material Export)	((1)-(2))			((4)+(5))	
1.	52.8	22.4	30.4	9.1	8.7	17.8	12.6
2.	52.8	22.4	30.4	9.1	7.8	16.9	13.5
3.	52.8	22.4	30.4	9.1	6.8	15.9	14.5
4.	52.8	22.4	30.4	9.1	5.9	15.0	15.4
5.	52.8	22.4	30.4	9.1	5.0	14.1	16.3
6.	52.8	22.4	30.4	9.1	4.1	13.2	17.2
7.	52.8	22.4	30.4	9.1	3.2	12.3	18.1
8.	52.8	22.4	30.4	9.1	2.3	11.4	19.0
9.	52.8	22.4	30.4	9.1	1.4	10.5	19.9
10.	52.8	22.4	30.4	9.1	0.5	9.6	20.8

6557D

Table 7.5. Foreign Currency Saving (2/2)

(10^6 US$)

Operation Year	Without Project Case			With Project Case			Foreign Currency Saving ((3)-(6))
Year	(1) Requirement (Product Import)	(2) Earning (Raw Material Export)	(3) Net Requirement ((1)-(2))	(4) Refund of Loan	(5) Interest Payment	(6) Total ((4)+(5))	
11.	52.8	22.4	30.4	0	0	0	30.4
12.	52.8	22.4	30.4	0	0	0	30.4
13.	52.8	22.4	30.4	0	0	0	30.4
14.	52.8	22.4	30.4	0	0	0	30.4
15.	52.8	22.4	30.4	0	0	0	30.4
Total	792	336	456	91	45.7	136.7	319.3

FIG. 7.1 IRR VS RAW MATERIAL COST

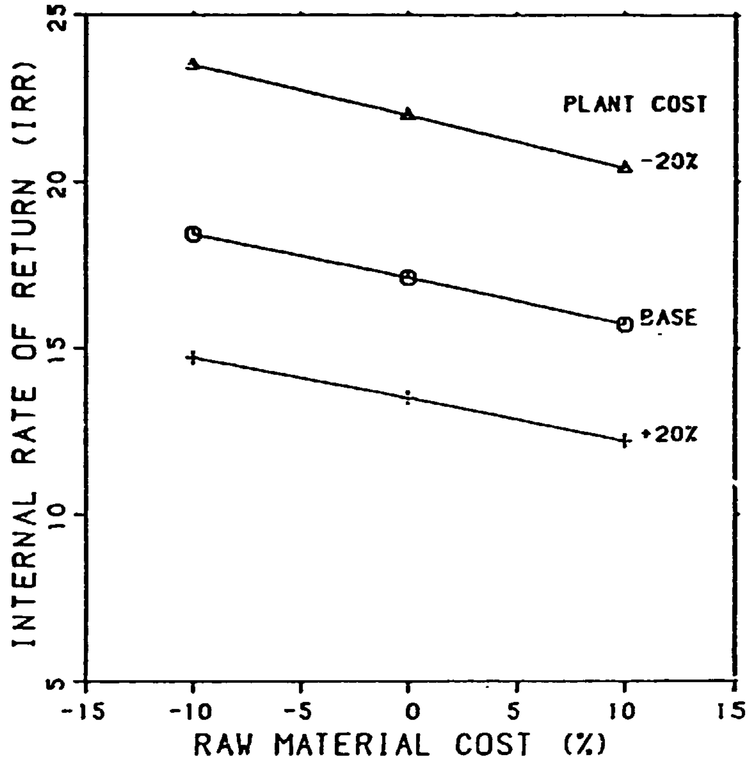
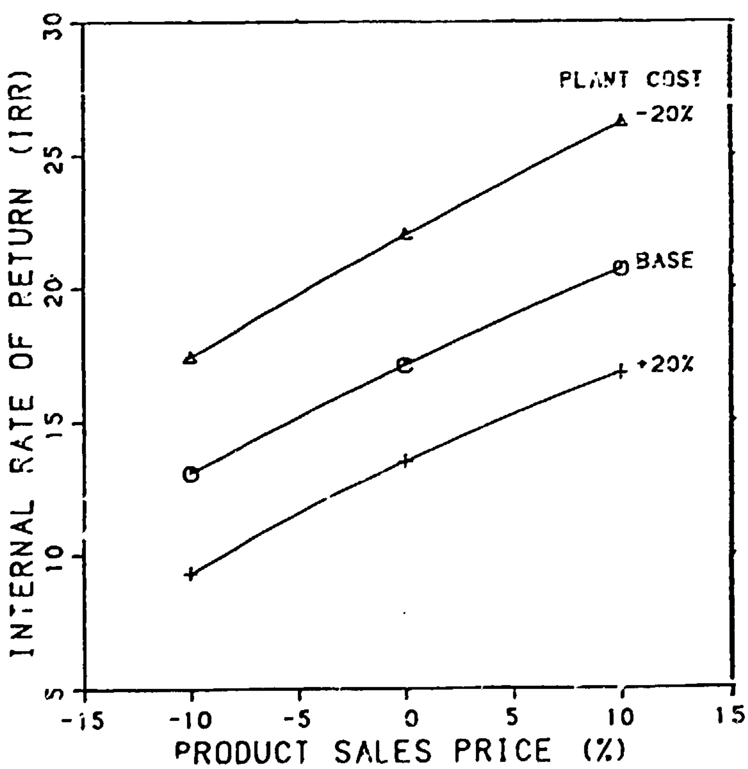


FIG. 7.2 IRR VS PRODUCT SALES PRICE



Chapter 8. DISCUSSION AND RECOMMENDATION

As the result of the study, an idea of a sucro-based chemical complex to produce six industrial chemicals is presented. While the profitability of this complex is not very favorable, it is able to reduce dependency of Indonesia on import of the industrial chemicals and contribute to the saving of foreign currency, and is economically viable under the conditions presupposed. The products of the complex are the most basic organic chemicals, for which demands in Indonesia is bound to increase, and which can be made from molasses by fermentation, or their derivatives.

However, there can be many alternative answers other than the one presented here to the problem of manufacture of industrial chemicals from molasses in Indonesia. Before making decision on whether this project is to be implemented, more in-depth consideration will be necessary. The following is discussions on some of the problems to be considered.

The products were selected from a list of eleven "candidate chemicals". The product selected are those which are not produced in Indonesia at present, or, even if produced, the production is not sufficient to fulfil the domestic demand and, consequently, are imported by Indonesia in substantial amounts.

But there are more industrial chemicals that can be made from molasses. The complex presented itself has possibilities of further extension to make more kinds of products. For example, acetic anhydride, which was on the list of candidate chemicals but was not selected because its consumption data in Indonesia was unavailable, can be synthesized from acetaldehyde.

Therefore, the kind of products to be produced must be decided based on the situation and trend in the market of industrial chemicals in Indonesia at the time of project implementation.

The next problem relates to the production quantity. The quantities of the products to be produced were mainly determined approximately at their estimated import amounts after five years from 1988, assuming that their import increase by 5 % annually.

It may be argued that the rate of increase assumed is too small compared with the past average annual growth rate of 7 - 10 % for whole industry, or too big in view of the past growth rate of 2 - 4 % per year for the basic chemical industry.

The development of industrial chemical industry in a country generally follows that of other industries which consume industrial chemicals. Therefore, in a country like Indonesia where industrialization is in its early stage, 5 % seems to be a reasonable value to be assumed as an average annual growth rate of industrial chemicals for coming five years.

Here, it must be emphasized that an assumption which is too optimistic can be dangerous since it may lead to a surplus production capacity. Since this project is aimed primarily at the replacement of chemicals hitherto imported, and the competitiveness of the products in the export market is questionable, overcapacity of the plant should be avoided. If, eventually, the products of the complex are not sufficient to fulfil their domestic demand, the shortage can be met by import.

