THE REPUBLIC OF INDONESIA SURVEY REPORT

ON

PETROCHEMICAL INDUSTRY DEVELOPMENT

VOL. I SUMMARY

OCTOBER 1974

Prepared for

JAPAN INTERNATIONAL COOPERATION AGENCY

by

UNICO INTERNATIONAL CORPORATION

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PREFACE

In compliance with the request made by the Government of Indonesia, the Government of Japan decided to conduct studies for formulating a long term plan in petrochemical industry, and also for investment and incouragement in synthetic rubber and synthetic detergent industries as well as plastic industry, and commissioned the execution of the surveys to the Overseas Technical Cooperation Agency (which was integrated into the Japan International Cooperation Agency on the 1st of August, 1974).

The agency, thereafter, formed a survey team consisting of twelve experts led by Mr. Y. Mikami, Vice President, UNICO International Corporation, and dispatched it to the Republic of Indonesia on the 6th of January, 1974.

During the survey work for a period of 30 days in Indonesia, the team held discussion meetings on the above subjects with Indonesian Government authorities concerned, i.e., the Department Perindustrian, Construction Ministry, Pertamina, etc., and carried out site surveys covering such areas as Jakarta, Bandung, Cilaciap, Cilegon in Java Island, Sarimanda, Balikpapan, etc., in the East Kalimantan area, Ache, Medan, etc., in the North Sumatra area and Palembang in South Sumatra.

Hereby presented in a report based upon the outcome of the survey performed. I hope that this report will contribute to the future development of the petrochemical industry in Indonesia and also will assist the policy making efforts of the Indonesian Government in the fields of fostering synthetic rubber, synthetic detergent and plastic processing industries of the country. As a result, anticipated that the industrialization in Indonesia will further be fostered and friendship between Indonesia and Japan will be more intensified than ever.

Finally, I take this opportunity to express my heartfelt gratitude to the Government of the Republic of Indonesia and other authorities concerned for their kind cooperation and support extended to the Japanese survey team.

October 1974

Sinsaku Hogen
President
Japan International Cooperation Agency

Letter of Transmittal:

Mr. Sinsaku Hogen
President
Japan International Cooperation Agency

Dear Sir,

Re: Petrochemical Industrial Development Project Survey, Republic of Indonesia

We are pleased to submit to your kind attention our report concerning the subject both in Japanese and in English.

We would like to take this opportunity to express our deep appreciation for your nominating our company for undertaking this important survey to be conducted in compliance with the requests made by the Government of the Republic of Indonesia. We would like to report to you that the subject survey was conducted in accordance with the following procedure with the cooperation extended by Messrs. Japan Gasoline Corporation who conducted at UNIDO Phase I of this subject and Messrs. Toyo Engineering Corporation who undertook to carry out the basic chemical industrial survey of Indonesia in 1973.

Towards the end of 1973, questionnaires for the survey and study were dispatched to the Government of Indonesia. Thereafter, a survey team consisting of 12 experts visited Indonesia for the period from 6th January to 4th February, 1974.

During the period of the survey, meetings were held between the Department Perindustrian, Pertamina, Ministry of Public Works, etc. and the survey team. Also, on-site surveys were conducted by the team, the findings of which have been summarized in the Interim Report compiled on 2nd, February, 1974. After returning to Tokyo, the compilation of this report has been started on the basis of the data and policies stated in the above-mentioned Interim Report, and the compilation of various economic calculation results and also the preparation of technical data have been undertaken with our utmost efforts.

Taking the results of the survey, we visited Indonesia. At the meeting held during our stay, we could obtain a definite plan of natural gas for raw material, which was uncertain at the time of January survey.

Because the component and prices of the gas differ from what we estimated in January, we add the results after studying the changes in component and prices. For this study covers a wide range of fields, petrochemical complex, synthetic rubber, industry, synthetic detergent industry and plastics processing industry, it is compiled as Executive Summary, which includes the whole study, and other five volumes separated respectively by the field.

The results of the studies indicate a strong possibility of establishing a petrochemical complex in Indonesia.

Because Petrochemical Industry is a huge complex, it is important for the Government and Pertamina as an enterpriser to prepare for receiving it. Therefore, we strongly recommend further detailed studies including construction site study.

Therefore, we sincerely recommend that another detailed survey be undertaken anew as and when the clarification of the information and data regarding the raw materials are made.

Thanking you for your kind attention, we remain,

Yours faithfully

Y. Mikami

Y. Mikami
Vice President
UNICO International Corporation

Abbreviations

AB	Alkylbenzene
ABS	Acrylonitrile-butadiene-styrene for polymer
ABS	Alkyl Benzene Sulfonate
AD	Acetic Acid
AG	Aromatic Gasoline (Pyrolysis Gasoline)
BR	Butadiene Rubber
B-B	Butan, Butadiene Residue
BTX	Benzene, Toluene, Xylene
CHP	Cumene Hydroperoxide
CCW	Circulating Cooling Water
CPP	Cast Polypropylene Film
CR	Chloroprene Rubber
C-X(CHX)	Cyclohexane
DEG	Diethylene Glycol
DMT	Dimethyl Terephthalate
DOP	Dioctyl Phthalate
E	Ethylene
EG(MEG)	Ethylene Glycol
EO	Ethylene Oxide
EP	Electric Power
EPDM	Ethylene-propylene-diene-methylene Linkage
EDC	Ethylene Di-chloride
EVA	Ethylene-vinyl Acetate Copolymer
FG	Fuel Gas
FO	Fuel Oil
FRP	Fiber Reinforced Plastic
FW	Filtered Water
GP	General Purpose (Polystyrene)
HDPE	High Density Polyethylene
HI	High Impact (Polystyrene)
IR	Isoprene Rubber
IIR	Butyl Rubber
LAB	Linear Alkylbenzene

LDPE	Low Density Polyethylene
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MI	Melt Index
M-xylene (Xylene)	Mixed Xylene
NBR	Nitril Rubber
NG	Natural Gas
NGL	Natural Gas Liquid
NR	Natural Rubber
OPP	Oriented Polypropylene Film
PP	Polypropylene
PS	Polysterene
PTA	Pure Terephthalic Acid
PVC	Polyvinyl Chloride
PW	Polished Water
p-Xylene (P-X)	Paraxylene
SBR	Styrene-butadien Rubber
SM	Styrene Monomer
TPA (TA)	Terephthalic Acid
UV	Ultra-violet
VCM	Vinyl Chloride Monomer

DCF	Discounted Cash Flow	
Exchange Rate	1971	1US$=360 Yen
		1US$=415 Rupiah
	After the End of 1973	1US$=300 Yen
		1US$=415 Rupiah
GDP	Gross Domestic Product	
GNP	Gross National Product	
IRR	Internal Rate of Return	
$(DL.)	U.S.$, unless Particularly Remarked	
ROI	Return on Investment	

CONTENTS

(Volume I)

List of Tables (Volume I)

List of Figures (Volume I)

