THE FEASIBILITY STUDY ON THE DEVELOPMENT OF SUGARCANE MOLASSES FERMENTATION INDUSTRY IN THE REPUBLIC OF INDONESIA

JULY, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Development of Sugarcane Molasses Fermentation Industry and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a survey team headed by Mr. Atsushi NISHIMURA from November 28 to December 25, 1982.

The team exchanged views with the officials concerned of the Government of Indonesia and conducted a field survey in Situbondo, Kediri and Pekalongan at eastern and central Java. After the team returned to Japan, further studies were made and the present report has been prepared.

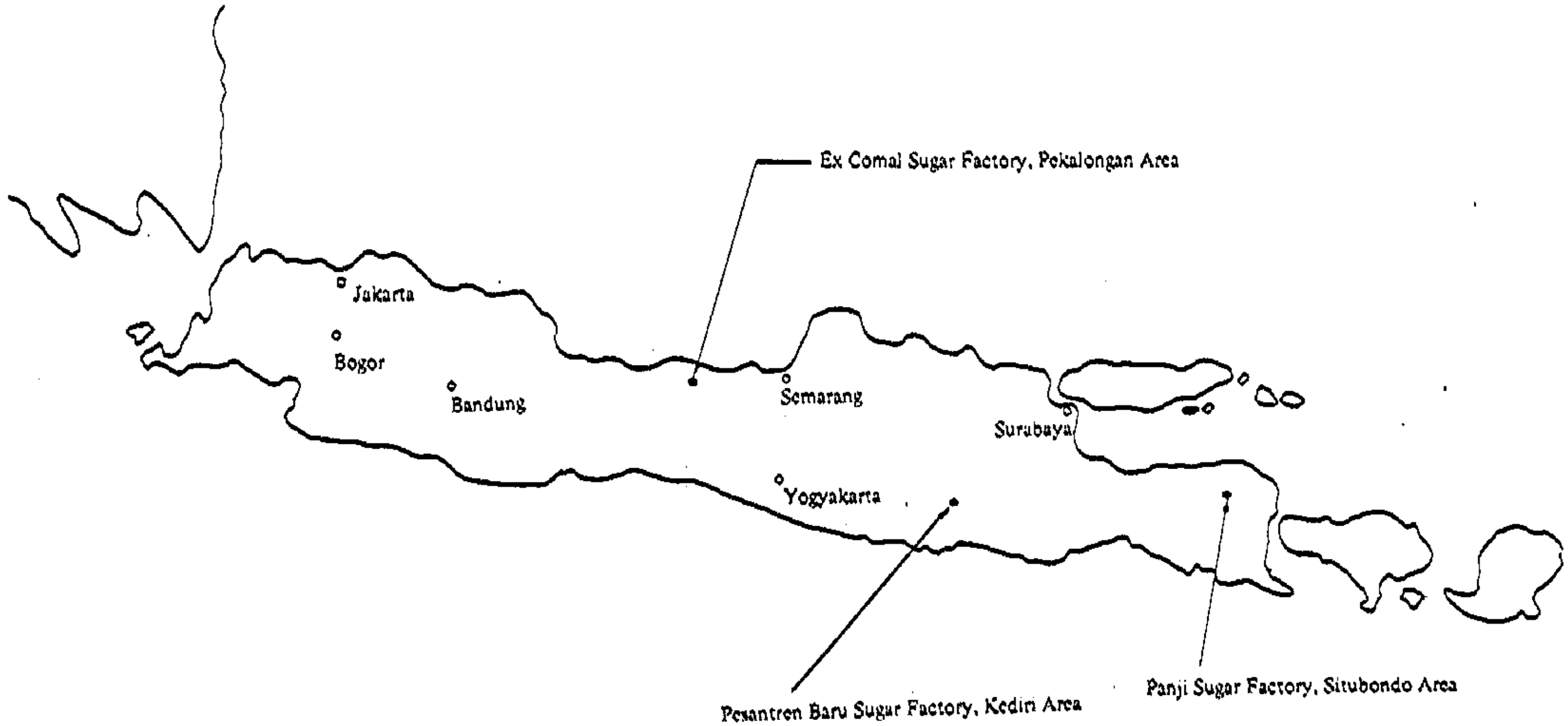
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

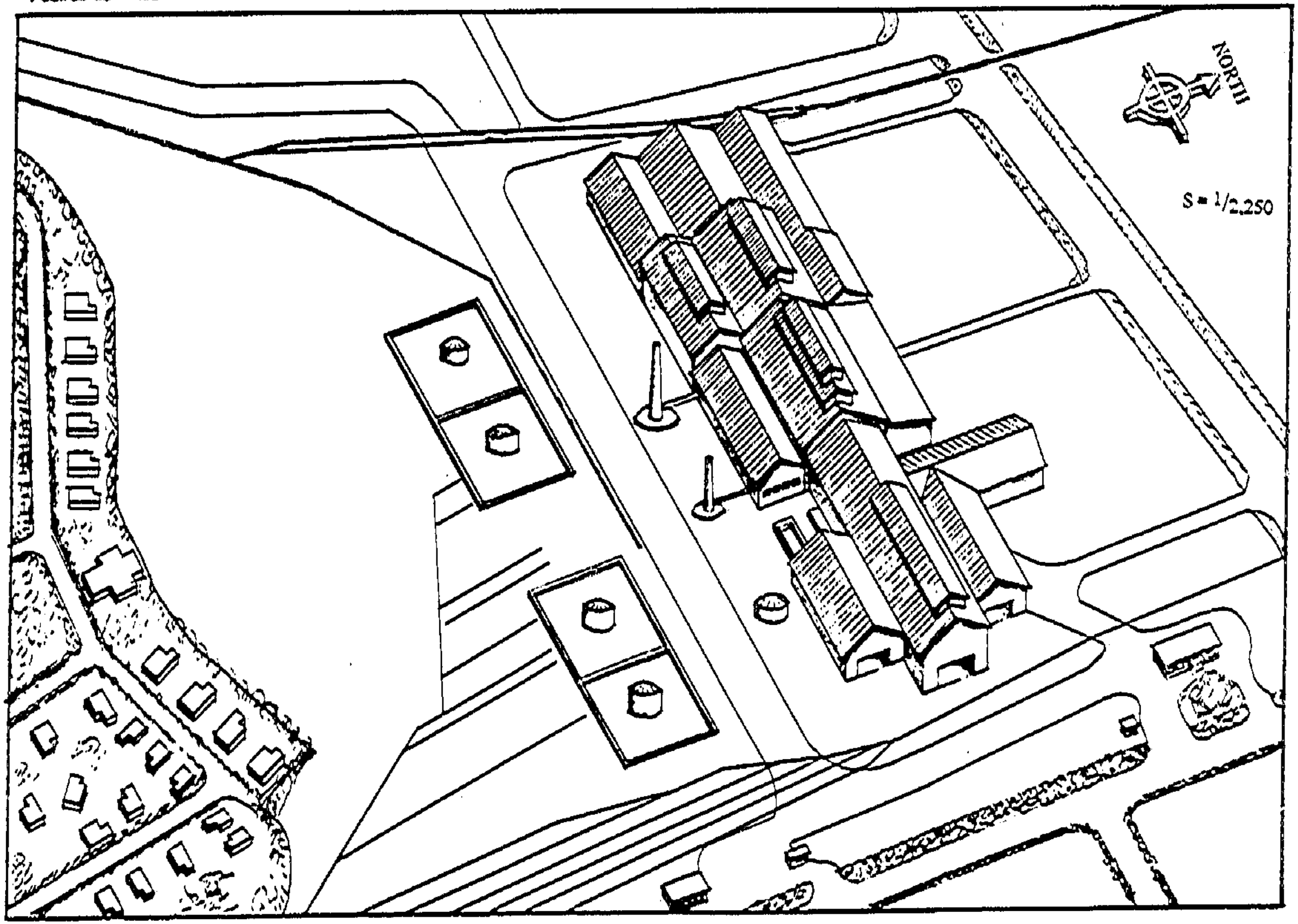
Tokyo, July, 1983

Keisuke Arita
President
Japan International Cooperation Agency

THREE CANDIDATE SITE IN JAVA ISLAND



AERIAL VIEW



In this report the following currency exchange rates are used:

US$1 = ¥240 = Rp.695

The rates are that of before devaluation at the end of March 1983.

ABBREVIATION

BKPM	Badan Koordinasi Penanaman Modal
BOD	Biological oxygen demand
BP_3G	Balai Penyelidikan Perusahaan Perkebunan Gula
BULOG	Badan Urusan Logistic
ha	hectar
KVA	Kilo volt ampere
km	Kilometer
kg	Kilogram
kl	Kiloliter
KAPB	Kantor Administrasi & Pemasaran Bersama
Lichit	Published document by F. O. Lichit GmbH
lb	pound
mm	milimeter
PTP	PT Perkebunan
Rp	Rupiah
SBPN	Staf Bina Perusahaan Negara Sektor Pertanian
sec.	second
TCD	ton cane per day
US$	US Dollar
Y	Japanese yen
USRT	US Refrigeration Ton

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SUMMARY, CONCLUSION & RECOMMENDATION

SUMMARY

I. Preface

1. Background and Objectives

The Government of Replublic of Indonesia is implementing production increase policies to become self-supporting on sugar, and as the result of this effort, the production of cane molasses, a byproduct of the sugar production, will increase to a million tons in 1986 from the current level of half million tons a year.

Since the price of cane molasses greatly fluctuates affected by the international market prices, the Indonesian government thought it essential that the cane molasses is converted to products of high added values by employing a fermentation industry, and requested the Japanese government a feasibility study to plan an industry development for utilization of sugar production byproducts.

Upon receipt of this request, Japan International Cooperation Agency (JICA) dispatched a preliminary survey mission to Indonesia for 11 days from August 31, 1982, and the mission and Indonesian government concluded and signed a "Scope of Work (S/W). This report describes the results of field researches conducted for about a month from November 28, 1982 in accordance with the S/W and results of further studies made in Japan afterward.

2. Scope of the Study

The field research mission was to select a site for plant construction out of the following three proposed sites and to select up to five products out of the proposed seven proposed products, as well as reviewing the feasibility of industrialization on each item.

Proposed plant sites

Panji Sugar Factory, in Situbondo area, eastern Java
Pesantren Baru Sugar Factory, in Kediri area, eastern Java
Ex Comal Sugar Factory, in Pekalongan area, central Java

Proposed products

- Ethyl alcohol (Ethanol)
- Mono Sodium Glutamate (MSG)
- Yeast
- L-Lysine
- Antibiotics
- Citric acid
- Acetic acid and vinegar

II. Sugar Industry in Indonesia

1. Outline of World Sugar Industry

The sugar demand is not growing in the world scale. The estimated stock from 1982 to 1983 is 36 million tons indicating apparent state of overstock. By the countries, India ranks at the top by producing 8.51 million tons a year, and South Africa is at the 10th by producing 2.18 million tons.

2. Sugar Production and Price in Indonesia

	Production (Million tons)	Consumption (Million tons)	Import (Million tons)
1981	1.30	1.80	0.50
1984 (schedule)	2.22	2.21	–
1989 (schedule)	3.26	3.15	–

At present, there are 51 sugar factories belonging to PTP and 9 sugar factories of private enterprise. Most of them are located in the Java Island, with only 3 factories located in other than Java. Majority of these factories are small in the scale and the productivity is low with the number of operation days ranging from 80 to 190 days a year.

BULOG, governmental agency, solely operates on sugar management, storage, distribution and price determination, and sugar itself is owned by Bank Bumi Daya.

The price structure of sugar as of December, 1982 is as follows.

Ex-factory price	35,000 Rp/100 kg
Distributor purchase price	46,000 Rp/100 kg
End user market price	50,000 Rp/100 kg

At a sugar factory in the eastern Java, the cost was about 38,000 Rp/100 kg. This high cost is attributable to the high purchase price of sugar cane and low productivity.

The trend of ex-factory prices is shown below.

May, 1974	7,599.8 Rp/100 kg
Nov. 1974	9,088 Rp/100 kg
Nov. 1975	10,907.7 Rp/100 kg
May, 1977	13,434 Rp/100 kg
May, 1978	15,557 Rp/100 kg
June, 1979	18,794.8 Rp/100 kg
May, 1980	22,553.7 Rp/100 kg
Oct. 1980	30,705.6 Rp/100 kg
Apr. 1981	35,000 Rp/100 kg

3. Molasses Situation in Indonesia

Generally, the yield of sugar from sugarcane is 9 – 11%, and cane molasses 3.5 – 4.5%. The Indonesian cane molasses is good in the quality on the sugar contents, but has a defect of high ash contents. Higher ash contents cause troubles like scaling to the equipment in the fermentation process, and such cane molasses is not prefereable as the material for fermentation industry.

Being influenced by the international market prices, the cane molasses prices fluctuated largely as shown below.

1977	15,200 Rp/ton
1978, first half	16,500 Rp/ton
second half	24,750 Rp/ton
1979, first half	30,950 Rp/ton
second half	36,100 Rp/ton

1980, first half	58,200 Rp/ton
second half	71,900 Rp/ton (≒ US$120)
1981, first half	50,000 Rp/ton
second half	50,000 Rp/ton
1982, August	20,000 Rp/ton

In the world scale, 30 to 34 million tons of molasses are produced yearly, out of which 10 million tons are from beet. 6 to 7 million tons of cane molasses are produced in each area of Asia, north, central and south Americas, and cane molasses production in Indonesia occupies less than 10% of the Asian production.

In Europe and America, molasses is used mainly as animal feed. In the South America, it is used mainly as the raw material for ethanol fermention and in Asia raw material for fermentation. The molasses demand in Asian countries can be broken down as follows.

Japan	800,000 tons/year
Korea	400,000 tons/year
Formosa	100,000 tons/year

Molasses producing Asian countries are severely competing each other on export to these countries.

III. Markets of Molasses Fermentation Products in Indonesia

1. Scope from Molasses Consumption (1980)

Production, domestic consumption and export of cane molasses in 1980 are as shown below.

Cane molasses production 380,000 tons	Domestic consumption	275,000 tons
	Breakdown	
	Ethanol	135,000 tons
	MSG	123,000 tons
	Yeast & Pellet	17,000 tons
	Export	105,000 tons

2. Ethanol

There are 13 ethanol fermentation plants, out of which 3 belong to PTP. While old plants using conventional technologies are not efficient with the unit consumption of cane molasses being 4 against ethanol, the unit consumption of the plant which was constructed based on the latest Austrian technologies is as low as 3.36. The ethanol production capacity of the whole of Indonesia is 194.5 Kℓ/day. With this capacity, 58,000 Kℓ can be produced if the number of operation days is 300 per year, but the actual production is around 26,100 Kℓ.

The "Gasohol Programme" is being reviewed as a project to increase domestic consumption of ehtanol. At present, the total consumption of petroleum products is Indonesia is 22 million Kℓ (7 – 10% of Japan's consumption), out of which 7.2 million Kℓ are used for transportation fuel, and 3.7 million Kℓ or about half of it is gasoline. If ethanol is mixed in the quantity of 10% of the gasoline, it creates ethanol consumption of 0.37 million Kℓ, which is equivalent to consumption of 1.2 million tons of cane molasses.

At present, ethanol is mainly used in the domestic industries and the competition with the recovered methanol from the textile industry is very keen. If the Gasohol Programme is promoted as the governmental policies, development of the ethanol industry using cane molasses is possible. Since we adopt the immobilized yeast method for the ethanol production, the new plant will be able to produce ethanol more economically than the current method because of the higher efficiency and less amount of investment.

3. Glutamic Acid (GA) and Mono Sodium Glutamate (MSG)

In Indonesia, there are 3 integrators, which vertically produce GA and MSG from cane molasses, and 6 converters which produces MSG only out of GA purchased from outside sources, and 2 more companies are constructing GA plants. The GA production capacity of the 3 integrators is 36,000 tons/year, and if it is added with the capacity of the 2 plants being constructed, the annual production capacity is 45,000 tons, which is equivalent to 54,000 tons when converted to MSG. On the other hand, the MSG domestic consumption in 1981 is estimated to be 30,000 – 35,000 tons, or the production capacity is far greater than the consumption. To increase the domestic MSG consumption, the food processing industry must be developed. Trying to sell GA or MSG in the export market is not too easy since competition with neighboring countries, especially with China, is very keen.

4. Bakery Yeast

Indonesia is annually importing 1,500 to 2,000 tons of active dry yeast from France and other countries and this amounts to US$2 million. There is a domestic yeast producer, PT Indo Fermex, who mainly produces compressed yeast. While the people's eating habits of relying on rice mainly cannot be changed all of sudden, there is a trend of shift to bread eating in urban areas, and for the future, self-supply of bakery yeast must be reviewed.

5. Feed Yeast

The number of farm animals is increasing, and as the result, the production of compound feed is increasing. There are 32 compound feed producers and 7 of them are large scale producers. The statistics indicate that in 1980, about 600,000 tons (or equivalent to 60,000 million Rp) of compound feed were produced in the eastern Java, and about 3 million tons in the whole country. For the protein source, which is the most important part of the feed, Indonesia depends on imported soybean meal and fish meal, and it is possible to replace these protein sources with the feed yeasts for animal produced from cane molasses through the fermentation process.

It is said that PT Sumber Protein is already producing 200 tons of feed yeast monthly, which contain 48% of crude protein and 5 – 6% of moisture, selling for 250 – 280 Rp/kg.

If feed yeast is mixed in the quantity of 3% of the 3 million tons of compound feed, it can amount to 90,000 tons, consuming 360,000 tons of cane molasses. Accordingly, production of feed yeast for animal is very pormising as an effective use of cane molasses, provided that technical services on how to use the compound feed can be given, the overall develops to the extent of a fair size market is established and that the production does not require any excessively large cost that is unforeseeable at this moment.

6. Antibiotics (Corynecin)

Indonesia imported medicines in the amount of US$600 million in 1980, including the following antibiotics.

Penicillin	62 tons	US$5,400,000
Streptomycin	29 tons	US$1,500,000
Tetracycline	182 tons	US$6,400,000
Chloramphenicol	99 tons	US$4,900,000
Others	396 tons	US$22,800,000
Total	768 tons	US$41,200,000

Generally, materials for medicines must be made from very pure raw materials, and there is no example of producing antibiotics from cane molasses, with an exception of Corynecin which can be easily converted to Chloramphenicol.

The Indoneisan government is making an effort to realize that the people receive advanced medical treatment by 2000 A.D. and it is studying domestic production of antibiotics. Although the fermentation process of Corynecin requires more advanced technologies than those of ethanol and feed yeast and many problems may be anticipated, we believe that Corynecin production is one that has to be pursued as it goes along the national policy.

7. Citric Acid

There are 6 producers of citric acid in Indonesia and they use cassava as the raw material and employes the surface culture process. The product is supplied mainly in the form of Ca-citrate. The total consumption is estimated to be about 2,000 tons, which is not a large quantity.

In the world scale, citric acid is produced in the quantity to 350,000 -- 400,000 tons a year out of molasses or glucose through the fermentation process.

8. Acetic Acid and Vinegar

The most superior method of acetic acid production is the petrochemical process. Also, while vinegar can be produced by oxidization of ethanol, the market is extremely small. Imported quantities of these in 1981 are shown below.

Acetic acid	4,000 tons	US$3,000,000
Vinegar	400 tons	US$130,000

9. Resume

Based on the market researches of products utilizing the sugar production by-products in Indonesia, the conclusion can be made that fermentation industries of ethanol, feed yeast for animal and Corynecin are promising.

IV. Basic Design of Fermentation Plant

1. Selection of the Site

The Ex Comal Sugar Factory in Pekalongan area in the central Java was selected as the appropriate site. The selection was determined based on various standards such as industrial water, raw material, fuel, transportation, site and waste water treatment. Water is especially important to the fermentation industry, and in the Ex Comal Factory, 500 ℓ/sec., that is 43,200 m^3/day, of water can be taken from the Comal river. Additionally, the existing building in the Ex Comal factory is good and the site condition and environmental of the factory are favorable.

2. Production Capacity

The scheduled increase of cane molasses of PTP 15/16, which controls the central Java sugar factories, is about 47,000 tons as shown below.

1981 production	91,968 tons
1984 production	139,154 tons
Production increase	47,186 tons

We planned a plant capacity to consume this annual production increase.

Ethanol	10,000 Kℓ (33,000 tons of cane molasses)
Feed yeast	3,300 tons (13,200 tons of cane molasses)
Corynecin	19 tons (2,200 tons of cane molasses)

This plant capacity is appropriate also from the viewpoint of the industrial water availability.

3. Production Quantity and Unit Consumption

	Ethanol	Feed Yeast	Corynecin
Plant capacity	30 Kℓ/day	10 tons/day	56 kg/day 112 kg/batch
Cane molasses consumption	99 tons/day	40 tons/day	13 tons/batch
Product specification	95 V/V%	Water content up to 10%	98% purity, powder
Manufacture process	Immobilized yeast	Batch process drum dryer	Batch process butanol extraction
Operation hours	24 h/day	24 h/day	24 h/day
No. of operation days	336 days/year	336 days/year	336 days/year
Production	10,080 Kℓ	3,360 tons	18.8 tons
Unit consumption			
Cane molasses	3.3 tons/Kℓ	4.0 tons/ton	111.3 tons/ton
Electricity	148 KWH/Kℓ	$4{,}332 \times 10^3$ KWH/ton	400×10^3 KWH/ton
Steam	2.89 tons/Kℓ	18.88×10^3 tons/ton	1.625×10^3 tons/ton

Corynecin is converted to Chloramphenicol by having it reacted to dichlor methyl acetate in methanol. The yield that is obtained generally is 725 kg Chloramphenicol out of 500 kg Corynecin.

4. Waste Water Treatment

The effective method to treat waste water from the fermentation plant is to separate it to high concentration fraction and low concentration fraction. The former is evaporated and mixed with excess bagasse for utilization as fertilizer or soil conditioner. The latter is diluted with water down to the level of regulation value and discharged into a drainage.

The summaries of these processes are as shown below.

i) High concentration fraction

600 Kℓ/day
↓
Condensed solution 102 Kℓ/day (Solid content 45%)
↓
Bagasse 300 tons + Urea 0.65 tons
↓
3-month aging
↓
Fertilizer 319 tons/day

ii) Low concentration fraction

BOD 1.2 tons/day
↓
Cooling water 42,000 m^3/day
↓
BOD 30 ppm or below
↓
Discharged into drainage

As a utilization method of bagasse, we describe cultivation of pleuroteus cystisus using a compost in which bagasse is mixed with lime cake and rice bran.

5. Utilities Requirement and Its Capacity

The table below summarizes the utilities and facility capacities to treat the fermentation plant waste water.

	Utilities requirement	Facility capacity
Steam (ton/h)	39.1	50
Electricity (KWH/h)	3,055	4,120
River water (m^3/day)	43,200	43,200
Well water (m^3/day)	125	150
Air (Nm^3/h)	25,500	26,000
Chilled water (USRT)	1,038	1,200

6. Economical Investigation of Basic Design

We analyzed the financial situation of the plan of producing three items of ethanol, feed yeast and Corynecin but determined that there would be no possibility of industrializing the feed yeast and Corynecin since these required huge amounts of energy expenses making the cost extremely high. The results of financial analysis on ethanol and Corynecin (excluding feed yeast) indicate a good possibility of industrializing the two items. Accordingly, this report mainly describes the two items. The results of financial analyses are summarized in the table below. The reference data on feed yeast is given in the Appendix.

	3-item production plan Ethanol 30 Kℓ/day Fodder yeast 10 tons/day Corynecin 56 kg/day	2-item production plan Ethanol 45 Kℓ/day Corynecin 56 kg/day
Capital investment	17,600 million Rp	12,500 million Rp
ROI after tax	-10.33%	13.37%
Remarks	Unable to recover the investment even in 15 years.	Industrialization is possible.

7. Sugar Recovery from Cane Molasses

Sugar recovery from molasses using the column chromatography is being mainly applied to beet molasses, and there is only one successful example of industrializing sugar recovery from cane molasses according to the information obtained from FINNSUGAR ENGINEERING. There is another recovery method of methanol precipitation, but the process has not been applied in the industry scale.

V. Plant Facility Design

1. Production Facilities

The major facilities are shown below.

Ethanol production facilities

1st column	75 m^3 x 1, coil 50 m^2
2nd column	40 m^3 x 1, coil 25 m^2
Holding tank	120 m^3 C.S.
Mash column	25 stages, ϕ2,000
Conc column	50 stages
Ethanol storage tank	1,000 m^3 x 1

Corynecin production equipment

Make up tank	20 m^3 x 1
Seed tank	2 m^3 x 1, 10 m^3 x 1
Fermenter	80 m^3 x 3
Broth tank	80 m^3 x 1
Balance tank	10 m^3 x 1

2. Raw Material and Utility Facilities

Cane molasses storage	1,000 m^3 x 1
Heavy oil tank	1,000 m^3 x 1
Cane molasses makeup tank	1,000 m^3 x 2
Boiler	2-shell reflection type
Air compressor	2-stage turbo type 25,000 Nm^3/h, 2 kg/cm^2

3. Waste Water Treatment Facilities

High concentration fraction storage	500 m^3, made of concrete
Evaporator	30 t/h, plate type, triple effect
Condensed solution storage	1,000 m^3 x 1

4. Auxiliary Facilities

Micro organism handling, analysis, electrical, communication and sanitation facilities.

5. Plant Layout

This plant is to be built in the existing sugar factory.

VI. Schedule for Plant Construction and Operation

1. Plant Construction Plan

The fermentation plant, including the outdoor tanks, will be constructed in the area of 23,000 m^2 (with the existing building as its center) in the total plant site of 376,550 m^2.

All civil engineering and construction conditions, and various conditions for inland transportation, storage, installation and test operation of imported machinery and equipment are clearly described.

The training and education will be conducted in the following steps.

1) Dispatch of supervisors at the construction stage

2) Dispatch of supervisors and managers to the construction site by the general contractor

3) Dispatch of supervisors at the test operation stage

4) Training of techniques and operation methods by the general contractor

5) On the job training by supervisors

6) Training of engineers and foremen and above in Japan

2. Plant Operation

The total number of employees will be 200. A general manager controls them in a two-department system of Production Department and Administration Department. The work system is on three shift for 336-day operation a year. A stock for 1 to 1.5 month operation will be carried on each of the necessary materials.

3. Construction and Test Operation Schedules

The plant construction will be completed in one year and 5 months after the construction start. After the completion, the plant will have one month of test operation and 1.5-month performance test.

Utility Requirements for 2-item Production

	Utility requirement	Facility capacity
Steam	25.5 tons/h	35 tons/h
Electricity	1,358 KWH/h	2,500 KWH/h
River water	24,600 m^3/day	36,000 m^3/day
Well water	87 m^3/day	120 m^3/day
Air	3,520 Nm^3/h	4,000 Nm^3/h
Chilled water	334 USRT	400 USRT

VII. Required Investment and Fund Plan

1. Basic Conditions of Estimation

1) Currency exchange rate — US$1 = ¥240 = Rp 695

2) Estimation period and price — Prices as of January, 1983

3) Price escalation

Foreign currency portion	5%
Local currency portion	10%

2. Investment (up to March, 1986)

The price escalation is applied to the project cost based on the prices of January, 1983 and in accordance with the project schedule. As the result, the investment required up to

March, 1986 at which time the operation start is scheduled, is as shown below.

Necessary investment

Foreign currency	¥3,596,176,000	(Rp 10,211,217,000)
Local currency		Rp 2,268,159,000
Total		Rp 12,479,367,000

(The interest on loans during the construction is not calculated in.)

3. Fund Procurement Plan

Owned capital	Rp 4,450,000,000	(35%)
Loang-term loans	Rp 8,474,905,000	(65%)
Total	Rp 12,924,905,000	(100%)

VIII. Financial Analysis

1. General Conditions for Financial Analysis

1) Price escalation is to be applied up to March, 1986 at a rate of 5% per annum on imported items and 10% per annum on domesite items. The prices will be fixed after the operation start of April, 1986.

2) Project life 15 years

2. Specific Conditions for Financial Calculations of the Basic Design

1) Production and Sale

	Ethanol	Corynecin
Annual Production	15,120 Kℓ	18,816 kg

2) Operation

Apr. '86 – Mar. '87	80%	70%
Apr. '87 – Mar. '88	90%	85%
Apr. '88 – Mar. 2000	100%	100%
Sales price	Rp361,220/Kℓ	Rp 32,521,000/ton

3. Variable Costs

The variable costs of ethanol (per 1 Kℓ) and Corynecin (per 1 kg) are as follows.

Ethanol	Rp 130,606/Kℓ
Corynecin	Rp 34,140,163/ton

4. Fixed Cost

1) Depreciation

The numbers of years applied for depreciation are as follows.

Machinery & equipment/contingency	8 years
Buildings and structures	20 years
Expenses before operation start, interest during construction & others	5 years

2) Maintenance and repair expenses

Machinery & equipment/contingency	3%
Buildings and structures	2%

3) The fire insurance premium is 1% of the purchase price of the tangible asset.

4) Annual personnel expenses (200 people) About Rp 366,900,000

5) Long-term borrowing

Loan conditions

Grace period	4 years
Repayment period	10 years (after grace period)
Interest rate (per annum)	13.5%
Repayment	Twice a year

5. Tax and Dividend

1) Tax — Tax rate 45%

2) Dividend — Rate 15%

6. Result of the Financial Analysis

1) Manufacturing cost

The maximum and minimum manufacturing costs of 1 Kℓ ethanol and 1 ton Corynecin are as follows.

Ethanol (Kℓ)	Rp 230,100 – 165,900
Corynecin (ton)	Rp 121,551,700 – 61,669,000

The ethanol manufacturing cost is much lower than the sales price and the profitability here is high. However, the Corynecin manufacturing cost is higher than the sales price, and Corynecin production alone cannot make profit.

2) Loss/Profit calculation and Fund flow

This project has a high profitability since the high profit on ethanol can cover the loss on Corynecin. Shortage of fund is not anticipated during the 15 year project life and the sales profit rate is favorable.

3) Internal Rate of Return (IRR)

The internal rate of return of this project is as shown below.

ROI before tax	15.5%
ROI after tax	13.37%
ROE after tax	11.42%

If ethanol can be sold as planned by this project, this project is very feasible from the above analysis also.

IX. Economic Evaluation

1. Economic Internal Rate of Return (ERR)

The economic internal rate of return of this project is as follows.

ERR	23.44%

This project is feasible from the standpoint of the national economy.

2. Economical Effect and Significance

1) Ethanol

The characteristic point of the ethanol production described in this report is its superiority in the unit consumption of the cane molasses. Supposing that 15,000 Kℓ of ethanol is produced a year, the saving of cane molasses will amount to as much as 10,000 tons, when compared with the conventional process.

Also, if the ethanol thus produced is used to replace the gasoline, the consumption of gasoline being imported can be reduced by about 300,000 Kℓ, or US$120 million, per year.

2) Corynecin

No profit can be expected based on the financial analysis of the Corynecin production, but if it is produced in the form of being benefited by the profit of ethanol production, it becomes the first antibiotics produced in Indonesia from the stage of the starting material up to the end product, and its technical meaning is great.

In 1981, Indonesia imported Chloramphenicol amounting to about US$5 million. Since domestic production of Corynecin can reduce the foreign currency expenditure for import, the significance of domestically producing Corynecin to the national economy is great.

CONCLUSION

To summarize the study results, we can conclude on the feasibility of this project as follows.

1. Plant Site

The three sites proposed in the Scope of Work are in the same conditions on the availability of the cane molasses, the main raw material of this project.

However, in consideration of the quantity of the water that is available, which is essential for the fermentation industry, we selected Ex Comal under the control of PTP 15/16 in Pekalongan area of central Java as the optimum plant site.

2. Fermentation Product Out of Cane Molasses

As the results of thorough investigation and analysis of the market situation and future potential on the 7 products proposed in the Scope of Work, we consider it preferable that Indonesia must study the industrialization of ethanol, Corynecin (antibiotic) and feed yeast. However, for the time being, the project is to be limited to a fermentation complex of model type producing only ethanol and Corynecin in consideration of the investment amount and profitability.

3. Ethanol as an Alternative Energy

Ethanol can be produced most simply by fermentation process of cane molasses, and the profitability is good even at the cane molasses price of Rp 20,000/ton. However, since the market of industrial alcohol is very limited at present, large demand of ethanol would open the market when the government has established the alternative energy policy for use of ethanol mixing with gasoline or diesel oil.

4. Internal Rate of Return of This Project

If the conditions in the preceding clause are satisfied, the investment for the fermentation complex to produce 45 Kℓ/day ethanol (15,000 Kℓ per year) and 56 kg/day Corynecin (19 tons per year), including waste water treatment facility, will amount to Rp 12,500 million. The ROI after tax is 13.37%, and the project is quite feasible from the financial analysis viewpoint.

RECOMMENDATION

1. If the system that allows ethanol be utilized in Indonesia as alternative energy, this project can be regarded feasible from the financial viewpoint. Therefore, various actions such as the preparation of bid specification must be proceeded by determining the contractor.

2. SBPN or PTP should have contact to Ministry of Health or CHIMIAFARM (National drug manufacturer) for further processing of Corynecin to Chloramphenicol.

3. It is recommended that a national institute for fermentation technology is to be established to develop the basic technology for the fermentation industry. The purpose of such institute are, firstly, to strengthen the fundamental activity on fermentation research and, secondly, to cultivate the technical service functions for marketing and how to use technology of the product. For PTP, which manages the sugar production and sales like a private company, it is essential that some fixed percentage of the sales amount is directed for such research purpose so as to raise the added value of their own molasses through fermentation.

4. Cane Molasses price

   The cane molasses is divided into the sugar factory and the farmer who delivered the sugarcane at a rate of 50 : 50 approximately, and the cane molasses in the farmers possession is bought back by the sugar factory at Rp 65,000/ton. This purchasing price was set in the latter part of 1980 when molasses price went up to an extremely high level of Rp 71,900/ton, and it is very high comparing with the domestic price is Rp 20,000/ton and export price is US$22.0 at the end of 1982.

   It is true that some incentives will be required to the cane farmers but to stick to this abnormally high price of about 3 times as much as the actual, would endanger the PTP management. It is hoped that the price arrangement should be made to be more realistically.

5. Although this has no direct relation with the fermentation complex plan, we must comment that the processing capacity of existing sugar factory is too small. It is generally said that minimum economical capacity of sugar factory is 3,000 tons cane crushing per

day. Out of the total 60 sugar factories in Indonesia, 45 factories have a capacity less than 2,000 tons a day. This essentially restricts the economy of the manufacturing cost. Since the transportation means have advanced so much, we recommend that the effort will be made to gather small factories unless there is no problem in collecting the sugarcane. This is an approach to rationalize the production system both sugar and molasses.

ABSTRACT OF SUMMARY

1. Cane Molasses

Good availability, production increase. (Unit: ton)

'76	'80	'82	'84	'86	'88
313,000	491,000	588,000	800,000	1,032,000	1,140,000

2. Consumption Pattern of Molasses

Production 380,000 ton →	Domestic consumption	275,000 ton
	for ethanol	135,000 ton
	for MSG	123,000 ton
	for yeast etc	17,000 ton
	Export	105,000 ton

Dependency on export increase, if domestic consumption not increase.