In this regard, too, actual implementation plan must be based on a detailed observation of the market situation and trend at the time.

The third problem is the availability of raw material, molasses. In Indonesia, the MSG industry is expanding rapidly in recent years. As of 1988, the national production capacity of MSG is 111,500 tons per year and actual annual production is 59,676 tons, apparent operating ratio being about 54 %. Consumption of molasses for MSG manufacture in the same year is 240,000 tons.

If the existing production capacity is fully utilized, consumption of molasses will amount to about 448,400 tons, which is an increase by 248,400 tons from 1988. In recent years, Indonesia has been exporting 600,000 - 700,000 tons of molasses annually. In calculation, the increase in molasses consumption caused by the full utilization of the existing MSG production capacity and the expected molasses consumption of 250,000 tons by the complex presented can be supplied by the molasses presently exported.

In Indonesia, production of molasses is dispersed in many small sugar factories. And sugar factories who have their affiliated ethanol distillery are limited to those with relatively big sugar-cane crushing capacities. These facts suggest that, to use molasses produced by smaller scale sugar refineries as raw materials for modern process industries, some mechanism of molasses gathering is needed. The facts that major portion of molasses exported by Indonesia goes through the port of Surabaya, and many of MSG manufacturing factories which consume large amount of molasses are located around Surabaya, suggest that some molasses gathering mechanism has already been established in this district. Therefore, the location of the complex presented is assumed also to be in this district, though its exact site has to be decided yet.

As already mentioned, if the production capacity of MSG is to be further expanded as a projection made by the Department of Industry, almost all molasses produced in Jawa will be used up by the manufacture of one single commodity, MSG, and a keen competition in securing molasses supply among consumers (including overseas ones) will be inevitable. If this projection become reality, some measure of adjustment (including "to let the forces of the market work") will be required on the part of the Government.

To argue on the validity of the projection is not an intention of this report. But it can be pointed out that the projected rate of the build-up of the MSG production capacity seems to be too ambitious : by 62.5 % for 1988/89; by 53.5 % for 1990/91; and by 59 % for 1991/92, resulting in increase by nearly four times in four years. The operating ratio in 1992 is calculated at as high as 80 %. And average annual rate of increase in the molasses consumption for the MSG manufacture from 1988 to1992 is calculated at 38 %, whereas the average rate from 1984 to 1988 was only 14 %.

While this complex is economically viable and can contribute to the saving of foreign currency of Indonesia, its profitability is modest and not very attractive from the viewpoint of investors. However, from the viewpoint of the Government, this kind of project will have to be valued by the role it plays in laying a foundation of the sound development of organic chemical industry in Indonesia.

Recently, in Indonesia, some entrepreneurs have been entering into manufacture of organic industrial chemicals. They seem to be investing in the manufacture of specific chemicals in which easy profit can be expected immediately, without prospect for future development of the industry. As a consequence, development of organic chemical industry in Indonesia so far seems to be sporadic and lacking interlinkage.

A saying that "the biggest customer of the chemical industry is the chemical industry itself" means that interlinkage is an important feature of modern chemical industry. If the present sporadic moves of the individual investors are left as they are, a fear is felt that a sound development of chemical industry in the country may be hindered.

In this regard, the evaluation of the complex presented should be made on the complex as a whole. The portion of the complex in which the largest investment is required will be the acetone/butanol fermentation section. But if this section is omitted from the project, butyl acetate and octanol, the products which have higher value added, cannot be produced any more, and the value of this project as a foundation of the development of organic chemical industry in Indonesia will be diminished. Some people would argue that octanol and butyl acetate can be made by importing their raw material, butanol. But it is no more a molasses based chemical industry but only an addition to the sporadic development that are going on presently in Indonesia.

As the Fourth Five-year Plan of Indonesia (REPERITA IV) states, the chemical industry is a key industry to support the establishment of a strong industrial structure and accelerate national capacity to process national resources. It seems that a firm policy concerning the future structure of organic chemical industry in Indonesia is needed.

As mentioned repeatedly, the products of the complex can be made by both fermentation and petrochemical routs. Since Indonesia is an oil producing country as well as an agricultural country, there is a potentiality for Indonesia to have its petrochemical industry to make these chemicals. And, under the present price relationship between petroleum and agricultural products, petrochemical route is advantageous to fermentation in the production costs of these chemicals.

However, very huge scale is required for the petrochemical production, and demand for organic industrial chemicals in Indonesia for a foreseeable future is far smaller than the economic scale of petrochemical production. For example, world standard scale of an acetone production plant is considered to be 50,000 - 100,000 tons per year, whereas the present demand in Indonesia is less than 10,000 tons per year. In addition, the petrochemical process presently used to make acetone co-produces phenol, for which demand is also small in Indonesia. For Indonesia, to export these surplus petrochemical products will not be easy because world export market is already occupied by the products of the industrialized nations, who manufacture these chemicals mainly for their domestic consumption and export a marginal portion of their products at low prices.

In these circumstances, the alternative policies for Indonesia with regard to these industrial chemicals are as follows: (1) to continue their import and wait until the domestic demands reach the economic scale of petrochemical production; (2) to start their domestic production by fermentation at a scale to meet domestic demand; or (3) to let the sporadic development go as it is. The choice will determine the future industrial structure of Indonesia.

Another decision will have to be made concerning the use of molasses.

There can be a big problem in regard to the supply/demand balance of molasses in future as already mentioned, and the Government may have to face another choice of alternative policies: (a) to let the enormous build-up of MSG production capacity go as projected by the Department of Industry. If this is realized, all other possibility of molasses utilization will be excluded; or (b) to work out some measures for allocating molasses to various consumers to diversify the utilization of molasses. The project presented can be realized only when this alternative is chosen. And, in addition, the diversification of molasses utilization may enable the development of new molasses based industries which can be practised on the sites of the small scale sugar refiners. Which is more beneficial for Indonesia ?

Whatever alternatives be chosen, fermentation is the indispensable basic technology for the utilization of molasses as a raw material for modern chemical industries. While nobody can predict the future of the petroleum price exactly, it is certain that whereas the petroleum is an unreplenishable resource, agricultural products are replenishable. An eminent scholar once predicted the 21st century is the century of bio-technology.

Fermentation industry can be developed only on the basis of long and intensive research and development efforts. The fermentation requires a wide range of technologies such as: to search, create and maintain superior microbial strain; to culture microorganisms; and to separate and purify fermentation products, for example. It is recommended that the Indonesian Government take measures to enhance R & D capabilities of the nation in fermentation technologies systematically. In recent years Indonesia has been sending not a few young students abroad to study bio-technology. It is desired to organize capability of these people.

Fermentation industry is destined to discharge large amounts of waste water, in which many potential nutrient materials are contained. In view of the already ongoing pollution of river waters in Jawa, disposal of fermentation waste water is an urgent task for the industry. In this regard, manufacture of fertilizer practised by one of MSG producers to recycle the nutrient contained in the factory's waste water to agricultural land offers a good example. In the complex presented in this study, a waste water treatment facility using activated sludge is considered.