Organization of the Survey Team

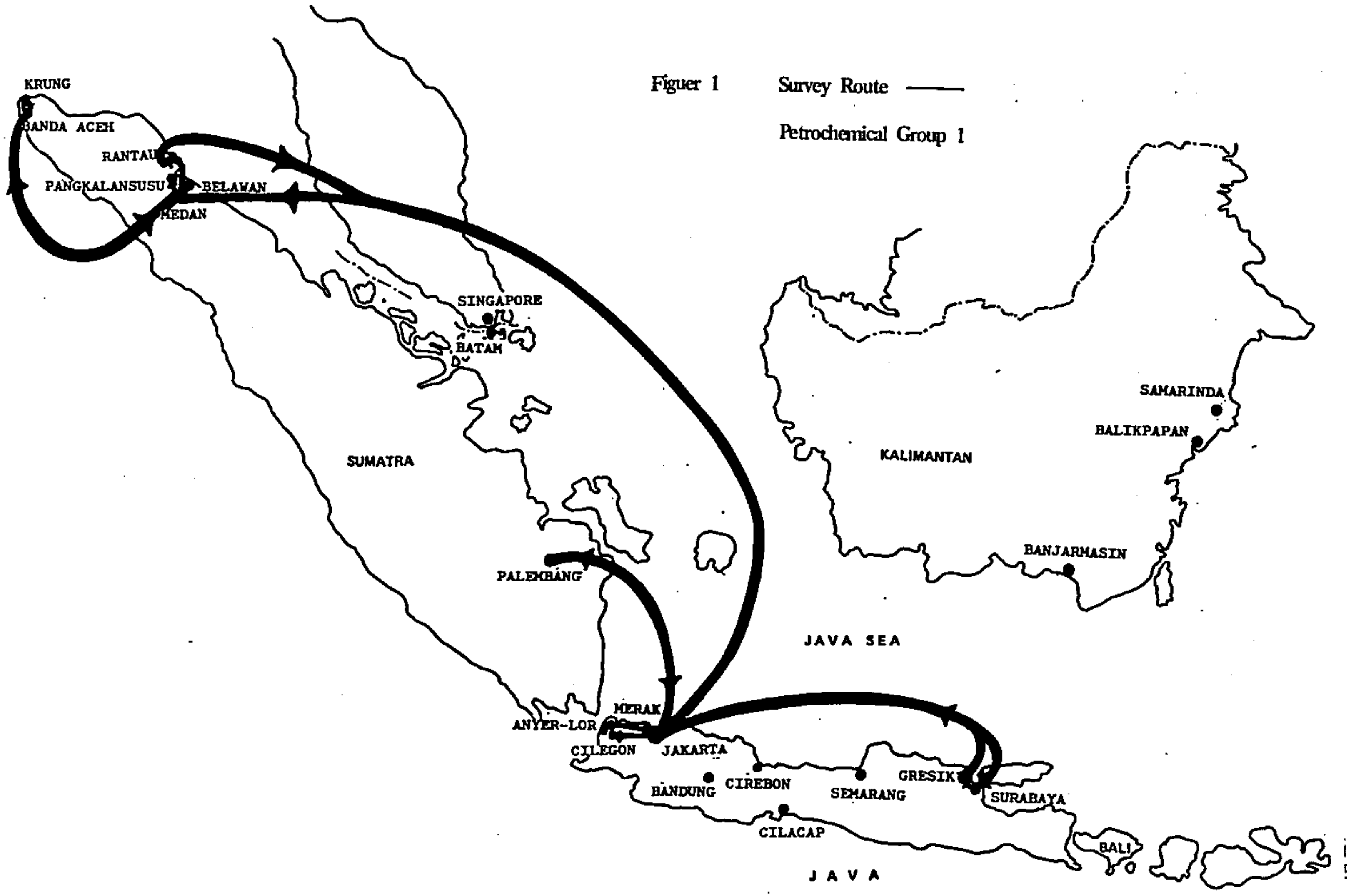
Members	Title	Allocation of Responsibility	Team
Yosiyasu Mikami Team Leader	Excecutive Managing Director, UNICO International Corp.	General Management	1
Hiroshi Shiina	UNICO Internatioanal Corp.	Complex Study	"
Tatsuo Hosoda	Senior Civil Engineer, Toyo Engineering Corp.	Site Survey, Construction	"
Masayuki Kondoh	UNICO International Corp.	Study on MeOH, Electrolysis, PVC, PS Production	"
Kensuke Yoshimura Assistant Team Leader	Assistant General Manager, Consulting Division, Toyo Engineering Corp.	Survey on Related Industries, Complex Designs	2
Kohichi Shibao	Manager, Engineering Department, UNICO International Corp.	Project Evaluation and Selection	"
Hiroyuki Nakanishi	UNICO International Corp.	Study on LDPE, HDPE, PP, EG Production	"
Yasuo Fukushima	Planning Division, Japan Gasoline Oil Co., Ltd.	Study on Aromatics Production, Hydrocarbon Raw Materials	"
Michio Kanda	International Corporation Agency	General Coordination	"
Takashi Chino	Manager, Polymer Industry Department, UNICO International Corp.	Market Survey, Plastic Processing, Synthetic Rubber and Detergent	3
Shuichi Sasaki	General Affairs Division, Basic Industries Bureau Ministry of International Trade and Industry	Policy for Petrochemical Industry Development	"
Toshitaka Matsushige	UNICO International Corp.	Market Survey, Plastic Processing	4

List of Visits Paid to

	Route				Visits Paid To			
	Team 1	Team 2	Team 3	Team 4	Team 1	Team 2	Team 3	Team 4
JAN. 6 (SUN.)	TOKYO → JAKARTA				Travelling			
7 (MON.)		JAKARTA			Embassy of Japan, OTCA, D.G. of Chemical Industry			
8 (TUE.)		JAKARTA			D.G. of Chemical Industry, Pertamina			
9 (WED.)		JAKARTA			TAISEI Construction Japan-Indonesia Joint Venture,	Pertamina, ILC	Pertamina	Majestic, Others
10 (TUR.)		JAKARTA			Directorate General Ports and Harbors,		Pioner, Others	Widjaya Indonesia Platik, Others
11 (FRI.)		JAKARTA			Nippon Koei, P. T. Sam Nusantra		ILC, Departemen Perindustrian	The Public Ltd, Others
12 (SAT.)		JAKARTA			Water Works Consultans,	Ministry Of Industry, Others	Departemen Perindustrian	
13 (SUN.)	JAKARTA → MERGUI	JAKARTA → BANGDUNG		JAKAKTA	Travelling			Data Processing
14 (MON.)	MERGUI → JAKARTA	BANGDUNG		KAKARTA	Kecamatan Cilegon	A Hydrodynamics Laboratory, Propelat, A Geological Lab.	Nikatsu Elec., Others	Chemindo, Others
15 (TUE.)	JAKARTA → PALEMBANG	BANGDUNG → CILACIAP	BANDUNG → JAKARTA	JAKARTA	Pertamina Unit II/Sungaigerong	Geological Lab. Others	Polytex, Others	Plastic Co., Others (Bg)
16 (WED)	PALEMBANG	CILACIAP → BANGDUNG	JAKARTA		Pertamina Unit II/Sungaigerong	Cilacap Refinary Project Office, Perindustrian Office	Data processing	
17 (TUR.)	PALEMBANG	BANGDUNG → JAKARTA	JAKARTA		Push	Travelling, (Mr. Mikami: Embassy of Japan)	Hibar, Others (J)	Lucky, Others (J)
18 (FRI.)	PALEMBANG	JAKARTA → BALIKPAPAN	JAKARTA → SURABAYA	JAKARTA	Data Processing	Travelling		Departemen Perindustrian
19 (SAT.)	PALEMBANG → JAKARTA	BALIKPAPAN	SURABAYA	JAKARTA	Travelling	Office of Pertamina Unit IV, Perindustrial Office	Mitsui & Co., Others	Chandra Markono, Others
20 (SUN.)	JAKARTA → SURABAYA (Mr. Kanda: Jakarta → Tokyo)	BALIKPAPAN → SAMARINDA	SURABAYA	JAKARTA	Travelling (Mr. Kanda: Data Processing)	Travelling	Data Processing	
21 (MON.)	SURABAYA (Mr. Kanda: Jakarta → Tokyo)	SAMARINDA → BALIKPAPAN	SURABAYA	JAKARTA	P. N. Garam (Mr. Kanda:	Perindustrial Office	Abadi, Others	Cypress Plas; Others
22 (TUE.)	SURABAYA → JAKARTA	BALIKPAPAN → BANDJARMASIN	SURABAYA	JAKARTA	Travelling P. N. Petrokimia Gresik	Pertamina Unit IV	Saman, Others	United International, Others
23 (WED.)	JAKARTA → MEDAN	BANDJARMASIN → JAKARTA	SURABAYA → SEMARANG (Mr. Sasaki: Tokyo → Jakarta)	JAKARTA	Travelling Pertamina Unit VI	Travelling, Proyek Kertas-Martapra	Berlina, Others (Mr. Sasaki: Travelling)	Omniseals, Others
24 (TUR.)	MEDAN → ACHE	JAKARTA	SEMARANG (Mr: Sasaki: Jakarta)	JAKARTA	Annex of Departement Perinsudtrian, D.G. of Development of Ache State	D.G. of Chemical Ind., Pertamina, Embassy of Japan	Central Java Marine Products (Mr. Sasaki:	Paralon Co., Others
25 (FRI.)	ACHE	JAKARTA	SEMARANG → JAKARTA (Mr. Sasaki: Jakarta)	JAKARTA	Annex of Dep. Perindustrian, Port Autholity of Ache State	B.G. of Basic Chemical Industry	Travelling (Mr. Sasaki: Joins Team 2)	Speki, Others
26 (SAT.)	ACHE → MEDAN	JAKARTA		JAKARTA	Travelling, Brawan Bay Research	B. G. of Light Chemical Industry, Embassy of Japan	Electric Wire Industry Association (Mr. Sasaki: joins Team 2)	Shinta Modern Plastic, Others
27 (SUN.)	MEDAN → JAKARTA	JAKARTA	JAKARTA → MEDAN	JAKARTA	PERTAMINA	Report (Mr. Mikami: A meeting with P. S. G.)	Travelling	Data Processing
28 (MON.)	JAKARTA	JAKARTA → SINGAPORE (Mr. Mikami: Jakarta)	MEDAN	JAKARTA	Lumigas	Travelling (Mr. Mikami: Bapenas Pertamina)	Departemen Perindustrian Others	Wilis Utama, Others
29 (TUE.)	JAKARTA	SINGAPORE (Mr. Mikami: Jakarta)	MEDAN	JAKARTA	D. G. of Electricity. Report	Batang Island Research (Mr. Mikami: Dep. Perindustria)	Sukarera, Others	Perlin Industria, Others
30 (WED.)	JAKARTA	SINGAPORE → JAKARTA (Mr. Mikami: Jakarta)	MEDAN → JAKARTA	JAKARTA	Interimo Report	Travelling (Mr. Mikami: Japan-based Joint Venture)	Sumatra Plk, Others	Kerplindo, Others
31 (TUR)		JAKARTA			Report		Travelling Central Institute of Agriculture, Others	Indonesia Evagreen, Others
FEB 1 (FRI.)		JAKARTA			Report		Unilaver, Others	Plasnal, Others
2 (SAT.)		JAKARTA			D. G. of Chemical Industry (Explanation of an Interimo Report)		D. G. of Light Industry, D. G. of Chemical Industry	Kalijaya Utama, Others
3 (SUN.)		JAKARTA						
4 (MON.)	JAKARTA → TOKYO							