- → price fluctuate by international market
- → price competetion with Asian countries

3. Present Market for Fermentation Product and Recommendable Item

Item	Ethanol	MSG	Bakery yeast	Feed yeast	Antibiotic	Citric acid	L-lysine	Acetic acid
Production capacity	57,450 Kℓ	54,000 ton	Very small	Very small	–	2,000 ton	–	–
Import quantity	–	GA 2,000 ton	1,500–2,000 ton	–	US$42 million	500 ton	–	4,000 ton
Market size	26,000 Kℓ	30,000 ton	US$2 million	Soybean meal Fish meal	Import only	2,000 ton	–	4,000 ton
Market potential and Future prospect	Transport fuel 7,200,000 kℓ Gasoline 3,700,000 Kℓ 10% blending 370,000 Kℓ	Excess production capacity against to demands	Food intake custom Cold chain distribution	Farm animal increase Compound feed 3,000,000 ton 3% blending 90,000 ton	Advanced medical care along WHO recommendation Chloramphenicol US$5 million	Small market	Premature on market	Not fermentation

Note: investment include waste water treatment facility

4. Investment and Profitability of Project

		Investment	ROI after tax
3 item	Ethanol 30 Kℓ/day Feed yeast 10 ton/day Corynecin 56 kg/day	17,600 million Rp	-10.33%
2 item	Ethanol 45 Kℓ/day Corynecin 56 kg/day	12,500 million Rp	13.37%

5. Profitability of Each Product

	Ethanol	Corynecin	Feed yeast
Variable cost	130,600 Rp/Kℓ	34,140,163 Rp/ton	416,858 Rp/ton
(Molasses (Fuel	89,958 30,915	3,034,038 20,610,240	110,480 257,383
Sales price	361,220	32,521,000	328,000
Fuel consumption	252 L/Kℓ	168 L/kg	2.1 L/kg

Reason of much fuel consumption:

Evaporation for wast water treatment
High temperature for cooling water

6. Essential Condition for Development of Fermentation Project

i. Stable supply of molasses with stable price
ii. Abundant for industrial water and its lower temperature
iii. Establishment of fermentation research laboratory supporting with fundamental technology to industry
iv. To cultivate the function for technical service and marketing to customers

DATA FOR REFERENCE

	Indonesia	Japan
Population	148 million	116.8 million
GNP per capita	US$ 520	US$ 9,689
Growth rate of energy consumption	10.3%	3.1%
Sugar consumption	9.5 kg/year.head	25 kg/year.head
Compound feed production	3 million ton	22 million ton
MSG production	30,000 ton	80,000 ton
Citric acid consumption	2,000 ton	10,000 ton

Chapter 1.

INTRODUCTION

Chapter 1. INTRODUCTION

1.1 Background and Purpose

The Government of Republic of Indonesia is making efforts to increase the domestic sugar production to meet the country's demand of sugar by both rehabilitating the existing sugar factories and constructing new sugar factories in the peripheral territories such as Sumatra, Sulawesi and Kalimantan.

As more sugar is produced, production of its by-products like cane molasses and bagasse naturally increases. At present, majority of sugar factories locate in the Java Island, producing about half million ton cane molasses a year. If the current sugar production increase plan proceeds as scheduled, about one million tons of cane molasses will be produced in one year of 1986. Cane molasses is an established international commodity and the price fluctuate under the influence of international market. For an example, its price was FOB US$119.00/ton in December, 1980 but lower by $20 to $22 in December, 1982. The price for domestic consumption was 71,900 Rp in November, 1980, but dropped sharply down to 20,000 Rp in December, 1982. Such sharp fluctuation of cane molasses price naturally disturbs growth of the sugar industry and the Government of Indonesia is facing the urgent necessity of developing effective use of these by-products.

From the viewpoint of effective use of these by-products, the Government of Republic of Indonesia requested the Government of Japan a feasibility study of development of industries to effectively use by-products from the sugar production, centering in the fermentation industry.

Based on the request, Japan International Cooperation Agency (JICA) dispatched a preliminary survey team to Indonesia to study the case during the period of 11 days from August 31, 1982. The team conferred with the Indonesian government about the range of investigation on the basic points, and the "Scope of Work for the Feasibility Study on the Development of Sugar Cane Molasses Fermentation Industry in the Republic of Indonesia" (hereinafter referred to as "S/W") was agreed upon and signed by both parties on September 8, 1982.

This report summarizes the results of the field investigation conducted from November 28, 1982 to December 25, 1982 in accordance with the S/W and the results of works in Japan conducted based on the information obtained through the field investigation.

1.2 Scope of the Study

The S/W specified three sites to be investigated and seven items as possible porducts of the fermentation industry.

The specified three sites are as follows:

Eastern Java:
- Panji sugar factory in Situbondo area
- Persantren Baru sugar factory in Kediri area

Central Java:
- Ex Comal old sugar factory and comal alcohol plant in Pekalogan area

On the investigation of the Ex Comal old sugar factory, various data was obtained from the Sragi sugar factory which located close to Ex Comal. Also, team visited the Jatiroto sugar and alcohol plant in eastern Java, taking the opportunity of travelling through the area, although this was not the investigation objective site.

The first job is to select the most preferable site out of the three proposed sites based on studies of all possible problems that may be had for construction of a fermentation plant.

The following seven items were specified as products of the newly constructed fermentation plant:

(1) Ethyl alcohol (Ethanol)
(2) Mono Sodium Glutamate (MSG)
(3) Yeast
(4) L-Lysine
(5) Antibiotics
(6) Citric acid
(7) Acetic acid and Vinegar

The team conducted market researches of these items in Indonesia, and this report describes the possibilities of industrializing up to five items among them that look promising.

This report further describes conceptual design of the plant, estimation of the investment, and financial and economic evaluation on these proposed sites and production items.

In addition, this report roughly outlines the possibilities og effective use of bagasse, which is a product of sugar industry other than cane molasses, as well as technical and economical studies of justification to recover sugar from the cane molasses.

1.3 Survey Team Organization

The field survey team consisted of the following members.

Team leader:

Mr. Atsushi Nishimura
Associate Director and General Manager, Research & Development Dept.
Kyowa Hakko Kogyo Co., Ltd.

Members:

Mr. Takeshi Saito (in charge of raw material, sub-leader)
Deputy General Manager, Overseas Planning Dept.
Kyowa Hakko Kogyo Co., Ltd.

Mr. Tomoatsu Usuku (in charge of design engineering)
Manager, Engineering Section, Hofu Plant
Kyowa Hakko Kogyo Co., Ltd.

Mr. Yutaka Sumie (in charge of market analysis)
Sr. staff of Management Planning Dept.
Kyowa Hakko Kogyo Co., Ltd.

Mr. Hiroshi Hosoda (in charge of process engineering)
Sr. staff of Production Engineering Dept.
Kyowa Hakko Kogyo Co., Ltd.

Mr. Shogo Mochizuki (in charge of economy)
Sr. staff of Affiliated Enterprise Dept.
Kyowa Hakko Kogyo Co., Ltd.

Mr. Yasuji Noda (in charge of economy and marketing)
Consultant, Economist
Japan Consulting Institute

1.4 Itinerary

The survey team spent the first five days in Jakarta to gather various data, two weeks for survey of the sites in the eastern and central Java, and the remaining ten days for collection of supplementary data and preparation and submission of the progress report. The following are the itinerary details.

Nov. 28 (Sun)	Nishimura, Saito, Usuku, Mochizuki and Sumie left Narita and arrived in Jakarta
Nov. 29 (Mon)	Visit to JICA and Japanese Embassy Conference with SBPN
Nov. 30 (Tue)	Visit to Statistics Bureau and SEKNEG
Dec. 1 (Wed)	Visit to JETRO and Industrial Bank
Dec. 2 (Thu)	Hosoda arrived in Jakarta from Tokyo
Dec. 3 (Fri)	6 members left Jakarta and arrived in Surabaya Conference with PTP21/22
Dec. 4 (Sat)	Travel to Pasuruan Conference with BP3G
Dec. 5 (Sun)	Travel to Panji sugar factory (5 members excluding Sumie)
Dec. 6 (Mon)	Survey of Panji sugar factory Sumie continued data survey in BP3G

Dec. 7 (Tue)	The same as yesterday Travel to Jatiroto in the afternoon Sumie remained in BP3G
Dec. 8 (Wed)	Survey of Jatiroto sugar and alcohol factory Travel to Tretes
Dec. 9 (Thu)	Travel to Pesantren Baru sugar factory Sumie returned to Jakarta
Dec. 10 (Fri)	Survey of Pesantren Baru sugar factory
Dec. 11 (Sat)	The same as yesterday Travel to Solo in the afternoon Sumie left Jakarta for Japan
Dec. 12 (Sun)	Work on data Noda arrived in Jakarta from Tokyo
Dec. 13 (Mon)	Conference with PTP15/16 Travel to Semarang Noda came to Semarang from Jakarta
Dec. 14 (Tue)	Travel to Sragi sugar factory Survey of Ex Comal
Dec. 15 (Wed)	Survey of Sragi sugar factory and Comal Alcohol factory
Dec. 16 (Thu)	Nishimura, Saito and Noda travelled to Cirebon, visited PTP14, and returned to Jakarta Mochizuki, Usuku and Hosoda travelled to Semarang and returned to Jakarta
Dec. 17 (Fri)	Visit to JETRO
Dec. 18 (Sat)	Visit to the Industry Ministry and KAPB Mochizuki left Jakarta for Japan

Dec. 19 (Sun)	Work on data
Dec. 20 (Mon)	Visit to Cattle Production Bureau, Agriculture Ministry and BKPM
Dec. 21 (Tue)	Visit to SBPN and JETRO
Dec. 22 (Wed)	Visit to JICA and Japanese Embassy Hosoda left Jakarta for Japan
Dec. 23 (Thu)	Visit to BPPT Conference with Mr. Soedjai in the evening
Dec. 24 (Fri)	Submission of report to SBPN
Dec. 25 (Sat)	Nishimura, Saito, Usuku and Noda left Jakarta for Japan

1.5 Major Officials Attended to Conferences

Dewan Gula Indonesia

Secretary	Ir. Soedjai Kartasasmita Ir. Kisdarto Ir. Soedarto

SBPN

Head, Project planning	Ir. Soetjipto Wirjopranoto
Assistant	Mr. Suharto

BP_3G

Associate director	Ir. M. Mochtar Ir. Sudjanto Tedjowahjono Ir. Untung Ir. Yahya Kurniawan

PTP 14 (Cirebon)

Development director	Ir. Lockman Zain
	Mr. R. Oedojo

PTP 15/16 (Solo)

Director	Ir. Warjatmo
	Drs. Benno Djoko Soetamri
Development director	Ir. Djoko Moeljono
Head, Research Dept.	Mr. Hardiman Joedo
	Mr. Soetardi

PTP 21/22 (Surabaya)

Development director	Ir. Sjamsir
	Mr. Satmoko

PTP 24/25 (Surabaya)

Development director	Ir. BSM Hutabarat
Head, Research	Mr. Abdoel Madjid Soejoedono
	Mr. Noerdjamil

Panji Sugar Factory

Administrator	Mr. H. M. Soemadjono
Chief, Mechanics	Mr. F. M. de Fretes
	Mr. Soeparno Teng

Jatiroto Sugar Factory

Chief, Chemist	Mr. Salem Brotojuwano
Chief engineer	Mr. Pitojo
Chief, Alcohol	Mr. Widodo

Pesantren Baru Sugar Factory

Manager	Mr. Soeleiman
Administrator	Mr. Sunardi
Chief engineer	Mr. Soewarso
Process engineer	Mr. Walujo

Ex Comal

Field manager	Mr. Ash Simatupang

Comal Alcohol Factory

Factory manager	Mr. Soegiharto
Production manager	Mr. Ichwani
Factory engineer	Mr. Soedarsono

Sragi Sugar Factory

Assistant manager	Mr. Suyanto
Chief engineer	Mr. J. Susatio

Ministry of Industry

Direktorat Jenderal Industri Kimia Dasar

Ir. Nico Kansil

Ministry of Agriculture

Direktorat for cattle production

Mr. Sumarmo

KAPB

Managing director	Mr. U. Basuki
	Mr. Naswir Kawi

BPPT	Ir. Wardiman Djojonegoro

Chapter 2.

INDONESIAN SUGAR INDUSTRY

Chapter 2. INDONESIAN SUGAR INDUSTRY

2.1 Outline of World Sugar Industry

"Lichit" estimates that the worldwide sugar production increased in successive years of 1981/1982 and 1982/1983 owing to increase of sugar cane plantation area size and favorable weather in the sugar cane plantation areas around the world. Accordingly, there are excessively large amount of stocks and this keeps the sugar market at a depressed level of US¢6 per pound.

As Table 2-1 shows, there is a tendency that the sugar price goes up when the world-wide stock reduces below 25 million tons and stabilizes when the stock exceeds 30 million tons. The estimated stock at the end of 1982/83 year reaches 36 million tons. This is equivalent to 40% of the annual consumption and it really is an overstock.

Table 2-1 World Sugar Production, Consumption & Inventory

(Unit: 1,000 tons)

	77/78	78/79	79/80	80/81	81/82
Cane sugar	56,947	65,604	50,289	54,491	60,466
Beet sugar	35,146	35,498	33,805	32,937	36,722
Total production	91,097	90,965	84,857	88,183	97,608
Consumption	85,234	89,649	89,573	88,616	90,743
Inventory	30,576	31,307	25,931	24,975	31,358
Sugar price (average cent/lb)	10	10	30	15	8

The recent trend of sugar consumption is that while in major advanced countries like USA, Europe and Japan, the consumption is decreasing as the result of precaution for health and increased consumption of isomerized sugar, sugar consumption is increasing in developing countries and oil-producing ocuntries. The consumption in the world scale is expected to increase slightly or at least the current level will continue.

Under such circumstances, the sugar industry cannot necessarily be considered to be an industry of a bright future. Nevertheless, it is true that the sugar price abnormally rises sometimes in reflection of poor harvest of sugar cane caused by bad weather in specific areas when the past records are studied, and related parties of advancing countries where sugar produc-tion increase plans are being enforced must pay attention to such pehnomenon. For reference purpose, Table 2-2 shows the sugar production out of sugar cane. India ranks at the top in the world by producing 8.51 million tons and followed by Brazil, Cuba, USA (including Hawaii), Australia, China, Mexico, Thailand, Philippines and South Africa. South Africa, which is the 10th largest country produces 2.18 million tons.

Table 2-2 Major Cane Sugar Producing Countries

1.	India	8,514,000 tons
2.	Brazil	8,500,000 tons
3.	Cuba	7,000,000 tons
4.	U.S.A.	5,536,000 tons
5.	Australia	3,550,000 tons
6.	China	3,360,000 tons
7.	Mexico	2,600,000 tons
8.	Thailand	2,520,000 tons
9.	Philippines	2,254,000 tons
10.	South Africa	2,179,000 tons

2.2 Sugar Industry in Indonesia

2.2.1 Outline

In the period before World War II, Indonesia was said to produce 3 million tons of sugar annually, and about 2.7 million tons, the balance after 0.3 million tons of domestic consumption, were exported. The sugar industry was greatly damaged by World War II and independent war that followed, and the annual production during the period from 1958 to 1966 dropped to as low as 0.75 million tons. On the other hand, sugar consumption in Indonesia increased substantially due to increase of the population and a higher income level, and the consumption seems to have reached 1.8 million tons in 1981. While old sugar factories have been rehabilitated and new factories have been built, the domestic production in 1981 is about 1.3 million tons, and the shortage is filled by import.

To overcome this situation, in order to raise the selfsupply rate of sugar with the ultimate aim of becoming completely self-sustaining by 1984, the Government of Republic of Indonesia planned rehabilitation of existing sugar in the Java Island and construction of new sugar in peripheral areas such as Sumatra, Sulawesi, and Kalimantan. Some parts of these projects have already started. Table 2-3 shows the plans of sugar cane farming areas, sugar production and sugar consumption up to 1989, as announced by the government.

Significant points in these plans are that the sugar cane farming areas will increase substantially in the peripheral areas and sugar production will proportionately increase in such areas.

2.2.2 Sugar Factories in Indonesia

Majority of sugar factories in Indonesia are government-owned and are under the management of the Agriculture Ministry. The ministry controls these sugar factories by grouping them regionally. The unit of control is called PTP (P.T. Perkebunan-state owned plantation company). PTPs which handle sugar are PTP24/25, PTP21/22, PTP20, PTP15/16, and PTP14, ranging from the east end toward west in the Java Island. PTP9 is the only sugar handling company in Sumatra.

As of December, 1982, there are total 60 sugar factories in Indonesia, which can be broken down to 51 factories belonging to PTPs and 9 private factories. Table 2-4 shows locations and sugar cane processing capacities of these factories as of 1981. As the table shows, there are only 3 plants in islands other than Java.

Table 2-3 Project for Cane Field, Sugar Production and Consumption

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Cane field (ha)									
Java	182,834	229,417	250,255	259,172	259,172	259,172	259,172	259,172	259,172
Outside Java	18,098	22,984	59,286	98,183	158,478	200,738	245,699	293,959	343,959
Sugar production (ton)									
Java	1,260,739	1,626,321	1,780,187	1,854,627	1,887,716	1,920,805	1,953,894	1,986,984	1,986,984
Outside Java	86,320	106,179	230,518	364,536	587,400	750,100	923,200	1,109,000	1,272,648
Total	1,347,059	1,732,500	2,010,705	2,219,163	2,475,116	2,670,905	2,877,094	3,095,984	3,259,632
Consumption (ton)									
	1,769,473	1,905,463	2,052,250	2,211,813	2,384,250	2,556,285	2,739,596	2,936,480	3,147,519

Table 2-4 Location and Capacity of Sugar Factory

No.	Name	Location	Class	Capacity (TCD)
1.	Asembagus	Asembagus	PTP 24/25	1,520.7
2.	Panji	Situbondo		1,622.9
3.	Olean	Situbondo		1,075.8
4.	Wringinanom	Situbondo		1,050.7
5.	Prajekan	Situbondo		1,802.8
6.	De Maas	Besuki		710.4
7.	Semboro	Jember		4,099.0
8.	Pajarakan	Probolinggo		1,055.1
9.	Gending	Probolingo		1,147.5
10.	Jatiroto	Jember		4,534.8
11.	Wonolangan	Probolinggo		1,165.9
12.	Kedawung	Pasuruan		1,244.5
13.	Krian	Sidoarjo	PTP 21/22	922.1
14.	Watutulis	Krian		1,373.5
15.	Tulangan	Surabaia		1,122.4
16.	Krembung	Surabaia		1,018.9
17.	Gempolkrep	Mojokerto		3,098.4
18.	Cukir	Jombang		1,568.8
19.	Jombang Baru	Jombang		1,068.0
20.	Ngadirejo	Kediri		1,652.0
21.	Pesantren Baru	Kediri		3,094.5
22.	Merican	Kediri		1,086.7
23.	Mojopangung	Tulungagung		1,481.6
24.	Lestari	Kediri		1,570.8
25.	Kanigoro	Madium	PTP 20	1,971.2
26.	Pagotan	Madium		1,777.7
27.	Rejosari	Madiun		1,786.5
28.	Purwodadi	Madiun		1,855.3
29.	Sudhono	Madiun		2,097.6
30.	Bone*	Ujung Pandang		1,936.9
31.	Mojo	Sragen	PTP 15/16	1,595.9
32.	Tasikmadu	Solo		2,187.3
33.	Colomadu	Solo		1,107.4

No.	Name	Location	Class	Capacity (TCD)
34.	Ceper Baru	Kalten		1,274.1
35.	Gondang Baru	Klaten		1,437.0
36.	Kalibagor	Banyumas		1,047.7
37.	Rendeng	Kudus		1,396.7
38.	Cepiring	Kendal		1,689.0
39.	Sragi	Pekalongan		3,094.5
40.	Sumberharjo	Tegal		1,517.5
41.	Pangka	Tegal		1,334.4
42.	Jatibarang	Tegal		1,643.6
43.	Banjaratma	Tegal		1,521.4
44.	Cot Girek*	Lhok Sukon – Aceh		1,043.1
45.	Tersana Baru	Cirebon	PTP 14	2,459.9
46.	Karangsuwung	Cirebon		–
47.	Sindang laut	Cirebon		1,402.2
48.	Gempol	Cirebon		1,065.4
49.	Jatiwangi	Cirebon		872.0
50.	Kadhipaten	Cirebon		1,125.9
51.	Jatitujuh	Cirebon		3,139.2
52.	Kebonagung	Malang	Private	3,223.9
53.	Krebet Baru I	Malang		1,875.9
54.	Krebet Baru II	Malang		2,857.4
55.	Candi	Sidoarjo		1,260.6
56.	Rejoagung Baru	Madiun		2,994.1
57.	Madukismo	Yogya		2,291.0
58.	Trangkil	Pati		1,873.5
59.	Pakis Baru	Pati		982.7
60.	Gunung Madu*	Lampung Tengah		–

Note: * Outside Java

Another characteristic point that we might add here is that most of these sugar factories have small processing capacities. 3,000 ton per day is the economically minimum processing quantity, but only 7 factories, or slightly over 10% of the total, have a capacity of this minimum unit, making the cost very high, as explained in the latter part of this report.

Table 2-5 shows number of working days per year of these factories in the last 3 years. The number of working days per year is unrelated to factories location, and some plants operate for 190 days a year and some for 80 days, or less than half.

However, as an overall trend, sugar factories belonging to PTP21/22, locating in the area from the eastern to central Java, operate for more number of days than the rest. The normal harvest season of sugar cane in Indonesia is from April to November.

2.2.3 Sugar Cane Production in Indonesia

Table 2-6 shows the statistics of the Indonesian government on sugar cane cultivation area, crop per unit area and production, as reported in FAO's YEAR PRODUCTION of the 1981 edition. The statistics clearly indicate that both of the cultivation area and production are steadily growing in reflection of the government policy.

A noteworthy point is that the production per unit area is 100 ton/ha, which is a very good production that cannot be seen in any other Southeast Asian countries. From this, we consider that the species, irrigation and fertilization are being managed sufficiently, indicating the high level of Indonesia's sugar industry. We have, however, some doubt on the prospect of the sugar production increase plan for the future since the emphasis is placed on peripheral areas, rather than on the Java Island, for increase of the cultivation area.

The Indonesia National Sugar Research Institute (Balai Penyelidikan Perusahaan Perkebunan Gula, commonly referred to as "BP3G") estimates the sugar cane production by PTP areas as shown in Table 2-7. In short, it estimates that the sugar cane production in Java will increase and the sugar production will be increased accordingly by increasing the number of working days of sugar factories in the island up to 1984. Substantial increase of sugar cane production in peripheral areas will have to wait till after 1985.

Table 2-5 Milling Session of Sugar Factory (days)

No.	Name	1979	1980	1981
1.	Asembagus	139	109	131
2.	Panji	103	85	84
3.	Olean	85	71	63
4.	Wringinánom	105	79	100
5.	Prajekan	134	110	119
6.	De Maas	93	65	80
7.	Semboro	128	96	103
8.	Pajarakan	124	115	122
9.	Gending	134	133	133
10.	Jatiroto	153	154	154
11.	Wonolangan	133	135	135
12.	Kedawung	181	181	167
13.	Krian	148	157	151
14.	Watutulis	168	146	161
15.	Tulangan	184	154	155
16.	Krembung	148	135	118
17.	Gempolkrep	165	164	152
18.	Cukir	165	152	147
19.	Jombang Baru	190	163	125
20.	Ngadirejo	188	146	152
21.	Pesantren Baru	189	171	173
22.	Merican	195	184	143
23.	Mojopangung	179	152	149
24.	Lestari	166	158	131
25.	Kanigoro	123	139	133
26.	Pagotan	138	152	145
27.	Rejosari	110	117	132
28.	Purwodadi	126	127	134
29.	Sudhono	141	170	151
30.	Bone*	85	139	169
31.	Mojo	132	154	168
32.	Tasikmadu	120	140	158

No.	Name	1979	1980	1981
33.	Colomadu	127	131	160
34.	Ceper Baru	122	115	152
35.	Gondang Baru	103	104	116
36.	Kalibagor	70	73	93
37.	Rendeng	173	149	141
38.	Cepiring	118	135	123
39.	Sragi	166	185	191
40.	Sumberharjo	139	144	151
41.	Pangka	123	151	152
42.	Jatibarang	95	119	120
43.	Banjaratma	86	81	128
44.	Cot Girek*	64	78	123
45.	Tersana Baru	123	124	143
46.	Karangsuwung	84	78	-
47.	Sindang laut	110	120	139
48.	Gempol	101	115	139
49.	Jatiwangi	103	106	114
50.	Kadhipaten	109	106	139
51.	Jatitujuh	-	-	79
52.	Kebonagung	153	146	136
53.	Krebet Baru I	129	100	121
54.	Krebet Baru II	122	122	104
55.	Candi	129	157	173
56.	Rejoagung Baru	120	119	134
57.	Madukismo	151	157	148
58.	Trangkil	198	196	163
59.	Pakis Baru	172	165	155
60.	Gunung Madu*	-	-	-

Note: * Outside Java

Table 2-6 Area Harvest, Yield and Production of Sugar Cane in Indonesia

	1979	1980	1981
Area harvest (1,000 ha)	166	170	177
Yield (Kg/ha)	96,353	100,500	99,208
Production (1,000 ton)	15,995	17,085	17,560

Table 2-7 Cane Production in Java

(Unit: 1,000 ton)

	1980	1981	1982	1983	1984
PTP 14	922	1,333	1,675	2,404	2,744
PTP 15/16	2,831	3,095	3,997	4,082	4,174
PTP 20	1,310	1,372	1,653	1,712	1,764
PTP 21/22	2,875	3,023	3,208	3,402	3,676
PTP 24/25	2,205	2,661	3,735	4,263	4,263
Total PTP	10,145	11,485	14,270	15,901	16,696
Non PTP	2,385	2,501	3,281	3,336	3,392
Grand total	12,530	13,986	17,552	19,237	20,089
Outside Java	-	1,097	1,368	3,080	4,249

(Source: BP3G)

2.2.4 Sugar Price in Indonesia

Sugar produced by factories under PTP is placed under control of BULOG immediately. This system applies not only to sugar but all food stuffs under management of the Agriculture Ministry. BULOG has the functions of storage, distribution and price stabilization of food stuffs from the national standpoint. Actual owner of sugar is Bank Bumi Daya. Sugar purchasers place purchase orders with BULOG but receive sugar upon payment to Bank Bumi Daya.

As of December, 1982, sugar is distributed at an average price of the following structure:

Sugar plant sales price		35,000 Rp/100 kg
Tax		
Bank interest for storage		
BULOG commission		
Distributor purchase price		46,000 Rp/100 kg
Distributor expenses & profit		
Final market price	Approx.	50,000 Rp/100 kg

The market price of 50,000 Rp/100 kg is equivalent to US71.9¢/kg, or ¥173/kg. This is extremely high when compared with the current international price of US6 to 7¢/lb or ¥31 to 36/kg.

Factors such as high purchase price of sugar cane, small scale and large number of employees more than proportionate of the scale cause the high sugar price.

Just as a reference, the Panji sugar factory under PTP24/25 has a capacity of processing 1,600 ton sugar cane a day, but 1,800 employees work at the time of sugar production. The sugar production cost at the plant is estimated as follows:

Production expenses	279,238 Rp
Management expenses	104,942 Rp
Plant cost	384,180 Rp/ton

While this cost is over the 35,000 Rp/100 kg line determined by the government, it does not create a loss to the PTP.

The trend of sugar factory prices as determined by the government is shown below. As it shows, the price has been raised at a high rate every year. We cannot help but have a doubt on the cause of the necessity of enforcing domestic production of such high priced sugar instead of importing it, especially under the current situation of sugar international price being at a low level.

Trend of sugar prices in Indonesia

May, 1974	75.598 Rp/kg
Nov., 1974	90.88
Nov., 1975	109.077
May, 1977	134.34
May, 1978	155.577
June, 1979	187.948
May, 1980	225.537
Oct., 1980	307.056
Apr., 1981	350.000

2.2.5 Cane Molasses Production

While there are some regional differences, the rates of produced cane sugar and cane molasses to the sugar cane are about 9 to 11% and about 3.5 to 4.5%, respectively in Indonesia. Accordingly, from themacroscopic viewpoint, 0.6 to 0.7 million tons of cane molasses are produced out of 1.7 million ton sugar cane. Table 2-8 shows the cane molasses production by sugar plants under PTP in 1981. The total of production quantities in this table comes to 489,353 tons, or about 0.5 million tons, proving that the above estimation is fairly close.

The data of KAPB, which exclusively handles distribution and sales of cane molasses, indicates that the total production of cane molasses in 1981, including 5,000 tons produced by PTP9, is 493,824 tons. The data obtained from KAPB is given in Table 2-9. The numerical values contained in the table were announced in the PTP annual meeting of April, 1982, and those up to 1981 are actual values while those after 1982 are planned values. If the plans are accomplished, Indonesia will be producing more than one million tons of cane molasses in 1986, which is the fourth largest in Asia, after India, China and Thailand, and exceeds Philippines.

Table 2-8 Molasses Production of Sugar Factory (ton)

No.	Name	1981
1.	Asembagus	7,540
2.	Panji	4,646
3.	Olean	2,374
4.	Wringinanom	3,425
5.	Prajekan	7,492
6.	De Maas	3,653
7.	Semboro	14,822
8.	Pajarakan	4,510
9.	Gending	5,480
10.	Jatiroto	25,058
11.	Wonolangan	6,067
12.	Kedawung	6,448
13.	Krian	5,016
14.	Watutulis	7,963
15.	Tulangan	7,110
16.	Krembung	4,660
17.	Gempolkrep	16,893
18.	Cukir	8,083
19	Jombang Baru	4,952
20.	Ngadirejo	9,788
21.	Pesantren Baru	19,791
22.	Merican	8,027
23.	Mojopangung	7,283
24.	Lestari	7,801
25.	Kanigoro	8,902
26.	Pagotan	8,715
27.	Rejosari	9,675
28.	Purwodadi	7,410
29	Sudhono	11,420
30.	Bone*	14,730
31.	Mojo	8,858
32.	Tasikmadu	9,678

No.	Name	1981
33.	Colomadu	6,038
34.	Ceper Baru	4,442
35.	Gondang Baru	4,150
36.	Kalibagor	3,116
37.	Rendeng	6,674
38.	Cepiring	6,222
39.	Sragi	24,241
40.	Sumberharjo	6,644
41	Pangka	7,902
42.	Jatibarang	6,726
43.	Banjaratma	7,179
44.	Cot Girek*	5,632
45.	Tersana Baru	11,260
46.	Karangsuwung	–
47.	Sidang laut	4,302
48.	Gempol	5,024
49.	Jatiwangi	3,117
50.	Kadhipaten	6,912
51.	Jatitujuh	13,083
52.	Kebonagung	18,428
53.	Krebet Baru I	8,412
54.	Krebet Baru II	11,038
55.	Candi	–
56.	Rejoagung Baru	12,027
57.	Madukismo	13,259
58.	Trangkil	10,351
59.	Pakis Baru	4,874
60.	Gunung Madu*	–

Note: * Outside Java

Table 2-9 Molasses Production in Indonesia

(Unit: tons)

Year	PTP9	PTP14	PTP15/16	PTP20	PTP21/22	PTP24/25	PTP sub-total	Non-PTP	Total
1976	2,715	30,780	71,237	29,064	67,769	70,628	272,193	41,290	313,483
1977	4,935	29,720	80,282	37,577	89,524	84,309	326,437	52,090	378,437
1978	5,239	25,698	78,846	39,961	115,727	97,195	362,666	62,096	424,762
1979	3,022	23,568	78,634	47,361	115,273	98,480	366,338	103,924	470,262
1980	3,789	27,765	85,381	66,081	118,554	87,866	389,436	101,858	491,294
1981	5,155	41,394	91,968	58,014	107,904	90,926	395,361	98,463	493,824
1982	4,140	51,839	123,600	66,361	117,442	121,488	484,870	103,057	587,927
1983	28,135	66,686	136,945	69,076	126,906	142,497	570,245	123,423	693,668
1984	61,413	84,332	139,154	77,835	147,543	151,908	662,185	137,340	799,525
1985	71,802	96,518	156,566	103,837	163,116	186,706	778,545	141,629	920,174
1986	72,603	113,657	174,021	124,502	179,713	218,926	883,422	148,893	1,032,315
1987	72,602	119,997	184,799	139,002	198,652	230,136	945,188	156,243	1,101,431
1988	72,600	119,997	189,326	146,744	206,930	241,521	977,118	163,843	1,140,961

Source: Year meeting PTP 1982

When the table is studied for each PTP, cane molasses production in PTP24/25, eastern Java, will be increasing the most.

To realize such increase, not to mention of constructing new sugar factories, expansion of the processing capacity of existing facotries by rehabilitating more of them and by increase of working days of these factories, coping with increase of the sugar cane production, will be essential.

2.2.6 Quality of Cane Molasses

In the current system, all sugar factories send cane molasses samples to BG3P for analysis every 15 days during sugar production.

Table 2-10 shows the analysis results of quality changes with time on cane molasses from the Pesantren Baru sugar factory, one of the objective sites of the current survey.

Table 2-11 shows results of the same analysis on cane molasses from the Sragi sugar factory in the neighborhood of Ex Comal.

As to the cane molasses quality, there is phenomenon that sugar yield is low during the time immediately after starting sugar manufacture, that is, cane molasses of a high quality is produced during the period. During this initial period of production, the cane molasses has 59% to 60% sugar contents as inverted sugar. As the production enters the normal state, sugar contents of cane molasses as inverted sugar drops to 54% at the lowest and 58% at the highest. Therefore, Indonesian cane molasses is superior on the sugar content rate. However, it has a defect of having a high ash content of about 10%. A high sugar content is a merit for cane molasses for being a raw material of fermentation industry, but a high ash content is not favorable as it causes scaling. If possible, the ash content should be reduced down to 5 to 6% by improving the sugar manufacture techniques.

2.2.7 Cane Molasses Price in Indonesia

Cane molasses has been established as an international commodity and naturally its price is influenced greatly by the international market situation. As a matter of fact, Indonesian cane molasses price fluctuates substantially. The following shows the record of price fluctuation based on the data obtained from KAPB in December, 1982. All these prices are for CIF Java.

Table 2-10 Analytical Data of Molasses from PG Pesantren Baru (1982)

	Date	Brix	Pol	Saccharose (%)	Reducing sugar (%)	Total sugar as Invert (%)	Ash (%)
June	1–15	90.62	25.77	32.64	24.90	59.26	9.95
June	16–30	90.01	26.19	33.12	24.51	59.37	9.91
July	1–15	88.65	27.18	33.61	23.59	58.97	9.79
July	16–31	88.98	25.92	31.99	23.38	57.05	10.07
Aug.	1–15	88.09	28.57	35.12	17.67	54.64	10.07
Aug.	16–31	88.49	28.14	34.47	20.04	56.32	10.49
Sep.	1–15	86.24	28.87	34.40	20.04	56.25	10.15
Sep.	16–30	88.33	32.03	36.94	19.45	58.33	9.90
Oct.	1–15	93.46	27.00	33.31	19.58	56.18	9.61
Nov.	1–15	86.61	22.63	30.88	20.05	52.26	10.07

Table 2·11 Analytical Data of Molasses from PG Sragi (1982)

	Date	Brix	Pol	Saccharose (%)	Reducing sugar (%)	Total sugar as Invert (%)	Ash (%)
Mar.	16–30	96.13	27.38	33.66	24.91	60.34	10.88
Apr.	1–16	94.18	26.71	33.22	24.34	59.31	10.85
Apr.	15–30	93.21	25.34	32.57	22.30	56.58	11.34
May	1–15	91.90	24.66	31.59	22.39	55.64	11.16
June	1–15	93.70	25.88	32.39	24.23	58.32	11.32
July	1–15	96.42	27.38	34.59	23.09	59.50	11.56
Sep.	16–30	96.18	28.76	34.56	23.01	59.39	11.08
Oct.	1–15	92.61	31.72	32.11	24.26	58.06	11.32

1977		15,200 Rp/ton
1978,	first half	16,500
	second half	24,750
1979,	first half	30,950
	second half	36,100
1980,	first half	58,200
	second half	71,900
1981,	first half	60,000
	second half	50,000
1982,	August	20,000

In other words, cane molasses price at present is 20,000 Rp/ton, but in the second half of 1980, which is only two years ago, it was as high as 71,900 Rp/ton (about US$120). At that time, cane molasses was very expensive around the world and it is not that Indonesian cane molasses only was high, nor Indonesia had a small production of cane molasses causing short supply.

If the fermentation industry is to be developed in Indonesia as a measure to utilize cane molasses, all related parties must be fully aware of that cane molasses price is not influenced by supply/demand relation within the country but is wholly depended on the international market situation.