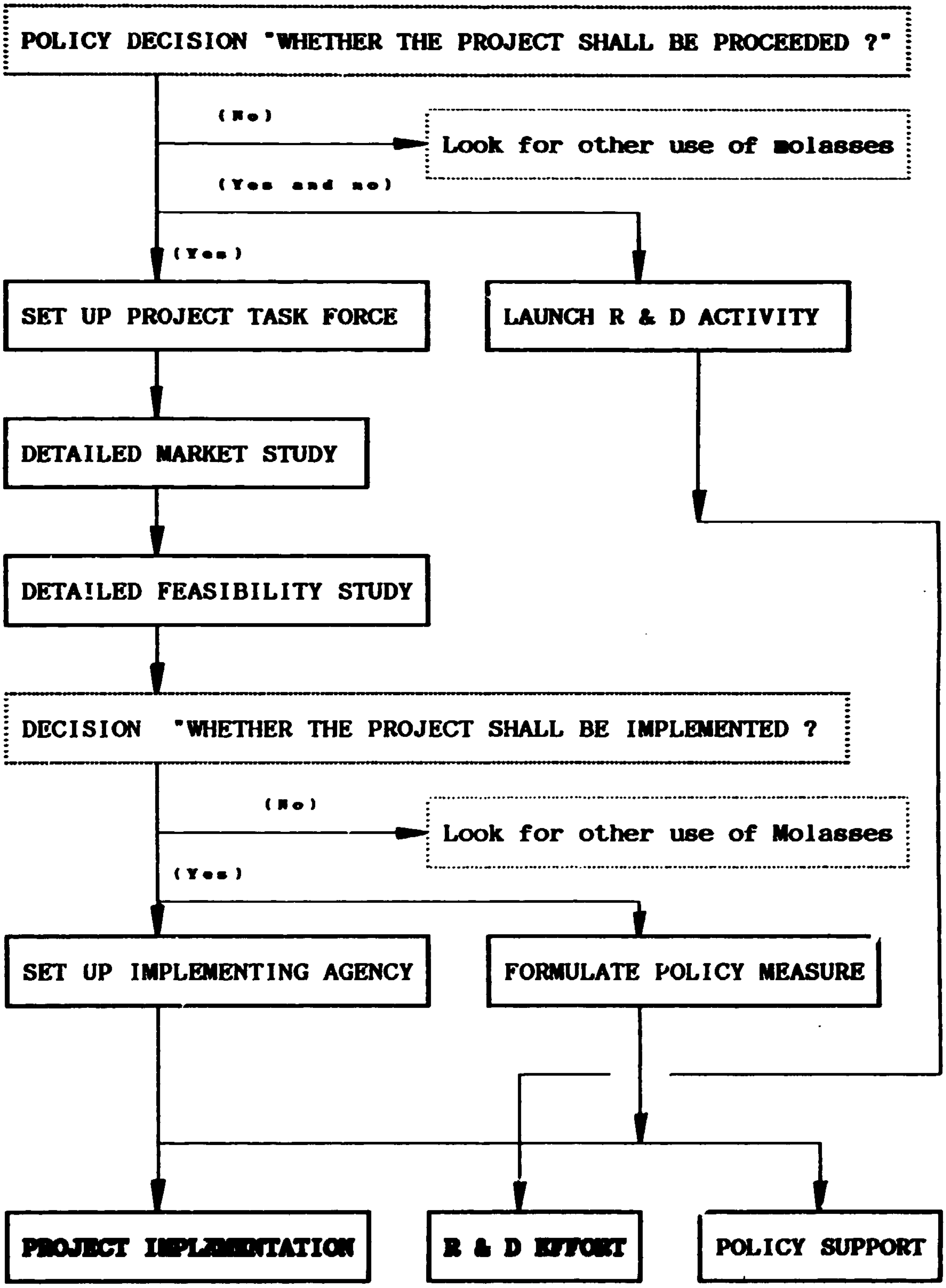
It must be emphasized again that the present study is not intended to be a feasibility study of a particular project, but a broader survey to look for possible way of molasses utilization which is beneficial to Indonesia but is not practised presently in the country. The result of the study has indicated that there is a possibility for Indonesia to develop molasses based organic chemical industries.

However, the decision on whether Indonesia shall bring this possibility into reality implies policy decisions of more fundamental nature. They are: What shall be the future structure of organic chemical industry in Indonesia ? and, What will be the beneficial way of molasses utilization for Indonesia ?

Wise decisions on the part of the Government is most desired.

Recommendable steps to be taken towards the realization of the project are summarized and explained in the following pages.

POLICY RECOMMENDATION



STEPS TO BE TAKEN TOWARD PROJECT IMPLEMENTATION

1. Policy Decision

Clear guidelines should be established as to the future structure of organic chemical industry and future development of domestic use of molasses in Indonesia. and,

Decision should be made on whether the project is to be proceeded with or not. If Yes,

2. Project Task Force

A task force which is responsible for the promotion of the project should be set up. The task force shall undertake such activities as enumerated below to proceed with the project.

In the execution of its task the task force may cooperate with, or entrust some activities to, other organizations when necessary, and make necessary recommendations to the Government concerning policy measures reguired. The members of the task force shall preferably be selected from both Governmental and industrial organizations, and at least some of them are to be expected to form the nucleus of the implementing agency when it is set up,

3. Project Preparation

3.1. Detailed Market Study

Actual situation and trend of the consumption, import, and distribution in Indonesia of the products (six chemicals selected plus those which can be derived from them, for example, acetic anhydride, MIBK, etc.) should be studied precisely.

3.2. Feasibility Study and Project Formulation

Kinds and quantities of the products to be produced, their production scheme, plant site, and other main features of the project should be formulated based on a detailed feasibility study. According to the result of the feasibility study, a policy decision should be made as to whether the project shall be implemented or not. If Yes,

4. Institutional Preparation

4.1. Implementing Agency

An agency who is responsible for the implementation of the project should be set up. It seems to be appropriate that the agency is to be affiliated to one of P.T.P.s in East Jawa.

The management of the implementing agency should have sufficient knowledge in fermentation and organic chemical technologies and capability of production and marketing management, and, above all, creativity and entrepreneurship.

4.2. Policy Measures

The Government should take policy measures necessary to facilitate the implementation of the project, for example, project finance, protective import duty, favored taxation, etc.

5. Project Implementation

5.1. Production Facility and Man-Power

The implementing agency should take necessary steps to construct its production facility and to train its personnel who run the business.

5.2. Raw material Gathering and Product Distribution

The implementing agency should organize channels for secureing the supply of raw materials and marketing of its products. It seems to be desirable to utilize existing channels as far as possible.

6. Research and Development

If Indonesia is to use molasses as raw material for modern chemical industries, fermentation technology is indispensable. Therefore, measures should be taken to promote systematic and organized R & D efforts in fermentation. A suitable candidate site of the R & D activities will be the Sugar Research Institute at Pasuruan in view of its location, its past achievement, and its relationship with P.T.P.s. However, it seems that the Institute needs to reinforce its research staff as well as its facilities.

IMPROVEMENT OF RESEARCH FACILITY AT PASURUAN

The following is a suggestion for the improvement of research facilities of the Sugar Research Institute at Pasuruan.

The Institute is expected to bridge between basic research carried out in universities and other institutions in Indonesia and the industry. The Institute presently is equipped with a 10 kiloliter fermenter and a distillation unit which seemingly are aimed at ethanol fermentation.

In order to upgrade the existing facilities to be used for multi-purpose R & D work in fermentation technology, it is suggested to add the following equipment :

(1) Fermentation and Distillation Section
- a 1,000 l pilot fermenter
- 20 - 30 l jar fermenters
- a fractionation column (to be integrated with existing distillation column)

(2) Product Finishing Section
- centrifugal separators
- extraction equipment
- evaporator, crystalizer, and dryer

The above additional facilities are estimated to cost around US$ 350,000.

LIST OF APPENDICES

APPENDIX-1 Financial Statements

UNIDO NO89/22/CW

ITEM NO.

CASE NO. CASE-1AX

E C O N O M I C

E V A L U A T I O N

P R O G R A M

J G C CORPORATION

JOB NO.