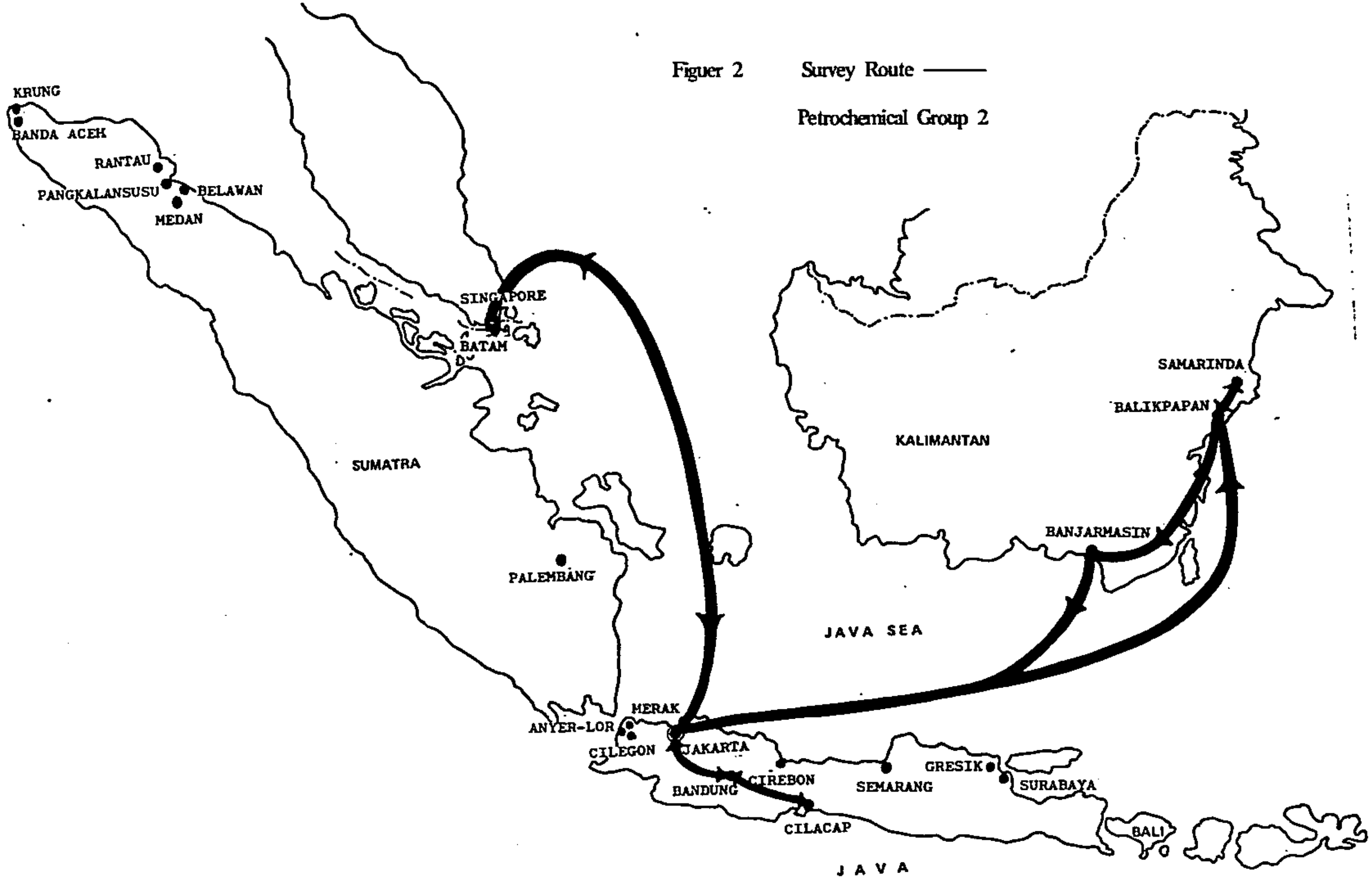
Figuer 1 Survey Route ——

Petrochemical Group 1



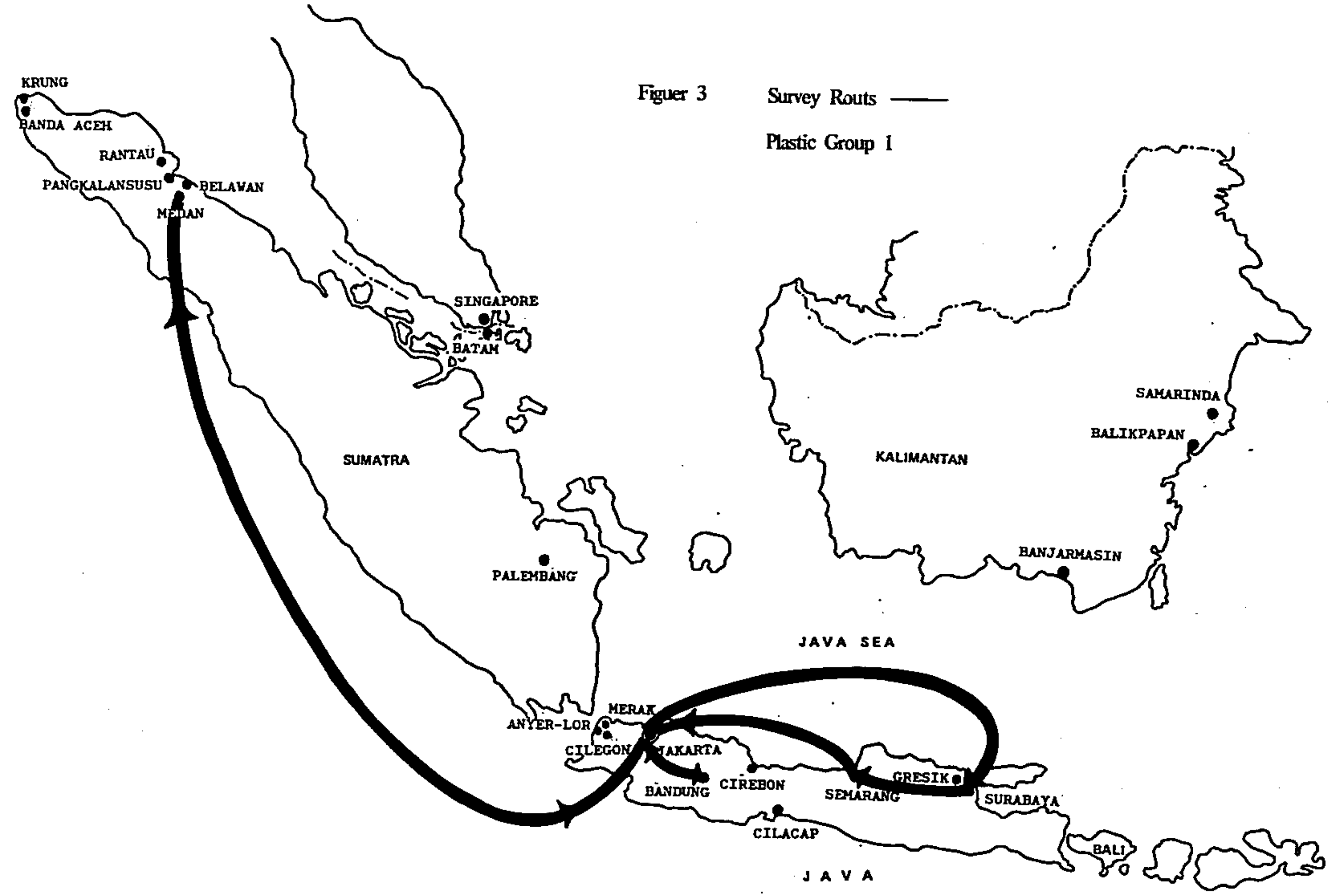
Figuer 2 Survey Route ——

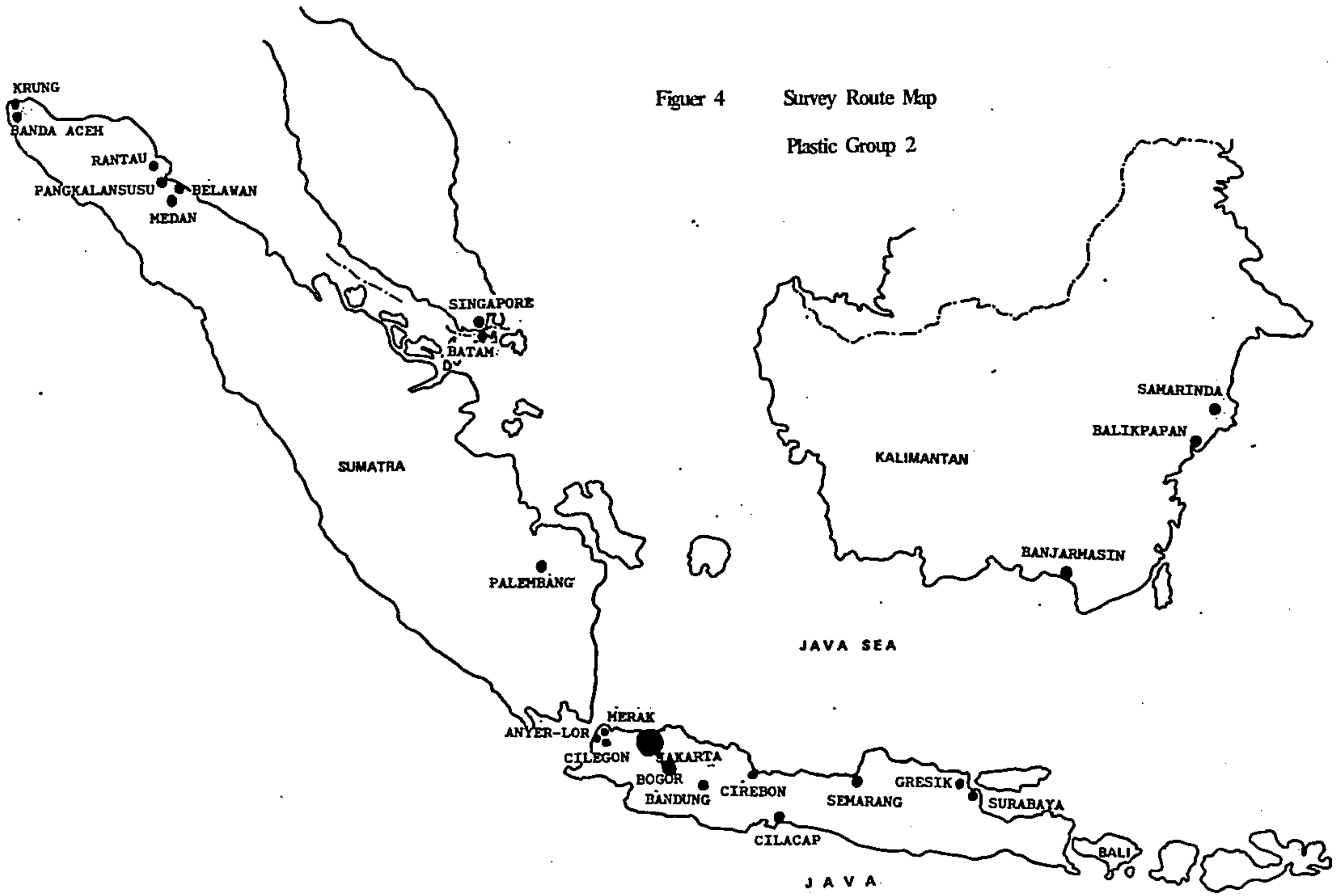
Petrochemical Group 2



Figuer 3 Survey Routs ——

Plastic Group 1





Figuer 4 Survey Route Map

Plastic Group 2

Compilation of Report

This survey consists of the following three parts, pertaining to the relative surveys undertaken in Indonesia.

(1) Petrochemical Industry Development Project (corresponding to UNIDO Phase II)

(2) Synthetic Rubber and Synthetic Detergents

(3) Plastics Processing Industry

In this report, the above-surveys have been described in separated volumes, executive summary, olefin, aromatics, synthetic rubber, synthetic detergent and plastics processing respectively.

In compiling this report, a number of problems were present as described below.

Survey period coincided with the oil crisis and acute world-wide inflation. Thus, the future trends of raw material prices, product prices, construction costs, transportation costs, etc. are all seemed uncertain. The uncertainty was also evident as to how the price increase would affect the market for petrochemical industrial products.

As far as supply of petrochemical industrial products is concerned, the main producing countries such as the U.S.A., European countries and Japan are seemed to be difficult to increase the production as before because of the difficulties in securing sites.

On the other hand, the oil producing countries such as Middle East countries, Iran, etc. are considering petrochemical industrial production projects.

It is difficult to formulate therefore, a forecast on the above-mentioned points due to the complexities of the conditions. On an assumption that the stabilization of the situation will be restored in due course, the present study has been conducted by taking the forthcoming stability into consideration and the obtained results are summarized in ANNEX. However, in view of the possibility that thus formulated forecasts should be different, the effects of individual deviation in the forecasts are also elaborated in this report.

I. Foreword

I-1 Background

Due to the following major reasons, Indonesia has a possibility for materializing petrochemical industrialization.

(1) The country is rich in raw material resources necessary for petrochemical industrialization.

(2) The population of the nation is approximately 130 million, so that a market for petrochemical products is expected enough for project, and it is also necessary to effect stable supply of low-cost raw materials for light industries for the production of plastics and textile goods for the operation of which a large amount of labor force will be absorbed.

(3) The petrochemical industrialization will contribute to the saving and new acquirement of foreign exchange.

In the light of the above-mentioned reasons, the Government of Indonesia requested the Government of Japan to undertake surveys on synthetic rubber, synthetic detergents, and plastics processing industries in addition to the follow-up survey of UNIDO Phase I (mainly covering olefin and aromatics) which had already been conducted by UNIDO.