2.3 Molasses Situation in The World and Southeast Asia

2.3.1 Molasses Production

According to "Lichit", 30 to 34 million tons of molasses are produced annually in the world as a by-product of sugar manufacture (Table 2-12). Out of this, about 10 million tons are from European beet and the balance 20 to 24 million tons are from sugar cane, as in the case of Indonesia. The three major producing areas of cane molasses are Asia, North and Middle America and South America, each producing 6 to 7 millions tons a year. Africa and Oceania produce some. Accoridngly, the cane molasses currently produced in Indonesia is no greater than 10% of the Asian production. In Asia, with production of 2.8 million tons, India ranks at the top and is followed by Thailand, China, Philippines and Pakistan, as shown in Table 2-13.

Table 2-12 World Production of Molasses

(Unit: 1,000 tons)

	77/78	78/79	79/80	80/81	81/82
West Europe	4,631	4,380	4,209	4,215	5,098
East Europe	5,227	5,226	4,667	4,232	4,891
Europe sub-total	9,858	9,606	8,876	8,447	9,989
North & Central Ameria	7,161	7,171	6,452	6,469	6,865
South America	7,181	7,217	7,362	6,913	6,985
Africa	2,115	2,096	2,207	2,197	2,486
Asia	6,670	6,676	5,202	6,289	7,110
Oceania	746	683	741	842	855
World total	33,631	33,449	30,749	31,057	34,180

(Source: "Lichit")

Table 2-13 Molasses Production in Asian Countries

(Unit: 1,000 ton)

	77/78	78/79	79/80	80/81	81/82
Philippines	808	818	818	860	834
Thailand	962	1,059	679	1,029	1,303
Indonesia	460	455	430	440	488
Pakistan	400	239	247	366	500
Australia	642	577	598	713	719
Hawaii	293	305	301	284	272
Fiji	103	84	111	108	111
India	2,971	2,564	1,582	2,129	2,800
China	858	932	878	1,068	1,176

(Source: Kaigai Satoh Jyohoo)

2.3.2 Molasses Distribution/Consumption

Majority of molasses is used as a feed of live-stock and use of more than half of import for fermentation like in Japan is a rare case. In the United States, 2.5 million tons or more is used as a feed annually. USA's production is about 1.5 million tons and the shortage is filled by importing cane molasses from Mexico and Cuba. European countries also import molasses from African countries like South Africa and Egypt for the majority of consumption and some from west Asia like Pakistan. South American countries like Brazil and Argentine very often export ethanol after processing the cane molasses.

In Asia, three countries of Japan, Korea and Taiwan are the major consumers of molasses and there the molasses is used as a material for fermentation industry. The total consumption of the three countries is estimated to be about 1.3 million tons a year, which can be broken down as follows:

Japan	Approx. 800,000 tons
Korea	Approx. 400,000 tons
Taiwan	Approx. 100,000 tons

Asian molasses-producing countries have enough capacities to satisfy the demand of these three countries, although the production fluctuates according to the sugar cane crop, and Philippines, Thailand and Indonesia, which are the major cane molasses-producers in Asia, must compete each other on the distribution.

Dominant factors on molasses distribution are freight charges and storage expenses. Therefore, concentration of molasses production facilities, short distance to a port, and storage tanks and advanced ship loading equipment are the essential conditions to minimize the distribution cost, and when these conditions are satisfied only, the molasses can be offered at an attractive export price.

The cane molasses distribution conditions of Thailand, Philippines and Indonesia can be summarized as follows. In Thailand, majority of sugar factories are located in the Kanchanaburi district, and molasses is collected for shipment from Bangkok entirely. In Philippines, most of sugar factories concentrate in the Negros Island, which is also called "Sugar Island", and the cane molasses is also collectively handled. On the other hand, in Indonesia, sugar factories are scattered in the eastern and central parts of the Java Island and the cane molasses is collected in various areas such as Surabaya, Banyuwangi, Semarang, Pekalongan and Cirebon. In other words, the cane molasses is collected in a smaller unit in Indonesia than in

Thailand and Philippines, making the distribution cost per unit volume much higher. The longer distance to the major consuming countries of Japan, Korea and Taiwan is also a handicap for marketing of Indonesian cane molasses.

Since sugar factories will be constructed in the peripheral areas in the case of Indonesia, there is no question that the subjects of molasses collection and distribution will be serious ones in the future.

Chapter 3.

SUGAR BY-PRODUCT UTILIZATION INDUSTRIES IN INDONESIA

Chapter 3. SUGAR BY-PRODUCTS UTILIZATION INDUSTRIES IN INDONESIA

3.1 Premise for Analysis related to Cane Molasses Utilization Industries

To analyze the current situation and prospect of the cane molasses utilization industries, the objective markets can be divided into two.

Domestic market of Indonesia
Export markets in overseas

On the domestic market, the focus is placed on the two points of forecasting the demand growth and conversion of imported products to domestic production based on research results of currently existing molasses utilization industries. Accordingly, the main information used for the analysis consists of governmental statistics, information obtained from various organisation and information obtained through interviews with the industry people.

Highly advanced statistical methods are used for the analysis, but generally there is a shortage of basic numerical information. At the same time, since the cane molasses utilization industires are on the stage to be developed from now on, a national policy and support of the Indonesian government are essential. In other words, since the core of cane molasses utilization industires is the fermentation industry, it is very important that measures in a wide range from a cultivation plan of personnel that supports the fermentation industry up to a market cultivation plan are established concurrently with the manufacture plan. For this reason, we will try to touch the subject of measures to be established for developing the domestic market as much as possible.

We cannot report much in relation to the export markets out of the survey completed this time. For, it is extremely difficult to determine whether or not the Indonesian fermentation will be able to possess the competitive power in the international markets since the industry is in the cradle age. We would consider that the more important policy for Indonesia to take at present is to develop industries related to fermentation to provide a firm ground for the fermentation industry products. If several fermentation industry products are developed, certainly, the time will tell which of them would be strong enough to win the competition in the international market.

With such basic concept in mind, we analyze the prospect of fermentation industry utilizing the cane molasses mainly for the domestic market in this report.

Also, since the items of study objective are limited to 7 items this time, our analysis is made placing stress on these items.

3.2 Current Situation from Viewpoint of Cane Molasses Utilization

Fig. 3-1 shows the utilization situation of cane molasses based on the data obtained from BP3G. In 1980, 380,000 tons of cane molasses were consumed, out of which 275,000 tons (70%) were consumed domestically. On the domestic consumption, 135,000 tons, or about half, were used for alcohol/spirit manufacture, which is followed by 123,000 tons used for MSG manufacture. The total of these two occupies 94% of the domestic consumption, and the remaining 17,000 tons were used for yeast and feed pellet.

While it is difficult to quickly forecast the prospect of cane molasses export since it is directly affected by the international market situation, Fig. 3-1 indicates that the domestic consumption of cane molasses has been growing steadily. Use of the cane molasses for MSG has rapidly increased since 1974 but in recent years, the growth is not as fast as it was.

Based on this observation, we conclude that the foundation of the industry of cane molasses for alcohol and MSG has been established in Indonesia and the important point to consider is their growth from now on. Another important point is whether or not a good growth rate can be expected on the yeast and feed pellet even though use of the cane molasses for these products is small at present. Furthermore, whether or not new products can be developed utilizing the cane molasses is also an important point, and these review results are described in the following.

3.3 Ethyl Alcohol

Ethyl alcohol can be easily produced by fermentation of cane molasses and it has the characteristic of consuming a large quantity of cane molasses. On the other hand, it has a crucial problem in advanced countries of how to dispose of the distillation stillage.

According to KAPB, there are 13 alcohol plants in Indonesia at present. Out of them, 3 plants belong to PTP but the rest are owned by private concerns (refer to Table 4-2).

During the survey of the proposed plant sites in the Java Island, the survey team had

Source: BP3G

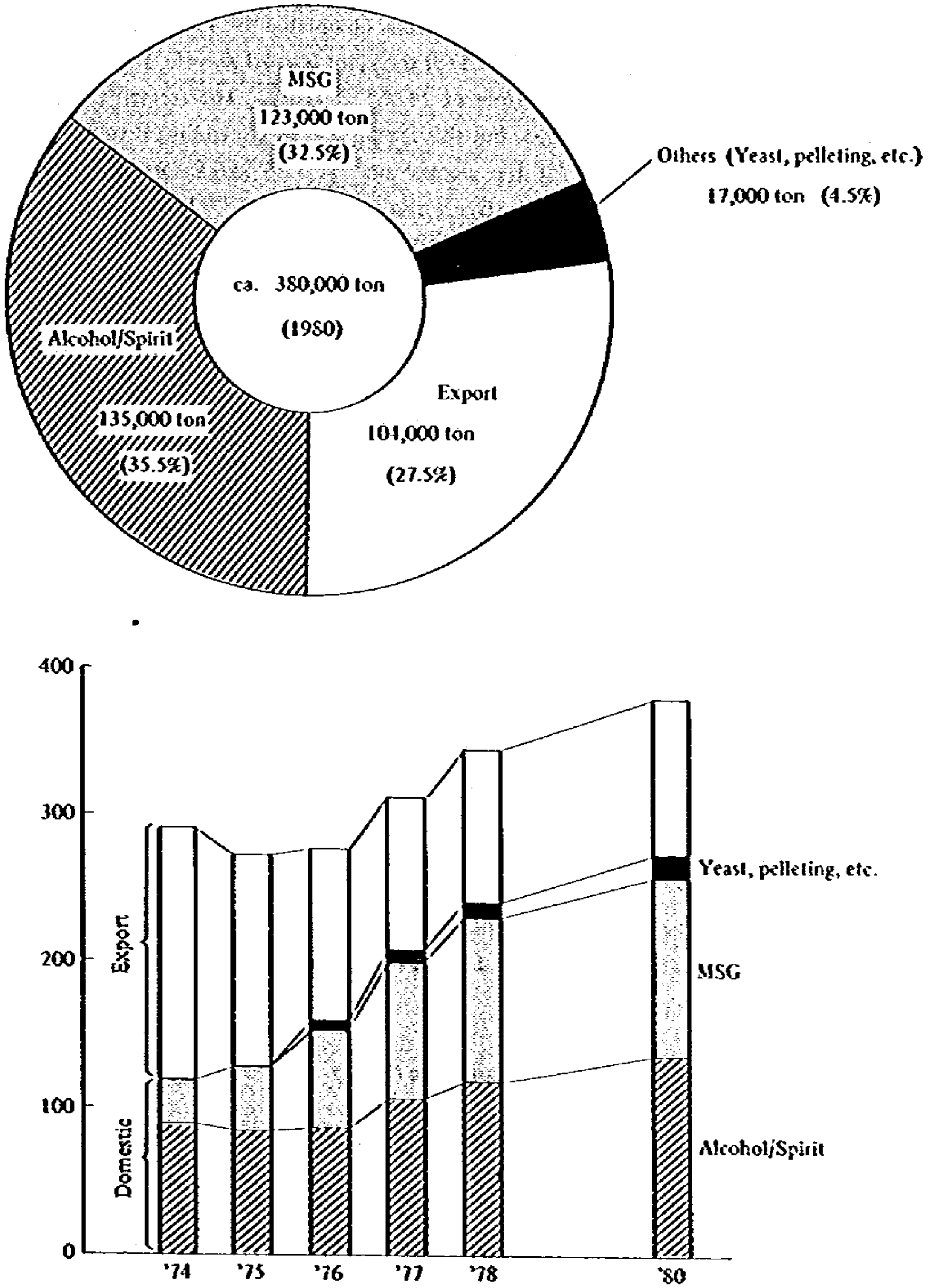


Fig. 3-1. Usage of Molasses in Indonesia

the opportunity of visiting both the latest and most classic alcohol plants. The latest plant is the Jatiroto plant belonging to PTP24/25, being completed in 1982 by the technology of Austrian Vogelbush. The system employed for the plant is yeast recycle, and the plant produces 20 kℓ/day of alcohol using 2 fermentors of 75 m^3 capacity. The fermentation temperature is a troublesome issue in tropical area, but this is managed by controlling it to 32°C with chilled water, resulting in a good level of the alcohol unit at 3.36 kg/kℓ. We understand that the distillation stillage is discharged into a river without being treated. The plant has a centrifugal separator for yeast recycle, stainless steel fermentors and stainless steel distillation columns arranged in a compact form.

The most classic plant is the Comal plant belonging to PTP15/16. This was constructed in 1917, and having 15 wooden open fermentors of 40 kℓ capacity, the plant can produce 18 kℓ/day alcohol. Since river water of 28 to 29°C is used, the fermentation temperature is 34 to 35°C. The fermentation time is 48 hours, obtaining mash of alcohol 10 V/V%, but the alcohol unit of the cane molasses is 4.0 kg/kℓ, which is not too good a level. The distillation stillage is discharged into a river without being treated.

Table 4-2 shows the production capacities of these plants and actual production amounts in 1982. As the table shows, the total production capacity is 194.5 kℓ/day, which should be able to produce about 58,000 kℓ a year if the plants operate for 300 days a year, but the actual production is only 26,100 kℓ. Since data on actual production is available on production of plants belonging to PTP only, the trend of total production is unknown. However, we understand that the operation ratio is rather low, or about half of the total capacity since the market of industrial alcohol is being lost affected by low priced methanol recovered from textile and other industires.

It seems that the only way for the industiral alcohol to survive is to promote use of so-called Gasohol which is blend of alcohol with gasoline or diesel oil as an alternative energy.

3.4 Glutamic Acid and Mono Sodium Glutamate (MSG)

Since no statistics is available on the production and consumption of MSG in Indonesia, we estiamte them using related data in two types.

One is use of the "Manufacturing of seasoning", Vol. II of "Industrial Statistics, 1980" published by the Central Statistics Bureau (BPS). The paper contains information on the amounts of glutamic acid and cane molasses used and our estimation of the MSG production from the information is shown in Table 3-1. Naturally, sugar concentration in the molasses, yields of fermentation and refining and conversion rate from glutamic acid to MSG must be taken into consideration when making such estimation, but standard rates are used in the sense of finding approximate values.

The other estimation is made using information of imported glutamic acid and cane molasses use. An assumption is made that all of imported glutamic acid (Table 3-3) reported in the BPS statistics was converted to MSG, and to the value thus obtained is added with the MSG amount calculated from the amount of cane molasses for MSG contained in the cane molasses use data of Fig. 3-1, and the results are shown in Table 3-2.

There are some differences between the two estimation results, but Fig. 3-2 shows approximate values of the two. From this future, it can be said that the MSG production in Indonesia was about 20,000 tons in 1976 but increased to over 30,000 tons in 1980.

Since glutamic acids are rarely exported (100 tons or thereabout?) from Indonesia, the level of current MSG production in Indonesia is estimated to be over 30,000 tons and around 35,000 tons.

Table 3-4 shows approximate figures of MSG production and consumption in Japan. The trend of MSG consumption per capita in Japan as the table shows is that it was at its peak in 1980 with about 700 g per capita and thenceforce it is on the declining tendency. Since the ratio of MSG consumption of the Japanese people between home use and business use (food stuff processing and restaurants) is 1 : 1, it can be said that each Japanese consumes MSG in the home at a rate of about 300 to 350 g.

On the other hand, supposing that 35,000 tons of MSG are all consumed in the home use in Indonesia and that the population is about 144 million, MSG consumption per capita is about 250 g. This level is not a low one at all when the differences of the eating habit and income level between Japan and Indonesia are taken into account.

When comparison is made simply on the quantity, MSG consumption in Indonesia can be twice as much as the current level, or up to about 70,000 tons. However, to realize this much consumption, the food-stuff processing industires and restaurants must be developed as the background.

Table 3-5 shows the glutamic acid and MSG production capacities.

Table 3-1 Estimation of MSG Production in Indonesia (Part 1)

Source: "Industrial Statistics 1980" – "Manufacturer of seasoning, Code 31270 (BPS)

(Unit: 1,000 tons)

	Glutamic Acid	Molasses	Estimated MSG		
	Total (Import + Local)	Total	from GA	from Molasses	Total
1975	2.2	4.2	2.6	1.0	3.6
1976	8.9	41.9	10.7	10.5	21.2
1977	10.5	66.3	12.6	16.6	29.2
1978	16.73	88.35	20.1	22.1	42.2
1979	11.43	79.23	13.7	19.8	33.5
1980	6.81	102.27	8.2	25.5	33.7

Table 3-2 Estimation of MSG Production in Indonesia (Part 2)

(Unit: 1,000 tons)

	Glutamic Acid imported*1	Molasse distributed to establishments*2	MSG		
			from GA	from Molasses	Total
1975	2.29	42.9	2.7	10.7	13.4
1976	1.51	66.6	1.8	16.5	18.3
1977	1.0	90.9	1.2	22.7	23.9
1978	1.41	109.3	1.7	27.3	29.0
1979	1.64	115.0	2.0	28.7	30.7
1980	3.27	123.2	3.9	30.8	34.7
1981	2.36				

*1: From Table 3-3.

*2: From Figure 3-1.

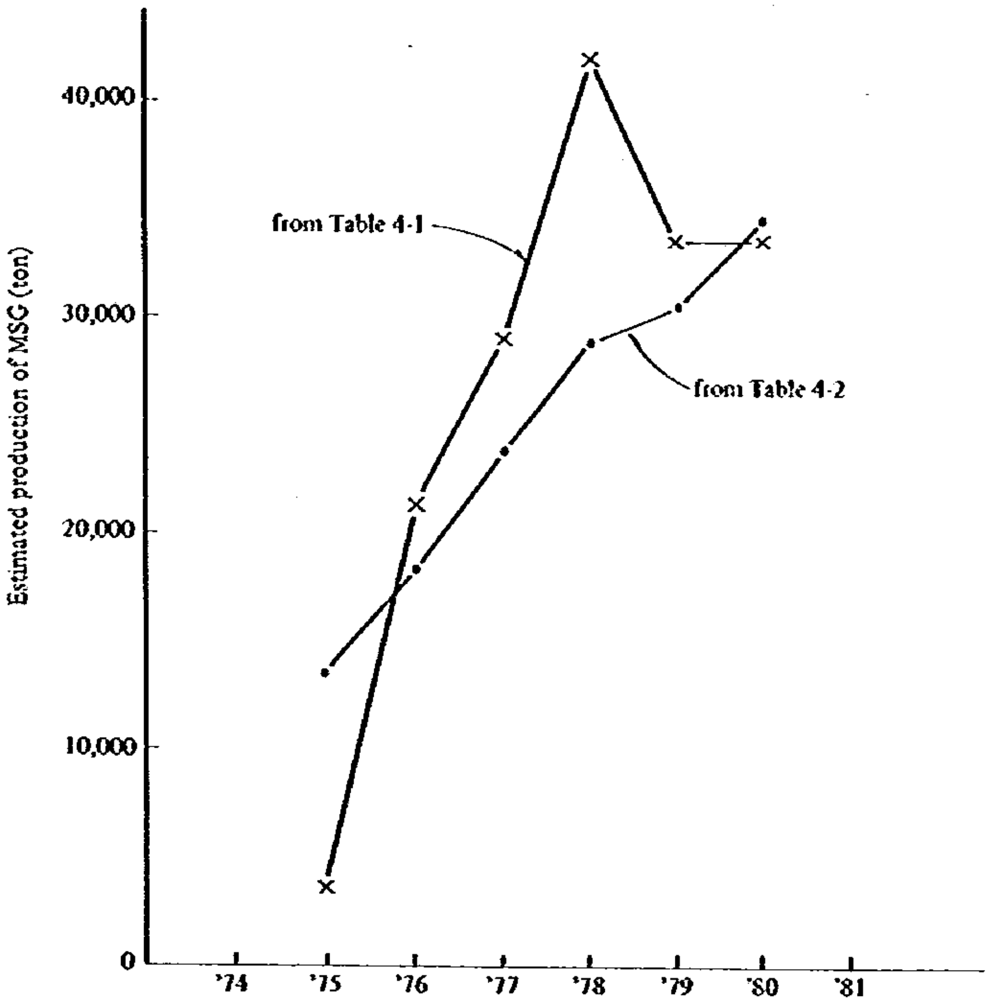


Fig 3-2. Trend of Estimated Production of MSG in Indonesia

Table 3-3 Imported Glutamic Acid in Indonesia

(N.W.: Net Weight, ton; CIF: x 1,000 US$)

Main Countries	1981		1980		1979		1978		1977		1976		1975	
	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF
(total)	2,363	3,445	3,268	4,522	1,640	2,148	1,414	1,981	1,006	1,569	1,506	2,240	2,293	2,686
People Rep. of China	2,052	2,987	2,638	3,517	1,150	1,478	1,100	1,476	150	214	318	443	395	512
France	307	438	204	276	255	329	250	391	300	455	860	1,303	1,161	1,317
Rep. of China			360	486	210	276	50	76	295	419	290	395	120	129

Source: Import (BPS)

Table 3-4 Production and Consumption of MSG in Japan

	Production (ton)	Export (ton)	Domestic (ton)	Consumipiton (g/man)
1975	72,900	10,150	65,750	596
1976	80,800	13,380	67,950	609
1977	73,900	10,650	63,980	567
1978	79,800	12,670	67,680	571
1979	86,900	13,320	74,240	645
1980	89,600	11,040	80,570	696
1981	79,000	10,000	72,000	615

Source: Daily Economic Telecommunication Co., Ltd.

Table 3-5 Number of Establishments for Manufacture of Seasoning in Indonesia

	GA production capacity (ton/Y)	MSG production capacity (ton/Y)
Integrated companies		
AJINOMOTO	12,000	9,600
MIWON	12,000	7,200
SASA	12,000	6,300
* PALUR RAYA	4,200	1,800
* INDO MIKI FERMENTATION	4,800	–
Convertors		
SASA FERMENTATION	–	3,600
INDONESIAN MIKI	–	4,500
INDONESIAN VETSIN	–	1,200
FOOMACO	–	1,200
RENA DJAJA	–	1,200
POLY INTERNATIONAL	–	400
	45,000	39,700

* Under construction

There are 3 glutamic acid manufacturers, having a total capacity of 36,000 tons of a year. 2 additional manufacturers are constructing production facilities, and when they are completed, the total capacity reaches the level of 45,000 tons (54,000 tons converted into MSG).

There are 9 existing MSG manufacturers and these can be divided into two types; so-called "integrated companies" who produce both glutamic acid and MSG through fermentation mainly using cane molasses and "converters" who procure glutamic acid and convert it to MSG. An additional manufacturer is constructing a plant, and as the total of the 10 manufacturers, the MSG production capacity will reach the 40,000 ton level (50,000 ton as the latent capacity).

At present, the MSG market size of Indonesia is about 35,000 tons, so that, this production capacity is too large. While growth of the MSG demand can be expected as the consumption in the food-stuff processing industries and the number of restaurants increases but the growth rate will not be a large one. Since 3 glutamic manufacturers and 9 MSG manufacturers already exist and 2 and 1 manufacturers, respectively, will start the operation shortly, we consider that the foundation of glutamic acid and MSG production is sufficiently established in Indonesia and that possible growth of the demand should be taken care of by appropriate expansion of the production facilities of the existing manufacturers. Since production of glutamic acid and MSG is the core of amino acid fermentation, which is one of the fields of fermentation industry, the desirable direction for Indonesia to step is cultivation of amino acid fermentation engineers by these manufacturers.

3.5 Yeast

Yeast can be divided into two types of bakery yeast and fodder yeast for animal, and the situation is analyzed on each type.

3.5.1 Bakery Yeast

According to "Industrial Statistics, 1980" Vol. II of BPS, the total production of bakery products (Code 31179) of Indonesia in 1980 amounts to a large sum of 1,950 million Rp but the production of bakeries who directly use yeast is 11,000 tons or 440 million Rp. The said document indicates that there are 197 bakers in Indonesia and the quantity of yeast used by them amounts to 62 tons including 24 tons of import. However, these figures are too small and we do not believe they can be used as they are.

On the other hand, Table 3-6 shows the import figures of natural yeasts shown in the import statistics of BPS. Majority of the natural yeasts are canned active dry yeasts, and Fig. 3-3 shows the trend of import from major supply countries. The main supply source is France and imports from Netherlands and Australia are also constant. The import quantity of bakery yeasts can be interpreted as being 1,500 to 2,000 tons a year. There are some ups and downs by years, but these irregularities are due to the method of calculating the imported quantities at the end to beginning of the year.

Thus, bakery yeasts are imported into Indonesia in the quantity of slightly less than 2,000 tons a year, which exceeds US$2 million in the money amount. In Indonesia, rice is the staple food and people have traditionally been eating rice three times a day including breakfast. However, they have a feeling that eating bread for the breakfast is a modern pattern and bread eating habit is expanding not only in the high class but in the middle class. For example, even servants prefer eating bread in the morning now. Also, school children who support the next generation desire eating bread, and it seems that the habit of eating bread will gradually penetrate into people's life.

Some parties in the related circle even forecast a 10% annual growth rate of bakery yeasts.

There are bakery yeast manufacturers in Indonesia, like PT INDO FERMEX. Most of them produce compressed yeasts but some produce dry type instant yeasts. Being in the tropical area, majority of the imported yeasts are active dry yeasts and bakeries are accustomed to use dry yeasts. We were told of stories of the yeast manufacturers that they had a difficult time in the beginning since bakeries did not have refrigerators to handle compressed yeasts and that use of compressed yeasts really launched only after the bakeries installing refrigerators.

Since the yeast use is changing from the compressed type to dry type in Europe, America and Japan, the preferable direction for Indonesia to take, especially in consideration of the hot climate, is increase of the supply power of dry type bakery yeasts.

There are additional points to be kept in mind when trying to expand use of bakery yeasts, and they are water quality and preference of sweet taste as characteristics of Indoneisa. The water quality largely variates in Indonesia by districts, and conditions of Company "A" for bread baking do not necessarily apply to yeasts of Company "B". Accordingly, guidance of engineers is essential to promote sales of yeasts.

Also, the Indonesian people have the definite tendency of preferring sweet taste.

Table 3-6 Import of Active Natural Yeasts in Indonesia

(N.W.: Net weight, ton; CIF: x 1,000 US$)

Main Countries	1981		1980		1979		1978		1977		1976		1975	
	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF	N.W.	CIF
(total)	1,030	1,381	2,403	2,326	2,114	1,980	2,171	1,984	2,051	1,783	1,671	1,294	1,018	837
France	799	1,052	1,332	1,427	976	984	1,325	1,221	1,283	1,069	981	740	550	399
R. F. Germany	111	293	11	13	76	77	52	54	24	34	37	35	8	8
Netherland	1	21	469	418	331	314	319	320	400	398	281	285	218	220
Australia	-	-	353	205	229	115	306	167	145	72	126	51	72	43

Source: Import (BPS)

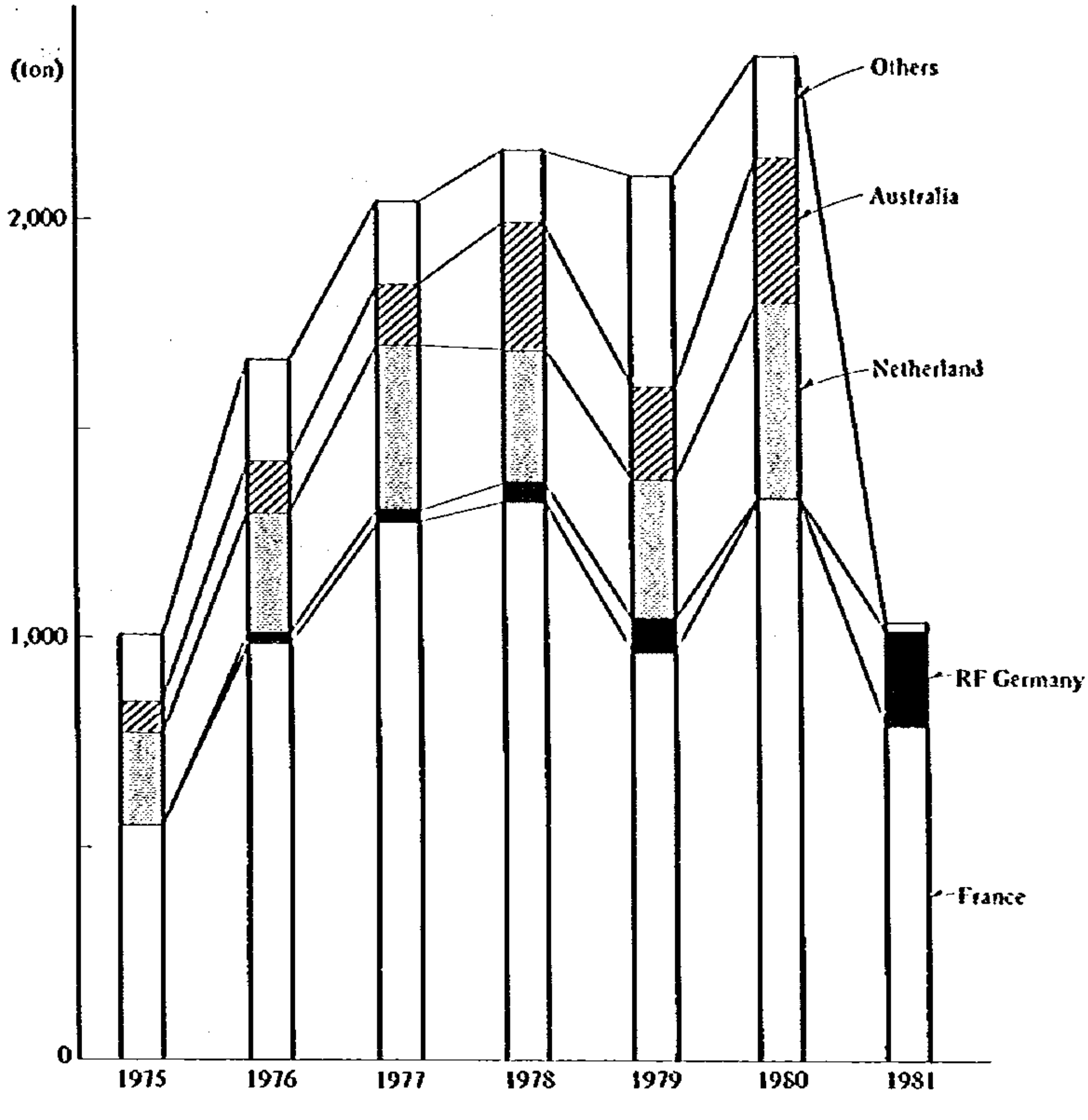


Fig. 3-3. Imported Natural Yeasts in Indonesia

10% of sugar is used even on regular bread and as much sugar as 20% is used for sweet bread. Because of this, we consider that there will be a need of supplying bread in several different sweetness as more bread is eaten by the people, and technical guidance of the use method of yeasts will be needed from this aspect also.

Since Indonesia is blessed with a rich variety of staple foods like, rice, tapioca and banana, it is inconceivable that bread will replace these foods rapidly. However, it is also important to have a long-range view that as the people's living standard rises and as modernization is achieved, demand for bread will increase. Since yeasts as much as 2,000 tons are imported even now, it is apparent that Indonesia should have real scale bakery yeast plants within the country.

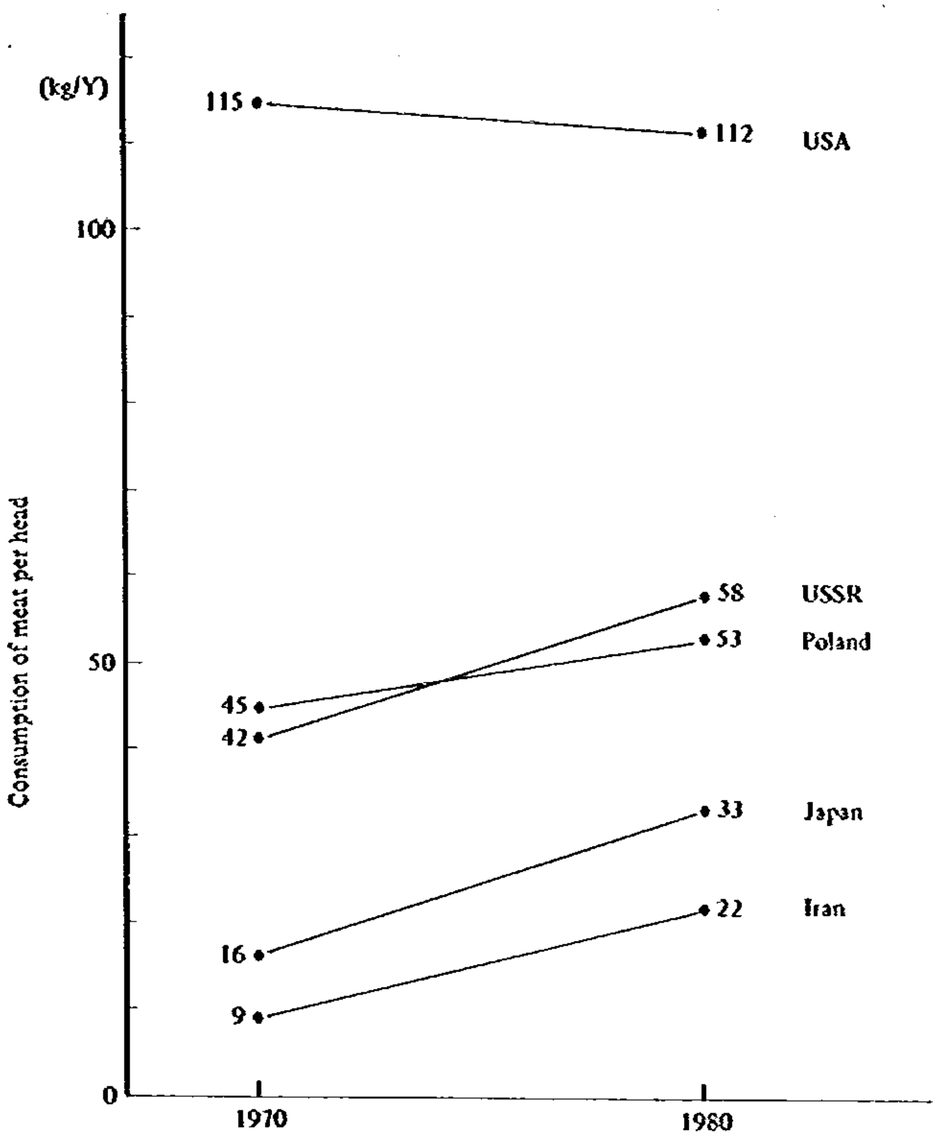
In planning bakery yeast plants, however, careful consideration must be given to establish appropriate distribution of bread bakers and improvement of bread distribution channels in each area since bread is very closely related with people's daily life. Bread is directly connected with people's dietary life and we think it better that bakeries are managed by private concerns rather than by the government.

If there are any plans in which the government directly manage or guide, for example, a school lunch program of national scale, it is possible that bakeries and bakery yeast plants are distributed in the national scale to ensure bread is adopted as the supply food. We are providing this opinion for reference only since we have not had the opportunity of confirming the government policy on the school lunch program.

3.5.2 Feed Yeast

As the income increases, people expect more for the higher living standard, and dietary life is an important factor of the living standard. In Indonesia also, a better level and modernization of the dietary life are taken up as an important mission of the government.

It is known historically that as the income level of the people rises, the dietary life tends to eating more meat. While the data is in the limited scale, Fig. 3-4 shows the trend of dietary life in 5 countries. Except USA which is in the state of saturation already, it indicates that the meat consumption is in the up trend in all these coutnries despite the fact that each of these country has different eating habit and social conditions. Although there is no available data on Indonesia, it is assumed that the same tendency exists or meat consumption will increase in Indonesia also.



Source: NHK

Fig. 3-4. Consumption of Meat in Several Countries

Accordingly, promotion of stock breeding industry is an important subject in Indonesia and the government is already taking measures. To promote the stock breeding industry, various measures such as modernization of the breeding method, enforcement of the feed supply power, modernization of the meat processing industry and improvement of the meat distribution sys tem must be taken on long-range planned basis, and among them, smooth supply of the feed is very important. The fodder yeast taken up in this clause must be taken as the effective measure to provide enough protein to animal. Effective utilization of protein resource must be promoted under the guidance of the government.