DATE MAY 1989

ENGINEER TASHIRO

P R O F I T & L O S S

10**06USD CASE-1AX

	1	2	3	4	5	6	7	8	9	10
	01	02	03	04	05	06	07	08	09	10
* REVENUE										
ACETIC ACID	0.0	0.0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
ETHYL ACETATE	0.0	0.0	21.4	21.4	21.4	21.4	21.4	21.4	21.4	21.4
BUTYL ACETATE	0.0	0.0	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
ACETONE	0.0	0.0	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
N-BUTANOL	0.0	0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
OCTANOL	0.0	0.0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
CRUDE ETHANOL	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
INT. RECEIVED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	62.7	62.7	62.7	62.7	62.7	62.7	62.7	62.7
* EXPENSES										
MOLASSES	0.0	0.0	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
ETHANOL	0.0	0.0	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
ELECTRICITY	0.0	0.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
FUEL OIL	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
CAT.AND CHEM	0.0	0.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
LABOR COST	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ADMINISTRATION	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
MAINTENANCE	0.0	0.0	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
INSURANCE & MISC	0.0	0.0	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
DEPRECIATION	0.0	0.0	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
INT. PAID	0.0	0.0	8.7	7.8	6.8	5.9	5.0	4.1	3.2	2.3
TOTAL	0.0	0.0	56.2	55.3	54.4	53.4	52.5	51.6	50.7	49.8
* PROFIT BEF. TAX	0.0	0.0	6.5	7.4	8.3	9.3	10.2	11.1	12.0	12.9
* INCOME TAX	0.0	0.0	2.3	2.6	2.9	3.2	3.6	3.9	4.2	4.5
* PROFIT AFT. TAX	0.0	0.0	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4
* CUM. PROFIT	0.0	0.0	4.2	9.1	14.5	20.5	27.1	34.3	42.1	50.5

P R O F I T & L O S S

10**06USD								CASE-1AX
	11	12	13	14	15	16	17	
	11	12	13	14	15	16	17	SUM
* REVENUE								
ACETIC ACID	12.6	12.6	12.6	12.6	12.6	12.6	12.6	189.0
ETHYL ACETATE	21.4	21.4	21.4	21.4	21.4	21.4	21.4	321.0
BUTYL ACETATE	9.2	9.2	9.2	9.2	9.2	9.2	9.2	138.0
ACETONE	4.8	4.8	4.8	4.8	4.8	4.8	4.8	72.0
N-BUTANOL	1.7	1.7	1.7	1.7	1.7	1.7	1.7	25.5
OCTANOL	12.6	12.6	12.6	12.6	12.6	12.6	12.6	189.0
CRUDE ETHANOL	0.4	0.4	0.4	0.4	0.4	0.4	0.4	6.0
INT. RECEIVED	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	62.7	62.7	62.7	62.7	62.7	62.7	62.7	940.5
* EXPENSES								
MOLASSES	16.3	16.3	16.3	16.3	16.3	16.3	16.3	244.5
ETHANOL	6.1	6.1	6.1	6.1	6.1	6.1	6.1	91.5
ELECTRICITY	2.1	2.1	2.1	2.1	2.1	2.1	2.1	31.5
FUEL OIL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	4.5
CAT.AND CHEM	3.0	3.0	3.0	3.0	3.0	3.0	3.0	45.0
LABOR COST	0.5	0.5	0.5	0.5	0.5	0.5	0.5	7.5
ADMINISTRATION	0.5	0.5	0.5	0.5	0.5	0.5	0.5	7.5
MAINTENANCE	3.6	3.6	3.6	3.6	3.6	3.6	3.6	54.0
INSURANCE & MISC	2.4	2.4	2.4	2.4	2.4	2.4	2.4	36.0
DEPRECIATION	12.7	12.7	0.0	0.0	0.0	0.0	0.0	127.2
INT. PAID	1.4	0.5	0.0	0.0	0.0	0.0	0.0	45.6
TOTAL	48.9	48.0	34.8	34.8	34.8	34.8	34.8	694.8
* PROFIT BEF. TAX	13.8	14.7	27.9	27.9	27.9	27.9	27.9	245.7
* INCOME TAX	4.8	5.2	9.8	9.8	9.8	9.8	9.8	86.0
* PROFIT AFT. TAX	9.0	9.6	18.1	18.1	18.1	18.1	18.1	159.7
* CUM. PROFIT	59.5	69.0	87.2	105.3	123.4	141.6	159.7	

F U N D S   O U T L O O K

10**06USD — CASE-1AX

	1	2	3	4	5	6	7	8	9	10
	01	02	03	04	05	06	07	08	09	10
* CASH OUT										
INVESTMENT	37.3	89.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PLANT COST	36.0	84.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INT.DUR.CONST.	1.3	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REFUND OF LOANS	0.0	0.0	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
LONG TERM	0.0	0.0	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	37.3	89.9	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
* CASH IN										
RETAINED EARN.	0.0	0.0	17.0	17.5	18.1	18.7	19.3	19.9	20.5	21.1
PROFIT AFT TAX	0.0	0.0	4.2	4.8	5.4	6.0	6.6	7.2	7.8	8.4
DEPRECIATION	0.0	0.0	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
LOANS	26.5	64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LONG TERM	26.5	64.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL	10.8	25.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	37.3	89.9	17.0	17.5	18.1	18.7	19.3	19.9	20.5	21.1
* SURPLUS	0.0	0.0	7.8	8.4	9.0	9.6	10.2	10.8	11.4	12.0
* CUM. SURPLUS	0.0	0.0	7.8	16.3	25.3	34.9	45.1	55.9	67.3	79.3
* BALANCE OF LOANS	26.5	91.2	82.1	73.0	63.8	54.7	45.6	36.5	27.4	18.2
LONG TERM	26.5	91.2	82.1	73.0	63.8	54.7	45.6	36.5	27.4	18.2
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FUNDS OUTLOOK

10**06USD	11	12	13	14	15	16	17	CASE-1AX
	11	12	13	14	15	16	17	SUM
* CASH OUT								
INVESTMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	127.2
PLANT COST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.0
INT.DUR.CONST.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2
REFUND OF LOANS	9.1	9.1	0.0	0.0	0.0	0.0	0.0	91.2
LONG TERM	9.1	9.1	0.0	0.0	0.0	0.0	0.0	91.2
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIVIDEND	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	9.1	9.1	0.0	0.0	0.0	0.0	0.0	218.4
* CASH IN								
RETAINED EARN.	21.7	22.3	18.1	18.1	18.1	18.1	18.1	286.9
PROFIT AFT TAX	9.0	9.6	18.1	18.1	18.1	18.1	18.1	159.7
DEPRECIATION	12.7	12.7	0.0	0.0	0.0	0.0	0.0	127.2
LOANS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	91.2
LONG TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	91.2
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAPITAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.0
TOTAL	21.7	22.3	18.1	18.1	18.1	18.1	18.1	414.1
* SURPLUS	12.6	13.2	18.1	18.1	18.1	18.1	18.1	195.7
* CUM. SURPLUS	91.9	105.0	123.2	141.3	159.4	177.6	195.7	
* BALANCE OF LOANS	9.1	0.0	0.0	0.0	0.0	0.0	-0.0	
LONG TERM	9.1	0.0	0.0	0.0	0.0	0.0	-0.0	
SHORT TERM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

CASH FLOW ANALYSIS

10**06USD CASE-1AX

YEAR	INVEST- -MENT (-)	PROFIT AFTER TAX (+)	DEPREC- -IATION (+)	INTEREST PAID (+)	INTEREST DURING CONST. (+)	CASH FLOW	D.C.F.	DISCOUNT RATE
01	37.3	0.0	0.0	0.0	1.3	-36.0	-36.0	1.0000
02	89.9	0.0	0.0	0.0	5.9	-84.0	-71.7	0.8541
03	0.0	4.2	12.7	8.7	0.0	25.6	18.7	0.7295
04	0.0	4.8	12.7	7.8	0.0	25.3	15.8	0.6231
05	0.0	5.4	12.7	6.8	0.0	25.0	13.3	0.5322
06	0.0	6.0	12.7	5.9	0.0	24.7	11.2	0.4545
07	0.0	6.6	12.7	5.0	0.0	24.3	9.5	0.3882
08	0.0	7.2	12.7	4.1	0.0	24.0	8.0	0.3316
09	0.0	7.8	12.7	3.2	0.0	23.7	6.7	0.2832
10	0.0	8.4	12.7	2.3	0.0	23.4	5.7	0.2419
11	0.0	9.0	12.7	1.4	0.0	23.1	4.8	0.2066
12	0.0	9.6	12.7	0.5	0.0	22.7	4.0	0.1765
13	0.0	18.1	0.0	0.0	0.0	18.1	2.7	0.1507
14	0.0	18.1	0.0	0.0	0.0	18.1	2.3	0.1287
15	0.0	18.1	0.0	0.0	0.0	18.1	2.0	0.1100
16	0.0	18.1	0.0	0.0	0.0	18.1	1.7	0.0939
17	0.0	18.1	0.0	0.0	0.0	18.1	1.5	0.0802
SUM	127.2	159.7	127.2	45.6	7.2	212.5	-0.0	