The Government of Japan caused to execute such widescope surveys by employing UNICO, who had conducted the synthetic fiber survey and the synthetic fiber raw material survey, Japan Gasoline Company, Limited, who conducted the UNIDO Phase I studies, and Toyo Engineering Corporation who effected the basic chemical industrial survey.

The survey team had a meeting with Indonesian government officials and the personnel of other offices concerned in January, 1974, and consequently undertook on-site surveys. Thereafter, economic calculations were processed at home in Japan. In August, 1974, another meeting was held with the Indonesian officers concerned on the basis of the obtained calculation results.

This report was completed by adding certain supplementary explanations and by incorporating the changes that took place in the situation since the January meeting, and the changes having been clarified at the August discussion.

I-2 Subject and Objective of the Survey

The subject of this survey was petrochemical industry in a broad sense of the term and the objective of the studies was the overall confirmation of the situation pertaining to the industry.

The following fields were included within the scope of the survey:

(1) Olefin complex (mainly thermo plastic resins)

(2) Aromatics complex (including intermediates for use as

synthetic fiber raw materials)

(3) Synthetic rubber industry

(4) Synthetic detergent industry

(5) Plastics processing industry

The (1) and (2) are follow-up studies of the UNIDO Phase I; however, as it was clarified at the January meeting in Indonesia that the olefin production will be based on the natural gas and aromatics the naphtha, it was decided that these two complexes shall be studied separately and independently from each other.

Further, prior to this survey, a synthetic fiber raw material industrial survey was undertaken. However, these two sets of surveys presented differences in accordance with the status of the subject projects covered. The difference in the context of these two surveys may be enumerated as follows:

(1) Olefin complex:

At the time of the survey team's visit to Indonesia in January, 1974, it was confirmed that natural gas will be employed as the basis for the complex. However, even then, the quantity and quality of the usable natural gas were still uncertain. Because of this reason, the survey had to assume, as the objectives, comparative studies and economic viability scrutinization of ethylene production amount of approximately 200,000 t/y, 300,000 t/y, and 450,000 t/y by taking as the candidate sites, North Sumatra, East Kalimantan, and Palembang. (In other words, changes had to be made to the scope of work required in UNIDO Phase II due to the uncertainty of the details pertaining to the raw material gas.) At the August meeting, it was mutually confirmed as a basic policy that the sites shall be North Sumatra in which ethane will be employed as the raw material for the production of 450,000 t/y of ethylene. Also, Indonesian governmental policy concerning the gas prices was also presented at the meeting. Therefore, additional economic viability scrutinization work was undertaken in compliance with these newly given conditions.