Fig. 3.5 shows the development situation of important domestic animals and poultry from the data of "Informasi Data Peternakan, 1982". Majority of the swine, duck and local chiken shown in the figure seem to be reared by local farmers. Since the number of these animals and poultry has constantly been increasing, it is assumed that the latent demand to them is great.

On the broilers and layers, the number has been sharply increasing since the third development plan started in 1979, and it can be said that the age of the mass-production modern breeding system is starting now. Since Indonesians like chiken meat, increased production of broilers and layers is very important to provide good quality protein to the people.

Along with the production increase of broilers and layers by adopting the modern breeding system and equipment of good sanitation control, study of cooperative type breeding for local farmers would be an important point for development and modernization of stock breeding in Indonesia.

Stable supply of feed is an important pillar to support development of the stock breeding industry. According to the "Industrial Statistics, 1980" of BPS, there are 32 live-stock feed manufacturers (including 7 large manufacturers) at present in Indonesia and their production in 1980 is about 600,000 tons or 6,000 million Rp (Fig. 3-6). It seems that feed used by local farmers is not included in the statistics. The feed types basically used are dried cassava, maize, copra cake and bran and they are all available in Indonesia. Majority of the protein resources are soybean meal and fish meal, and majority of the soybean meal must be imported.

Fig. 3-7 shows the trend of use of soybean meal and fish meal as learned from the BPS data. The quantity of soybean meal and fish meal used rapidly increased since about the start of the third development plan, as reviewed in Fig. 3-5, so is the number of live-stock feed manufacturers. However, what must be noted is that majority of these raw materials must be imported. Start of using these good quality protein resources indicates start of the modern live-stock breeding industry in Indonesia, but at the same time, it creates a new problems of

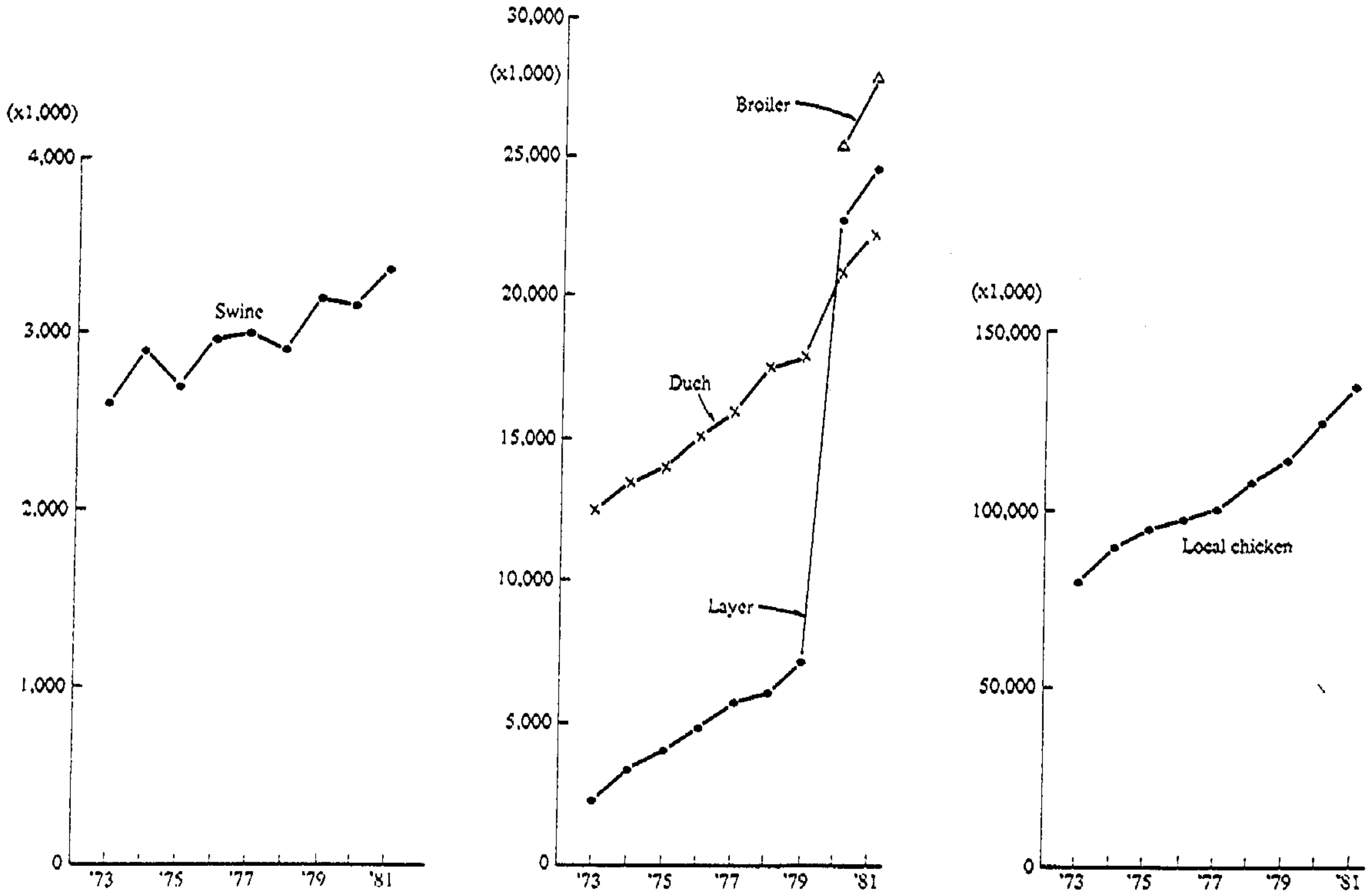
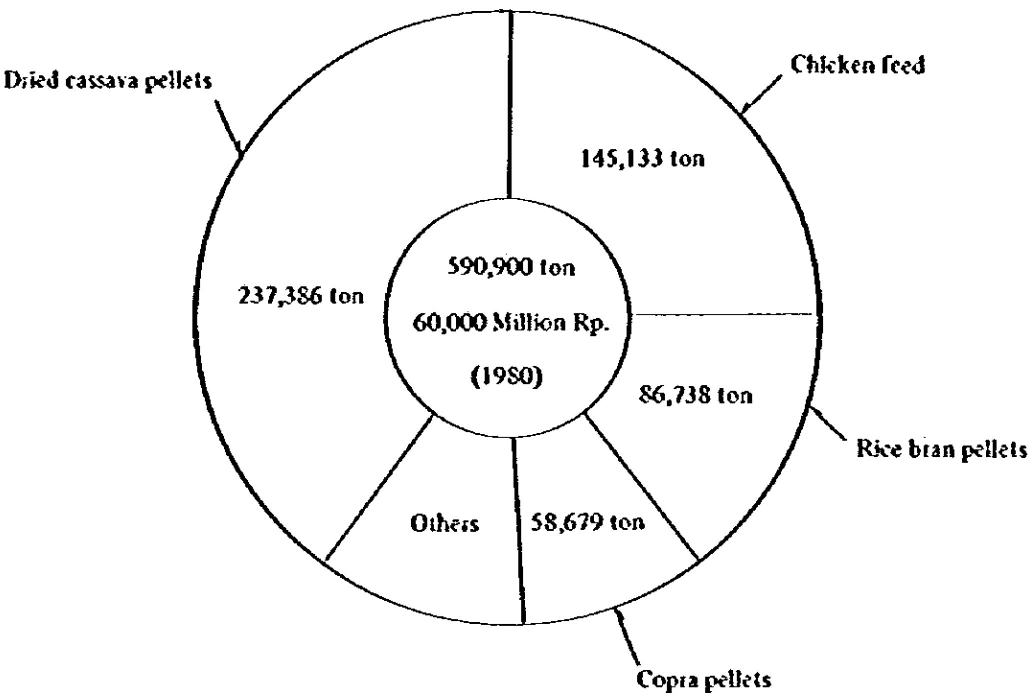


Fig. 3-5 . Population of Swine, Poultry and Others in Indonesia



Source: Industrial Statistics 1980 (BPS)
(Manufacture of cattle food, Code 31,280)

Fig. 3-6. Production of Animal Feed in Indonesia (1980)

Source: Industrial Statistics (BPS)

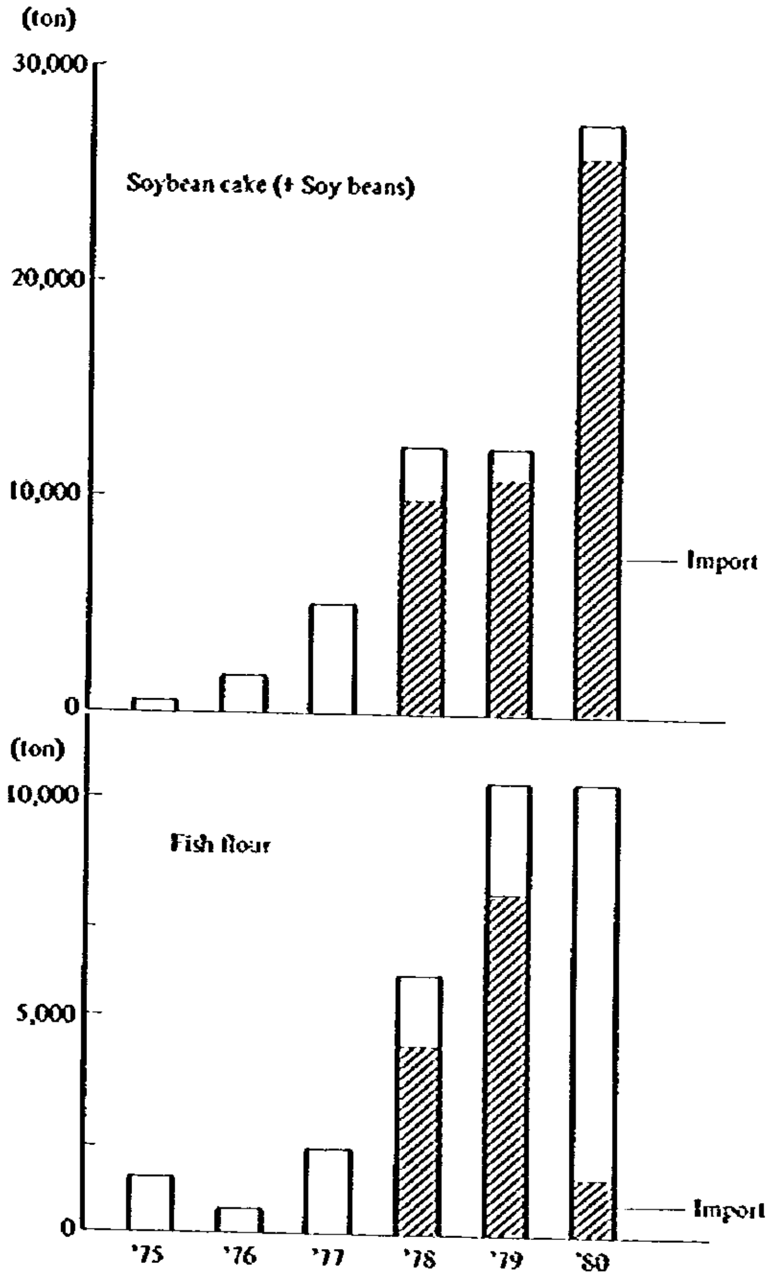


Fig. 3-7. Soybean Cake and Fish Flour for Animal Feed in Indonesia

what kind of protein resources for feed should be supplied and how to lower the dependency on import.

Generally, in modern live-stock breeding, the feed mainly consists of cereals, protein resources (fish meal or soybean meal) as the main protein and added with an adequate amount of premixes such as vitamines, minerals, antibiotics, hormones, enzymes, and amino acids. While there seems to be no particular problem in the cereals because of the abundant supply of agricultural products, to repeat ourselves, it is very important that long-range measures are taken on the protein. Since the catches are decreasing in the world scale, the price of fish meal fluctuates largely in addition to its being dear and it is not advisable to plan depending on fish meal as the protein supply source. In the United States, where the modern live-stock breeding is most advanced, use of fish meal in live-stock feeds is no longer as great as it used to be, and soybean meal replaced fish meal. Furthermore, the recent trend is adding amono acids (methionine and lysine) to corn. Since Indonesia must import soybeans, different from the United States, how to secure the protein resources to replace soybean meal and fish meal must be studied from the long-term viewpoint.

Speaking of the long-term views on food stuffs, it is necessary to consider an age of food shortage because of rapid increase of the population in the world, and it is conceivable that a part of cereals for live-stock may have to be used for human being. Men have to be prepared for the time in which very inferior cereals will have to be fed to domestic animals and poultry.

Production of fodder yeasts for animal as one of the use methods of cane molasses comes up from such analysis of the world situation. A conceivable first step to promote the live-stock breeding industry is to supply fodder yeasts, making the feed producers and breeders to be aware of the economical and efficient use of the feeds. As the second step to take when the modern live-stock breeding is developed and use of the economical and efficient feeds becomes common, the feed system is switched to a better one in which the feeds have more balanced amino acids. For this reason, amino acids, especially lysine fermentation, should be the item to take up after use of fodder yeasts becomes a common practice.

The survey team was unable to obtain much information on the current situation of fodder yeasts for animals in Indonesia. However, as an example, we take up our study in the east Java in the following.

In the east Java, P. T. Sumber Protein is producing 200 tons of fodder yeasts for animals monthly, consuming 10,000 tons of cane molasses a year. These yeasts are mainly used to poultry feed. The products are dried in drum dryer and we understand its contains 48% crude protein and 5 to 6% moisture.

The information obtained from BP3G forecasts the following prospect on poultry and swine in the east Java. These figures do not include poultry reared by individual farmers in small number each of up to several tens.

	Poultry	Swine
1979	2,300,000	54,000
1980	3,000,000	73,000
1981	3,700,000	65,000
1982	4,100,000	70,000
1983	4,600,000	74,000
1984	5,000,000	79,000

Feed production in the east Java required to feed these live-stocks is roughly estimated as follows.

		1982	1983
Feed production		394,000 tons	474,000 tons
Soybean meal requirement		88,000 tons	106,000 tons
Yeast	2% addition	7,800 tons	9,500 tons
	4% addition	15,600 tons	19,000 tons

Based on a plan of substituting a part of soybean meal with fodder yeasts, and supposing that the yeast is to be added in the rate of 2% or 4%, the expected yeast demand in 1983 is 10,000 to 20,000 tons. While we consider that substituting the whole part with fodder yeasts is not good, since the supply ability of Sumber Protein is only 2,400 tons a year, it is quite apparent that much more supply ability of fodder yeasts is needed.

This is a very rough analysis, but since a market size of 5 times as much as the above can be expected in consideration of the population ratio of the east Java to the whole Java Island, and no doubt the demand for fodder yeasts will continue to grow. For this reason, we think it practical to select an area in Java as a model area, construct a fodder yeast plant having a capacity of 10,000 to 20,000 tons a year, and to settle use of the modern feed to animals, for the purpose of substituting a part of soybean meal and fish meal, import of which will certainly increase from now on, and such trial will serve the other purpose of utilizing the cane molasses.

3.6 Citric Acid

Consumption of soft drinks is increasing in Indonesia. According to "Industrial Statistics, 1980" of BPS, the production of soft drinks in 1980 amounted to 24,000 million Rp. However, the document indicates that the citric acid consumed as the raw material for these soft drinks was 13 tons in total out of which 2 tons were imported. These figures look too small.

According to the information we obtained from the related circles, there are 6 citric acid manufacturers in Indonesia, including those being planned or constructed. The estimated consumption of citric acid used for refreshment drinks, medicines and cosmetics is slightly over 2,000 tons a year, Fig. 3-8 shows the estimated consumption of citric acid. As it shows, the consumption is increasing at a high pace and from this we can see that the domestic production is increasing rapidly. Some amount of citric acid is being imported from Taiwan and China, but the import is on the declining trend.

In Indonesia, citric acid is wholly produced by the surface culture method using cassava starch and no cane molasses is used. A large amount of citric acid (350,000 to 400,000 tons) is being produced by the submerged culture method out of molasses in other parts of the world, and in some areas glucose is replacing molasses since glucose is purer in the material state. The demand of 2,000 tons a year for citric acid is too small to justify for Indonesia to construct a plant of submerged culture method.

3.7 Antibiotics

The Government of Republic of Indonesia has a keen interest in the medical care of the people, and it aims to establish a supply system of medicines of their own production, especially on antibiotics.

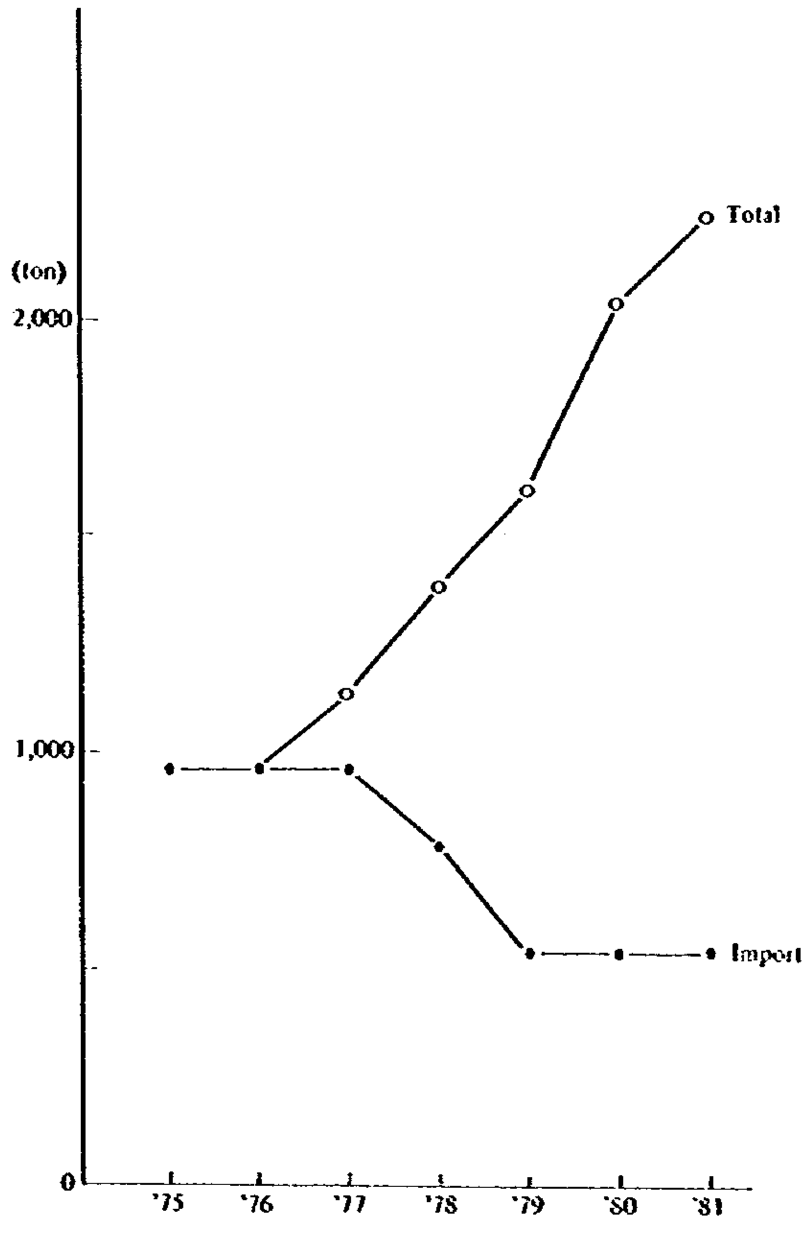


Fig. 3-8. Estimated Consumption of Citric Acid in Indonesia

The government is planning to faithfully implement WHO's drug policy applied to the tertiary countries and has the target of giving advanced medical treatments to the entire population of the country by 2000 AD.

The Essential Drug List issued to Indonesia based on the drug policy of UN/WHO covers 150 to 190 items and the types of medicines that the govenrment is contemplating to manufacture in Indonesia based on the list include antibiotics (Penicillin G, Tetracycline, Chloramphenicol, Neomycin, etc.) and super essential drugs (Aspirin, Metamizol, some sulfa drugs, and Vitamins C and B_1). This is the reason why antibiotics are taken up as objectives of fermentation industry production using the cane molasses.

The current situation of Indonesian medical industries can be broken down as follows.

Manufacturers of foreign capitals (30 foreign capital plants and 10 Indonesian plants operating under licensing)	About 40 companies
Indigenous capitals	
(Medium to large)	15 companies
(Small)	200 companies

Among the companies of indigenous capitals, KIMIAFARMA is a nation-founded company and INDOFARMA is under the control of the government. All othrs are privately owned companies, and the majority are very tiny companies. It is said that the emphasis for development is placed on these two companies with other private enterprises (including foreign capital enterprises) supplementing the two companies.

Fig. 3-9 shows the import trend of medicines and materials for medicines from the BPS statistics. The import rapidly increased in the past 5 years, and in 1980, the amount became close to US$600 million. The medicine self-supply policy of the Indonesian government is very understandable.

Fig. 3-10 shows the import trend of antibiotics from the BPS statistics. The import amount has been increasing year by year, exceeding US$40 million in 1981, and the import increased to twice as much in 4 years. Antibiotics are being imported from many countries, but the major supply countries are Italy, West Germany, Singapore, China, France and Japan.

Source: BPS

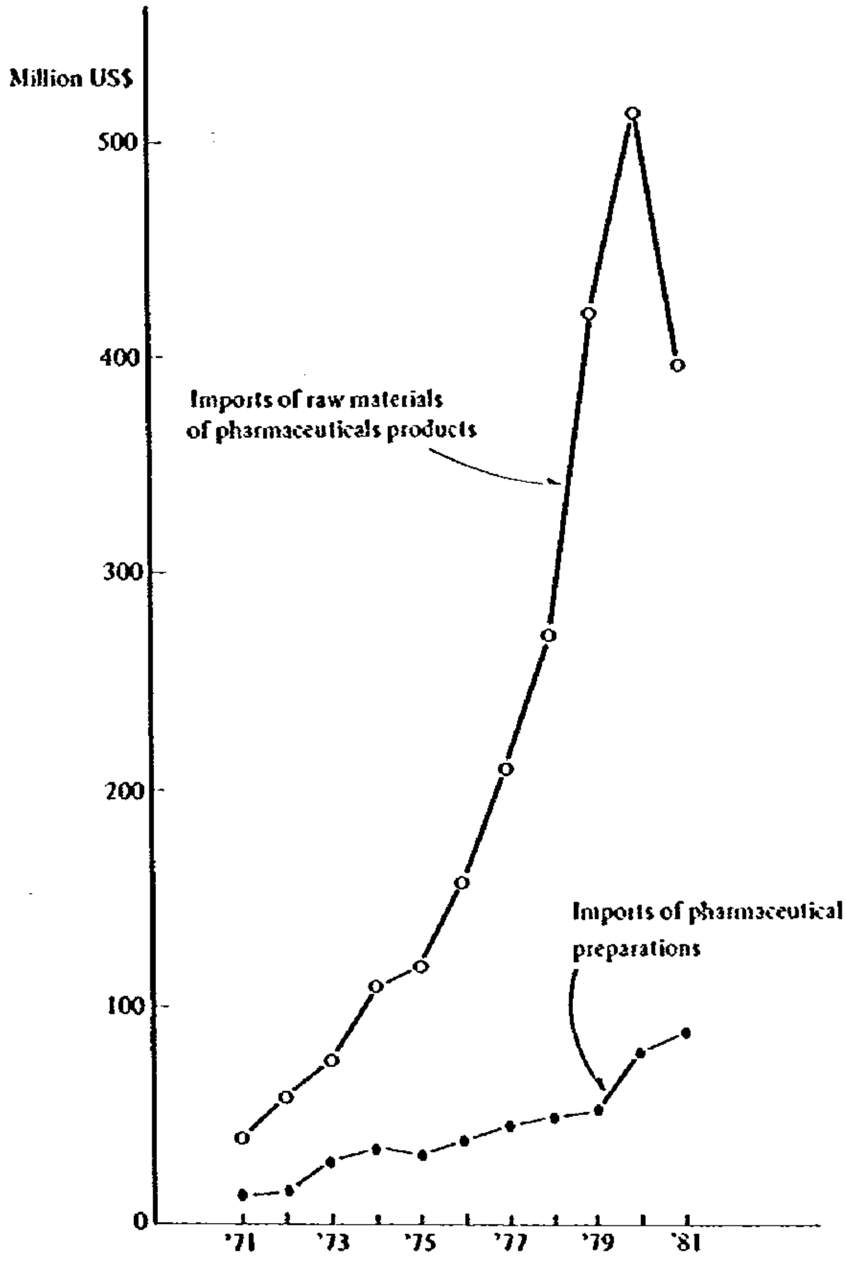
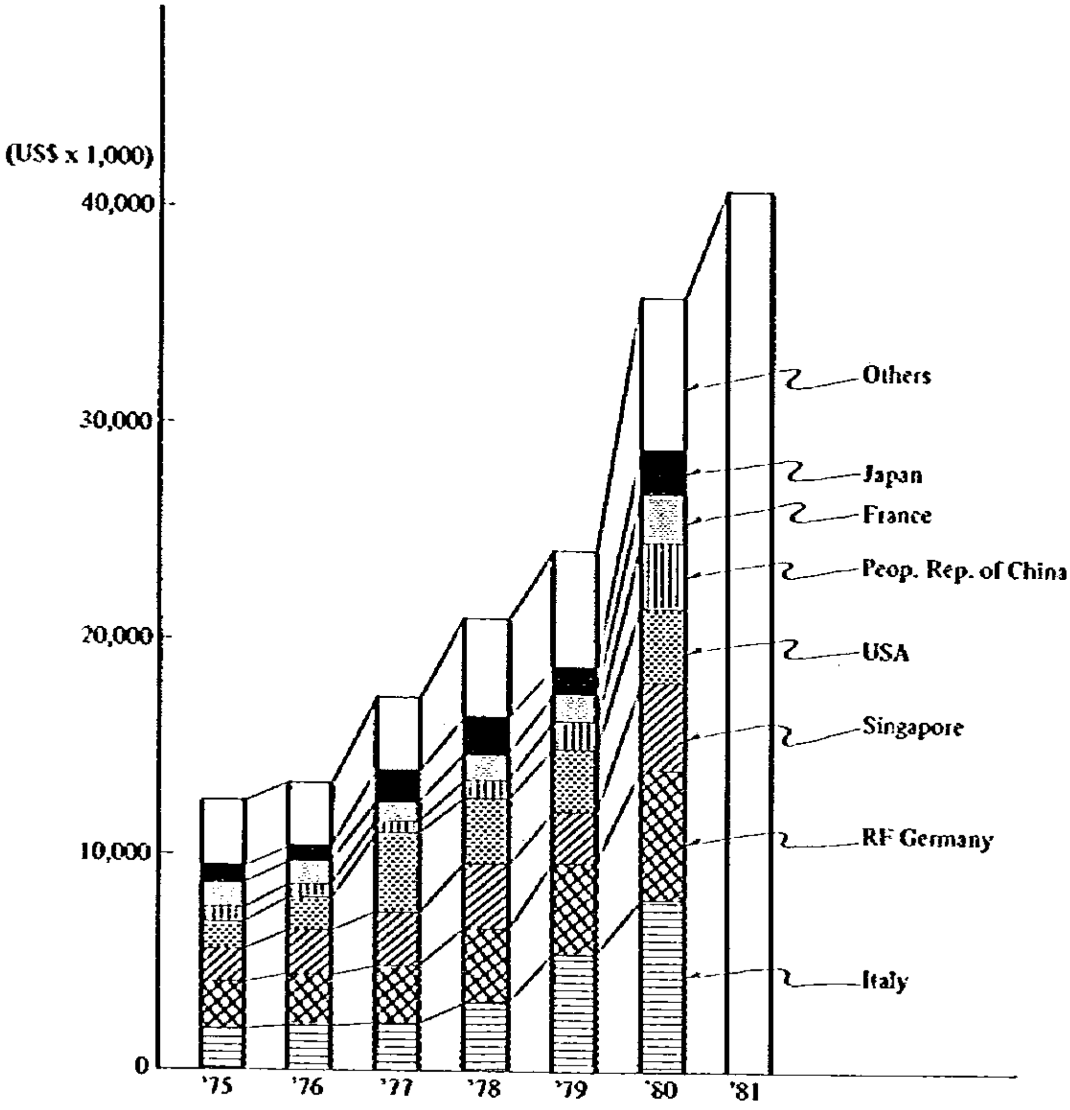


Fig. 3-9. Import of Pharmaceutically Related Material in Indonesia



Source: Import (BPS)

Fig. 3-10. Import of Antibiotics in Indonesia

The 1981 edition of BPS's Industrial Statistics shows breakdown of antibiotic import as follows:

Penicillins	62 tons	US$ 5.4 million
Streptomycins	29 tons	1.5 million
Tetracyclines	182 tons	6.4 million
Chloramphenicol	99 tons	4.9 million
Other antibiotics	396 tons	22.8 million
Total	768 tons	41.2 million

The basic antibiotics of Penicillins, Streptomycins, Tetracyclines and Chloramphenicol occupy 45% of the total and the government policy of developing these productions to a self-supply level is understandable.

Normally, pure source of carbon such as glucose or starch is used as the raw material for fermentation production of antibiotics to lessen the complicacy and difficulty of the refining process in which the objective useful components are extracted from the culture solution. Therefore, while we can understand the zeal that the Indonesian government has to domestic production of antibiotics, we must say that the types of antibiotics that can be produced by using cane molasses are extremely limited. Also, it must be clearly understood that even if some antibiotics could be listed as objective items for production out of cane molasses, the quantity of cane molasses consumed for such production is very small. Nevertheless, since the production amount in the money sense is great, to replace even a part of import with domestic production is very meaningful.

Through the investigation, the survey team came up with an idea of producing a precursor of Chloramphenicol out of cane molasses or cane juice in some cases. Since the precursor is a medical use antibiotic, highly advanced production skill and equipment are essential but the idea seems to be worthy for review.

3.8 Acetic Acid and Vinegar

It seems that the reason why acetic acid is included in the group of production items is not for the value in the use of cane molasses but as a mean to consume the ethanol that is over-supplied from time to time. In other words, this plan aims at supply of acetic acid and solvents like ethyl acetate or butyl acetate as the raw material for refining of antibiotics by producing them as shown below.

Fig. 3-11 shows the import trend of acetic acid from the statistics of BPS. It is in the up trend and the amount of import in 1981 is a little less than 4,000 tons or US$3 million.

However, the method of producing acetic acid out of ethanol through fermentation is not used recently. Acetic acid is produced as a part of the petrochemical industry, and it is inconceivable that acetic acid produced by the fermentation process can compete with that produced by large scale petrochemical plants. Although the possibility of a new manufacture technology cannot be totally denied, at present, there is no practical process to produce acetic acid from ethanol through fermentation competitively. In Japan, ethanol is used as a part of material for edible vinegar, but this is a really exceptional case.

In Pakistan, there is an example of producing ethanol from cane molasses and the ethanol is used for acetate rayon production by converting the ethanol to anhydrous acetate. This example may be used as a reference from the standpoint of utilizing local alcohol plants in Indonesia, but in this report we are just introducing it since the background has not been analyzed in details.

As is well known, aceton and butanol fermentation using cane molasses was actually done in the past worldwide including Indonesia. However, nowadays, the production processes of aceton and butanol are incorporated with the modern petrochemical industry and reuse of the classic fermentation process is inconceivable. Nevertheless, in this field also, development of a new process employing a new biotechnology has been started and a new fermentation process using cane molasses may be developed in the future. At this moment, we must wait and see this development.

There is vinegar production in the field related to acetic acid. Vinegar can be produced from ethanol by the oxidative fermentation process. The BPS import statistics indicate that import of vinegar which used to be 40 tons a year abruptly increased to 400 tons in 1981. The exact reason for this sharp increase is unknown, but even with 400 tons of import, the money amount involved is US$130,000 and not large. Also, since vinegar is a kind of seasoning

Source: Import (BPS)

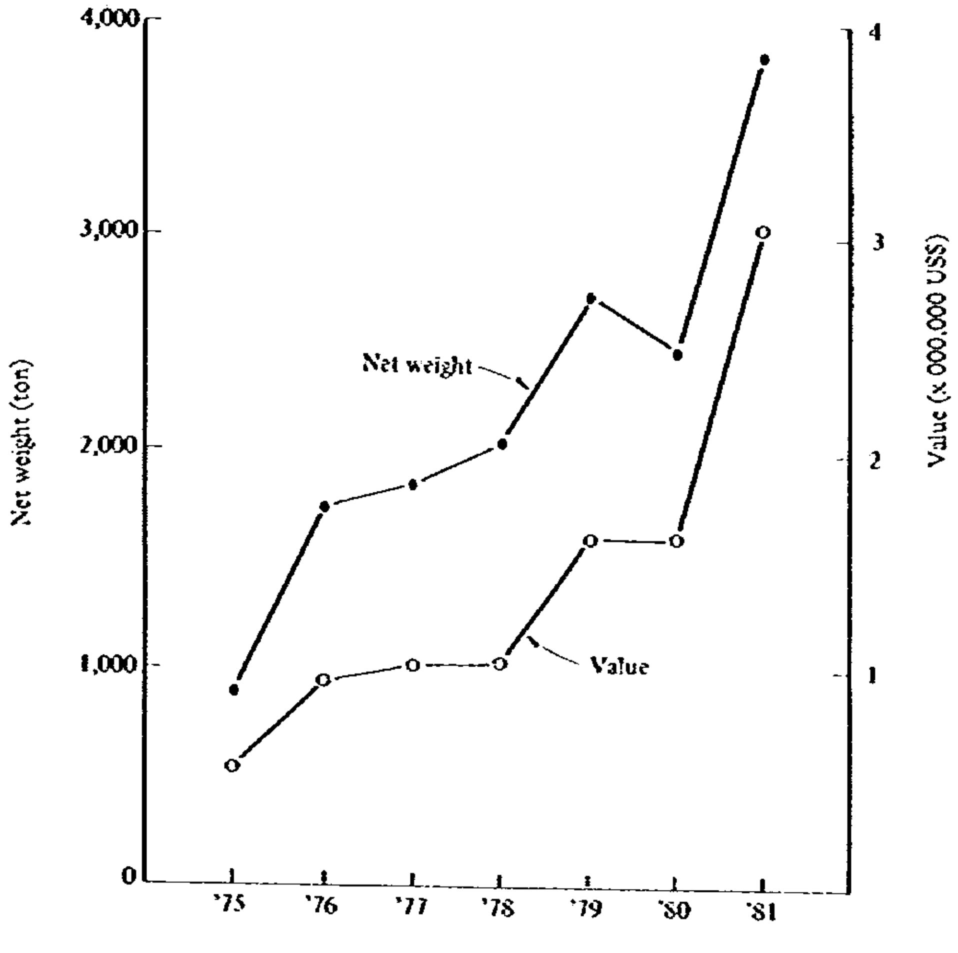


Fig. 3 11. Import of Acetic Acid & Its Derivatives in Indonesia and the majority is imported from China, the main consumption seems to be by Chinese restaurants and home use. (Fig. 3-12).

It is extremely difficult to make an exact forecast on seasonings which relate with people's eating habit, and we consider that this type item should be produced by private enterprises, as in the case of soya sauce, in Indonesia rather than by the government.

3.9 Summary

The analysis results on the 7 items of ethanol, MSG, yeast, lysine, citric acid, antibiotics and acetic acid, including the related fields, based on the statistics of the Indonesian government are reported in the preceding clauses, and we selected the following 3 items as possible products of the fermentation industry using cane molasses and to be conducted by the government:

(1) Ethanol as utilization of renewable resource and as an energy resource for the future

(2) Feed yeast for promotion and modernization of live-stock breeding industry

(3) Corynecin as one of a few antibiotics that can be produced from cane molasses

Recommendation

We had several feelings during the market analysis conducted this time, and we think that the following matters are key points for the Indonesian government to increase the sugar production and to promote use of the by-product cane molasses.