RATE OF RETURN 17.08 %

PAYOUT PERIOD 6.65 YEAR

<APPENDIX 2>

DIARY OF THE FIELD STUDY

March	4 (Fri.)		Team leader's briefing at UNIDO Headquarters in Vienna
	6 (Mon.)	a.m.	Greeting to UNIDO SIDFA at UNIDO Jakarta Office
		p.m.	JGC Office
	7 (Tue.)		JGC Office
	8 (Wed.)	a.m.	First Meeting at Sugar Council Office
		p.m.	JGC Ofice
	10 (Fri.)		JGC Office
	11 (Sat.)	a.m.	Department of Industry
	13 (Mon.)	a.m.	Central Bureau of Statistics
		p.m.	JGC Office
	14 (Tue.)	a.m.	Second Meeting at Sugar Council Office
		p.m.	Sugar Council Office
	15 (Wed.)		Sugar Council Office
	16 (Thu.)	a.m.	Department of Agriculture
			Central Bureau of Statistics
		p.m.	Department of Industry
	17 (Fri.)		Sugar Council Office
	18 (Sat.)		Sugar Council Office
			Mr. Itami replaced Mr. Oda
	20 (Mon.)	a.m.	Department of Industry
		p.m.	Sugar Council Office
			UNIDO Jakarta Office
	21 (Tue.)		Sugar Council Office

22 (Wed.) Sugar Council Office

23 (Thu.) Sugar Council Office

24 (Fri. National Holiday) Sugar Council Office

25 (Sat.) a.m. Sugar Council Office

27 (Mon.) Sugar Council Office

28 (Tue.) a.m. P.T. Sari Sarana Kimia

p.m. P.T. Nippon Paint Indonesia Co., Ltd.

29 (Wed.) a.m. Sugar council Office

p.m. P.T. Pardic Jaya Chemicals

30 (Thu.) a.m. Indonesia Toyo Paint

31 (Fri.) a.m. P.T. Eternal Buana Chemical Industries

P.D.H.S. KOKVAN

April 1 (Sat.) Sugar Council Office

2 (Sun.) Moved to Surabaya

3 (Mon.) Sugar Research Institute at Pasuruan

4 (Tue.) P.T. Ajinomoto Indonesia at Mojokerto

5 (Wed.) P.T.P. XXIV-XXV, PG Jatiroto-Lumajang

6 (Thu.) Moved to Solo

7 (Fri.) P.T. Indo Acidatama

10 (Mpn.) Seminar at Sugar Council Office

11 (Tue.) JGC Office

12 (Wed.) JGC Office

13 (Thu.) Sugar Council

14 (Fri.) UNIDO Jakarta Office

evening Leave Jakarta

17 (Mon.) Team Leader's consultation at UNIDO Headquarters in Vienna

<APPENDIX 3>

LIST OF MATERIALS COLLECTED DURING THE FIELD STUDY

1. Statistical Yearbook of Indonesia 1987
2. -do- 1985
3. Industrial Statistics 1986 (Vol. 1, 2, and 3)
4. -do- 1984 (extract of Vol. 1, photocopy)
5. -do- 1981 (extract of Vol. 1. photocopy)
6. Foreign Trade Statistical Bulletin - Import, Oct.1988
7. Indonesia Foreign Trade Statistics - Import, 1987 (Vol. 1. and 2)
8. -do- 1984 (extract of Vol. 1. photocopy)
9. -do- 1981 (extract of Vol. 1. photocopy)
10. Foreign Trade Statistical Bulletin - Export, Oct. 1988
11. Indonesia Foreign Trade Statistics - Export, 1987 (Vol. 1 and 2)
12. National Income of Indonesia (1984 - 1987)
13. Provincial Income in Indonesia (1983 - 1986)
14. Kapasitas Nasional Terpasang Industri Alkohol/Spiritus
15. Prognosa Produksi Industri Alkohol/ Tahun 1988 dan Pencana Produksi Tah
16. Produksi Industri utamic Acid tahun 1988 dan Pencana
17. Produksi Industri Citric Acid Tahun 1988 dan Pencana Produksi Tahun 1989
18. Price and Producers for In-organic Cchemicals
19. Data Concerning Fructose
20. Aplikasi High Fructose Syrup
21. The Molasses production of the Sugar Factory in Indonesia in 1987
22. Produksi dan Pemakaian Tetes
23. Proyeksi Produksi Tetes Seluruh Pabrik Gula Reperita V
24. Proyeksi Produksi Tetes PG di Luar Jawa

25. Produksi Areal, Produksi, dan Hasil Panen Tahun 1988 - 1993

26. Analisa Tetes Typis (1986) untuk masing-masing proses adalah sebagai berikut

27. Realisas Roduksi dan Penjualan Tetes PNP/PTP

28. Rekapitulasi Produksi & Distribusi Tetes PTP Gula

29. Kapasitas Nasional Terpasang Cobang Industri Kimia Organik S/D 1991 (Alkohol/Spiritus)

30. -do- (MSG)

31. Posisi & Projeksi Supply Demand Tetes Dalam Negeri

INDUSTRIAL CHEMICALS FROM INDIGENOUS CARBOHYDRATE IN INDONESIA

EXECUTIVE SUMMARY

July 198[illegible]

JGC CORPORATION

TOKYO, JAPAN

UNIDO CONTRACT NO. 89/22/CW

(Project No. DP/INS/86/003)

INDUSTRIAL CHEMICALS FROM INDIGENOUS CARBOHYDRATE IN INDONESIA

—— EXECUTIVE SUMMARY ——

July 1989

JGC CORPORATION

TOKYO, JAPAN

INDUSTRIAL CHEMICALS FROM INDIGENOUS CARBOHYDRATE IN INDONESIA

<EXECUTIVE SUMMARY>

CONTENTS

This <EXECUTIVE SUMMARY> is prepared by combining Chapter 1. INTRODUCTION and Chapter 8. DISCUSSION AND RECOMMENDATION of the Final Report. The PREFACE of the Final Report, which describes the progress of the study, is also attached hereto as a POSTSCRIPT.

PROJECT SUMMARY

1. PRODUCT AND PRODUCTION QUANTITY

(1) Acetic Acid	15,800	ton/year
(2) Ethyl Acetate	18,700	
(3) Butyl Acetate	8,000	
(4) Acetone	8,000	
(5) n-Butanol	2,200	
(6) Octanol (2-Ethyl Hexanol)	9,600	
(7) Crude Ethanol	2,700	

2. RAW MATERIAL

(1) Molasses	250,000	ton/year
(2) Ethanol	20,000	

3. PRODUCTION CAPACITY OF MAIN PROCESS UNIT

(1) Ethanol	23,000	ton/year
(2) Acetaldehyde	35,000	
(3) Acetic Acid	20,000	
(4) Ethyl Acetate	19,000	
(5) Butyl Acetate	8,000	
(6) Acetone/Butanol	27,000	
(7) Octanol	10,000	

4. LOCATION — East Jawa

5. PLANT CONSTRUCTION COST — US$ 120 Million

6. CONSTRUCTION PERIOD — 2 Years

7. EMPLOYMENT — 200 Persons

8. ECONOMY

(1) Annual Sales Revenue	US$ 62.7	Million
(2) Internal Rate of Return (IRR)	17.1	%
(3) Payout Period	6.7	Years
(4) Cummulative Surplus Cash*	US$ 196	Million
(5) Foreign Currency Saving *	US$ 319	Million

(* in 15 years)

INTRODUCTION

The purpose of this study is to provide the Government of Indonesia with a basis for decision making on the production of industrial chemicals from indigenous carbohydrate raw material, particularly molasses.