(2) Aromatics complex:

At the January meeting, the investment plan was disclosed by the Indonesian Government. Therefore, studies were made for the purpose of collecting and submitting necessary materials for further studying the plan. (Also, at the August meeting, it was revealed again that considerable changes had been made to the Indonesian plants, however, the studies of such changed plans were discarded at that time in view of the fact that the changes caused too great an alteration in the basic conditions.)

(3) Synthetic rubber industry:

SBR was taken up as the commodity from various synthetic rubber products in view of the Indonesian domestic market situations and the mutual complementation aspect between synthetic rubber and natural rubber. Market forecast and pre-economic studies were undertaken on this subject.

(4) Synthetic detergent industry:

Alkylbenzene sulphonate was taken up out of several synthetic detergents in view of the presently prevailing market conditions. Market forecast on this item and preliminary studies on the economic viability of an alkylbenzene plant were conducted.

(5) Plastic processing industry:

This survey involved an objective of clarifying the ideal status of plastics processing industry which should grow commensurate with the future plastics market expansion, and to point out the discrepancy between such an ideal status and the presently existing situation of the industry, and finally to give recommendations for filling the gap.

II. Summary

Because the raw material conditions were entirely uncertain during the UNIDO Phase I, economic viability studies were conducted concerning an ethylene plant on naphtha basis having a capacity of 300,000 t/y, and an ethylene plant of 200,000 t/y capacity on the basis of a combination of naphtha and natural gas as raw materials. However, through the present survey, it was finalized that natural gas would be the basic material for the olefin complex, and naphtha will be for the aromatics complex. Therefore, the olefin complex and aromatics complex were separately and independently studied.

The studies themselves involved independent analyses of olefin complex, aromatics complex, synthetic detergent industry, and plastics processing industry. However, these fields of industry have, between and amongst themselves, close relationship in view of the raw material supply aspect and the market aspect when relative products are turned out. In other words, the olefin complex based on natural gas will be in a position to supply thermoplastic resins to the plastics processing industry; styrene and butadiene to the SBR synthetic rubber industry; propylene to alkylbenzene (synthetic detergent) industry, and finally EO/EG to polyester fiber production operation. The aromatics complex based on naphtha will be supplying cyclohexane as a nylon fiber raw material, p-xylene to polyester fiber production, and benzol to polystyrene and SBR production as a raw material. The combination of these fields of industry entirely depends on the composition and the available quantity of the raw materials, and on the other hand, on the scope of market and the economic scale of the relative plants in view of the product-side considerations. Following are the points which will present the particular problems throughout the present survey concerning the mutual relationships of these industrial fields:

(1) The economic viability of the olefin complex will be affected by the extent of development and growth of plastics processing industry. The plastics market forecast for Indonesia recently compiled by UNIDO Phase I was utilized in the present survey. However, the recently effected crude oil price increase and the consequently appeared plastics price increment have a strong potential effect of shrinking the scope of market along with the overall stagnation of the world's

economy. Systematic policy for plastics processing industry development will be an absolutely indispensable condition for the success of olefin complex establishment, along with accurate forecast on the plastics market.

(2) If ethane is to be employed as the raw material for the olefin complex, the production of propylene and butadiene will decrease. Therefore, it will become necessary to consider some other sources of supply of butadiene for SBR production, or to plan an increment of high-density polyethylene production in place of propylene production.

(3) If the aromatics complex is to produce a large amount of benzol exceeding the required quantity for domestic market-destined caprolactam, the production of polystyrene can be considered as a possibility. However, the Indonesian domestic market for this item is extremely small, and on the other hand, in view of the fact that the styrene production must be undertaken on a large scale, most of the output will have to be allocated for exportation. In other words, in this case a possibility is shown for sheming a project on the basis of raw material availability alone, without regard to the problems pertaining to the domestic market situation. However, in this case, economic viability of such a project may be deteriorated unless studies were made in view of international competitiveness.

The following paragraphs will briefly state the obtained conclusions concerning the above-mentioned various fields of industry. Quantitative explanations will be made in respective chapters. Concerning the policies and prerequisite conditions which were taken as the basis for the quantitative observations, they are stipulated in respective volumes (separate covers).

For the purpose of formulating the forecast on raw materials and product prices within the framework of the presently made economic calculations, the crude oil price as of January, 1974, was taken as the basis of considerations.

(1) Olefin complex:

It was concluded that an olefin complex on natural gas basis is extremely prospective, and was judged to be viable even without the provisions of protective import duty. In view of the foreign exchange balance, this project will have the highest extent of contribution to the national economy.

(a) Regarding the priority given to the sites for the complex, the order of preference was Palembang, North Sumatra, and East Kalimantan; the plant capacity preference order being ethylene annual production of 450,000 t, 300,000 t, and 200,000 t, i.e., a higher extent of advantage is available as the scale of capacity becomes greater. However, when it was assumed that the natural gas price as of January, 1974, was at US¢63/MMBTU, it was revealed that any of the established cases possessed economic viability.

(b) Even when the natural gas price was presumed as of January, 1974, at US¢100/MMBTU, it was discovered that cases involving more than 300,000 t/y capacity of ethylene production will present economic viability. In this case also, a higher advantage is available for larger production scale. Nevertheless, regarding such products as LDPE, PVC, PP, etc., the difference in Production Cost between the Singaporian competitiveness will become extremely small.

In assessing the international competition, factors other than production cost will also have to be taken into consideration so that a much further detailed study in this respect will be necessary.

(c) On the other hand, petrochemical industry is a so-called "facilities intensive industry". Therefore, the effect of operation rate is extremely significant. This effect becomes the more important, the larger the production scale becomes (in this respect, refer to Sensitivity Analysis). Therefore, thorough planning must be made not only concerning the construction of the necessary facilities, but also regarding the management of the enterprise, infrastructural conditions including transportation facilities, market development possibilities, etc. It must also be noted that manpower training and education for industrialization should be commenced at an earliest possible stage.

(d) When the hydro-electric power of Asahan Dam is to be utilized, the overall economy of the complex as a whole will be improved slightly; however, not to any significant degree.

(e) The time of construction of the complex will be much more greatly affected by the length of the necessary preparatory periods for the construction, and the time required for the construction works, and further by the raw material supply conditions (i.e., the LNG project status), rather than by the market factors. It is recommended that the most appropriate time for the commencement of commercial operation will be sometime during the year 1979.

(2) Aromatics complex:

Because the aromatics complex will take naphtha as the basis, the raw material price-wise advantage is not very great. Therefore, the economic viability is not as high as that expected of the olefin complex. Also, in this aromatics complex, the fixed cost portion is lower when compared with that of the olefin complex. Therefore, the effects of not only the raw material cost but also that of prices of intermediate products and final products will be so much greater.

(a) Due to the above reasons, the production scheme selection must be effected with due attention. Some of the calculated cases were revealed to be poor in economic viability.

(b) The effects of the fuel cost has been found to be comparatively great, and if the utilization of natural gas is possible, the economy of the plant will be improved.

(c) The raw material situation assumed as of January, 1974 (i.e. 14,900 bbl/day of naphtha), and the product pattern (commensurate with the domestically required amount as synthetic fiber production raw material) have since been largely altered due to the changes of the plans effected by the Indonesian Government. As a result, the utilization amount of naphtha became 40,000 bbl/day, and also regarding the product pattern, a large amount of exportation of benzol, p-xylene, etc. were newly added as requirements.

As has been mentioned in the foregoing, the trend of the prices of these export items will greatly affect the economic viability of the operation. On the other hand, the increment made to the benzol production amount further created a possibility of polystyrene production.

(d) No economic viability evaluation of the new plan has been undertaken. It has been learned by the survey team that the Indonesian authorities are aiming at 1978 operation commencement.

(3) Synthetic rubber industry:

The present survey was made by taking up the production of SBR which is being consumed in Indonesia, and will not come in competition with natural rubber, but rather has supplementary characteristics to natural rubber in such aspects as quality improvement. As a result, it was revealed that there is a possibility of constructing an SBR producing plant with a preliminary acceptable and adequate production scale of 25,000 t/y with a target operation commencement sometime after 1980. However, due to the alteration made to the raw material availability as mentioned below, re-studied by incorporating such changes will be necessary.

(a) The domestic demand for SBR will be approximately 10,000 tons in 1980 and will be 22,000 tons by 1985.

(b) At the January discussion in Indonesia, light gas condensate was assumed as being the raw material for olefin production. This being the circumstance, it was considered that the butadiene would become available. On the other hand, in accordance with the Indonesian plans which were revealed at the time of the discussion, it seemed impossible to expect any surplus in the benzol production amount turned out from the aromatics complex after covering the requirements of caprolactam domestic production. Therefore, the feasibility studies of styrene production was excluded from the scope of examinations. At the August discussion, it was confirmed that ethane will be utilized for the production of olefin. Therefore, the availability of butadiene from the olefin complex thus became difficult, and it also became clear that other methods such as dehydrogenation, etc. would be necessary for obtaining necessary butadiene. On the other hand, aromatics complex will have surplus benzol, thereby creating a possibility of styrene production as well. Of these alterations, the availability and production cost of butadiene will largely affect the nature of SBR project.