Firstly, PTP must have an integrated marketing ability. PTP is positioned to fully understand the basic policies and actual project plans of the government and it is very important that PTP has the ability of how to plan projects that would contribute to the welfare of the people under the long-range vision of the government and to study and establish plans which markets or which industries would be important to the nation.

The second point relates with the first point, and that is PTP must have a capacity to engage in sales promotion. Their mission should not end at fermentation production using cane molasses, but they must be capable enough to introduce their products to the markets and cultivate and lead new demands. At the same time, PTP must be operating in close contact with

Source: Import (BPS)

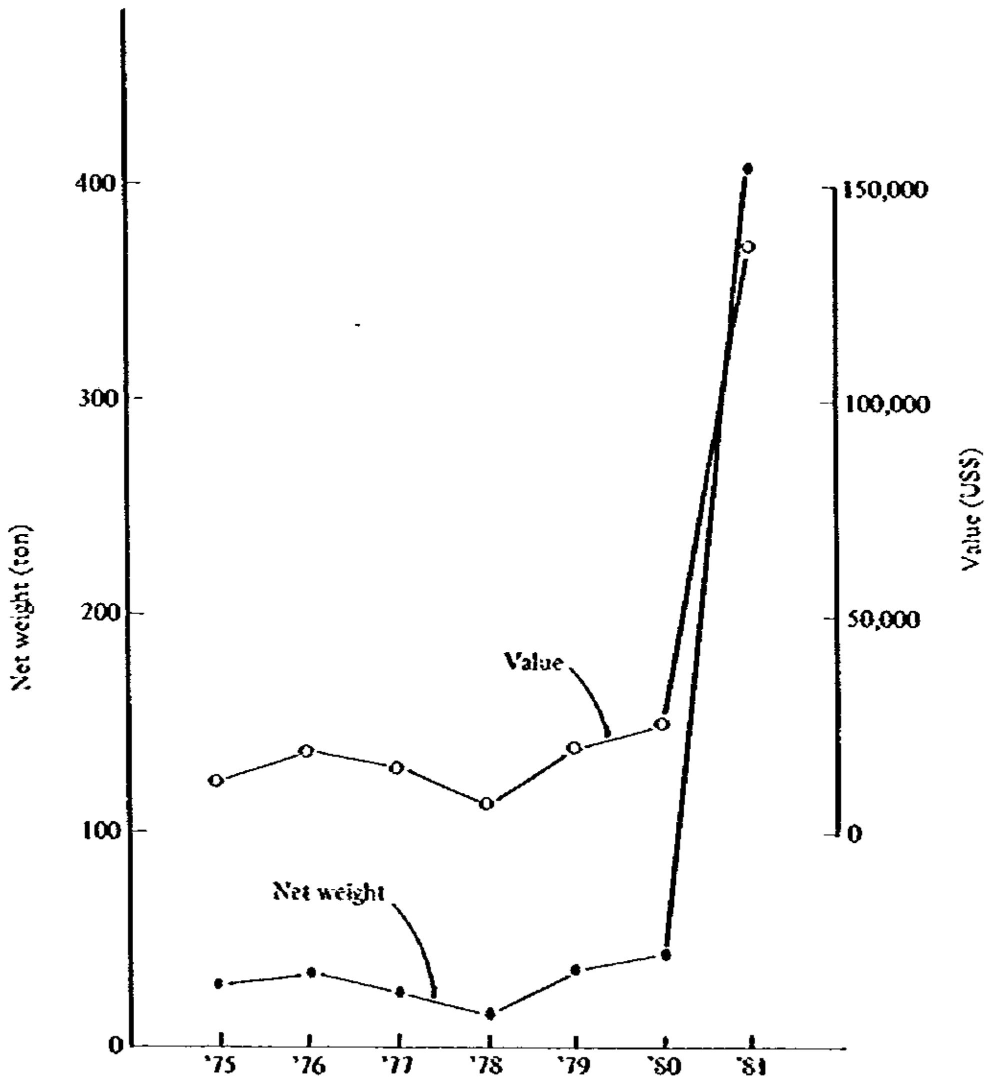


Fig. 3-12. Import of Vinegar in Indonesia

the industries and enterprises related to the fermentation products and must have views how they can contribute to development of the whole industries of the nation, as well as the power of implementating actual measures taken for the purpose.

The third point is establishment of a fermentation research laboratory. The desirable functions of the research laboratory are not mere studies of the manufacture processes but the laboratory should be able to engage in overall researches including the marketing techniques, technology guidance and industry development. We firmly believe that talents for new age are brought up in the laboratory and that these talents will form a precious leading power that pushes forward new industries and development of a new society.

3.10 Demand Forecast by Statistical Techniques

Our demand forecasts on fermentation products in Indonesia based on the various data adopted in this report and as the result of applying the statistical techniques are given in "Appendix".

Although the analysis given in the Appendix represents purely mathematical results applied to the basic data, we wish that it is treated for reference only, for, we anticipate that the foecast may not be precise enough in spite of the suprior statistical techniques applied since the number of basic data items collected is not large.

Nevertheless, the two statistical techniques we used in the analysis, trend analysis and double regression analysis, are superior techniques to predict future demand based on data of demand in the past, and we believe that they will be effective analysis emasures to make demand forecasts through the course of basic data items being accumulated in Indonesia. Therefore, we except that the contents of Appendix are reviewed thoroughly as very sueful reference materials.

The following describes some of our comments on these demand forecast data by the statistical techniques.

3.10.1 Bakery Yeast

The forecast based on import statistical data of natural yeasts from 1975 to 1980 indicates a latent demand of 4,000 tons in 1986. This seems to be useful information for review of countermeasures of bakery products being propagated, the subject described in 3.5.1.

3.10.2 Antibiotics

The forecast based on import statistical data of antibiotics from 1975 to 1981 indicates that the import of antibiotics will greatly expand, exceeding US$60 million, in 1986. As described in 3.7, domestic production of antibiotics is a very important subject in Indonesia. While antibiotic production using molasses is not a process that is commonly adopted, we selected Corynecin production as the precursor of Chloramphenicol since we judged that it would provide a foothold for domestic production of antibiotics.

3.10.3 MSG

On MSG, the forecast is made based on import statistical data from 1975 to 1981. It indicates the possibility of importing about 10,000 tons in 1986, but we would like to caution that the reliability of the statistical numerics used on MSG is not as high as on those used for forecast of other products. In spite of this, a latent demand does exist on MSG, and we judge that the government is required to take measures to lead the existing MSG producers, who appear to have excessively large capacities than the actual need, toward the right direction.

3.10.4 Fuel Oil

The forecast was made based on the data of fuel oil consumed in Indonesia during the period from 1963 to 1977. Rapid increase of fuel oil consumption is foreseen, exceeding 1,900 million Kℓ in 1986. While the petroleum policy of how to manage this demand growth is a subject separate from the project that we are taking up in this report, the Gasohol Programme is one of the measures to solve this program as is commonly known. We took this up as an important market of ethanol and selected ethanol as the promising item for this project.

3.10.5 Numbers of Chickens and Pigs

We took up local chickens and pigs as representatives to study the growth of farm animal and poultry in Indonesia. According to the forecast prepared based on the statistics from 1973 to 1981, the number of pigs is 3.3 million in 1986 which is not a large growth. However, on local chickens 130 million in 1981 will increase to 180 million in 1986, which is a very growth rate of close to 40%. The statistical review also provides highly reliable results backing up the rapid growth, and as described in 3.5.2, we judge that there is a latent demand supporting the importance of the feed yeast.

Chapter 4.

INVESTIGATION ON BASIS OF THE PROJECT

Chapter 4. INVESTIGATION ON BASIS OF THE PROJECT

4.1 Fermentation Industry

4.1.1 History of Fermentation Industry

In the fermentation industry, substances of high added values are produced by useful microorganisms acting on materials of agricultural products and their by-products or waste. Since before the birth of Jesus Christ, mankind has had the knowledge of brewing alcohol drinks by alcohol fermentation of cereals that were saccharificated with saliva. Also, there are many traditional food stuffs utilizing the metabolic activities of microorganisms all over the world. Japan has MISO (bean paste), SHOYU (soy sauce) and NATTO (fermented soybeans), and Indonesia has a food stuff called TEMPE. Yet, industrialization of products other than alcohol and bakery yeasts, utilizing metabolic activities of microorganisms, started and stabilized only in the 20th century.

In Germany, the fermentation industry developed in a large scale in such fields as glycerin fermentation to fill the shortage of gunpowder during World War I, or production of edible yeasts to manage the shortage of food stuffs. Since then, the citric acid fermentation was industrialized in Europe utilizing molasses and the aceton butanol fermentation was industrialized in USA utilizing corn. While the citric acid fermentation is conducted in industry scales even now, the aceton butanol fermentation declined as the petrochemical industry developed from the 1950's.

The discovery of Penicillin by Fleming of England in 1929 and application in the medical field during World War II and discovery of Streptomycin by Waksman of USA in 1943 initiated development of a new field of industrial fermentation production of antibiotics. From that time on, production of antibiotics by the fermentation method occupies a large share in the pharmaceutical industry.

The fermentation production of antibiotics brought in advancement of new technologies such as development of large submerged fermentation vessels and improvement of fungus stocks by the genetic technologies.

Based on these new technologies, the fermentation techniques of amino acid, especially Mono Sodium Glutamate (commonly called "MSG") were established by Kyowa

Hakko (Japan) for the first time in the world. The technique employed in it is fermentation while controlling the metabolic activities of microorganisms, and its feature is that a large amount of amino acid, which was confined inside of the cell membrane of microorganisms in the conventional techniques, can be accumulated in a culture solution by modifying their metabolic activities through artificially induced genetic mutations. Following MSG, essential amino acid of various other types, such as, lysine, threonine, is produced in this new method. Also, nucleic acid having good taste and pharmacological substances related to nucleic acid are produced by application of this technique.

Standing on mass-production of bulk products such as alcohol, MSG, citric acid and antibiotics, the fermentation industry at present is developing its way for the future to produce substances of even higher added values by developing technologies such as fine chemicals and interferon.

Separate from the above mentioned technology development, much effort is being paid in production of fuel alcohol by fermentation method as energy to replace the petroleum in countries having abundant agricultural resources but no petroleum. Brazil is a good example, and there the alcohol production in 1981 is said to be over 4 million Kℓ. Even in the United States, much alcohol is being produced from corn nowadays, and farmers are trying to self-supply the energy consumed in their farmland. In all Southeast Asian countries, alcohol production plans are being studied under leadership of each government.

4.1.2 Characteristics of Fermentation Industry

The basic characteristic of fermentation industry is use of microorganisms as catalysts, and in the catalysis multiple stage reactions can be completed with one microorganism. Furthermore, since thereaction is conducted under conditions of normal temperature and pressure and neutral pH area, the reaction completes in fermentors of fairly simple structure, and this provides the merit of the vessels being designed and manufacturered for multiple purposes. On the other hand, it has a disadvantage of being extremely sensitive to contamination. Therefore, particular care must be paid to sterilization of the materials and maintenance of sterility of the fermentors.

So-called renewable sources of agriculture products in sugar or starch families are the source of carbon which is the main material of the fermentation industry. Staple supply of these materials is the essential condition of the fermentation industry and as the natural result, development of agriculture as its peripheral industry and secondary effect of absorption of labor can be expected with the fermentation industry.

Furthermore, the fermentation industry can be a basic industry in relation with other industries. For example, 490,000 Kℓ of alcohol are produced annually by the fermentation method in India, out of which 360,000 Kℓ are converted into chemicals such as ethylene glycol, styrene, acetic acid and aceton. The same examples are observed in Pakistan. Industries of this type conversion are possible in areas where the fermentation materials are comparatively low priced, and the matter should be studied for Indonesia as well.

4.1.3 Essential Conditions of Fermentation Industry

Water is a physically essential item to establish a fermentation plant in a new site. Good quality water is needed as process water since catalysis of microorganisms is conducted in an aqueous system. Also cooling water is needed to keep the reaction temperature at the optimum level since the catalysis is an exothermic reaction. In tropical areas like Indonesia, the temperature of used water is high and enough Δt is not available in many cases, and so much more cooling water must be used. Accordingly, availability of enough water is a crucial condition.

Also, sufficient precaution must be paid to processing of the distillation stillage in the case of fermentation of cane molasses. Even if the COD or BOD is lowered to a permissible level, the colored stillage coming from the cane molasses color givès unfavorable impressions psychologically. While high cost of waste liquor processing is a large burden to any industry, in the case of fermentation, consideration must be paid particularly to the possibility of existence of the industry itself being questioned unless a rational processing method optimum to the regional requirements is employed, since a large amount of water and cane molasses, which is a colored substance, are used in the fermentation industry.

Another essential condition for th fermentation industry is the scientific foundation. Let us take an example of Japan. Annual production of fermentation industreis in Japan is estimated to amount to ¥3,500,000 million from various available data, sharing about 2% of Japan's GNP (Table 4-1). The basic reason for such advancement of the fermentation industries is that the Japanese people have been appreciating fermentation food stuffs like SAKE (rice spirit), MISO (bean paste), SHOYU (soy sauce) and preserved vegetable, but it is nothing but a reflection of Japanese companeis' constant effort of investing 2 to 3% of th sales proceeds to research and development and a result of research and development activities of engineers who have received high level education.

In Japan, about 2,500 students graduate form national, municiapl and private universities and colleges, mastering a science called "agricultural chemistry" which relates to fermentation. Also there are many scientific societies which publish research and development

Table 4-1 Production of Fermentation Industry in Japan

Beverages	¥2,307 Billion
(Beer, Sake, Whisky, Liquor)	
Soy Sauce	¥584 "
Miso Paste	¥205 "
Seasonings	¥114 "
(MSG, Nucleic Acid)	
Citric Acid	¥40 "
Vinegar	¥37 "
Ethanol	¥24.5 "
(Industrial Use)	
Bakers Yeast	¥16 "
Amino Acid (Lysine)	¥12 "
Enzymes	¥4 "
Total	¥3,464.5 Billion Yen

results and provide a field of technology study, and to name some of them, they are The Agricultural Chemical Society, The Society of Fermentation Technology, The Society of Food Science and Technology, and The Brewing Society of Japan.

If Indonesia wants to develop its own fermentation industry, efforts must be made to establish the foundation for many many years. We consider that an industrial nation cannot be built from easy technology transfer only.

4.2 Desirable Fermentation Industry Products

In Chapter 3, we described the current situation and prospect of development of the market for 7 items which were selected as possible products for the fermentation industry of this project, and in it we suggested 3 items of alcohol, fodder yeasts for animal and Corynecin (precursor of antibiotic Chloramphencol) as desirable fermentation industry products. The following describes the reason for recommendation on each item.

4.2.1 Ethyl Alcohol (Ethanol)

Ethyl alcohol can be produced most easily from cane molasses by the fermentation process. In Indonesia, there are already 13 ethanol plants having a total capacity of 58,000 Kℓ per year. Yet, the estimated production in 1982 is only 26,100 Kℓ, or only about 45% of the capacity (Table 5-2). This inactivity is caused by poor export and poor competitive position in the price against methanol for use as a chemical in the domestic consumption.

For this reason, we would like to recommend ethanol as an alternative fuel to the Indonesian government. From what we were told by BPPT, the government had planned an alternative energy policy by intermingling an immigration policy into peripheral areas and ethanol production from cassava, and the plan is in the stage of implementation study already. We believe that both SBPN and PTP strongly promote ethanol production as an alternative energy as one of the effective utilization of cane molasses which will be produced more and more in the coming years.

As Table 5-3 shows, the total consumption of petroleum products in Indonesia in 1980 is about 22,000,000 Kℓ, out of which 32.7% or 7,200,000 Kℓ are consumed by transportation industry. About 50%, or 3,700,000 Kℓ of the transportation industry consumption are gasoline. The consumption of petroleum products by the transportation industry in increasing at a rate of 8 to 10% per annum. Since it is said that the petroleum reserves in Indonesia would last form the coming ten some years only, saving of the petroleum resource by substituting about 10% of the domestic gasoline consumption with ethanol is very meaningful. 10% of 3,700,000 Kℓ gasoline is equivalent to 370,000 Kℓ of alcohol, meaning about 6 times as much as the current production are needed and this would consume about 1.2 million tons of cane molasses.

Even if the use is limited within the Java Island in consideration of the distribution expenses, demand for 60% of the figure can be expected. Ethanol is an essential production item since it consumes a large amount of cane molasses.

In the past, the batch system fermentation, as in the case of Comal alcohol plant, was the main stream of ethanol production. There are new processes like the yeast recycle method as employed by the Jatiroto alcohol plant (Austrian technology is introduced to the Jatiroto plant), but for this project, we would like to adopt the immobilized yeast process which is being developed at the Research Association of Petroleum Alterantives Development with Kyowa Hakko acting as the core. Instead of the alcohol fermentor used in conventional systems,

Table 4-2 Existing Ethanol Factory, its Capacity and Actual Production in 1982

Factories Location	Capacity (kl/day)	Production (kl)
P.A. Palimanan	10	1,600
P.A. Comal	18.5	2,000
P.S. Jatiroto	20	1,500
P.A. Madukismo	20	2,000
P.S. Padahardja	10	1,000
P.S. Madusari	12	3,000
P.A. Asan Pabuaran	56	13,500
P.A. Permata Sakti	18	1,500
P.A. Basis Indah	10	–
P.A. Sari Murni	8	–
P.A. Sari Kengnga	5	–
P.A. Nabati Sarana	6	–
P.A. Malindo Raya	10	–
Total	193.5	26,100

(Source: KAPB)

Table 4-3 Petroleum Products Utilization in 1980

(Unit: kl)

Product	Transportation	Industry	Electricity	Household	Total
Avgas	20,002	–	–	–	20,002
Autur	518,299	–	–	–	518,299
Super 98	74,448	–	–	–	74,448
Premium	3,707,350	–	–	–	3,707,350
Kerosene	–	–	–	7,783,372	7,783,372
Auto Diesel	2,698,368	2,893,098	775,217	–	6,366,683
Industrial Diesel	111,705	1,073,285	26,677	–	1,211,667
Fuel oil	69,260	1,266,291	1,209,811	–	2,365,362
Total	7,199,432	5,232,674	1,831,705	7,783,372	22,047,183
%	32.7	23.7	8.3	35.3	100

(Source: BPPT)

this immobilized yeast process converts cane molasses into ethanol by passing the cane molasses through a column in which yeasts are adsorbed onto carriers, and the ethanol production speed per unit volume and unit hour is extremely fast. This enables the equipment to become compact, subsequently reducing the equipment investment, and we think it is particularly suitable for production of ethanol of alternative energy.

The current ethanol ex-factory price is 265 Rp per liter and the gasoline price at gasoline stations is 240 Rp per liter. When alcohol is produced by a rational production system and as long as the cane molasses price is maintained at the present level, there is a good possibility of the ethanol price coming down and much interest can be had in this ethanol project since the petroleum product prices are on the increase tendency.

4.2.2 Feed Yeast

According to the data obtained from the Cattle Production Bureau, Agriculture Ministry, the number of live-stocks in the Indonesian live-stock breeding industry is increasing rapidly in recent years. As shown in Table 4-4, the numbers of live-stocks which can be fed with compound feeds in 1980 are about 3.4 million of swine, 130 million of chiken, 25 million of layer and 28 million of broiler.

Table 4-4 Livestock Population in Indonesia

(Unit: 1,000 heads)

	Swine	Local chicken	Layer	Broiler
1973	2,622	79,906	2,202	
1974	2,906	89,650	3,450	
1975	2,707	94,572	3,903	
1976	2,947	97,504	4,878	
1977	2,979	101,686	5,807	
1978	2,902	108,916	6,071	
1979	3,183	114,350	7,007	
1980	3,155	126,310	22,940	25,462
1981	3,364	132,878	24,568	28,110

(Source: Information Data Peternakan)

There are the following 7 feed manufacturers all of which are large in the scale:

Jakarta

P.T. Charoen Pokophand Indo Animal Feed Mill

P.T. Bina Satwa

C V Subur/dh C V Indo Feed Mill

Eastern Java

P.T. Bama

Central Java

Eka Poultry

P.T. Printis Java

Western Java

P.T. Hirema

All these manufacturers produce compound feeds both for swine and chicken.

The total production in Indonesia is not known, but since 400,000 tons of compound feeds are produced in the eastern Java alone according to the BP3G investigation, the estimated nationwide production of compound feeds is about 3 million tons. At present, Indonesia cannot supply enough protein source, which is the most important part of compound feeds, and soybean meal and fish meal are being imported.

Therefore, to produce the protein source by the fermentation process of cane molasses in the form of fodder yeasts is very much desirable from the national viewpoint.

There is P. T. Sumber Protein, a company producing 200 tons of feed yeasts (containing 48% crude protein) monthly in the eastern Java and the yeasts are selling out at 250 to 280 Rp per kilogram.

If feed yeasts are used at a rate of 3% of the compound feeds, which is estimated to amount to 3 million tons, it means there is a market for 90,000 t/year of feed yeasts, and about 360,000 ton cane molasses can be consumed.

Feed yeast is an indispensable item as a large cane molasses consuming product after ethanol. From business operation viewpoint, since it is processing of cane molasses of 20 Rp/kg to feed yeasts of 280 Rp/kg, it is a very advantageous item as long as there is a market.

While bakery yeasts seem to be a fairly interesting item after fodder yeasts depending on changes of the eating habit of the Indonesian people, it takes some time until the market is established to a staple state since the cold chain distribution system must be improved. However, since Indonesia is already importing active dry yeasts from European countries in the quantity of 1,000 to 2,000 tons a year, bakery yeasts should be taken up as a review item in the next occasion.

4.2.3 Corynecin (Antibiotic)

The Government of Republic of Indonesia is studying how to faithfully implement the WHO's drug policy and has a goal of giving advanced medical treatments to the whole population by 2000 AD. The Essential Drug List that UN/WHO determined to Indonesia covers items as much as 150 to 190, and the bulk medicines that the government is contemplating to produce domestically are antibiotic group and Aspirin, sulfanilamide and its derivatives, and Vitamin B_1 and C, which are called super essential drugs.

The amount of these medicines being imported is about US$600 million in 1980, which can be broken down to US$80 million of completed medicines and US$500 million of medicine materials. Import amount of antibiotics is US$40 million or accounting about half of the completed medicines. Among the imported antibiotics, Penicillin ranks at the top with US$8 million and it is followed by Streptomycin of US$4 million, and Tetracycline and Chloramphenicol of US$2 million each.

None of these antibiotics can be produced from cane molasses. They have to be produced out of purer materials like starch or glucose through fermentation. However, Corynecin, which is a precursor of Chloramphenicol, can be produced through fermentation of cane molasses, and since Kyowa Hakko has experience of producing it with a field tank, this item is added as an objective product of the current feasibility study.

However, since the yield of Corynecin fermentation is not as high as that of amino acid fermentation and the refining process is long and complicated, industrialization of Corynecin fermentation bears very difficult problems of technological training for actual plant operation.

4.2.4 Treatment of Waste Water

How to dispose of the waste water is a subject that cannot be overlooked in the fermentation industry. This problem, however, must be solved by designing as rational and economical process that matches with the requirement of each district as otherwise, excessive investment and running cost of the treatment facilities will disturb the profitability of the operation itself. The survey team visited two plants during the survey travel in Java which were producing alcohol from cane molasses, but both of them were discharging the distillation stillage into a river without treatment. The larger fermentation plant is, the more difficult to dispose of the waste water including the distillation stillage.

Since the fermentation plant to be built in this project is supposed to be a model plant of PTP. We have determined to adopt the design for waste water treatment based on our experience.

In the system we adopted, the waste water is separated into two groups of thick portion and thin portion. The thick portion is condensed, mixed with bagasse and used as a fertilizer or soil improvement agent. The thin portion is diluted with the cooling water until it has values within specifications of the waste water disposal and then discharged.

In our plan, a compost is to be made by mixing about 100 tons of condensed liquor with 300 tons of bagasse in one day, and this has an additional advantage of effective use of baggase.

As to additional use of bagasse, pleurotus cystiosus can be cultured on a sterilized compost made by mixing and compressing bagasse, lime cake and rice bran. The pleurotus cystiosus is a kind of mushroom, being commonly called "abalone mushroom" and much of it is used in the Philippine, Malaysian and Taiwan cuisine. It is cultured under vinyl sheet coverage, but since the optimum conditions are said to be 24 to 30°C of temperature and 80 to 100% humidity, the Indonesian weather conditions are very suitable to it.

4.3 Production Capacity

The production scale is determined based on the quantity of cane molasses, the main material, that can be collected and the available quantity of industrial water which is the most important substance in the fermentation industry. Theoretically, it is possible to bring in 200,000 to 300,000 tons of cane molasses into the plant site by collecting them in all over Java Island, but such plan is not too advantageous since it will increase the expenses for transportation and storage. As described in the next clause, we have selected Ex Comal for the plant site as the result of current survey, and we have thought of a fermentation plant, as one unit, that consumes about 47,000 tons of cane molasses, which is the difference between the 91,968 ton cane molasses being produced by sugar factories under PTP15/16 which controls Ex Comal and the 139,154 ton cane molasses estimated for 1984. Supposing that the cane molasses is not produced for 4 months every year, even a plant of this size needs a cane molasses storage in the capacity of about 16,000 tons.

As to the availability of industrial water, while both of the Panji sugar factory of PTP24/25 and Pesantren Baru sugar factory of PTP21/22 are under restriction of 250 liters per second (about 21,600 m^3 per day), 500 liters per second (about 43,200 m^3 per day) out of the 1,000 ℓ/second canal flow is available in the Ex Comal site. Accordingly, the plant to be built anew in Ex Comal must be in the scale matching to the available water quantity. The high temperature of the water, which is 28 to 30°C, is an additional restriction naturally.

In consideration of these conditions, the production is set as shown below:

Ethanol	Approximately 10,000 Kℓ per year
Feed yeast	Approximately 3,300 tons per year
Corynecin	Approximately 19 tons per year

The estimated consumption of cane molasses is 48,400 tons with the breakdown as shown below. This is about equal to the difference of 47,000 tons between the current production and production of a few years later by the sugar plants under PTP15/16.

Cane molasses consumption for ethanol	33,000 tons
Cane molasses consumption for feed yeast	13,200 tons
Cane molasses consumption for Corynecin	2,200 tons
Total	48,400 tons

A plant of this scale requires about 40,000 Kℓ/day cooling water, but this is within the water take capacity of River Comal.

4.4 Site Selection

4.4.1 Proposed Plant Sites

The S/W of the preliminary survey team selected the following three sites for the plant to be newly constructed:

(1) Panji sugar factory, Situbondo area, east Java
(2) Pesantren Baru sugar factory, Kediri area, east Java
(3) Ex Comal sugar factory, Pekalongan area, central Java

The field survey team surveyed the proposed sites for about two weeks from December 4 to 16, 1982 and collected information to determine the site.

4.4.2 Plant Site Determination Conditions

Importance was placed on the following conditions when determining the plant site:

(1) Availability of good quality and ample water
(2) Problems in obtaining and transportation of materials and fuel
(3) Problems on transportation of equipment and materials for the plant construction
(4) Availability of suitable site for plant construction
(5) Easiness of drainage
(6) Possibility of causing pollution problem

The fermentation industry has its unique problems of necessity of a large amount of cooling water to maintain the culture temperature constant against the exotherm of microorganisms, steam sterilization for aseptic operation, consumption of a large volume of steam and electricity for evaporation condensation during the refinery process and generation of a large amount of waste liquor due to the use of cane molasses as the material, and sufficient precaution must be paid to these characteristics.

4.4.3 Recommended Plant Site

The field survey results on these three proposed sites are shown in Table 4-5. As the result of integrated judgement based on the above selection standards, we concluded that the Ex

Comal sugar factory would be the optimum. The decisive factors are as follows:

(1) Availability of good quality and ample water from the river, compared with other two sites.

(2) The site and environmental conditions are more favorable on the pollution control problem.

Outline of Ex Comal

(1) Site

This is located at a place of about 20 km north of Penkalongan in central Java and there was a sugar factory up to about 1944/45. The plant building is still existing in a fairly sturdy condition and within the plant site there are sporting facilities such as volley-ball and tennis courts, and welfare facilities which are open for the inhabitants in the surrounding area.

There are the PS Comal (alcohol plant) and PG Sragi (sugar plant) in the neighborhood and the site is favorable to construct a plant.

(2) Water supply

The industrial water can be taken from the irrigation channel running at a place of 300 to 500 meter distance from the plant. This channel is branching from the Comal river, about 13 km upstream, and enough water is running. The average flow is 1,000 liters per second, out of which 500 liters per second can be used by the fermentation plant.

(3) Drainage

There is a channel in the south side of the plant and the channel can be exclusively used by the plant.

The channel joins the Comal river at the downstream of about 4.5 km. The channel needs some repair work, but since it does not flow into the irrigation channel, hardly any influence is anticipated to the inhabitants and farmers in the area.

Table 4-5 Comparison of Proposed Site

1. Factory site

	Item	PANJI	PESANTREN	COMAL
1	Candidate Site	It's possible to utilize planting field outside of the existing factory (East side of the factory) Area: ±3.5 ha	It's possible to utilize the building area of the old sugar factory Area: ±13,000 m², (±90m x 150m)	It's possible to utilize the building area of the old sugar factory Area: ±13,000 m² (±75m x 230m)
2	Geological condition			
	1) Natural disaster			
	Storm	Nothing	Nothing	Nothing
	Earthquake	Nothing	Nothing	Nothing
	Flood	Nothing	Nothing	Nothing
	2) Height of ground level	13 m	90 – 100 m	8 m
	3) Ground water level	GL. – 3 m	GL. – 9 m	GL. – 5 m
	4) Bearing force	It's guessed to be good (1) New molasses tank near the candidate site hasn't piles	It's guessed to be good (1) Old building exist	It's guessed to be good (1) Old building exist

	Item	PANJI	PESANTREN	COMAL
3	Transportation of materials			
	1) Road	Near 1st class road	SURABAYA – KEDIRI: 130 km 1st class road KEDIRI – PESANTREN 2nd class road	SEMARANG – COMAL: 120 km 1st class road Main road COMAL – EXCOMAL: 2 km The pavement of road is not so good
	Size limitation	2.5 mW x 3.5 mH 7 T/axle	2.5 mW x 3.5 mH 1st class: 7 T/axle 2nd class: 5 T/axle	2.5 mW x 3.5 mH 1st class: 7 T/axle Main road: EXCOMAL 2 – 3 T/axle
	2) Rail	Only local	Branch from KEDIRI to near candidate site	Main rail way with branch is about 500 m distance from candidate site
	3) Port	BANYWANG: 91 km SURABAYA: 198 km	SURABAYA: 130 km	SEMARANG: 120 km CIRBON: 140 km TEGAL: 70 km
	4) River for cargo	Nothing	Nothing	Nothing

2. Water

	Item	PANJI	PESANTREN	COMAL
1	Kind of water available	RIVER & WELL	RIVER & WELL	RIVER & WELL
2	Quantity of water			
	(1) RIVER	1) Limitation (a) No treatment of waste water 250 l/sec. = 21,600 m^3/D (b) To supply for farm after treatment of waste water 700 l/sec. = 60,480 m^3/D	1) Permission for plant site 250 l/sec. = 21,600 m^3/D 2) Usage in existing sugar factory 160 l/sec. = 13,800 m^3/D Self-controlled 3) It will be necessary to lead new water from BRANTAS river Distance from the river to plant site about 8 km Ground level of plant site 20 or 30 m higher than the river Construction cost ±Rp 500 million	1) It is possible to get water from irrigating channel Distance from the canal to plant site is ±500 m 2) Water of the canal is leaded from COMAL river 3) Capacity of the canal Max. ±1,000 l/sec. = 86,400 m^3/D 4) The canal covers 100 ha plantation field 5) Demand of water for 100 ha RICE 1.2 l/sec. ha x 100 = 120 l/sec. = 10,400 m^3/D

Item	PANJI	PESANTREN	COMAL
			CANE 0.7 l/sec.ha x 100 = 70 l/sec. = 6,050 m^3/D 6) ±500 l/sec. (43,200 m^3/D) of water can be used for new
(2) WELL	1) Existing well capacity 110 m^3/H = 2,640 m^3/D Deep well x 1 (135 m) for human use and process water 2) It is possible to dig well by permission Permission fee = Rp500,000/1 well	1) Existing well capacity 30 l/sec. = 110 m^3/M Deep well x 3 (100 m) for human use, process water and boiler start up 2) It is possible to dig well by permission but there is limitation	1) Existing well capacity 40 l/sec. = 144 m^3/H 200 m x 1, 100 m x 3 for human use (for swimming pool) 2) It is possible to dig well by permission
(3) Cooling tower (Existing)	None	Cooling tower and spray pond for sugar plant (800 l/sec.)	Cooling tower for PG SRAGI 125 l/sec. x 3 = 375 l/sec. = 1,350 T/H Inlet: 45°C Outlet: 32°C

	Item	PANJI	PESANTREN	COMAL
3	Temperature of water			
	(1) RIVER	28°C – 30°C	28°C – 30°C	28°C – 30°C
	(2) WELL	29°C	29°C	30°C
		7 Dec. 1982 checked		15 Dec. 1982 checked
4	Analytical date of water		Data at 1977, Actual standard, 25 Aug. 1980	
	(1) RIVER	No data	pH at 25°C: 8.3	7 – 8
		Treated water for boiler	Hardness: 8.0 ppm > 7 ppm	No data
		(Ion exchange)	Oil: 0 < 2 ppm	0
		pH: 8.7	O_2 solved: 7.6 ppm < 2 ppm	No data
		Hardness: 0.3 ppm	T. Fe: 0 < 0.1 ppm	0.1 ppm
		Cl: 19.4 ppm	T. Cu: 0.02 ppm	0.0
		P: 100 ppm	NH_4: –	+
		TiO_2: Nv	SiO_2: 28 ppm < 50 ppm	No data
		Ca: Nv	Elec. cond. 25°C: 402.5 ppm	No data
		Alkality: 20.9	M Alkality: 412.36 ppm < 600 ppm	No data
			P Alkality: 15.36 ppm < 400 ppm	No data
			Total solid: 645.8 ppm < 2,000 ppm	No data
			Cl: 17.2 ppm < 300 ppm	+
			PO_4: 20 ppm, 20 – 40 ppm	5 ppm
			SO_3: 123 ppm, 10 – 20 ppm	0

	Item	PANJI	PESANTREN	COMAL
			Suspended solid: No data Zn: No data F: No data BOD: No data COD: No data	64.5 ppm 0.28 ppm No detect 2.5 ppm 61.3 ppm Data received * Date from P.G SURAGI as same as COMAL river
5	Unit price of water			
	(1) RIVER	P.G. PANJI pays Rp564,000/year for Irrigation Dept. now Consumption of water	P.G. PESANTREN pays Rp1,000/1/sec./year and Rp1,440,000/M for employee of irrigation 1,000 x 250 x 8/12 = 167,000 1,440,000 x 8 = 11,520,000 Total: Rp11,687,000	EXCOMAL will pays Rp20/1/sec.D. If 500 l/sec. 20 x 500 = Rp10,000/D
	(2) WELL	Electricity only	Electricity only	Electricity only

3. Electric Power

	Item	PANJI	PESANTREN	COMAL
1	Purchase			
	(1) Reality	Not reality	Not reality	Main cables PLN: 150 KV, 20 KV about 500 m distance from EXCOMAL
	(2) Reliability	–	–	–
	(3) Unit price (If purchase)	Capacity Basic Consumption Fee: 3.8 – 99 KVA: 1,750 Rp/KVA 49 Rp/KWH (day) 30,5 Rp/KWH (night) 100 – 200 KVA: 1.750 Rp/KVA 46.5 Rp/KWH (day) 29 Rp/KWH (night) More than 201 KVA: 1.600 Rp/KVA 44 Rp/KWH (day) 27.5 Rp/KWH (night)	As same as PANJI	As same as PANJI