Since Indonesia is basically an agricultural country and sugar cane is one of the country's major crops, and since Indonesia is in the process of industrializatiuon and the demand for industrial chemicals is bound to increase, it is quite reasonable for the country to consider the manufacture of industrial chemicals from sugar by-products. Molasses is the most important sugar by-product but it is not fully utilized in Indonesia and is exported to such countries as Japan, Taiwan, and South Korea mainly as a fermentation raw material.

At the start of the present study, eleven kinds of "candidate chemicals" were identified. They were : ethanol, acetone, n-butanol, acetic acid, acetic anhydride, ethyl acetate, butyl acetate, fructose, citric acid, monosodium glutamate (MSG), and L- lysine. All of the candidate chemicals can be made, theoretically, from carbohydrate raw material by fermentation, or as derivatives of fermentation products.

It cannot be said, however, that Indonesia has an advantage in the production of these chemicals by fermentation simply because Indonesia has a fermentation raw material and because these chemicals can be made by fermentation.

Some of the candidate chemicals are manufactured almost exclusively by way of fermentation and other biochemical processes worldwide. Fructose, citric acid, MSG, and L- lysine can be classified in this group and, except L- lysine, they have already been manufactured in Indonesia, and most are established as export commodities.

On the other hand, the situation is different for the rest of the candidate chemicals, namely, acetone, n-butanol, acetic acid, acetic anhydride, ethyl acetate, and butyl acetate. These organic chemicals were manufactured in the past as fermentation products or their derivatives, but nowadays the fermentation has almost completely given way to petrochemical processes because of the lower cost of the latter. Ethanol can be regarded as in between the two groups, it is made by both fermentation and petrochemical processes.

These chemicals are produced in huge scale mostly by petrochemical manufacturers in industrialized countries who dominate the world export market. The manufacturers seem to be producing these chemicals primarily for consumption in their respective domestic markets (in case of European producers, Europe is regarded as one common market), and exporting only a marginal portion of the products. It can be said, therefore, that for these manufacturers the need for making profit by product export is not very strong. They can set their export price so as to recover only variable costs of the products when necessary.

In this situation, it will not be wise for Indonesia to plan manufacture of these chemicals mainly for export. If Indonesia is to manufacture these chemicals, they will have to be targeted primarily to the domestic market of Indonesia to replace the chemicals hitherto imported.

This study is carried out with the above fundamental consideration in mind. The products to be manufactured should be those which are not produced in Indonesia, or, even if they are produced, the domestic production is not sufficient to fulfil the domestic demand. They should be made as fermentation products from molasses or their derivatives, and they should be cost-competitive with the products imported.

In this report, the economy and industry of Indonesia in general are surveyed in the first place (Chapter 2.), and an overview is made on the availability of the raw material, molasses (Chapter 3.). Then the situation in Indonesia of each candidate chemical is examined. Reference is also made to the world market of the chemicals (Chapter 4.). Against the above background, those chemicals which seem to be suitable for production in Indonesia are selected (Chapter 5.), and their production scheme is worked out (Chapter 6.). Then the economy of the project is evaluated (Chapter 7.). And, in the last part of the report (Chapter 8.), discussion is made on a number of problems which will have to be considered prior to the implementation of the project, and conceivable steps to be taken for a successful implementation of the project are recommended.

The main features of the project are summarized in the first page of this Executive Summary.

D I S C U S S I O N

As the result of the study, an idea of a sucro-based chemical complex to produce six industrial chemicals is presented. While the profitability of this complex is not very favorable, it is able to reduce dependency of Indonesia on import of the industrial chemicals and contribute to the saving of foreign currency, and is economically viable under the conditions presupposed. The products of the complex are the most basic organic chemicals, for which demands in Indonesia is bound to increase, and which can be made from molasses by fermentation, or their derivatives.

However, there can be many alternative answers other than the one presented here to the problem of manufacture of industrial chemicals from molasses in Indonesia. Before making decision on whether this project is to be implemented, more in-depth consideration will be necessary. The following is discussions on some of the problems to be considered.

The products were selected from a list of eleven "candidate chemicals". The product selected are those which are not produced in Indonesia at present, or, even if produced, the production is not sufficient to fulfil the domestic demand and, consequently, are imported by Indonesia in substantial amounts.

But there are more industrial chemicals that can be made from molasses. The complex presented itself has possibilities of further extension to make more kinds of products. For example, acetic anhydride, which was on the list of candidate chemicals but was not selected because its consumption data in Indonesia was unavailable, can be synthesized from acetaldehyde.

Therefore, the kind of products to be produced must be decided based on the situation and trend in the market of industrial chemicals in Indonesia at the time of project implementation.

The next problem relates to the production quantity. The quantities of the products to be produced were mainly determined approximately at their estimated import amounts after five years from 1988, assuming that their import increase by 5 % annually.

It may be argued that the rate of increase assumed is too small compared with the past average annual growth rate of 7 - 10 % for whole industry, or too big in view of the past growth rate of 2 - 4 % per year for the basic chemical industry.

The development of industrial chemical industry in a country generally follows that of other industries which consume industrial chemicals. Therefore, in a country like Indonesia where industrialization is in its early stage, 5% seems to be a reasonable value to be assumed as an average annual growth rate of industrial chemicals for coming five years.

Here, it must be emphasized that an assumption which is too optimistic can be dangerous since it may lead to a surplus production capacity. Since this project is aimed primarily at the replacement of chemicals hitherto imported, and the competitiveness of the products in the export market is questionable, overcapacity of the plant should be avoided. If, eventually, the products of the complex are not sufficient to fulfil their domestic demand, the shortage can be met by import.

In this regard, too, actual implementation plan must be based on a detailed observation of the market situation and trend at the time.

The third problem is the availability of raw material, molasses. In Indonesia, the MSG industry is expanding rapidly in recent years. As of 1988, the national production capacity of MSG is 111,500 tons per year and actual annual production is 59,676 tons, apparent operating ratio being about 54 %. Consumption of molasses for MSG manufacture in the same year is 240,000 tons.

If the existing production capacity is fully utilized, consumption of molasses will amount to about 448,400 tons, which is an increase by 208,400 tons from 1988. In recent years, Indonesia has been exporting 600,000 - 700,000 tons of molasses annually. In calculation, the increase in molasses consumption caused by the full utilization of the existing MSG production capacity and the expected molasses consumption of 250,000 tons by the complex presented can be supplied by the molasses presently exported.

In Indonesia, production of molasses is dispersed in many small sugar factories. And sugar factories who have their affiliated ethanol distillery are limited to those with relatively big sugar-cane crushing capacities. These facts suggest that, to use molasses produced by smaller scale sugar refineries as raw materials for modern process industries, some mechanism of molasses gathering is needed. The facts that major portion of molasses exported by Indonesia goes through the port of Surabaya, and many of MSG manufacturing factories which consume large amount of molasses are located around Surabaya, suggest that some molasses gathering mechanism has already been established in this district. Therefore, the location of the complex presented is assumed also to be in this district, though its exact site has to be decided yet.