Therefore, re-scrutinization by taking this point into consideration will become necessary.

For Indonesia as a natural rubber producing country, the production of synthetic rubber may have a certain extent of resistance. No clear governmental policy concerning the direction of this industry was available. However, synthetic rubber is not necessarily a competing material to natural rubber. Instead, synthetic rubber has supplementary characteristics to natural rubber. It must also be noted that the production growth of natural rubber may not be quite able to cope with the overall demand growth of rubber as a whole. This being the circumstance, the studies of synthetic rubber production industrialization should be made as and when the raw material problems have been cleared.

(4) Synthetic detergent industry:

In the present survey, studies were made concerning alkylbenzene sulphonate which are being used in Indonesia. As a result, it was discovered that there is a possibility of construction sometime after 1977 of alkylbenzene plant of 150,000 t/y capacity.

(a) The demand for synthetic detergent has recently been rapidly growing in the form of cream detergent consumption. It is estimated that, at the present, approximately 40,000 t/y of synthetic detergent is being consumed. Further, it is estimated that the consumption will attain a level of 90,000 t/y by 1980. The alkylbenzene amount commensurate with such a level of consumption is estimated at approximately 17,000 tons.

(b) In order to produce 15,000 tons of alkylbenzene, 18,200 tons of propylene and 7,000 tons of benzene will be necessary. Concerning the availability of these two materials, studies must be conducted in connection with the olefin complex, aromatics complex and oil refinery projects.

(c) No finalization has been made by the Government of Indonesia concerning the hard-type synthetic detergent. Governmental policies concerning this point should be clarified prior to the commencement of industrialization project. However, if the policy dictates the utilization of soft type alone, re-scrutinization of the project feasibility should be conducted centering around the raw material availability.

(5) Plastics processing industry:

The present level of plastics consumption in Indonesia is estimated at 80,000 t/y. On the other hand, according the UNIDO Phase I, the consumption will attain 300,000 t/y by 1980. (The above-mentioned figures should be duly modified by taking into consideration the plastics price increase caused by the recently effected crude oil price increment, as well as by the overall stagnation of world economy.)

Also, the present Indonesian plastics processing industry is suffering from instability of raw material availability, and also from an extremely low degree of added value realization due mainly to technical problems. This suggests the necessity for serious consideration for the improvement of the present state of plastics processing industry and the systematic fostering of plastics processing industry in order to cope with the forecast 300,000 t/y consumption level.

(a) In order to cover the above-mentioned 300,000 t/y of plastics consumption, the necessary scope of investment will be US$12.34 billion for processing facilities alone, and as a whole, the ncessary amount will be US$27.8 billion. Even if the labor productivity is enhanced to 3.5 times the present level, further 200,000 new workers will have to be employed.

(b) In order to attain the above-mentioned goal, it is necessary for the government to firmly establish the investment and policies and the fostering strategies, and to conduct systematic training of workers of more than 1,000 persons per year. Some recommendations have been made concerning these points in the report. It is sincerely anticipated by the survey team that the recommended points be studied by the Government of Indonesia for early implementation. The above-mentioned points do not merely apply to the plastics processing industry but also will significantly affect the economic viability of the olefin complex which is the raw material supplying industry to the plastics processing field.

III. Olefin Complex

III-1 Forecast on Indonesian Domestic Market

For market forecast, Table II-6 which appeared in UNIDO Phase I, has been employed here. As has already been stated, the market forecast so far conducted should be re-examined in view of the price increase of petrochemical industrial products due to crude oil price increment, and also in view of the purchasing power deterioration caused by the confused status of the world economy.

Table II-6 Estimated Domestic Demand of Petrochemical Products in Indonesia

(Unit: 10^3 t/y)

	1975	1976	1977	1978	1979	1980	1981	1982
LDPE	36	43	52	63	75	90	106	125
HDPE	11.5	13	14.5	16	18	20	22	24
PVC	23	29	36	44	54	65	78	95
PP	-	2.5	8.5	16.5	26.5	40	51.5	65
EG	15.2	17.5	21	24.8	28.2	32.5	47.5	43.3
(EG)*			27.5	37.8	48.2	58.5	62.5	66.7

	1983	1984	1985	1986	1987	1988	1989
LDPE	148	175	200	228	260	296	338
HDPE	26	28	30	32.7	35.6	38.9	42.3
PVC	113	135	160	190	225	266	315
PP	81	100	120	144	173	207	249
EG	49.8	57.7	66.7	76.7	88.2	101	117
(EG)*	70.9	75.0	79.1	83.2	87.4	91.7	96.3

Note : * To be estimated base on the result of synthetic fibre material survey
Figures 1975 - 1985 is the result from UNIDO Phase I.

III-2 Export Market Forecast

The future world and Southeast Asian supply/demand balance forecast is still extremely unstable, and it is difficult to forecast qualitatively the trend of exportation to be made from Indonesia in the future. Therefore, three cases were taken as the basis of consideration, i.e., the first case in which no exportation will be made and the total production will be allocated to cover the domestic market: a case in which 1/3 of the production will be allocated for exportation; and a case in which the export is aimed to cover the Philippines market. In other words, the three cases respectively assume annual ethylene production capacity of 200,000 t, 300,000 t, and 450,000 t. By so doing, economic calculations were conducted by reflecting to the export prices calculated in consideration of the international competitiveness with Japanese, Singaporian, and Middle East exports. Fortunately, ample competitiveness will be available in the Indonesian olefin complex which takes natural gas as the basis, and it has been indicated through the survey that higher extent of economy will be attained if a larger amount is allocated to exportation. It must be added here that it was confirmed at the August discussion that the Indonesian authorities had decided upon adopting 450,000 t/y as the capacity scale for the ethylene production.

III-3 Raw Materials and Utilities

(1) At the January discussion in Indonesia, the following assumptions were made (in the Interim Report) because of the fact that no finalization had been made regarding the composition, available amount, and available location of the raw material natural gas.

The candidate sites for the complex shall be North Sumatra, East Kalimantan and Palembang, in all of which the necessary amount of gas would be available. Concerning the composition, it was assumed that the gas will be of light condensate and the composition shown in Table II-4 would be applicable. In this case, the gas composition at the exit of ethylene cracker was assumed to be as follows:

Table II-4 Light Condensate Gas Composition

	Weight ratio
Ethane	1.0
Propane	1.47
C_4 fraction	0.97
C_5+ fraction	0.654

Cracked Gas Analysis in Weight Ratio

H_2	0.105
C_1	0.348
C_2"	1.000
C_3"	0.293
C_3 - LPG	0.094
C_4 - Mix	0.216
C_5 - 200°C	0.143
200°C -	0.022

It is assumed here that salt produced in Madura Island shall be transported to each site. Concerning utilities, all the necessary supply shall be made within the complex except for a Asahan case in which the electrical power is to be supplied from hydro power generator.

However, it was revealed at the August meeting that ethane will be used as the raw material (to be separated at the LNG plant), and North Sumatra will be given priority as the candidate site. In this event, the gas composition available from the ethylene plant will be as shown in Table II-2.

Table II-2 Yield Pattern of Ethane Feed Olefin Plant

	Feed	Products	(Weight ratio)
Ethane	1.24	-	
Residue Gas	-	0.155	
Ethylene	-	1.00	
Propylene	-	0.03	
$C_{4,5}$	-	0.025	
Aromatic Gasoline	-	0.03	

(2) Raw material and utilities prices (annual inflation factor of 7% incorporated).

Regarding the gas price as of January, 1974, an assumption was made on the basis of the desulphurized heavy oil price derived in Japan from Middle East crude oil. The assumed price was US¢63/MMBTU. Preliminary economic calculations were made on this basis; however, at the August discussion, the Indonesian authorities indicated the Minas-crude-slide proposal. Therefore, additional economic calculations were made on the basis of the newly calculated gas price level of US¢100/MMBTU. (Refer to Table II-5(1) and (2)

Table II-5(1) Prices of Hydrocarbon Raw Materials Based on Middle East Crude Oil

	Prices @ 1974	Prices @ 1980
Natural Gas (Fuel gas)	63¢/MMKcal	94¢/MMKcal
Condensate Gas	29$/t (=64.5¢/MMKcal)	43.5$/t
Crude Oil	9.35$/bbl (CIF Japan)	14.04$/bbl

Table II-5(2) Prices of Hydrocarbon Raw

	Prices @ 1974 January	Prices @ 1980
Natural Gas (Fuel gas)	100¢/MMBTU	150¢/MMBTU
Condensate Gas	45.5$/t (=102¢/MMBTU)	68.3$/t
Ethan	50.1$/t (=102¢/MMBTU)	75.1$/t
LNG	170¢/MMBTU (FOB)	255¢/MMBTU (FOB)
Minas Crude	10.8$/bbl (FOB)	16.2$/bbl

Regarding the salt, the price figures of FOB US$5.00 at Madura Island as of January, 1974, and US$8.10 on the same basis as of 1980. Concerning the Asahan electric power, a price figure of US¢12/KW was employed. Further, the calculations were made on an assumption that all the other utilities will be generated and supplied within the complex. Table II-25 shows the utility costs for natural gas price at US¢63/MMBTU, site at North Sumatra, and ethylene production capacity at 300,000 t/y.