	Item	PANJI	PESANTREN	COMAL
		More than 5.000 KVA: 1.500 Rp/KVA 40 Rp/KWH (day) 25.5 Rp/KWH (night)		
2	Existing generator	Steam x 2 Water x 1	2.500 KW	Diesel, 140 KW x 1
	(1) Capacity	But not available for new factory	But not available for new factory	But not available for new factory
	(2) Herz	55	50	50
	(3) Unit price	No data	No data	No data

4. Steam

	Item	PANJI	PESANTREN	COMAL
1	Quantity of steam available	Not available	Not available	Not available
2	Existing Boiler (Reference)			
	(1) Capacity	57.5 T/M: high 3 sets, low 6 sets	Max. 100 T/H, Actual 87 T/H	
	(2) Fuel	Oil or Oil & Bagasse	Oil and Bagasse	
	(3) Temp.	–	325°C	
	(4) Pressure	High: 12 kg/cm^{2}G Low: 6 – 7 kg/cm^{2}G	17 – 20 kg/cm^{2}G	
	(5) Efficiency	–	65	

5. Fuel

	Item	PANJI	PESANTREN	COMAL
1	Fuel oil			
	(1) Supplyer	PERTAMINA	PERTAMINA	PERTAMINA
	(2) Transportation		By tank trailler, stable and constantly	PERTAMINA
	(3) Unit price			
	Kerosene			
	Market price	–	–	–
	Transportation	–	–	–
	Total	Rp85/l	Rp85/l	Rp85/l
	Resudial			
	Market price	Rp74/l	Rp75/l	Rp75/l
	Transportation	–	Rp6/l	Rp15/l
	Total	–	Rp81/l	Rp90/l
2	Others	Bagasse But not available for new factory	Bagasse But not available for new factory	Bagasse But not available for new factory

6. Pollution

	Item	PANJI	PESANTREN	COMAL
1	Law and Regulation for waste water	National regulation & Local regulation (East Java)	National regulation & Local regulation (East Java)	National regulation only Local regulation is not yet issued
2	Law and Regulation for Air pollution	National regulation but not yet standardized	National regulation but not yet standardized	National regulation but not yet standardized
3	Miscellaneous pollution control (Noise, oder, etc.)	National regulation but not yet standardized	National regulation but not yet standardized	National regulation but not yet standardized
4	Environment of the factory site			
	(1) Route of waste water flow	Irrigation channel	Irrigation channel	Factory's channel to Comal River
	(2) Distance to River	None	±8 km (Brantas River) (but not connected)	±4.5 km (Comal River)
	(3) Distance to Sea	±10 km (but not connected)	Long distance (to SURABAYA)	±14 km
	(4) Environment of fishing	Fishing area near coast	–	Fishing area (pond) around the mouse of the river

	Item	PANJI	PESANTREN	COMAL
	(5) Environment of town	Near to SITUBONDO	4 km to KEDIRI	Good enough
	(6) Environment of pollution by other Factories	No Problem (PG PANJI)	No Problem (PG PESANTREN)	P.S. COMAL discharges no treatment waste water
	(7) Treatment method used	None	None	None
5	Possibility of no treatment for waste water	Not suitable	Not suitable	Not suitable

7. Labors

	Item	PANJI	PESANTREN	COMAL
1	Labors cost	(Manager: 300,000 – 500,000 Rp/M)		(Average)
	(1) Specialists (Engineer, chemist, biologist)	–	126,900 – 282,000 Rp/M	204,036 Rp/M
	(2) Supervisor	–	70,500 – 126,900 Rp/M	91,266 Rp/M
	(3) Operator (Skilled)	±2,000 Rp/D → 50,000 Rp/M	40,625 – 75,000 Rp/M	82,238 Rp/M
	(4) Operator (Unskilled)	±1,000 Rp/D → ±25,000 Rp/M	940 Rp/D → 23,500 Rp/M	1,200 Rp/D → 30,000 Rp/M
	(5) Clerk	–	69,000 Rp/M	75,338 Rp/M
2	Working hour	3 shift	3 shift	40 hrs/week, 3 shift
3	Attendance rate of labors	–	–	Approx. 90%
4	Strike of labor union	Not allowed by government	Not allowed by government	Not allowed by government

8. Summary for Record of Atmosheric Temp.

Item	PANJI				PESANTREN				COMAL			
	1978–1980 monthly data P.G. WRANGINANUN from 6 km distance from PANJI				Monthly data at P.G. MERICAN 1980				Monthly data 1980–1982 at EX COMAL			
		Max.	Min.	Ave.		Max.	Min.	Ave.		Max.	Min.	Ave.
	Jan.	30.2	23.5	27.0	Jan.			26.9	Jan.	29.0	24.5	26.9
	Feb.	32.8	23.7	27.7	Feb.			26.5	Feb.	30.5	25.0	27.2
	Mar.	31.1	23.6	27.3	Mar.			26.1	Mar.	31.0	25.0	28.0
	Apr.	32.3	23.5	27.9	Apr.			30.6	Apr.	31.0	26.0	28.3
	May	32.2	21.0	27.7	May			30.8	May	31.0	26.0	28.4
	Jun.	32.1	23.3	27.6	Jun.			28.0	Jun.	31.0	26.0	28.4
	Jul.	31.8	22.5	27.5	Jul.			27.8	Jul.	31.0	26.0	28.3
	Aug.	32.0	23.0	27.5	Aug.			27.0	Aug.	31.0	26.0	28.6
	Sep.	32.1	23.2	27.9	Sep.			27.4	Sep.	31.5	26.0	29.3
	Oct.	32.4	23.9	28.5	Oct.			27.4	Oct.	33.0	26.5	29.8
	Nov.	32.9	24.5	28.7	Nov.			28.6	Nov.	32.5	26.0	29.2
	Dec.	31.2	24.0	27.6	Dec.			27.0	Dec.	31.5	25.0	28.4
	Yearly	32.9	21.0	27.7	Yearly			27.8	Yearly	33.0	25.0	28.4

9. Summary for Relative Humidity

Item	PANJI				PESANTREN				COMAL
		Max.	Min.	Ave.		Max.	Min.	Ave.	No data
	Jan.	89	72	83.6	Jan.	77.1	67.5	72.1	
	Feb.	91	71	84.8	Feb.	87.3	73.6	81.2	
	Mar.	90	66	81.8	Mar.	86.2	61.5	72.4	
	Apr.	87	59	79.4	Apr.	87.6	68.8	80.3	
	May	89	57	77.2	May	83.4	65.1	73.9	
	Jun.	89	59	79.6	Jun.	83.3	67.3	76.1	
	Jul.	86	57	76.0	Jul.	79.3	55.4	68.2	
	Aug.	89	56	75.8	Aug.	75.0	51.8	66.2	
	Sep.	88	55	77.1	Sep.	79.0	56.2	68.7	
	Oct.	87	55	75.4	Oct.	89.6	59.2	73.6	
	Nov.	90	58	77.1	Nov.	88.3	60.0	69.6	
	Dec.	91	70	82.9	Dec.	77.7	62.7	77.1	
	Yearly	91	55	79.2	Yearly	89.6	51.8	73.3	

10. Summary of Rain Fall Data

Item	PANJI				PESANTREN				COMAL			
	Data of P.G. Wringin Anom 6 km from PANJI 1978–1982				Data of south 1 km distance from PESANTREN 1979–1981				Data of Ex COMAL 1977–1982			
	mm/month				mm/month				mm/month			
		Max.	Min.	Ave.		Max.	Min.	Ave.		Max.	Min.	Ave.
	Jan.	635	241	523	Jan.	404	318	376	Jan.	1,000.5	447	691
	Feb.	493	220	335	Feb.	407	260	352	Feb.	819	173	413
	Mar.	343	53	172	Mar.	339	198	289	Mar.	656	181	310
	Apr.	156	17	85	Apr.	433	208	313	Apr.	305.5	82	143
	May	150	0	55	May	264	20	123	May	158	33	77
	Jun.	97	0	40	Jun.	78	0	26	Jun.	145	0	63
	Jul.	63	0	17	Jul.	93	0	56	Jul.	226	0	48
	Aug.	75	0	15	Aug.	71	0	26	Aug.	156	0	41
	Sep.	31	0	10	Sep.	127	0	44	Sep.	131	0	35
	Oct.	46	0	11	Oct.	101	9	46	Oct.	140	3	66
	Nov.	252	0	79	Nov.	301	63	192	Nov.	465	42	191
	Dec.	346	180	247	Dec.	399	272	319	Dec.	479	279	394
	Yearly	635	0	132	Yearly	464	0	180	Yearly	1,000.5	0	349
		Total	1,589			Total	2,162			Total	4,192	

11. Summary of Fastest Wind Velocity

Item	PANJI	PESANTREN	COMAL
	Data of P.G. Wringin Anom 6 km distance from PANJI 1979--1982		
	km/H Jan. 68.6 Feb. 55.6 Mar. 49.6 Apr. 49.4 May 49.8 Jun. 55.7 Jul. 59.0 Aug. 75.5 Sep. 71.5 Oct. 62.7 Nov. 59.5 Dec. 55.3 Yearly 75.5 = 21 m/sec.	km/H Jan. 6 Feb. 7 Mar. 4 Apr. 4 May 9 Jun. 6 Jul. 6 Aug. 8 Sep. - Oct. 9 Nov. 7 Dec. 5 Yearly 9 = 0.5 m/sec.	No data

4.5 Outline of Sugar Recovery from Molasses

While it is outside of the scope of work for the current feasibility study, since it was learned that the Indonesian side had much interest in the sugar recovery process from molasses, we are summarizing our knowledge on the process in Japan and preliminary study results in the following.

4.5.1 Column Chromatogram Separation

This process has been developed by Finnish Sugar Co., Ltd. In northern Europe like Finland, beet is used to produce sugar, and naturally, this process has been developed to process beet molasses. The production flow is outlined in Fig. 4-1.

The most crucial point of this process resides on the separation stage, in which chromatographic separation is conducted using a special resin column. The type of resin used and the separation conditions are the know-how of Finnish Sugar Co., Ltd.

While there are a few sugar recovery plants operating in Europe using this process, it must be clearly remembered that all these plants use beet molasses as the starting material.

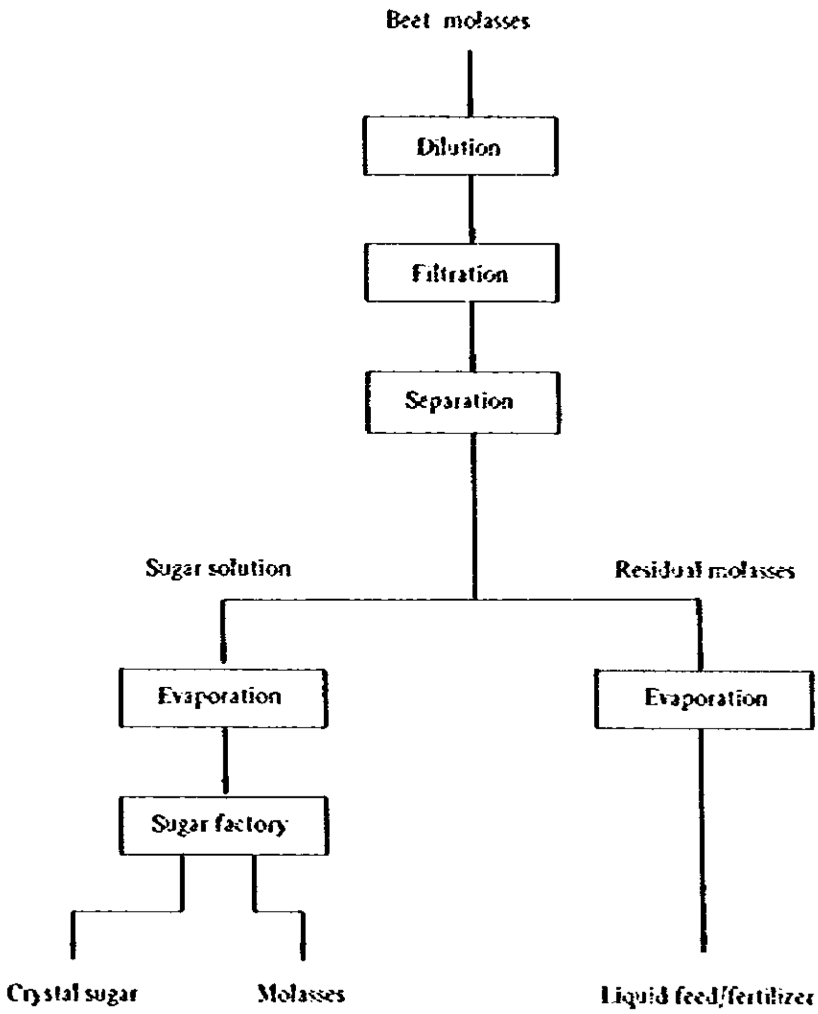
From what we can learn in Japan, to apply this Finnish process to cane molasses, an extremely complicated pre-processing is necessary because of the difference of components between cane molasses and beet molasses. As an example, cane molasses containing vibalent ion contents such as Ca and Mg much more than beet molasses does, and these must be removed prior to the separation process by the resin column. Another reason for the complicacy is that cane molasses contains slimy solid much more than beet molasses does, so that a centrifugal separation process added with a flocculant must be applied to cane molasses in order to obtain clear solution.

The necessity of pre-processing essentially reduces the sugar recovery rate and increases the investment. Therefore, the economy of the Finnish process becomes quite uncertain if it is applied to cane molasses.

For this reason, the process of Finnish Sugar Co., Ltd. is not employed by any sugar plant that uses cane molasses in the world.* A comparison table of components in

* It is reported the first plant to treat cane molasses for desugarization process was recently established in Finland by Finn Sugar Engineering Co., Ltd.

Fig. 4-1. Process Flow for Sugar Recovery from Molasses



Indonesian cane molasses and general beet molasses is attached for reference as Table 4-6.

Table 4-6 Analytical Data for Cane and Beet Molasses

	Cane molasses	Beet molasses	
	Indonesia	Japan	Europe
Total sugar (%)	54.16	41.94	54.30
Direct sugar (%)	18.42	1.40	0.46
Non fermentable sugar (%)	5.71	–	–
Total solid (%)	75.07	–	79.90
Ash (%)	8.55	6.02	10.90
Ca (%)	0.99	0.25	0.10
Mg (%)	0.12	0.02	–

4.5.2 Methanol Precipitation Method

The methanol precipitation method has been developed by Kyowa Hakko Kogyo Co., Ltd. In the method, cane molasses and heated methanol are mixed and the solution is left as is. Almost all Ca and up to 80% of the pigment contained in the cane molasses are removed in the form of precipitation and very clear sugar solution can be obtained from the recovered methanol of the supernatant liquid.

The amount of methanol to be added, temperature and other conditions are the know-how of Kyowa Hakko Co., Ltd. Since surcose is inverted during the process, the sugar liquid contains much more glucose and fructose.

The process has not been industrialized because of taxation problems. If taxation system bears no problem, as it does in Japan, the methanol precipitation method can be applied as a simpler process than the column chrolomatogram separation.

Chapter 5.

BASIC DESIGN OF THE FERMENTATION PLANT

Chapter 5. BASIC DESIGN OF THE FERMENTATION PLANT

5.1 Baisc Principle

1) The production items of the new fermentation plant are limited to the three items outlined in Clause 4.2, i.e., ethyl alcohol, feed yeast, and Corynecin.

2) The production quantities are set as shown below, based on the market research results and increased amount of cane molasses resulting from scheduled increase of the sugar production and in consideration of the conditions of the plant site location:

Ethanol	Approx.	10,000 Kℓ/yr.
Feed yeast	Approx.	3,300 t/yr.
Corynecin	Approx.	19 t/yr.

Approximately 47,000 tons of cane molasses per year are needed to produce the above, and this is about equal to the increased amount of cane molasses, as shown below, resulting from sugar production increase of PTP15/16 being planned by the Indonesian government.

1981	91,968 t
1984	139,154 t
(Increase)	47,186 t

Concurrent production of the above three items requires at least 40,000 Kℓ water (30°C) per day. This is equivalent to the water intake at the Ex Conal plant site.

3) The continuous fermentation system of the immobilized yeast process, instead of the conventional process, is employed for the ethanol production. (The continuous fermentation system has been developed and established by the Research Association of Petroleum Alternative Development and Kyowa Hakko Kogyo Co., Ltd.)

4) Corynecin production must be eventually connected with a Chloramphenicol production system. The chloramphenicol production system, however, is excluded from the construction plan of this project for the reason that the production technology has already been established and since it does not require difficult production techniques, any existing pharmaceutical plant can produce it. (If necessary, Kyowa Hakko Kogyo Co., Ltd. is prepared to submit the know how separate from this project.)

5) Continuous culture process is conceivable for production of the feed yeast, but the batch culture process is adopted in view of the production scale.

6) As to the disposal method of waste water, the distillation stillage is first divided into two parts of high concentration fraction and low concentration fraction and the former is to be converted to a fertilizer after being condensed to the state of 45% solid content. For fertilizer production, we recommend processing the high concentration fraction into a compost, mixed with bagasse and dead sugar cane leaves, as described in detail in Clause 5.5.3. The fertilizer production in the plant site is not preferable when the transportation problem is taken into consideration, and for this reason, we are submitting this know how but excluding the fertilizer plant from this project.

We consider that the low concentration fraction can be diluted to a level below the limitation for BOD (30 ppm) since the plant has an abundant supply of cooling water.

5.2 Ethanol Production

5.2.1 General Scope of the Plant

(1)	Plant capacity	30 Kℓ/day
(2)	Raw material	Cane molasses (99 t/day) and other auxiliary raw materials
(3)	Product	Ethyl alcohol (95 V/V %)
(4)	Production process	Fermentation by immobilized yeast process and continuous distillation

(5) Operation hour 24 hours/day

(6) Operation period 336 days/yr.

5.2.2 General Scope of the Process

Refer to Fig. 5.1, Block diagram and Fig. 5.6, Flow sheet.

1) Fermentation

(1) Seed propagation: The seed is poured into a jar fermenter containing sterilized culture medium. The air is fed for breeding of the seed.

(2) Gel manufacturing: The bred yeasts are immobilized to alginate gel.

(3) Fermentation: The immobilized yeasts are charged into a tower fermentor, and prepared raw material cane molasses is continuously fed through the tower for continuous fermentation of alcohol.

2) Distillation

(1) Mash distillation: The fermentation solution is supplied to a mash distillation tower and steam is fed from the tower bottom. Alcohol is taken out from the top and distillation stillage is discharged from the bottom.

(2) Condensation: The alcohol solution from the mash distillation tower is supplied to a condensation tower. Product alcohol is taken out from the tower top, and the solution discharged from the bottom is returned to the mash distillation tower.

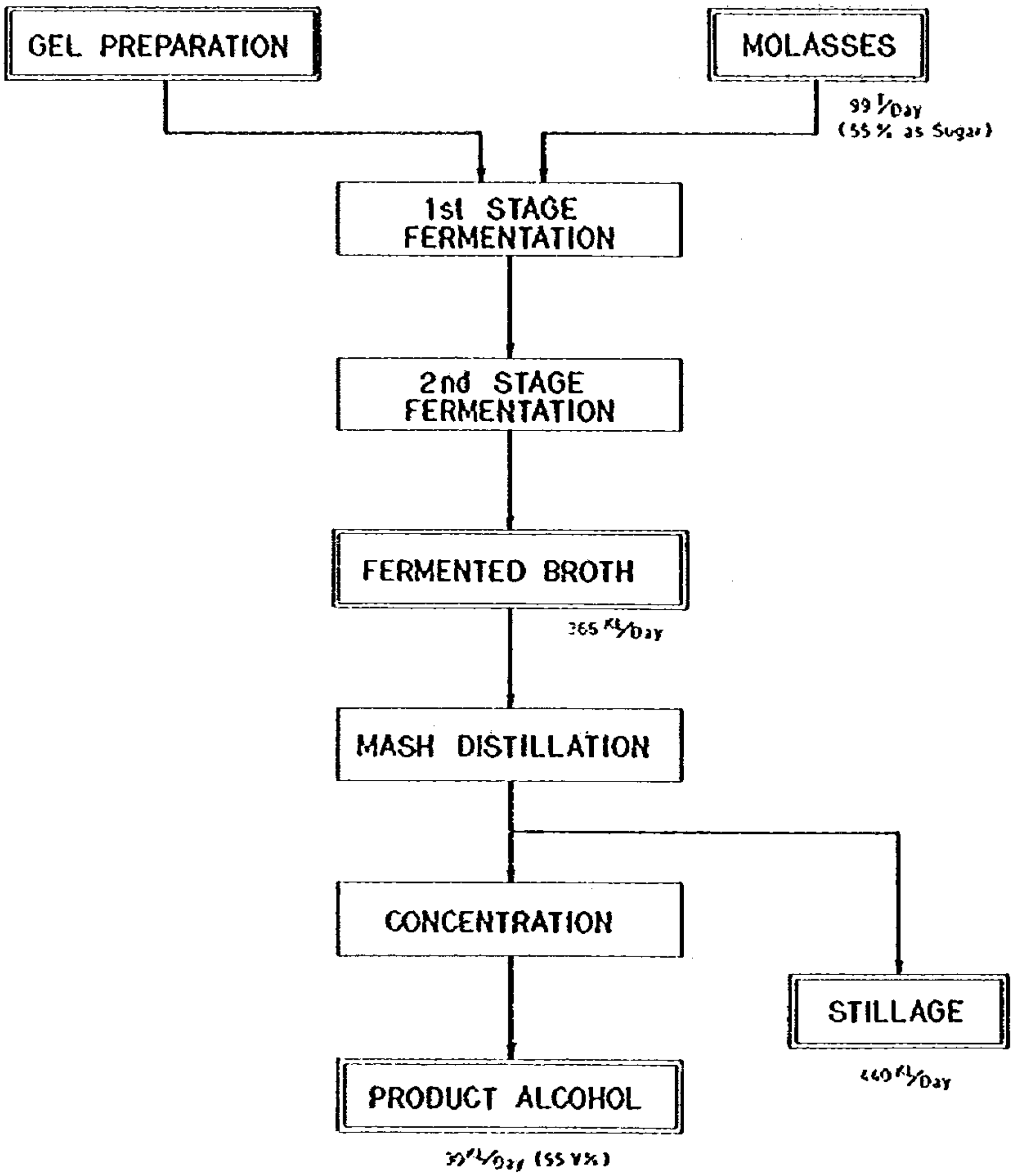


Fig. 5-1. Process Block Diagram of Ethanol

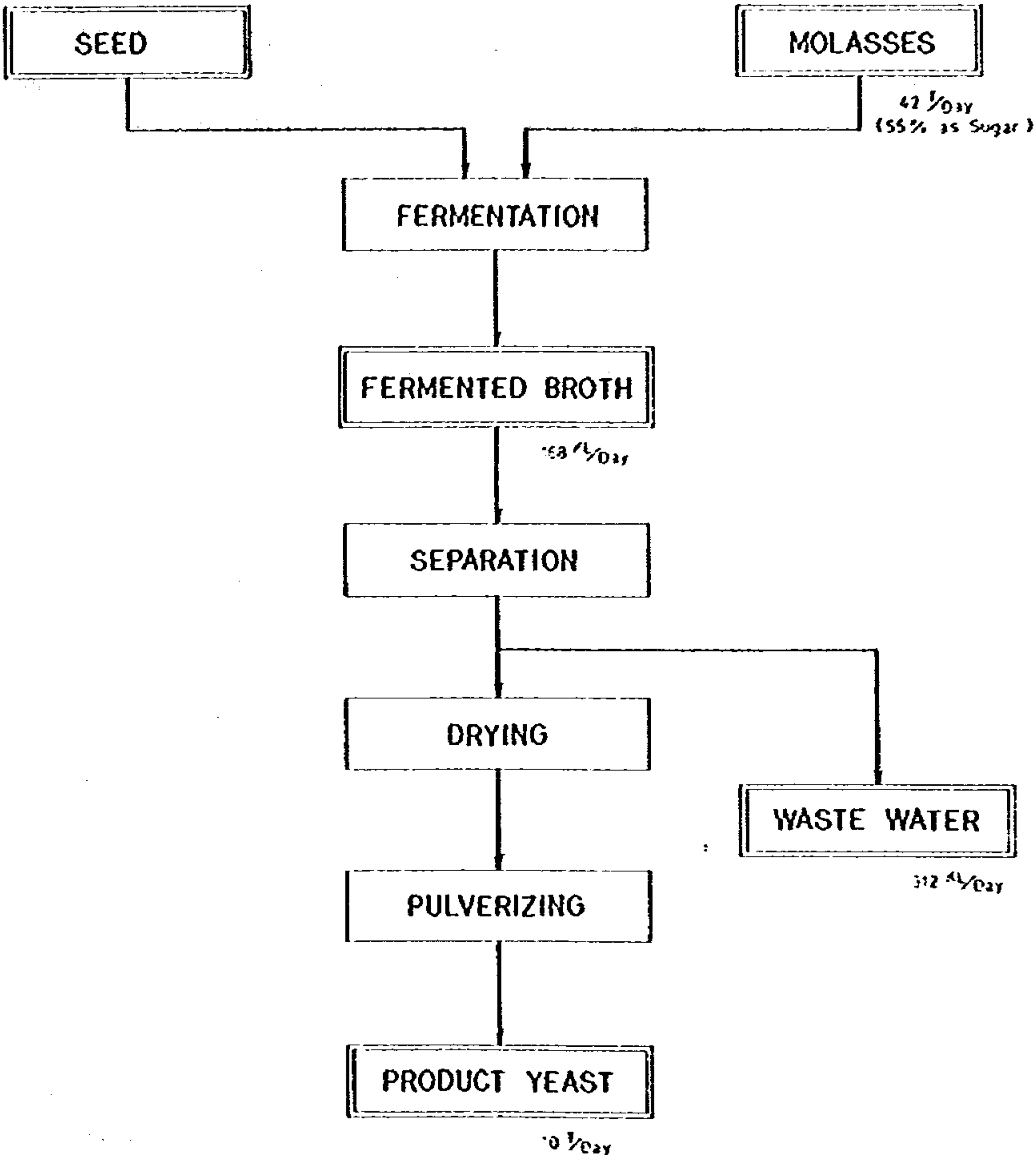


Fig. 5-2. Process Block Diagram of Yeast

5.2.3 Consumption of Raw Materials and Utilities and Unit Consumption

Table 5-1 shows the standard consumption of the materials and utilities and unit consumption. Fluctuation of the sugar concentration is anticipated on the material cane molasses, but 55% is used as reference. Care must be paid since lower sugar concentration makes the unit consumption rate poorer.

Table 5.1 Main Raw Materials and Utilities of Ethanol

Item	Per Day	Unit Consumption
Molasses (55%)	99 T	3,300 Kg/Kℓ
Oleic Acid	37.2 Kg	1.24 "
Alginate	10.3 "	0.344 "
Calcium Chloride	15 "	0.500 "
Electricity	4,440 KWH	148 KWH/Kℓ
Steam	86.8 T	2.89 T/Kℓ

5.2.4 Number of Operation Days and Production

The following are set as the standard number of operation days and production:

Number of operation days	336 days/yr.
Production	10,080 Kℓ/yr.

The remaining one month is reserved for gel manufacturing and maintenance/repair of the machines and vessels. The actual operation schedule must be determined in relation with production schedules of other products.

5.3 Feed Yeast Production

5.3.1 General Scope of the Plant

(1)	Plant Capacity	10 t/day
(2)	Raw material	Cane molasses (about 40 t/day) and auxiliary raw materials
(3)	Product	Feed yeasts for animal (moisture contents up to 10%)
(4)	Production process	Aeration culture by batch method, gathering of yeast, and drying by drum dryer
(5)	Operation hour	24 hours/day
(6)	Operation period	336 days/yr.

5.3.2 General Scope of the Process

Refer to Fig. 5-2, Block diagram and Fig. 5-7, Flow sheet.

1) Fermentation

(1) Seed propagation: The seed of yeasts cultured in a flask scale is further cultured in a seed tank of the plant scale. Submerged culture.

(2) Fermentation: The seed is charged in a fermentor that contains culture medium that has been sterilized and prepared for the submerged culture process. Cane molasses is added during the culture for efficient propagation of the yeast cells.

2) Refining

(1) Yeast separation: The yeast is separated from the fermentation broth as the solution is processed through a continuous centrifugal separator, and the yeast is accumulated.

(2) Drying: The collected yeast cream is continuously dried by a double-drum dryer.

(3) Packing: The dried product is ground and packed into paper bags for shipping out.

5.3.3 Consumption of Raw Materials and Utilities and Unit Consumption

Table 5-2 shows the standard consumption of the raw materials and utilities and unit consumption. The reasons for larger consumption of utilities are that a large amount of chilled water is needed to maintain the culture temperature and much energy must be spent for drying. In the future, introduction of high-temperature resistive yeast and energy-conservation of the drying process must be pursued by employing the genetic engineering technologies.

Table 5-2. Main Raw Materials and Utilities of Yeast

Item	Per Batch	Unit Consumption
Molasses (55%)	20,956 Kg/B	4.0 Kg/Kg
Ammonium Sulfate	327 "	0.063 "
Urea	570 "	0.110 "
Ammonium Phosphate ($NH_4H_2PO_4$)	175 "	0.034 "
Electricity	43,320 KWH/D	4,332 KWH/Kg
Steam	189 T/D	18.88 T/Kg

5.3.4 Number of Operation Days and Production

The following are set as the standard number of operation days and production:

Number of operation days	336 days/yr.
Production	3,360 t/yr.

The remaining one month is reserved for maintenance/repair of the machines and vessels.

5.4 Corynecin Production

5.4.1 General Scope of the Plant

(1)	Plant capacity	112 kg/batch (56 kg/day)
(2)	Raw material	Cane molasses (about 13 t/batch), ammonium sulfate, and other auxiliary materials
(3)	Product	Corynecin powder (98% purity)
(4)	Production process	Submerged culture by batch process. Isolation consists of a butanol extraction process and crystalization from the aqueous layer.
(5)	Operation hour	24 hours/day
(6)	Operation period	336 days/yr.

5.4.2 General Scope of the Process

Refer to Fig. 5-3, Block diagram and Fig. 5-8, Flow sheet.

1) Fermentation

(1) Seed propagation: The corynebacterium hydrocarboclasta is cultured through the seed stages shown below and fed to a fermentor. Submerged culture is applied to all these stages.
A-unit (preservation culture) → B-unit (activation culture) → C-unit (flask cultivation) → D-unit (primary seed culture in plant) → E-unit (secondary seed culture in plant) → F-unit (final culture)

(2) Fermentation: Corynecin is accumulated while the bacterial is being cultured. Sterilized culture medium is used, and temperature control and adding of the cane molasses are given during the submerged culture.

2) Refining

(1) Crude crystallization: Butanol is added and mixed with the fermentation solution and Corynecin is extracted in solution state. The extracted solution is processed to remove the butanol, condensed, treated with acid, and condensed for crystallization. The crystals are separated as crude crystals.

(2) Re-crystallization: The crude crystals are solved in water, decolored and condensed for crystallization. The crystals are separated as the second stage crystals.

(3) Third stage crystallization: The second stage crystals are again solved, decolored and crystalized for a higher purity of the product. The crystals from the third stage are separated, dried and packed as final products. Table 5-4 shows examples of the standard product quantity.

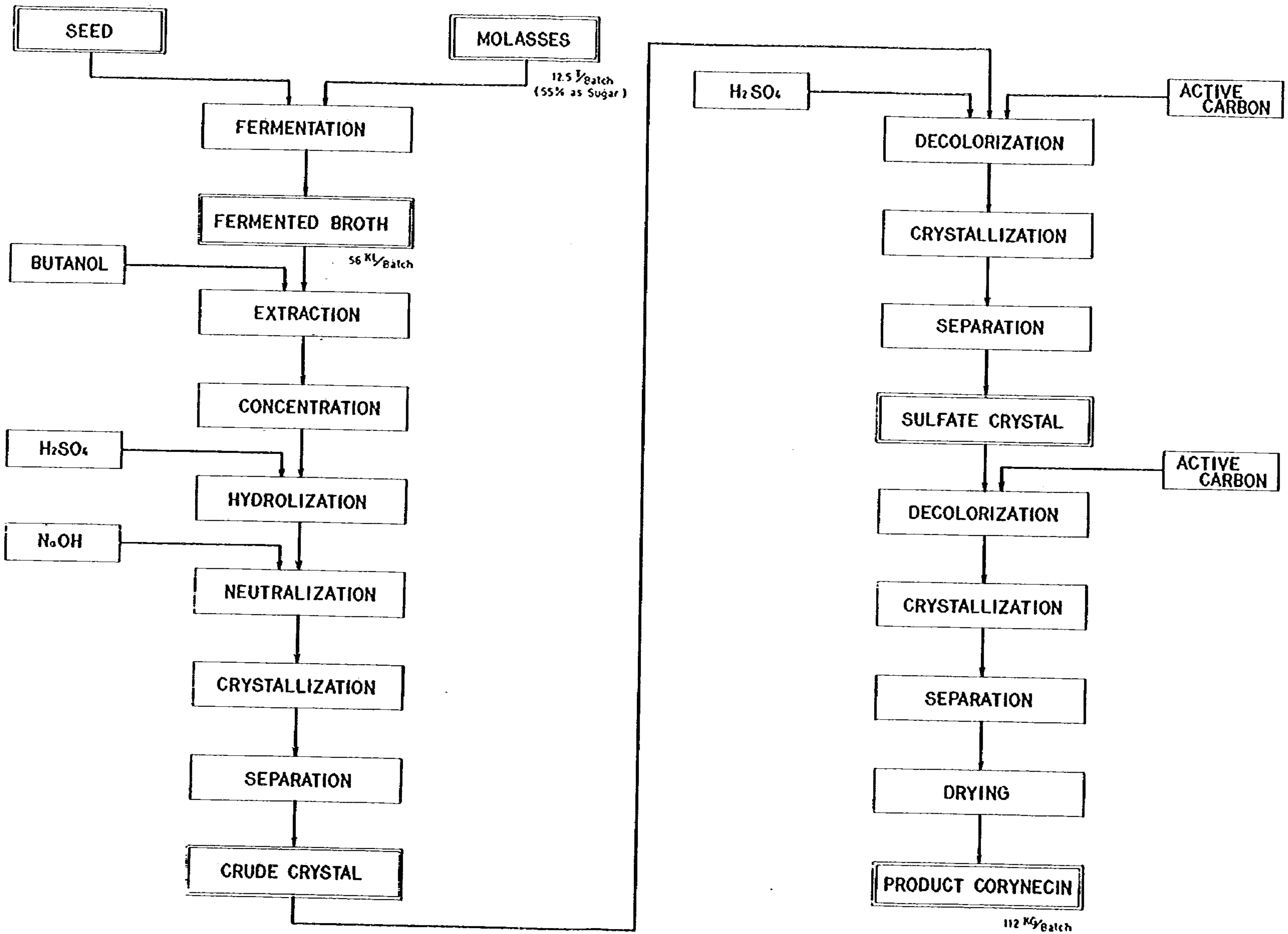


Fig. 5-3. Process Block Diagram of Corynecin

Table 5-3. Main Raw Materials and Utilities of Corynecin

Item	Per Batch	Unit Consumption
Sucrose	174 Kg	1.6 Kg/Kg
Potassium Phosphate (KH_2PO_4)	12	0.1 "
Molasses (55%)	12,463	111.3 "
CSL	244	2.2 "
Ammonium Sulfate	488	4.4 "
Ammonia	500	4.5 "
Sulfuric Acid	351	3.1 "
Caustic Soda	431	3.9 "
Butanol	650	5.8 "
Active Carbon	51	0.5 "
Filter Aid	138	1.2 "
Electricity	44,880 KWH	400 KWH/Kg
Steam	182 T	1.625 T/Kg

Table 5-4. Standard Quality of Corynecin Product

Item	Product
Transparency (C = 0.1 MeOH)	99.0%
Melt. point	161.7°C
Specific rotation	- 28.4°
Paper Chromatography	Single spot (50 g)
Drying loss (60°C, 4 hrs)	< 0.2%
Pyrogen	Negative
Purity	98.4%

5.4.3 Consumption of Raw Materials and Utilities and Unit Consumption

Table 5-3 shows the standard consumption of the raw materials and utilities and unit consumption.