As already mentioned, if the production capacity of MSG is to be further expanded as a projection made by the Department of Industry, almost all molasses produced in Jawa will be used up by the manufacture of one single commodity, MSG, and a keen competition in securing molasses supply among consumers (including overseas ones) will be inevitable. If this projection become reality, some measure of adjustment (including "to let the forces of the market work") will be required on the part of the Government.

To argue on the validity of the projection is not an intention of this report. But it can be pointed out that the projected rate of the build-up of the MSG production capacity seems to be too ambitious : by 62.5 % for 1988/89; by 53.5 % for 1990/91; and by 59 % for 1991/92, resulting in increase by nearly four times in four years. The operating ratio in 1992 is calculated at as high as 80 %. And average annual rate of increase in the molasses consumption for the MSG manufacture from 1988 to1992 is calculated at 38 %, whereas the average rate from 1984 to 1988 was only 14 %.

While this complex is economically viable and can contribute to the saving of foreign currency of Indonesia, its profitability is modest and not very attractive from the viewpoint of investors. However, from the viewpoint of the Government, this kind of project will have to be valued by the role it plays in laying a foundation of the sound development of organic chemical industry in Indonesia.

Recently, in Indonesia, some entrepreneurs have been entering into manufacture of organic industrial chemicals. They seem to be investing in the manufacture of specific chemicals in which easy profit can be expected immediately, without prospect for future development of the industry. As a consequence, development of organic chemical industry in Indonesia so far seems to be sporadic and lacking interlinkage.

A saying that "the biggest customer of the chemical industry is the chemical industry itself" means that interlinkage is an important feature of modern chemical industry. If the present sporadic moves of the individual investors are left as they are, a fear is felt that a sound development of chemical industry in the country may be hindered.

In this regard, the evaluation of the complex presented should be made on the complex as a whole. The portion of the complex in which the largest investment is required will be the acetone/butanol fermentation section. But if this section is omitted from the project, butyl acetate and octanol, the products which have higher value added, cannot be produced any more, and the value of this project as a foundation of the development of organic chemical industry in Indonesia will be diminished. Some people would argue that octanol and butyl acetate can be made by importing their raw material, butanol. But it is no more a molasses based chemical industry but only an addition to the sporadic development that are going on presently in Indonesia.

As the Fourth Five-year Plan of Indonesia (REPERITA IV) states, the chemical industry is a key industry to support the establishment of a strong industrial structure and accelerate national capacity to process national resources. It seems that a firm policy concerning the future structure of organic chemical industry in Indonesia is needed.

As mentioned repeatedly, the products of the complex can be made by both fermentation and petrochemical routs. Since Indonesia is an oil producing country as well as an agricultural country, there is a potentiality for Indonesia to have its petrochemical industry to make these chemicals. And, under the present price relationship between petroleum and agricultural products, petrochemical route is advantageous to fermentation in the production costs of these chemicals.

However, very huge scale is required for the petrochemical production, and demand for organic industrial chemicals in Indonesia for a foreseeable future is far smaller than the economic scale of petrochemical production. For example, world standard scale of an acetone production plant is considered to be 50,000 - 100,000 tons per year, whereas the present demand in Indonesia is less than 10,000 tons per year. In addition, the petrochemical process to make acetone presently used co-produces phenol, for which demand is also small in Indonesia. For Indonesia, to export these surplus petrochemical products will not be easy because world export market is already occupied by the products of the industrialized nations, who manufacture these chemicals mainly for their domestic consumption and export a marginal portion of their products at low prices.

In these circumstances, the alternative policies for Indonesia with regard to these industrial chemicals are as follows: (1) to continue their import and wait until the domestic demands reach the economic scale of petrochemical production; (2) to start their domestic production by fermentation at a scale to meet domestic demand; or (3) to let the sporadic development go as it is. The choice will determine the future industrial structure of Indonesia.

Another decision will have to be made concerning the use of molasses.

There can be a big problem in regard to the supply/demand balance of molasses in future as already mentioned, and the Government may have to face another choice of alternative policies: (a) to let the enormous build-up of MSG production capacity go as projected by the Department of Industry. If this is realized, all other possibility of molasses utilization will be excluded; or (b) to work out some measures for allocating molasses to various consumers to diversify the utilization of molasses. The project presented can be realized only when this alternative is chosen. And, in addition, the diversification of molasses utilization may enable the development of new molasses based industries which can be practised on the sites of the small scale sugar refiners. Which is more beneficial for Indonesia ?

Whatever alternatives be chosen, fermentation is the indispensable basic technology for the utilization of molasses as a raw material for modern chemical industries. While nobody can predict the future of the petroleum price exactly, it is certain that whereas the petroleum is an unreplenishable resource, agricultural products are replenishable. An eminent scholar once predicted the 21st century is the century of bio-technology.

Fermentation industry can be developed only on the basis of long and intensive research and development efforts. The fermentation requires a wide range of technologies such as: to search, create and maintain superior microbial strain; to culture microorganisms; and to separate and purify fermentation products, for example. It is recommended that the Indonesian Government take measures to enhance R & D capabilities of the nation in fermentation technologies systematically. In recent years Indonesia has been sending not a few young students abroad to study bio-technology. It is desired to organize capability of these people.

Fermentation industry is destined to discharge large amounts of waste water, in which many potential nutrient materials are contained. In view of the already ongoing pollution of river waters in Jawa, disposal of fermentation waste water is an urgent task for the industry. In this regard, manufacture of fertilizer practised by one of MSG producers to recycle the nutrient contained in the factory's waste water to agricultural land offers a good example. In the complex presented in this study, a waste water treatment facility using activated sludge is considered.

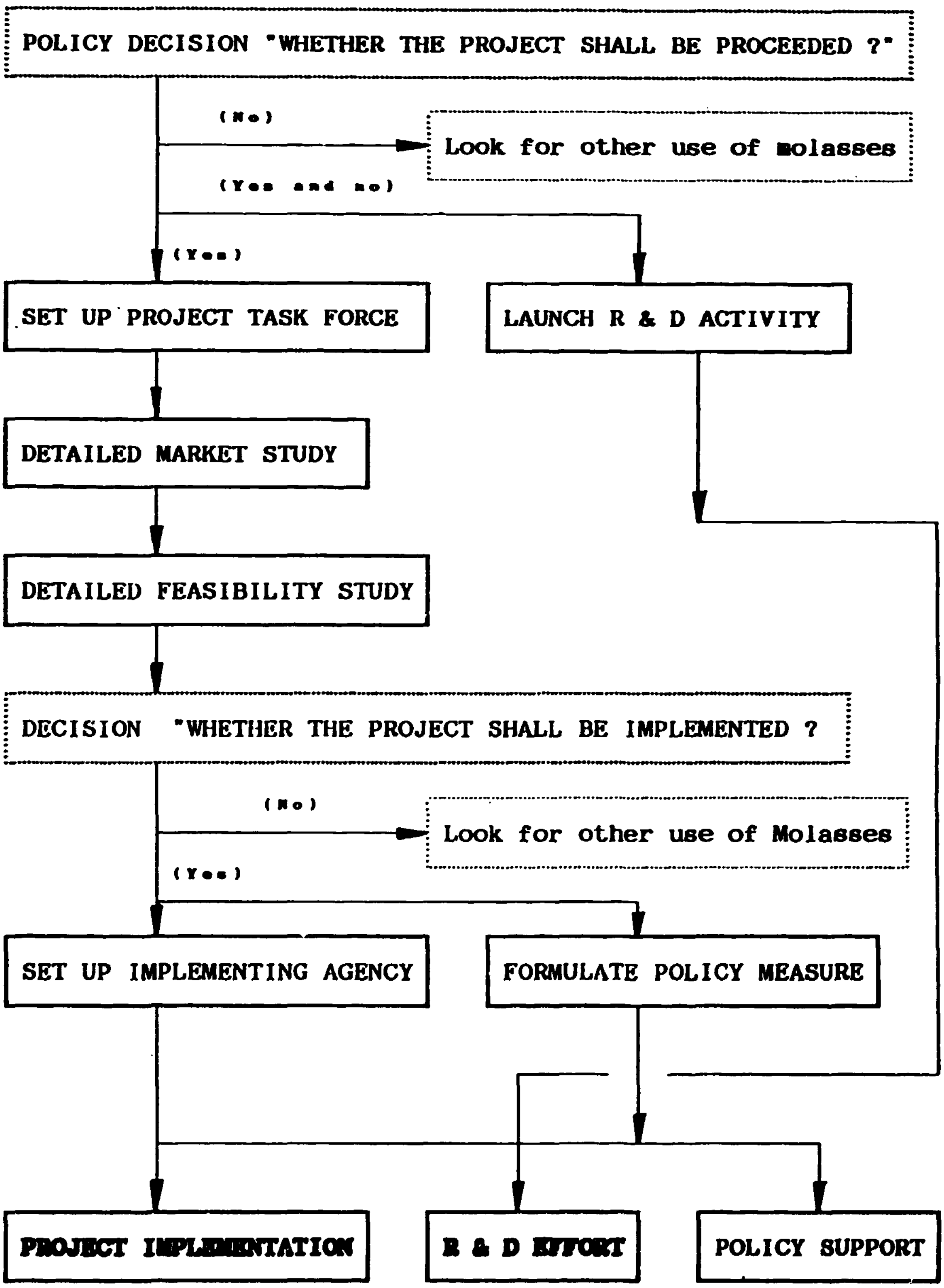
It must be emphasized again that the present study is not intended to be a feasibility study of a particular project, but a broader survey to look for possible way of molasses utilization which is beneficial to Indonesia but is not practised presently in the country. The result of the study has indicated that there is a possibility for Indonesia to develop molasses based organic chemical industries.