Table II-25 Utilities Price for PVC, VCM and Electrolysis Plant in Asahan and Other Plants in North Sumatra

Stream Factor : 85%

Items		ASAHAN	North Sumatra
Electric Power	\$/KWH	0.012	0.0552
110^k Steam	\$/t	-	7.84
10^k -20^k Steam	\$/t	-	4.03
15^k Steam	\$/t	10.7	-
Sea Water	\$/t	-	0.0410
River Water	\$/t	0.11	0.106
Filtered Water	\$/t	0.307	0.272
Deminerized Water	\$/t	0.69	0.522
Polished Water	\$/t	-	0.784
Instrument Air	$\$/Nm^3$	0.032	0.0370
Oxygen	$\$/Nm^3$	0.052	0.0532
Plant Air	$\$/Nm^3$	0.030	0.0344
Inert Gas	$\$/Nm^3$	0.057	0.0516
Steam Condensate	\$/t	-	0.0850
Fuel	\$/MMKcal	10.3*1)	3.75*2)

Notes: *1) Fuel oil

*2) Fuel gas - NG price is 63¢/MMBTU in 1974,

III-4 Product Prices and Intermediate Product Prices

The Indonesian domestic prices and export prices of the purposed final and intermediate products were assessed on the basis of the Middle East crude price as of January 1974; and on the basis of the production costs required in the case of producing the same items at the existing Japanese plants, and at newly constructed plants; as well as on the basis of the production costs prevailing in Middle East plants; and further, by taking transportation costs into consideration. The results are shown in Tables II-7 and II-8. (It was assumed here that the crude oil price will increase by 7% per year.)

Table II-7 Exfactory Price for Domestic Market

(Unit:¢/kg)

	Minimum Exfactory Price, Japan		Exfactory Price Middle East	Standard Price
Products	1974*	1980	1980	1980
LDPE	53	72	75	83.3
HDPE	52	70	73	81.0
VCM	26	37	31	-
PVC	41	58	82.6	79.4
EG	-	50	44	55.3
PP	57	78	70	82.7

Notes: *Standard price is used for economic evaluation of project.*
Price increase per year is about 5%.
* = Estimation

Table II-8 Exfactory Price for Exportation

(Unit:¢/kg)

Products	CIF Manila from Japan	CIF Manila from Middle East	Exfactory price for export: Competitive Price with Japanese Export	Exfactory price for export: Standard Price
LDPE	84.0	91.1	71.9	67.2
HDPE	81.8	88.9	69.9	65.5
VCM	44.6	64.9	37.1	-
PVC	68.6	100.0	57.9	61.7
EG	57.6	54.1	50.0	40.0
PP	90.6	85.8	77.9	72.5

Note: Standard price is used for economic evaluation of project

The minimum exfactory prices of Japan were taken from the prices quoted in the case of producing the items in the existing plants in Japan; however, there is no differentiation incorporated between the domestic and export-destined product prices. Therefore, in calculating the export prices from Indonesia, the export price level was established on an assumption that the price will be brought lower than the domestic prices in the event of international competition becoming keen excepting PVC because PVC price of Japan seems very cheap.

III-5 Various Alternatives and Economic Viability Comparison

The plant-wise capacity and the investment amounts for various alternatives are as shown in Table II-12. Cases 1 to 3 involve instances of light condensate employment while Case 4 employs ethane as the raw material.

Table II-12 Comparison of Alternative Scheme

Sites	Case 1 Palembang		Case 2 East Kalimantan		Case 3 North Sumatra		Case 4 *2 North Sumatra	
	Plant Capacity 10^3MTA	Investment Cost $10^6$$	Plant Capacity 10^3MTA	Investment Cost $10^6$$	Plant Capacity 10^3MTA	Investment Cost $10^6$$	Plant Capacity 10^3MTA	Investment Cost $10^6$$
Olefin Plant	205	133	442	243	298	173	453	225
Electrolysis Plant (chlorine)	43	49	86	82	62	62	86	78
VCM	73	50	146	84	104	63	146	81
LDPE	100	163	210	282	120	184	180	244
HDPE	30	45	80	91	50	63	120	114
PVC	70	53	140	89	100	67	140	85
EG	50	57	100	95	100	91	100	92
PP	48	70	103	124	69	89	0	0
Total *1		620		1,089		792		920

Notes: *1 = Excluding the investment cost for utilities

*2 = Ethan feed complex

Production pattern is corresponding to the domestic market in 1984.

Case 1 is to cover the Indonesian domestic market alone; Case 3 involves 1/3 of total production to be allocated for exportation; Case 2 further incorporates the Philippines market as the export destination, as has already been noted.

Further, it should be noted here that Case-4 presupposes North Sumatra as the site. Therefore, the Philippines market has not been considered as the possibility. Instead, the extension of the Indonesian domestic market has been incorporated. Also, it has been presupposed in this case that the polypropylene production will be suspended and instead, the production of high density polyethylene is assumed. The study results show the following points:

(1) Higher advantages are available for larger production capacities, and the order of preference of the candidate sites is Palembang, North Sumatra and East Kalimantan. Refer to Table II-13. These points have been studied on the basis of the natural gas price as of January, 1974 at US¢63/MMBTU. The second line in the IRR signifies the cases of 200,000 t/y, 450,000 t/y, and 300,000 t/y production capacities in North Sumatra. It is obvious from this line that a higher advantage is available for a larger production capacity. Also, by comparing the first and the second lines of the IRR, it is possible to assess the extent of advantages possessed by each one of the candidate sites. In other words, when compared with the 200,000 t/y production capacity at North Sumatra (second line), the IRR of Palembang (first line) is higher, thereby showing the greater advantage of the latter. Also, in the case of 450,000 t/y capacity, it is obvious that East Kalimantan is inferior to North Sumatra. However, the difference between North Sumatra and East Kalimantan is not significantly great, so that the final judgement between these two sites should be given after conducting further detailed studies.

(2) If the natural gas price as of January, 1974 is assumed at US¢100/MMBTU, the internal rate of return will become lower;

however, if the production capacity is maintained higher than 300,000 t/y, the rate will still be maintained above 17%. (Refer to Table II-17(1) However, as is shown in paragraph III-5-6, the internal rate of return of PVC production for instance will become poorer in terms of the process-wise IRR

Table II-13 Comparison of Alternatives

(Comparison of Internal Profit Rate of the Complexas a Whole) *3

	Case 1	Case 2	Case 3
Ethylene capacity x 10^3 MTA	200	450	300
Site	Palembang	East Kalimantan	North Sumatra
I.R.R. of Whole Complex	20.2%	23.9%	(20.9%) *2 21.8%
I.R.R. of Whole Complex with corresponding capacity*1	17.3%	25.5%	(20.9%) 21.8%

Note: The product price are assumed prices.
Refer to Clause pertaining to porduct prices

*1 The North Sumatra case was slided up and down to obtain these results.
*2 ( ) showns the calculation results obtained by detailed financial analyses.
All the other figures were obtained comparative calculations by utilizing models.
*3 Price of natural gas is 63 ¢/MMBTU for the year of 1974.

Table II-17(1) The Effects of Changes in the Raw Material Hydrocarbon Prices - IRR of Complex as a whole - *North Sumatra Case*

Ethylene Capacity / Price of NG @1974	@1980	200,000 MTA*	300,000 MTA	450,000 MTA*
63¢/MMBTU	95¢/MMBTU	17.3%	21.8%	25.5%
100¢/MMBTU	150¢/MMBTU	12.3%	17.0%	20.2%

Note: * The North Sumatra Case (Case 3) was slided up and down.

(3) The economic evaluation of the change in the basic natural gas from light condensate to ethane is shown in Table II-18. The table implies that the case of employing light condensate realizes a price lower than that of ethylene, thereby improving the internal rate of return of the complex as a whole. It must be noted that the reason for such a result is that the by-product exemption such as LPG is exerting a great effect in the case of the light condensate utilization. This further implies that the evaluation results will vary depending on how to set the prices of the exempted by-products. This being the circumstance, the economic calculations should be made again as and when all the pertinent conditions have been firmly established.