55% sugar concentration is set as the standard for cane molasses. Since there is the tendency of the unit consumption becoming poorer as the sugar concentration drops, we recommend to use better quality of molasses as possible.

5.4.4 Number of Operation Days and Production

The following are set as the standard number of operation days and production:

Number of operation days	336 days/yr.
Production	18.8 t/yr.

Since a long time is necessary to manufacture Corynecin, the actual operation schedule must be set by leaving off the production at the crude crystallization process. 336 days per year operation means 168 batches per year.

5.4.5 Chloramphenicol

Chloramphenicol is produced by having Corynecin and dichloroacetic acid methyl react in methanol as solvent. A process block diagram is given in Fig. 5-4 as a reference. Normally, 725 kg of Chloramphenicol is produced from 500 kg of Corynecin.

Since manufacture of Chloramphenicol is comparatively easy and ordinary pharmaceutical plants can produce it, constructing a Chloramphenicol plant is omitted from this project.

5.5 Waste Water Treatment

5.5.1 General Scope of the Process

Since cane molasses is used as the raw material, generation of a large amount of waste liquor is inevitable with the fermentation plant. In order to process the waste liquor, it is divided into high concentration fraction and low concentration fraction. The high concentration fraction is condensed to a solution of about 45% solid content. This solution is to be used as a fertilizer as is or by converting it to compost described in Clause 5.5.3.

The low concentration fraction is mixed with the cooling water for discharge into the drainage since it is possible to maintain the BOD value below the regulation specification.

5.5.2 Process and Treating Quantity

Fig. 5-5 and 5-9 show a process block diagram and flow sheet. Approximately 600 kl/day of the high concentration fraction is generated from the production of the three items. This is condensed by a multi-effect evaporator and about 102 kl/day of high concentration solution having 45% of solid content is produced.

The BOD value of the low concentration fraction is about 1.2 t/day. If this is mixed with about 42,000 t/day chilled water, the limit of BOD value (30 ppm) is cleared.

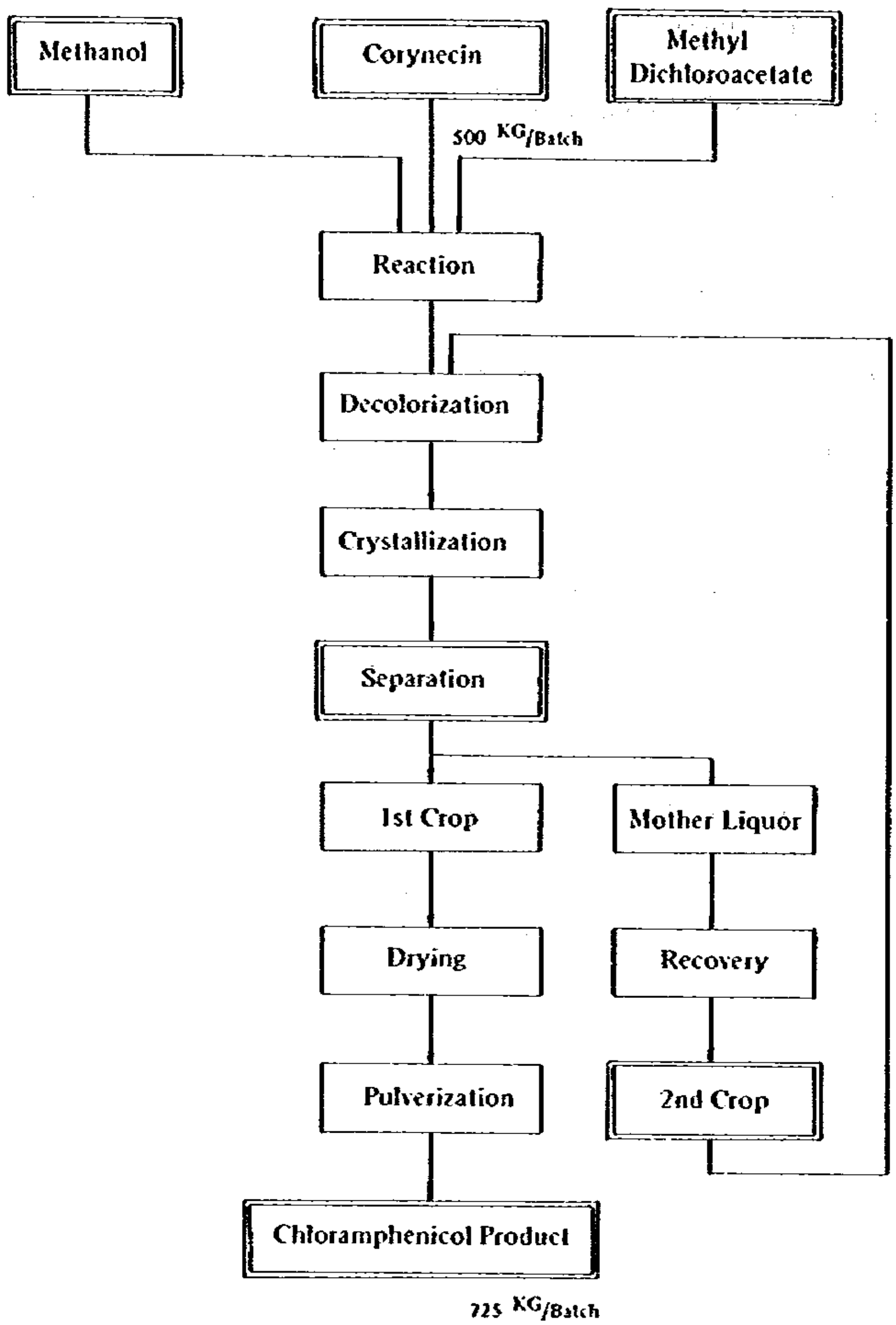


Fig. 5-4. Process Block Diagram of Chloramphenicol

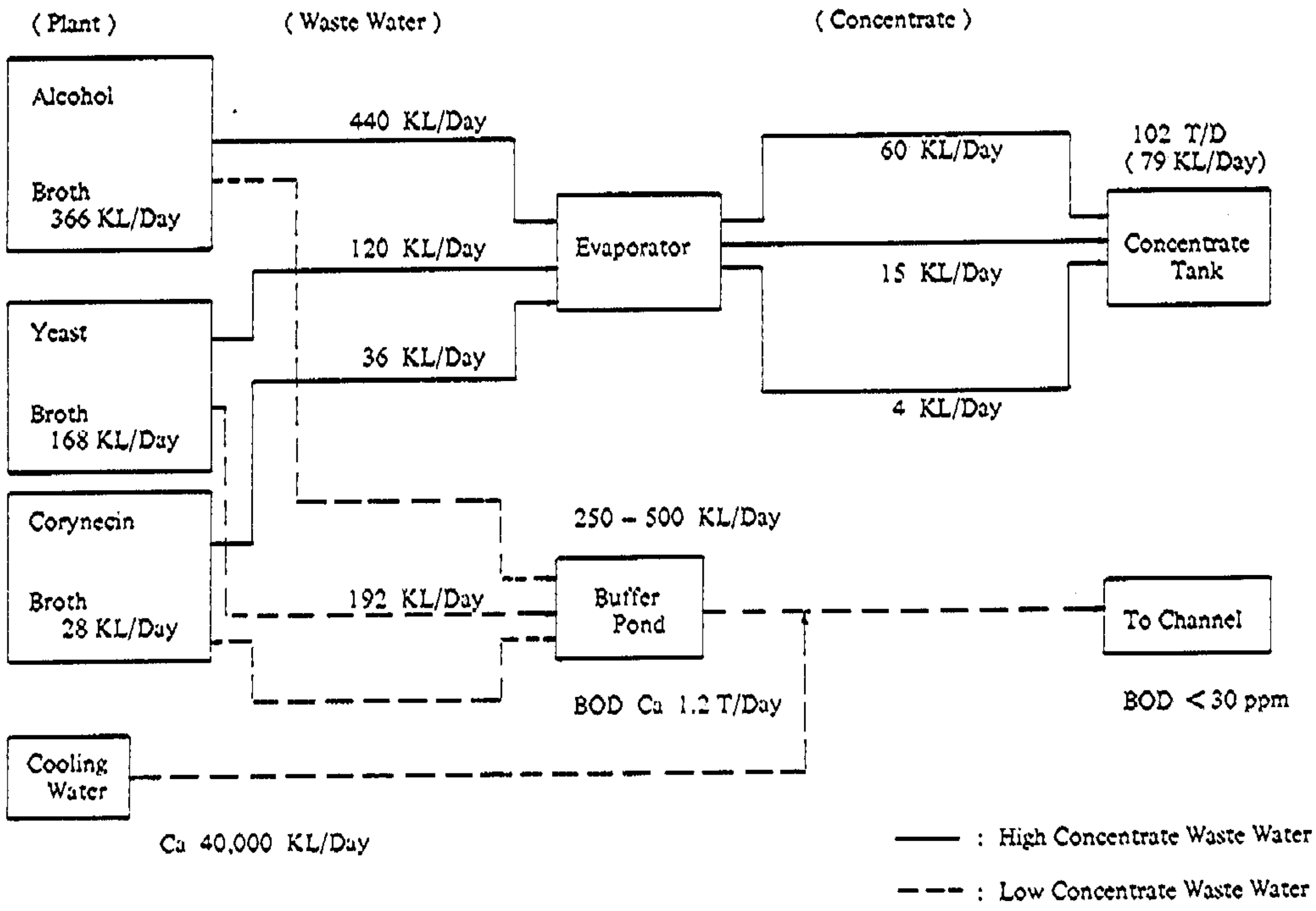


Fig. 5-5. Block Diagram of Waste Water Treatment

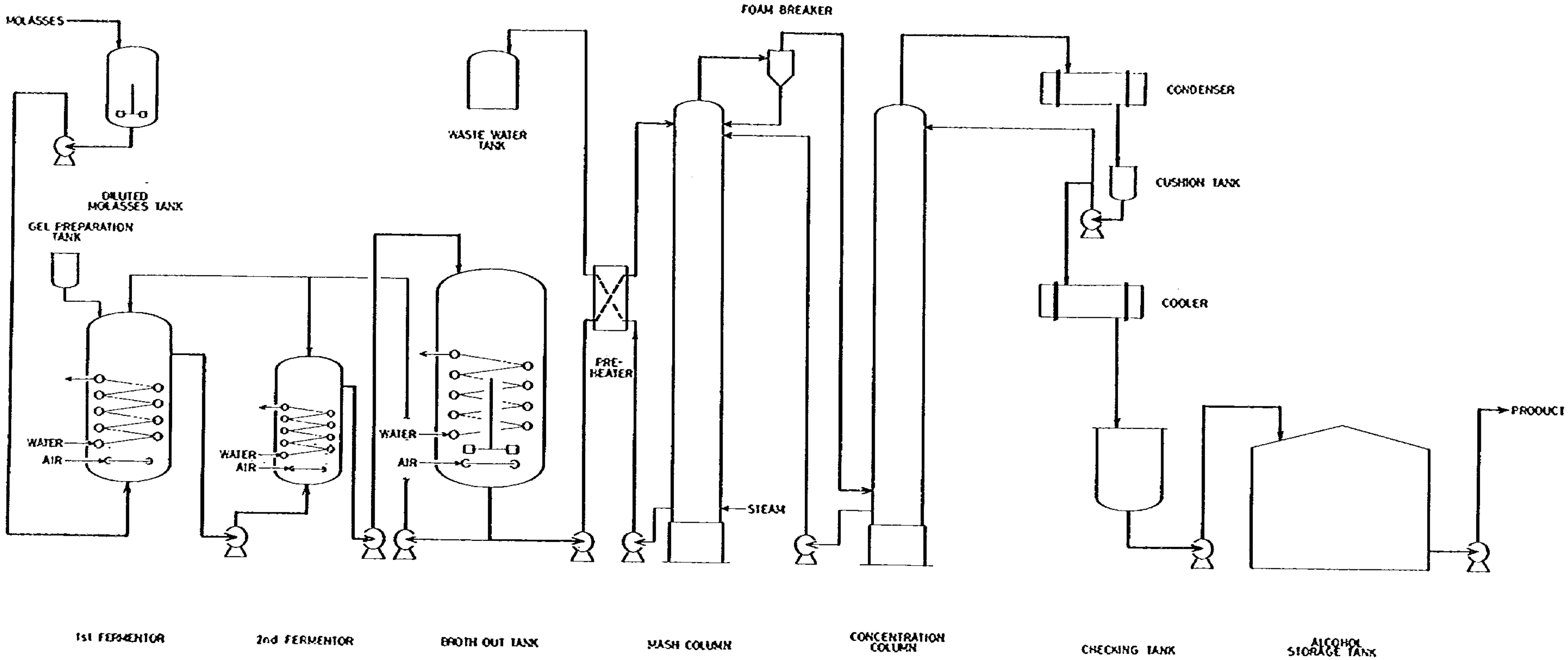


Fig. 5-6. Process Flow Sheet of Ethanol

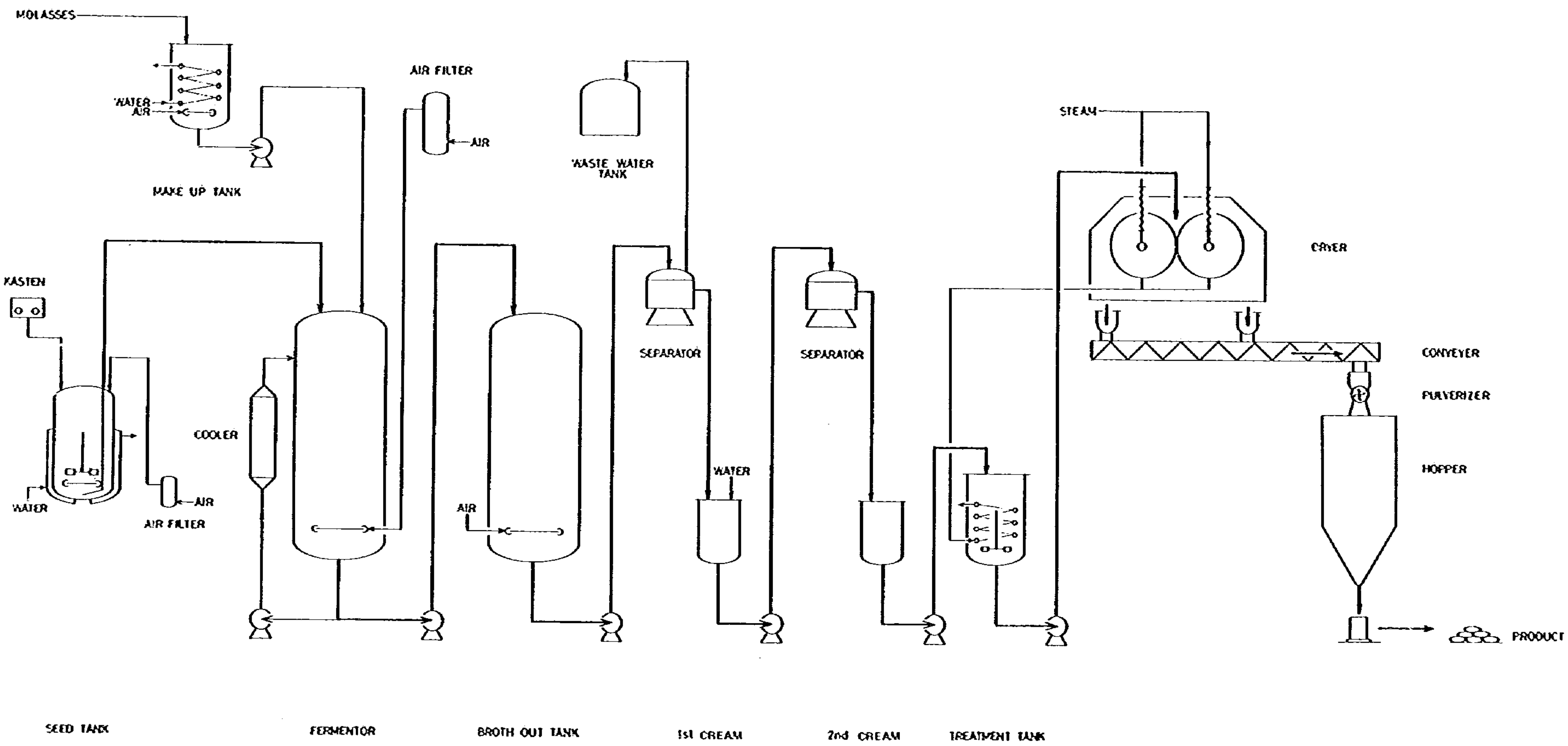


Fig. 5-7. Process Flow Sheet of Yeast

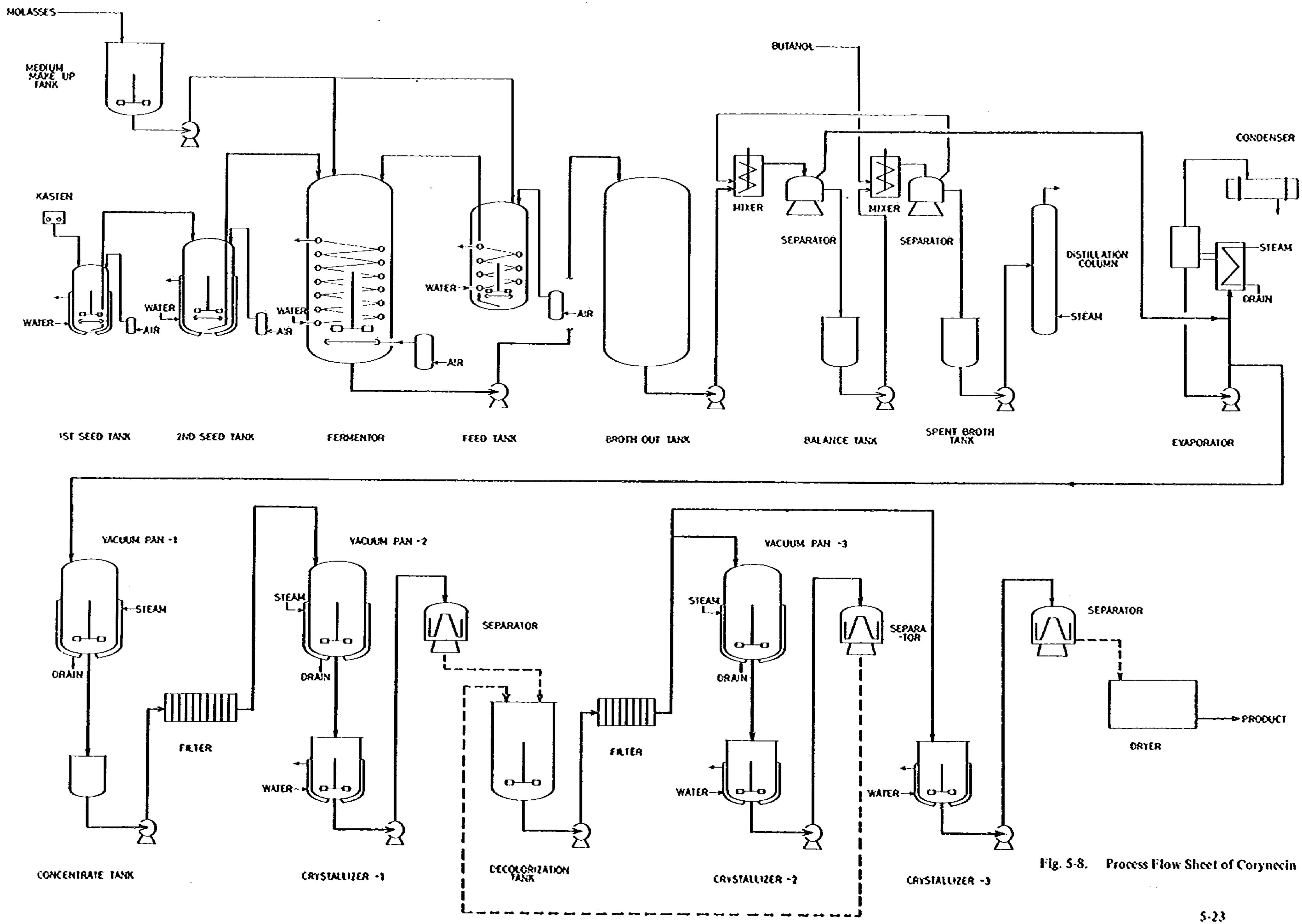


Fig. 5-8. Process Flow Sheet of Corynecin

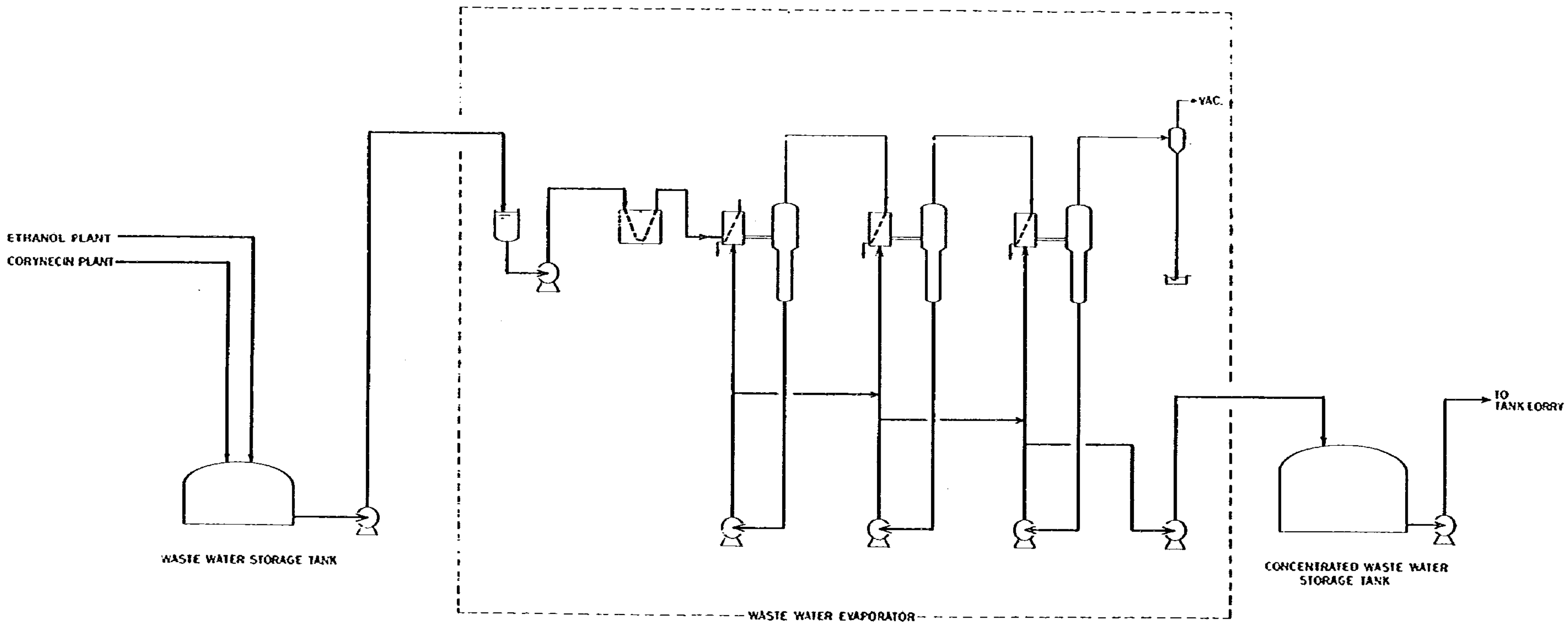


Fig. 5-9. Process Flow Sheet of Waste Water Treatment

This waste liquor is discharged to the channel exclusively provided to the plant, but its quality is in a level that causes no harmful effect even if it is used for irrigation.

5.5.3 Conversion of High Concentration Solution to Compost

Although the condensed solution of the high concentration fraction can be returned to the soil as a fertilizer, when the necessity of transportation, difficulty of preservation and fertilizing properties are taken into consideration, conversion to a compost as described in the following would be more advantageous.

The high concentration solution is added to sugar cane dead leaves and bagasse and filter cake that come out of sugar production, mixed with urea and other auxiliary raw materials, and kept through high temperature aging. This produces a compost or soil improvement agent. The bagasse compost has the following features:

1) Being a solid substance, it can be easily handled.

2) Owing to its high base exchange capacity, the chemical fertilizing effect lasts longer, contributing to plant growth.

3) Owing to its high buffering strength, the compost mitigates malnutrition of the soil resulting from stabilized acidity, chemicals and other harmful substances.

4) Since the compost is durable, its properties are not destructed physically nor in the sense of microorganisms and the effect lasts long.

5) The fertilizing ingredients such as nitrogen, phosphoric acid, potash and others that are essential for plant growth are contained in the compost.

6) The compost prevents plant diseases since it contains much of effective microorganisms.

7) The compost creates humus that is desirable to plant growth by promoting generation of particles of the soil.

Table 5-5 shows the material unit for the case of converting the entire high concentration fraction to compost.

The actual manufacturing method is that sugar cane dead leaves, bagasse and filter cakes are accumulated into a heap of 50 to 100 tons per plot, and predetermined amounts of the condensed solution and auxiliary raw materials are sprinkled over the heap. The heap is turned once in every 10 days or so for aeration effect, and about 3 months are required for aging.

The land size necessary for compost making is about 6,000 m^2 to process about 50 tons of the product per day. Therefore, to process the total 319 ton condensed solution per day, a site of 38,000 m^2 is needed.

Table 5-5. Main Raw Materials of Bagasse Compost

Item	Per Day	Unit Consumption
Concentrate (45%)	102 T	320 Kg/T
Bagasse, Dead Leaf etc.	300	940 "
Urea	0.65	2 "

Product : Bagasse Compost 319 T/D

Transportation of the condensed solution is easier than that of bagasse and other materials. Therefore, production of the compost in the plant site of this project is not advantageous. Our recommendation is that the condensed solution is delivered to each sugar plant utilizing the return trips of the cane molasses tank trucks and the compost is made in the sugar plants using the bagasse and dead leaves.

5.6 Utilities

5.6.1 General Scope of the Plant

1) Outline

Utilities such as steam, electricity, water, chilled water and air are needed to operate the plant. As indicated in the progress report, required electricity is to be generated on the site. The chilled water is used in cycles, and supply of well water is sufficient in normal cases.

Therefore, utilities that must be taken from outside of the plant are water and air. Also, heavy oil must be supplied, which normally is not included in the utility category.

The supply methods are major usage of these utilities are described in the following.

2) Steam and electricity

On-site electricity generation method is adopted for this plant.

6KV power is generated by a generator which is connected to a back pressure turbine driven by steam generated by a boiler. The boiler is a heavy oil burning type. The existing diesel generator of 140 KVA is to be used at the time of the boiler start only. As soon as the boiler starts and power is generated, it becomes the source of power supply to the plant, and the diesel generator is stopped other than in an emergency case or at the time of periodical repair of the new generator system. The flow is shown as Fig. 5-10.

3) Electricity supply station

A transformer station is built in the power generation building for distribution of power to all facilities.

POWER PLANT (OIL FIRED BOILER, BACK PRESSURE TURBINE)

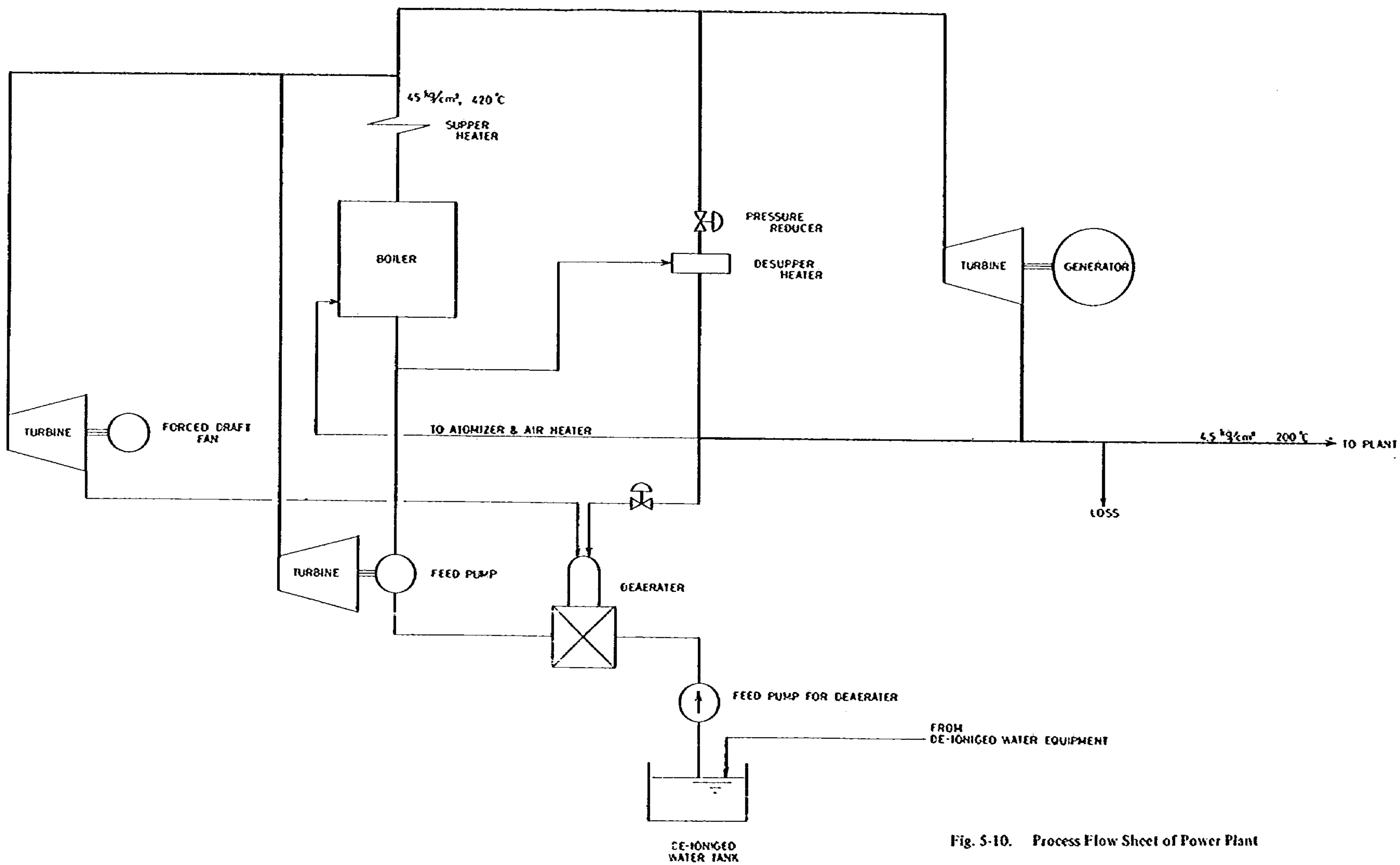


Fig. 5-10. Process Flow Sheet of Power Plant

Fig. 5-11 shows a single diagram of the power supply.

for mechanical power:

3φ 4W	6000V	for compressor only
3φ 4W	380V	for common equipment
1φ 2W	220V	for lighting

3φ 3W 220V or 1φ 100V are to be supplied, if necessary, by installing a small transformer at a position close to the device that needs the power. Other electric facilities are described in the clause of auxiliary facilities.

4) Water

(1) River water

The river water is taken from the irrigation canal that is away from the plant site by about 500 m. A water intake pit is to be installed at a side of the irrigation canal and the water is directly supplied to using places in the plant from the intake pit by a pump and through a piping system.

The river water is mainly used for cooling. The major units that require cooling water are alcohol distillation, slop concentration, water cooling tower and air compressor.

(2) Well water

A pump is installed to the existing well, and the pump capacity is 150 t/hr. The well water is used as process water, boiler feed water, pump seal water, for drinking and miscellaneous use.

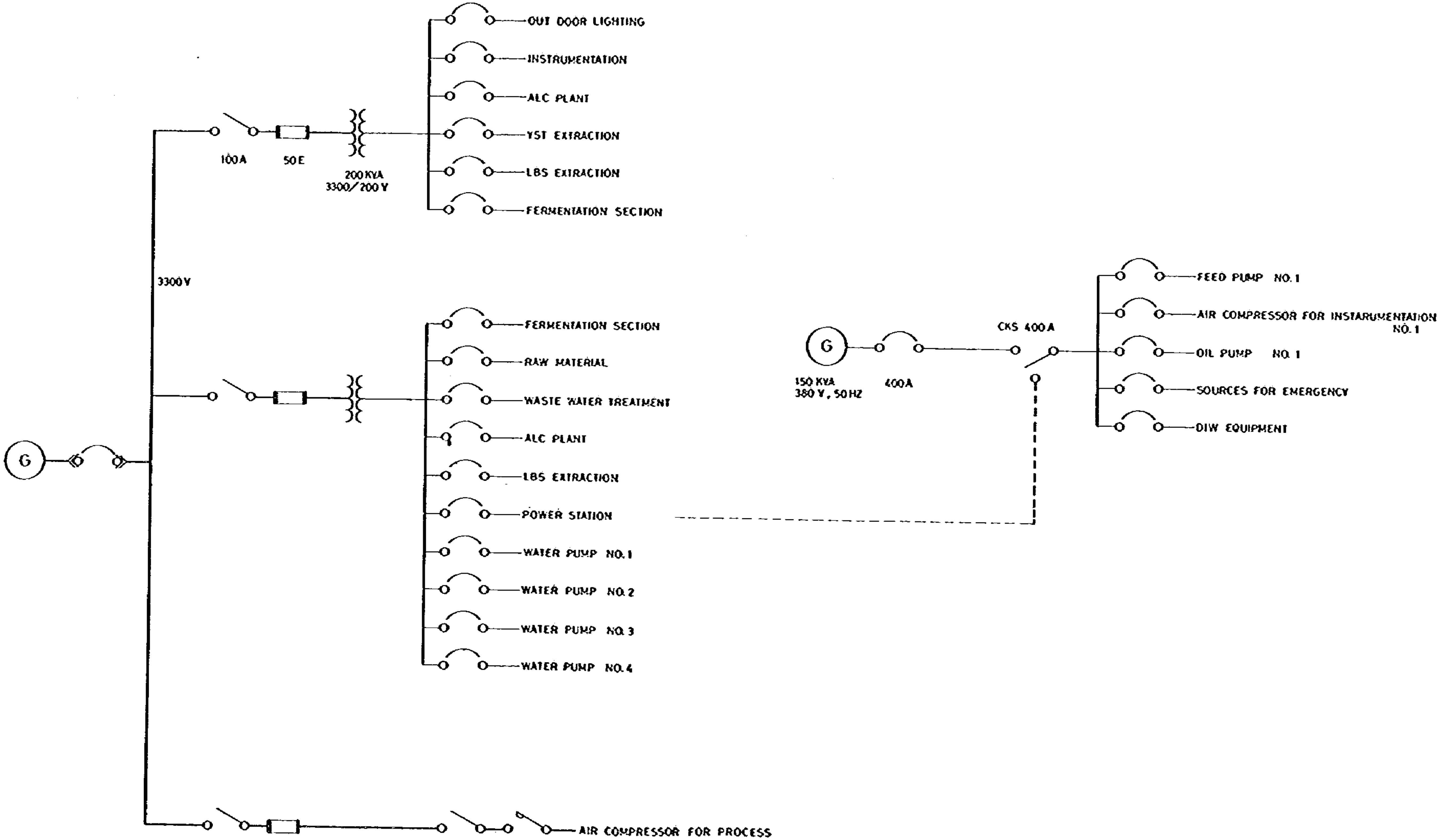


Fig. 5-11. Single-Line Diagram

5) Chilled water

The chilled water is to be made by a suction type freezer, and it is used mainly as chilled water for culture and Corynecin refining. The chilled water temperature is 18°C. It is stored in the chilled water pit, sent to each user by a pump, and returned to the receive pit. The flow is shown as Fig. 5-12.