However, the decision on whether Indonesia shall bring this possibility into reality implies policy decisions of more fundamental nature. They are: What shall be the future structure of organic chemical industry in Indonesia ? and, What will be the beneficial way of molasses utilization for Indonesia ?

Wise decisions on the part of the Government is most desired.

Recommendable steps to be taken towards the realization of the project are summarized in the following pages.

POLICY RECOMMENDATION



STEPS TO BE TAKEN TOWARD PROJECT IMPLEMENTATION

1. Policy Decison

Clear guidelines should be established as to the future structure of organic chemical industry and future development of domestic use of molasses in Indonesia. and,

Decision should be made on whether the project is to be proceeded with or not. If Yes,

2. Project Task Force

A task force which is responsible for the promotion of the project should be set up. The task force shall undertake such activities as enumerated below to proceed with the project.

In the execution of its task the task force may cooperate with, or entrust some activities to, other organizations when necessary, and make necessary recommendations to the Government concerning policy measures reguired. The members of the task force shall preferably be selected from both Governmental and industrial organizations, and at least some of them are to be expected to form the nucleus of the implementing agency when it is set up,

3. Project Preparation

3.1. Detailed Market Study

Actual situation and trend of the consumption, import, and distribution in Indonesia of the products (six chemicals selected plus those which can be derived from them, for example, acetic anhydride, MIBK, etc.) should be studied precisely.

3.2. Feasibility Study and Project Formulation

Kinds and quantities of the products to be produced, their production scheme, plant site, and other main features of the project should be formulated based on a detailed feasibility study. According to the result of the feasibility study, a policy decision should be made as to whether the project shall be implemented or not. If Yes,

4. Institutional Preparation

4.1. Implementing Agency

An agency who is responsible for the implementation of the project should be set up. It seems to be appropriate that the agency is to be affiliated to one of P.T.P.s in East Jawa.

The management of the implementing agency should have sufficient knowledge in fermentation and organic chemical technologies and capability of production and marketing management, and, above all, creativity and entrepreneurship.

4.2. Policy Measures

The Government should take policy measures necessary to facilitate the implementation of the project, for example, project finance, protective import duty, favored taxation, etc.

5. Project Implementation

5.1. Production Facility and Man-Power

The implementing agency should take necessary steps to construct its production facility and to train its personnel who run the business.

5.2. Raw material Gathering and Product Distribution

The implementing agency should organize channels for secureing the supply of raw materials and marketing of its products. It seems to be desirable to utilize existing channels as far as possible.

6. Research and Development

If Indonesia is to use molasses as raw material for modern chemical industries, fermentation technology is indispensable. Therefore, measures should be taken to promote systematic and organized R & D efforts in fermentation. A suitable candidate site of the R & D activities will be the Sugar Research Institute at Pasuruan in view of its location, its past achievement, and its relationship with P.T.P.s. However, it seems that the Institute needs to reinforce its research staff as well as its facilities.

POSTSCRIPT

In response to the award by UNIDO of the UNIDO Contract No. 89/22/CW, "Study on Industrial Chemicals from Indigenous Carbohydrate in Indonesia", the Consultant, JGC Corporation, dispatched a field study team of three experts to Indonesia. Prior to the arrival of the team at Jakarta, Mr. Mizuho Kitamura, the team leader, visited UNIDO Headquarters in Vienna for briefing on 3 March. The field study team started its work in Indonesia on 6 March, 1989.

At the start of the field study, the study team and the Indonesian Government agreed upon eleven "Candidate Chemicals" to be studied. The initial phase of the field study consisted mostly of the analysis of published Government statistics of Indonesia. Data on the availability of molasses and information concerning the Government's policy for the development of agro-industry of Indonesia were provided to the team by the Sugar Council, Department of Agriculture. And data on production capacities and actual production records in 1988 of candidate chemicals presently produced in Indonesia were provided by the Department of Industry. In addition, the team conducted a number of interviews with private companies which handled industrial chemicals to collect supplemental information.

The data and information thus collected were such as to enable the team to make assumptions which can form a basis to fulfil the aim of the present study, whereas the detailed historical data on demand/supply of industrical chemicals which the team had originally intended to collect were unavailable. And the team could draw up a concept for a complex for the manufacture of six industrial chemicals selected by use of the data and information collected.

Then the team moved to Pasuruan, East jawa and discussed the results of the study so far performed with the Indonesian counterpart at the Sugar Research Institute there. The team also visited manufacturers of ethanol, MSG, and acetic acid and its derivatives in and around Surabaya and Solo.

In the last week of the field study, the team returned to Jakarta, and completed the Interim Report of the study. Meanwhile, the outline of the Interim Report was presented together with most of the data included in the Report at a seminar held on 10 April under the auspice of the Sugar Council. A number of questions and comments were raised by the Indonesian audience of the seminer. The basis for the home office study was also confirmed.

The field study team submitted its Interim Report on 14 April, 1989 to the S.I.D.F.A. of UNIDO in Jakarta and left Indonesia on that evening. The team leader visited UNIDO Headquarters again for consultation on 17 April and submitted the Interim Report.

In the home office, the study team re-examined the result of the field study and made necessary modification and addition. Particularly, the questions and comments raised at the seminar in Jakarta on 10 April and advice given to the team leader on the consultation at UNIDO Headquarters were taken into consideration. The Draft Final Report which incorporated the above modification and addition was submitted to UNIDO Headquarters on 16 June 1989.

The team leader visited UNIDO Headquarters on 26 June for de-briefing, on which the Draft Final Report was accepted by UNIDO on condition that some correction were to be made to complete this Final Report.

The Consultant believes that this Final Report can provide the Indonesian Government with a basis for its desision on the manufacture of industrial chemicals from the country's indigenous carbohydrate resources.

The Consultant would like to expresses its gratitude to Governmental and private organizations of Indonesia for their assistance and also to S.I.D.F.A., UNIDO in Jakarta for his kind guidance and support, which enabled the field study team to accomplish its task in the field. Thanks are also due to the staff of UNIDO Headquarters whose guidance and advice were invaluable for the completion of this study.

July 1989
JGC Corporation