6) Air

(1) Process air

An SRM type air compressor is installed and it generates and supplies compressed air of 2 kg/cm^2G pressure. The process air is mainly used for culture. The process air is cooled by a cooler and reheated by steam for moisture control. The flow is shown as Fig. 5-13.

(2) Instrument air

The instrument air is used as air to drive instruments. Instrument drive systems can be divided into electrical and pneumatic types. Since alcohol and solvents are used in this plant, and since pneumatic type is commonly used for control valves, we have determined to use the pneumatic drive system.

The instrument air pressure is 7 kg/cm^2G.

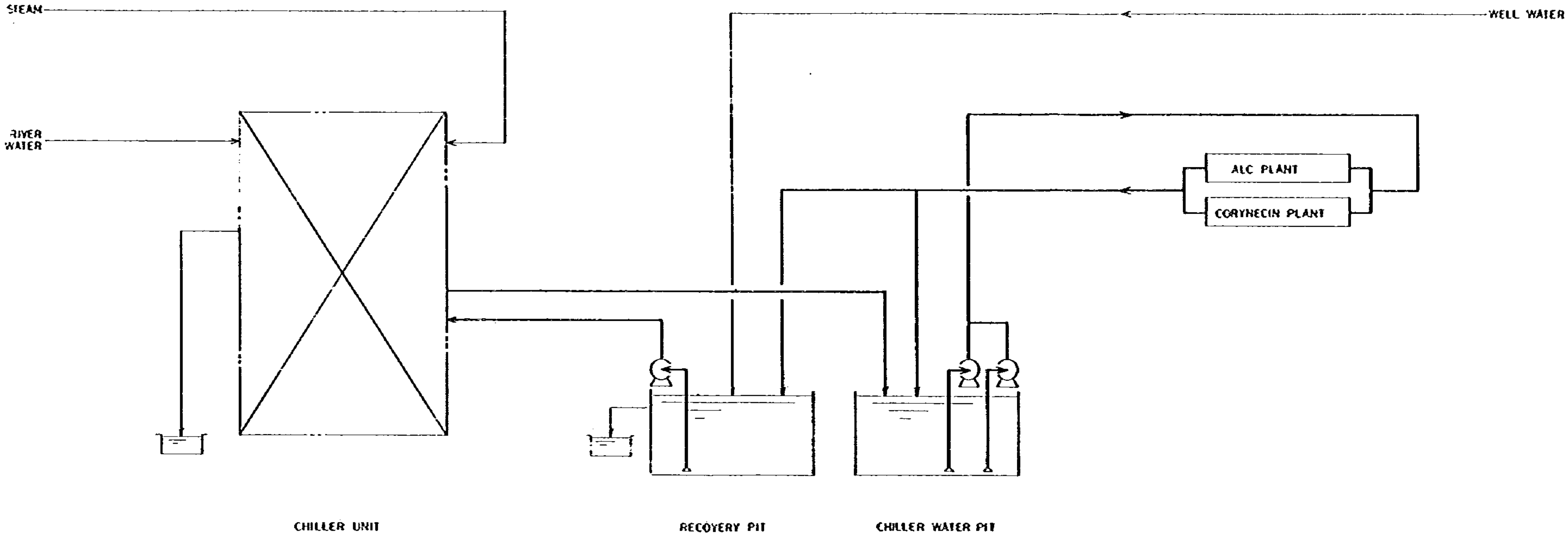


Fig. 5-12. Process Flow Sheet of Chiller Water

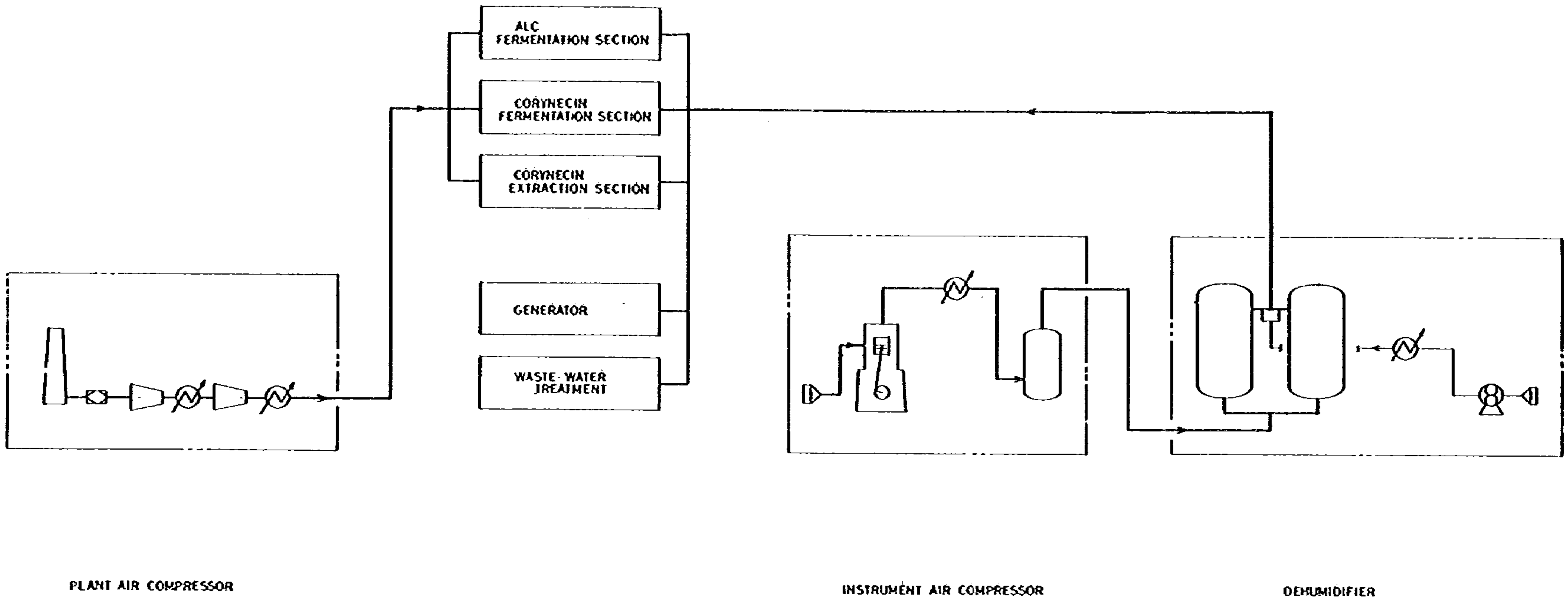


Fig. 5-13. Process Flow Sheet of Air

5.6.2 Utilities Requirement and Installed Capacity Steam

Steam

Boiler

Requirement 39.1 t/h

Capacity 50 t/h

Ethanol	2.9 t/h
Yeast	6.13 t/h
Corynecin	3.0 t/h
Chilled water	4.73 t/h
Evaporation	10 t/h
Others	3 t/h
General	9.34 t/h

Electricity

Generator

Requirement 3055 KWH/h

Capacity 5300 KVA (4120 KWH/h)

Ethanol	20 KWH/h
Yeast	330 KWH/h
Corynecin	590 KWH/h
Chilled water	15 KWH/h
Blower	1300 KWH/h
Water	330 KWH/h
Evaporation	130 KWH/h
General	150 KWH/h
Instrument	40 KWH/h
Lighting	100 KWH/h
Others	50 KWH/h

River water

River water

Requirement
43200 m^3/day

Capacity
43200 m^3/day

Ethanol	90 m^3/h
Yeast	0
Corynecin	70 m^3/h
Chilled water	1000 m^3/h
Evaporation	500 m^3/h
Blower	100 m^3/h
Others	40 m^3/h

Well water

Well water

Requirement
125 m^3/h

Capacity
150 m^3/h

Ethanol	25 m^3/h
Yeast	33 m^3/h
Corynecin	22 m^3/h
Boiler	25 m^3/h
Waste water	10 m^3/h
Others	10 m^3/h

Air

Air

Requirement
25500 Nm^3/h

Capacity
26000 Nm^3/h

Ethanol	40 Nm^3/h
Yeast	21910 Nm^3/h
Corynecin	3260 Nm^3/h
Others	290 Nm^3/h

Chilled water

Requirement
1038 USRT

Capacity
1200 USRT

Ethanol	79 USRT
Yeast	744 USRT
Corynecin	215 USRT

5.7 Economical Review of the Basic Plant Design

Based on the market research of fermentation products outlined in Chapter 3, knowledge on the basic conditions of this project outlined in Chapter 4 and the "Scope of Work" that was exchanged and agreed upon by the Preliminary Survey Mission and Government of Republic of Indonesia, we thought of a fermentation complex to produce three items, that is, 30 Kℓ/day of alcohol, 10 ton/day of feed yeast and 56 kg/day of Corynecin, and having slop concentration equipment that would concentrate the distillation stillage to the extent of being usable as fertilizer. Among the three items, alcohol is an only item on which the production cost is lower than the sales price. On the feed yeast, even the variable cost is higher than the sales price, and the similar trend is seen on the Corynecin also. The reasons for higher production costs are the necessity of making water for cooling since the water is warm and consumption of a large amount of fuel for the evaporation of waste water. The facility investment up to 1986 is estimated to be approximately Rp 17,600 million.

When the project is financially analyzed under these circumstances, the return of investment after tax is as low as -10.33%. This indicates that the investment would never be recovered even in 15 years, or to the contrary, additional fund would be needed. Such a project cannot be recommended as an industry to utilize the cane molasses.

Accordingly, we determined to plan a complex to produce two items of 45 Kℓ/day alcohol and 56 kg/day Corynecin on the condition of consuming about the same quantity of cane molasses. The plan is formed based on the concept of using the profit from alcohol production for production of Corynecin, and the slop concentration equipment is to be included in the same way as in the initial plan.

In this case, the estimated facility investment up to 1986 is approximately Rp 12,500 million. The financial analysis of the revised plan indicates that the return of investment after tax is 13.37%, bearing the possibility of being reviewed for industrialization.

For this reason, the project to produce these two items only will be described in the following chapters; Chapter 6, Facility Plan, Chapter 7, Plant Construction Plan and Plant Operation, Chapter 8, Required Investment and Fund Plan, and Chapter 9, Financial Analysis.

As a prerequisite to make this project a practical one, the ethanol produced by the newly established plant must be consumed within the Indonesian market. To satisfy this condition, use of the ethanol as a part of alternative energy, as described in Clause 4.2.1, is essential, and the Indonesian government, especially, the Ministry of Agriculture, Ministry of Industry, BPPT and Pertamina, national petroleum company, might closely cooperate with the realization for this project.

An outline of the feed yeast production facilities is given in the appendix of this report.

Chapter 6.

FERMENTATION PLANT DESIGN

Chapter 6. FERMENTATION PLANT DESIGN

6.1 General Scope

6.6.1 Classification of facilities

The fermentation plant facilities including those to be newly installed and existing ones to be utilized can be classified as follows.

1) Production facilities: Ehtyl alcohol and Corynecin production facilities

2) Raw material facilities: Storages, tanks and raw material preparation facilities

3) Utility facilities: Boiler, generator, water supply system, cooling water manufacture facilities, power supply station and air compressor

4) Waste water treatment facilities: Condensation equipment and drainage

5) Auxiliary facilities: Analysis equipment, microorganism handling facility, repairing facility, communication and alarm systems, sanitary facility, and welfare facilty

6.6.2 Construction of plant facilities

The following conditions were set to estimate the facility expenses. Some of the facilities must be constructed in Indonesia and the details are described in this chapter. While the construction expenses were reviewed based on the acutal situation in Indonesia on the construction materials, labor charges, construction period and contractors and field investigation results on the related laws and regulations and drainage standard, it is difficult to have exact information. Therefore, details of these must be studied at the stage of the project implementation.

1) Procurement and fabrication

(1) All equipment such as tanks, machines, electric equipment, instruments, and laboratory machines and fixture shall be procured in Japan. Any large equipment that cannot be transported as is shall be pre-fabricated in Japan, transported in parts, and assembled in the construction site.

(2) Pipes, wires, insulation materials and painting

Piping materials including auxiliary materials such as valves, fittings, welding rods, bolts and nuts, electric cables, electric wires, insulation materials and painting materials shall be procured in Japan and transported to the construction site for fabrication, assembling and painting.

(3) Machinery for construction work

Welders, cranes, and temporary installation materials shall be procured in Indonesia.

2) Transportation

All equipment and materials procured in Japan shall be packed adequately, transported to Jakarta from either Yokohama or Kobe over the ocean, and transported by trucks from Jakarta to Ex Comal.

6.2 Production Facilities

The following outlines the major production facilities.

6.2.1 Ethanol production facility

1) Fermentation section

(1) 1st column fermentor — 75 m^3, CS, air sparger cooling coil inside

(2)	2nd column fermentor	40 m^3, CS, air sparger, cooling coil inside
(3)	Broth out tank	120 m^3, CS, steam sparger, cooling coil inside
(4)	Make up tank	3 m^3, CS, with coil
(5)	Jar fermentor	30 l
(6)	Hoist	1,500 kg, 15 m

2) Distillation section

(1)	Mash column	25 bubble cap tray, SUS 304
(2)	Concentration column	50 bubble cap tray, SUS 304
(3)	Foam breaker	1 m^3, SUS 304
(4)	Cushion tank	2 m^3, CS,
(5)	Alcohol checking tank	15 m^3, CS,
(6)	Alcohol storage tank	1,000 m^3, CS,
(7)	Preheater	plate type, 45 m^2, SUS 304
(8)	Conc column overhead condensor	shell and tube, 150 m^2, SUS 304
(9)	Product cooler	shell and tube, 30 m^3, SUS 304
(10)	Hoist	1,500 kg

6.2.2 Corynecin production facility

1) Fermentation section

(1)	Medium make up tank	x 2	20 m^3, CS
(2)	Kasten	x 2	0.16 m^3, SUS 304
(3)	1st seed tank	x 2	2 m^3, SUS, with jacket and sparger
(4)	2nd seed tank		10 m^3, SUS 304, with jacket and sparger
(5)	Fermentor	x 3	80 m^3, SUS 304, cyclone, coil and sparger
(6)	Broth tank		80 m^3, SUS 304, air sparger

2) Isolation section

(1)	Balance tank		10 m^3, SUS 304
(2)	Mixer	x 3	5 m^3/h, SUS 304
(3)	Separator	x 2	5 m^3/h, SUS 316
(4)	Spent broth tank		50 m^3, SUS 304
(5)	Distillation column		3 m^3/h, SUS 316
(6)	Evaporator		0.7 m^3/h, SUS 304, Kontro type, with recycle
(7)	Condensor		SUS 304
(8)	Vacuum pan-1		4 m^3, SUS 304, with jacket cyclone and ejector
(9)	Concentrate tank		2 m^3, SUS 304

(10)	Filter press	4 m^2, CS + RL
(11)	Vacuum pan-2	4 m^3, SUS 304, with jacket cyclone and ejector
(12)	Crystallizer	3 m^3, SUS 304, with jacket
(13)	Centrifuge-1	36", SUS 316
(14)	Decolorization tank	10 m^3, SUS 304
(15)	Ultra filter	2 m^2, SUS 316
(16)	Vacuum pan-3	4 m^3, SUS 304, with jacket cyclone, baro-con ejector
(17)	Crystallizer-2	3 m^3, SUS 304, with jacket
(18)	Centrifuge-2	36", SUS 316
(19)	Crystallizer-3	3 m^3, SUS 304, with jacket
(20)	Centrifuge-3	36", SUS 316
(21)	Dryer unit	SUS 304, vacuum pump

6.3 Raw Material and Utlity Facilities

6.3.1 Raw material facilities

1) Liquid material facilities

Molasses storage: 1 unit, 1,000 KL capacity, cone roof tyep SS41, with suction heater and level gauge

Fuel oil storage: 1 unit, 1,000 KL capacity, cone roof type, SS41, with steam heater and level gauge

Others: Storages H_2SO_4, NaOH, HNO_3, antifoamer and solvent shall be installed.

2) Solid materials

The existing storage shall be used.

3) Molasses dilution tank

2 molasses diluting tanks shall be installed for common use of alcohol and corynecin cultivation. The approximate flow is shown in Fig. 6.1.

Molasses diluting tank: 2 units, 100 KL capacity, SS41 with agitator

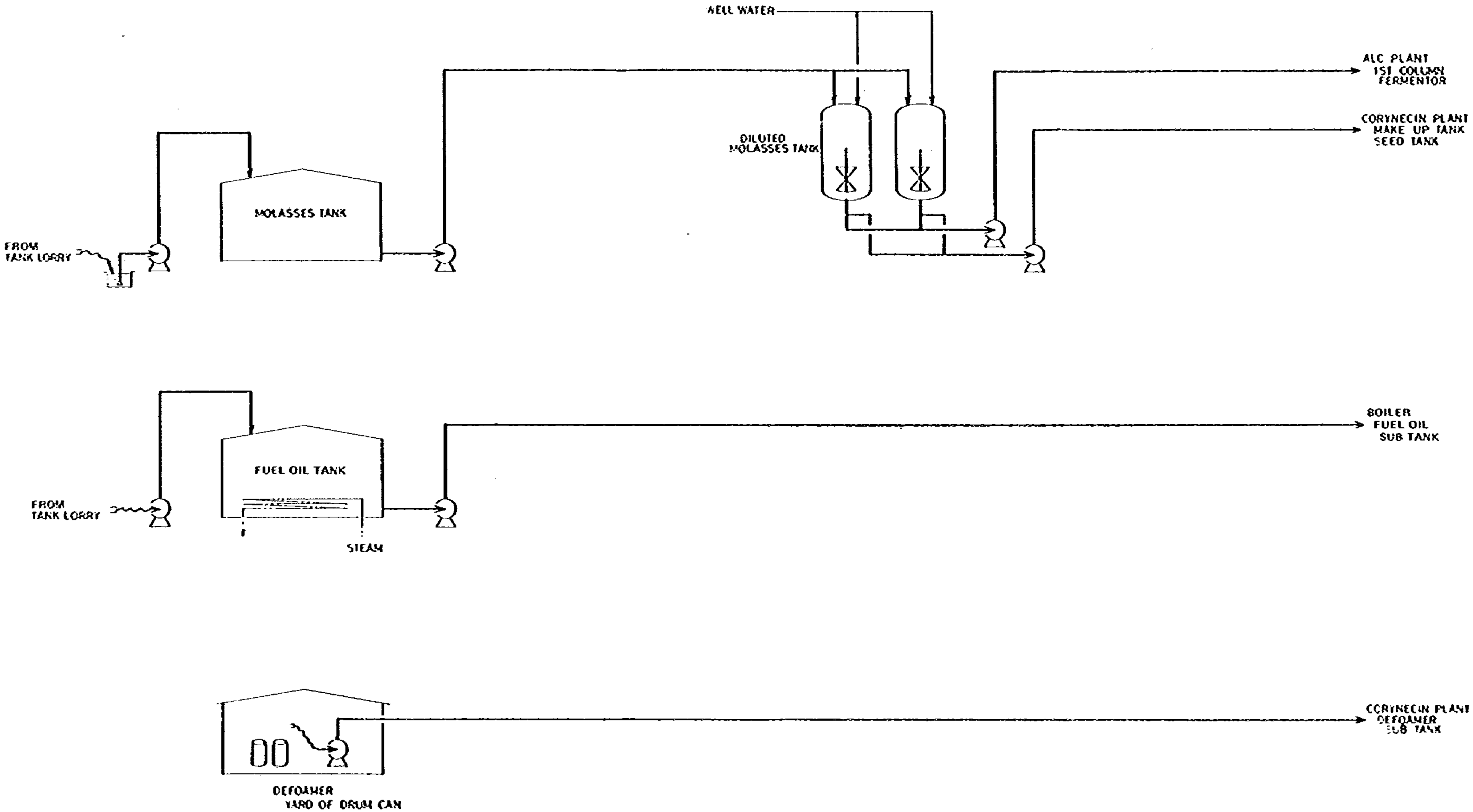


Fig. 6-1. Process Flow Sheet of Raw Material

6.3.2 Utilities facility

1) Boiler and power station

(1)	Boiler	2 drum natural circulatin type, outdoor use with instrument
(2)	Draft fan	steam turbine driven
(3)	Deaerator	
(4)	Auxiliary feed water pump	
(5)	Water deionizer	3 bed, 3 column type
(6)	Steam turbine	back pressure type outlet pressure 4.5 kg/cm^2
(7)	Mechanical reducer	
(8)	Exhaust fan	
(9)	Silencer	
(10)	Pressure and temperature reducing regulator	
(11)	Generator	rotating field type, 3,300 V, 1,800 RPM, power factor 0.86, equipped with brush-less exciter

2) Power distribution equipment

(1)	Transformer for motors	3 phase 4,000 KVA
(2)	Transformer for lighting & instrument	
(3)	Circuit breaker	

(4)	Combination with for compressor	3 pole, single throw
(5)	Combination switch for low voltage	
(6)	Combination for lighting & instrument	
(7)	Low voltage circuit breaker	400 V, 400 A diesel generator
(8)	Low voltage motor control center	
(9)	Low voltage power switchboard	for 7 circuit
(10)	Low voltage power switchboard	
(11)	Power switchboard	for lighting
(12)	Battery	

3) Air supply facility

(1)	Plant air compressor	2,500 Nm^3/h, 2 kg/cm^2G 2 stage turbo type, with inter cooler, suction and delivery blow silencer, instrument and electrical equipment
(2)	Instrument air compressor	oil free

4) Water supply facility

(1)	River water pit	
(2)	River water pump	
(3)	Well water pump	
(4)	Chiller unit	absorption type chiller
(5)	Chilled water pump	

6.4 Waste water treatment facility

(1)	High conoentration waste water receiver	
(2)	Waste water evaporator	30 t/h plate type
(3)	Concentrated waste water receiver	
(4)	NaOH tank	5 m^3, SS 41
(5)	HNO_3 tank	5 m^3, SUS 304

6.5 Auxiliary Facilities

Major auxiliary facilities are outlined in the following.

6.5.1 Microorganism handling facility and analysis equipment

1) Microorganism handling facility

A complete set of equipment for microorganism handling shall be included. The main members are autoclave, clean bench, shaker, thermostat incubator, refrigerator, testing bench, centrifugal settler, glassware and tools.

2) Analysis equipment

The analysis equipment can be divided into three categories; analysis for products, raw materials and process. The equipment must be usable for analysis of cane molasses, ethanol and corynecin, and the major ones are outlined in the following.

6.5.2 Electrical and communication facilities

1) Lighting

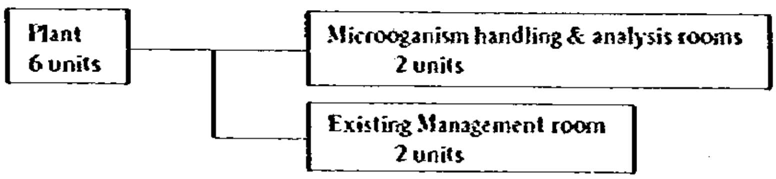
Fluorescent lamps shall be used mainly, with some incandescent and mercury lamps. The lux shall be as follows.:

Microorganism handling and analysis rooms
200 to 300 Lx

Plant building, machinery room, warehouses
50 to 100 Lx

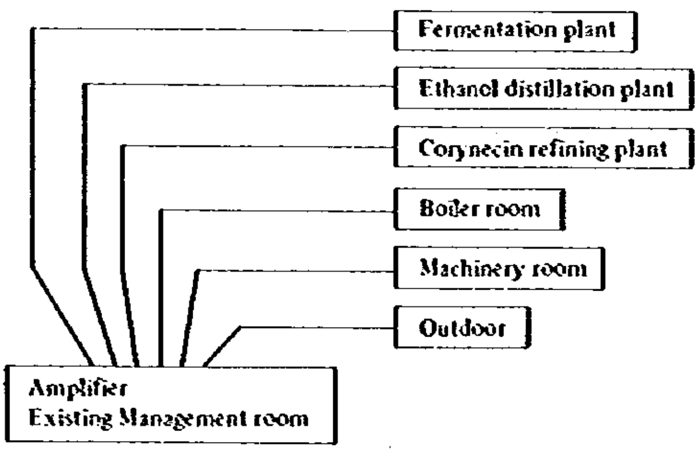
2) Communication facilities

An interphone system shall be installed for communication within the plant. The system shall be the two-way concurrent conversation type, and the number of telephone sets shall be about 10.



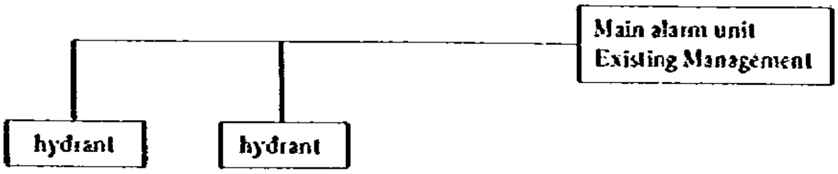
3) Broadcasting facilities

A broadcasting system shall be installed for paging and message relay in the plant. The amplifier shall be installed in the existing management room, and a time casting unit which is interlocked with an independent time casting device shall be incorporated into the system.



4) Alarm system

Alarm bells shall be installed for emergency case. The main unit shall be installed in the existing management room, and pushbuttons and bells shall be installed in places close to hydrant. About 10 hydrants shall installed.



About 10 hydrant

5) Lighting protection

A lightining conductor shall be installed to the heavy oil tank and alcohol tank.

6) Others

Power outlets and power supply for construction shall be installed.

6.5.3 Sanitary facility

1) Lavatory and shower

Lavatories and shower equipment shall be installed for field operators.

2) Washing room

Equipment necessary to wash tools and others shall be installed.

6.5.4 Others

1) Transportation equipment

One forklift shall be provided mainly for transportation of auxiliary materials.

Addtionally, about 3 push carts shall be provided.

2) Measuring machines

One each of large, medium and small measuring machines shall be provided.

3) Tools for maintenance work

No maintenance tool, other than for special purposes, shall be included in this project.

4) Spare parts

The least necessary number of spare parts shall be provided.

5) Land

Procurement expenses of the land for water intake shall not be included in the construction expenses.

6.6 Layout of Fermentation Plant

6.6.1 Basic conditions

1) Conditions for layout determination

In this project the fermentatin plant is built in an existing sugar factory. Therefore, we consider that the plant layout must be made after conducting the following works on the site where the equipment is actually installed:

a. Detailed investigation on the existing building and equipment

b. Adjustment with this project if the site is to be used for a purpose of other than this project

2) Basic conditions in this report

(1) Utilization of existing sugar factory building

The existing building shall be used for this project for the following reasons:

a. The basic structure as observed from the pillars and walls of the existing building is sturdy.

b. The existing building has enough area size and height.

c. Installing the necessary equipment is advantageous on stability of the operation, operation activities and durability of the equipment, as well as for the least amount of influence from the weather.

(2) Utilization of railroad

The railroad can be utilized for transportation of the products and raw materials.

(3) Utilization of existing chimney

Since the existing chimney has not been used for a long time, it can be used by the new fermentation plant.

(4) Utilization of rooms in existing building

The rooms in the existing building can be used by the new plant, especially as solid material storage and analysis room.

(5) Arrangement of production processes

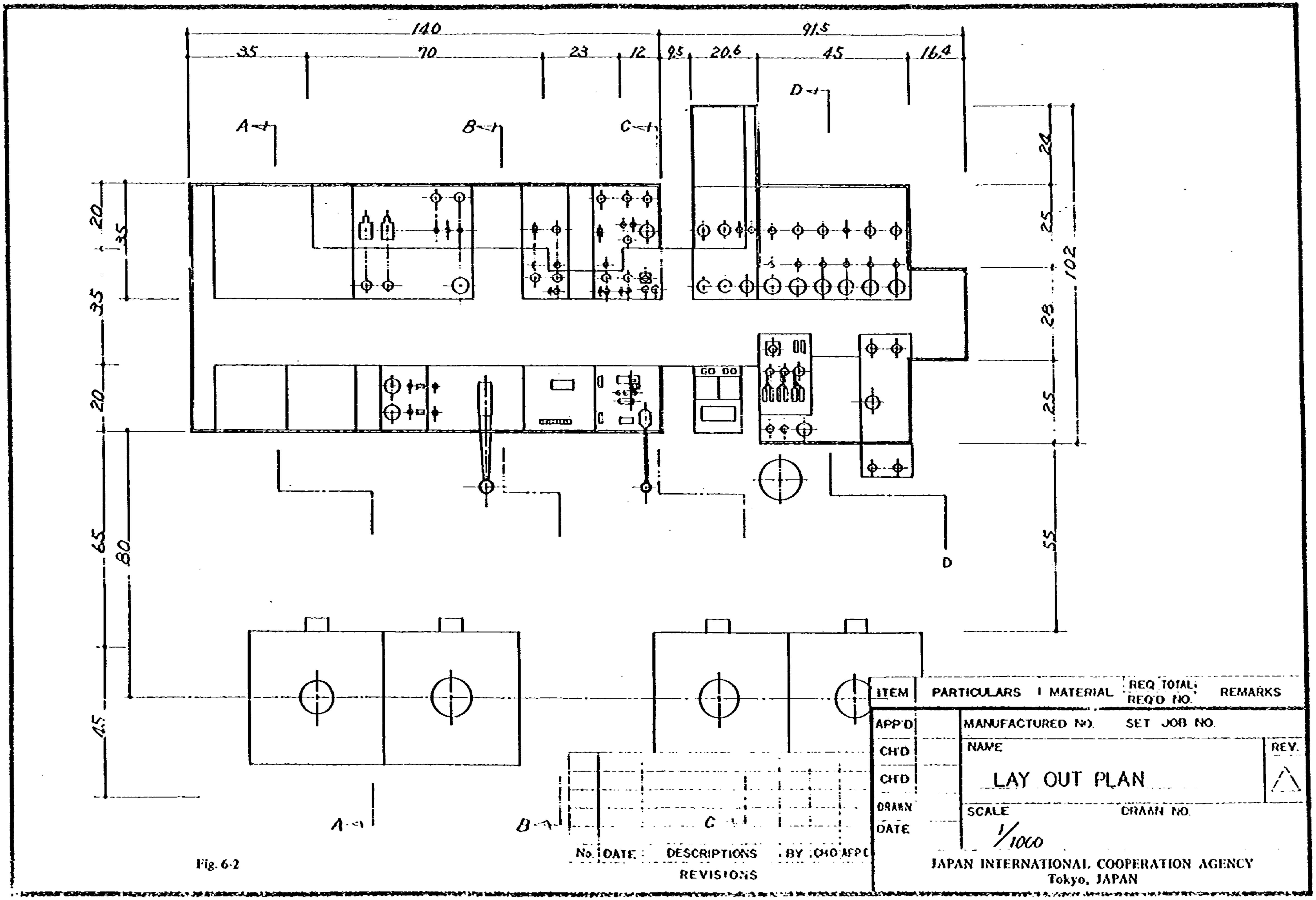
a. The production flow shall be laied out, separating the raw material processing process, fermentation process and utilities facilities.

b. Equipment for handling dangerous objects shall be installed at a mutually close place as much as possible.

(6) A passage each shall be installed between the building and raw material storage, product storage and waste water tank.

3) Layout drawing

Refer to Fig. 6.2 and 7.3.



140
91.5
35
70
23
12
9.5
20.6
45
16.4
A
B
C
D
20
35
35
20
65
80
45
24
25
102
28
25
55
ITEM
PARTICULARS
MATERIAL
REQ TOTAL
REQ'D NO.
REMARKS
APP'D
CH'D
CHD
DRAWN
DATE
MANUFACTURED NO.
SET JOB NO.
NAME
LAY OUT PLAN
REV.
SCALE
1/1000
DRAWN NO.
No.
DATE
DESCRIPTIONS
BY
CHD
APPD
REVISIONS
JAPAN INTERNATIONAL COOPERATION AGENCY
Tokyo, JAPAN

Fig. 6-2

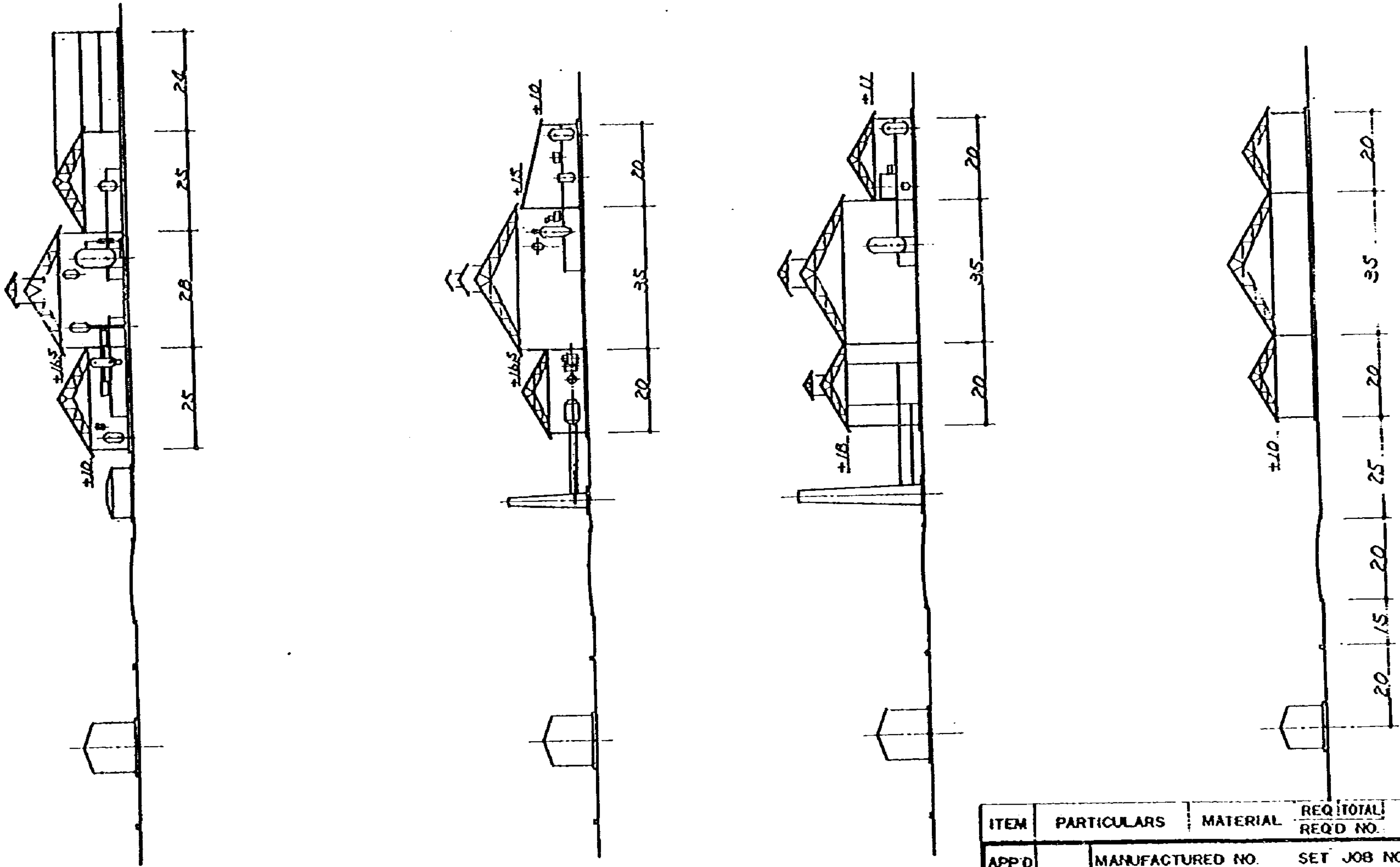


Fig. 6-3.

ITEM	PARTICULARS	MATERIAL	REQ TOTAL / REQ'D NO.	REMARKS

APP'D	MANUFACTURED NO. SET JOB NO.
CH'D	NAME
CH'D	SECTION VIEW
DRAWN	SCALE DRAWN NO.
DATE	1/1000

REV.

No.	DATE	DESCRIPTIONS	BY	CHD	APPD

REVISIONS

JAPAN INTERNATIONAL COOPERATION AGENCY
Osaka, JAPAN