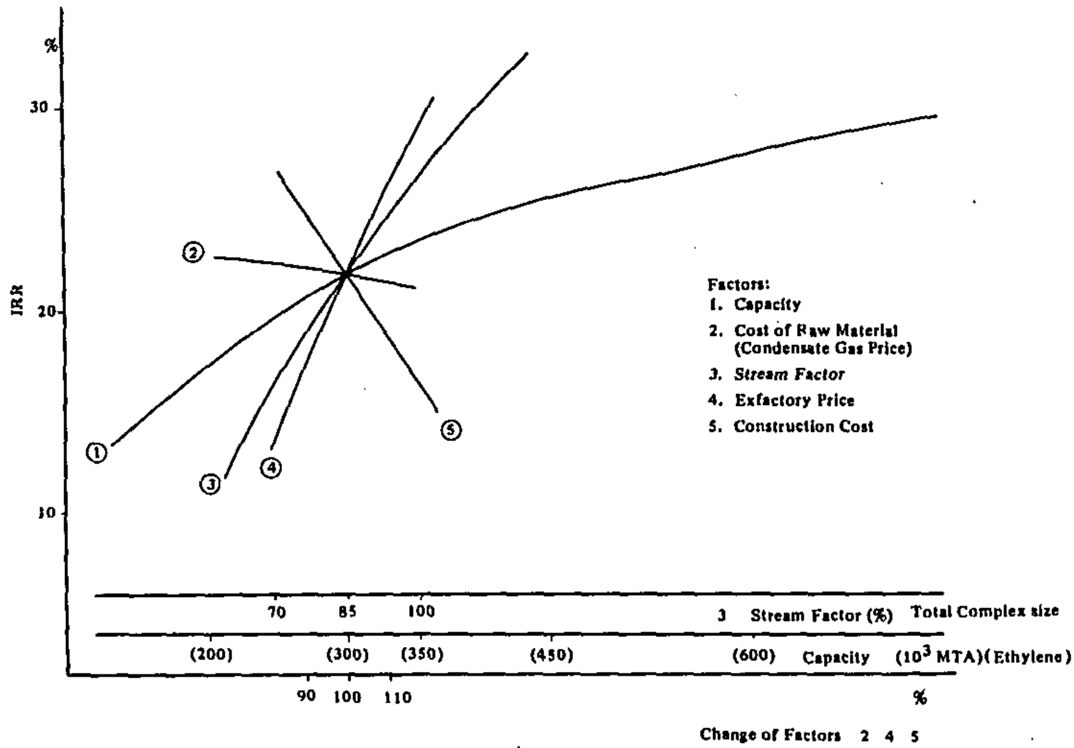
Table II-18 The Effect of Changes in the Raw Material Composition - C_2, C_3 Mixture - Ethane

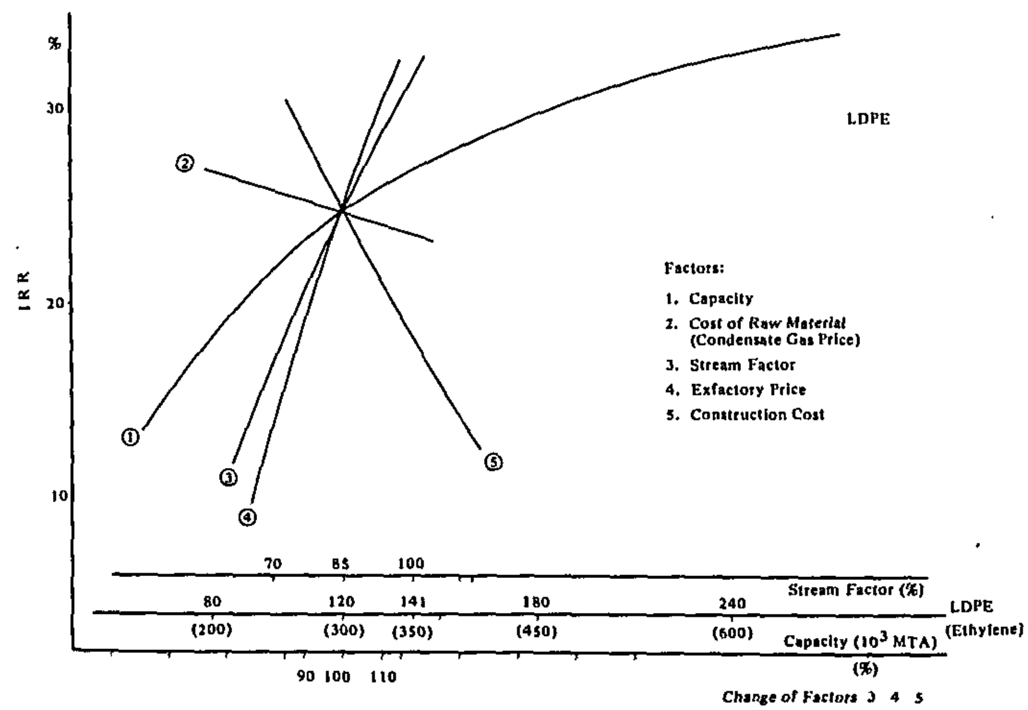
(Unit $/t)

Items \ Type of Feed	C_2, C_3 Mixture		Ethane	
Case	Sliding up of Case 3		Case 4	
Feed Components	C_2, C_3 mixture		Ethane	
Price of NG (1980)	150 ¢/MMBTU		150 ¢/MMBTU	
Price of Feed (")	68.3 $/t		75.1 $/t	
Price of Ethylene (")	208.9 $/t		257.4 $/t	
	Capacity	I.R.R.	Capacity	I.R.R.
Complex as a whole		20.2 %		18.1 %
Olefine	450,000 MTA	15	453,000 MTA	15
Electrolysis	92,000	15	86,000	15
VCM	156,000	15	145,600	15
LDPE	180,000	22.3	180,000	18.5
HDPE	75,000	19.5	120,000	26.9
PVC	150,000	21.7	140,000	16.5
EG	150,000	23.6	100,000	19.1
PP	104,000	28.6	-	-

(4) The effects of the product prices, operational rate, etc. in the ethylene production are shown in Figure II-9. The figures shows the case of taking the 1974 natural gas price at US¢63/MMBTU. Therefore, the effects of raw material price is not so significant here. This illustration implies that the extent of the operational rate alteration is significantly large, along with the alteration in the product prices. In other words, if the basic operational rate of 85% for the calculations became 70% for some reason, the internal rate of return will drop from 22% to approximately 17%. Also, the effect of construction cost is serious so that if the construction cost increases by 10%, the IRR will drop from 22% to 19%.

Figure II-12(2) shows the case of LDPE production in which the above-mentioned tendency has been further intensified. In this case, if the operational rate drops from 85% to 70%,





FigureII-9 Sensitivity of Internal Rate of Return of Total Complex to Various Factor Changes the IRR will be reduced from approximately 25% to 17%. This will be caused by the effects of the ethylene price increase due to the operational rate decrease at the ethylene plant. Regarding the construction cost in the case of the LDPE plant, the increase by 10% will lower the internal rate of return from 25% level to approximately 21%.

The above-mentioned points suggest the necessity of shortening the construction period by providing thorough preparation prior to the commencement of the works of plant construction and that proper attention should be paid not to impede upon the operation of the plant and the sale of the products after the plant has gone onstream.

(5) As typical instances, the following three cases were particularly studied:

Employment of light condensate for ethylene production capacity of 300,000 t/y, with the gas price at US¢63/MMBTU as of January 1974.

Exactly the same as above except that the gas price at US¢100/MMBTU,

Employment of ethane as a raw material in North Sumatra for the production of 450,000 t/y of ethylene with the gas price at US¢100/MMBTU.

Regarding the above three cases, the process-wise investment amounts, internal rate of return, and the breakdown of the production cost items were studied. (Refer to Table II-31(3), II-59 and II-61.

(6) Comparative studies were made with the case of employing the Asahan electric power, by taking the North Sumatra case in which the light condensate was taken as the basis for the production of 300,000 t/y ethylene. The obtained results are shown in Table II-34. In this case, some variation will be inevitable depending on how to set the caustic soda price; however, it is obvious from the results that no significant change will take place in the complex as a whole. This has been due to the fact that, in spite of the lowered level of electricity power cost, the facility costs and the overhead charges will nevertheless increase because of the separation of the complex into two locations.

(7) Effects of inflation

In all the present calculations, an assumption was made that 7% increase per year will be made to all such cost items as crude oil, labour, general price index, construction costs (up to the completion), etc. It must be noted that the product price increment will be approximately 5% per year due to the fact that the added value portion was fixed and that the variable cost portion alone is subject to inflation. The 7% rate by itself now seems to be on a lower side in view of the recent rate of the inflation progress; however in relation to the comparison to be effected with the economic evaluations of other projects, it has been illustrated in Figure II-11 that the effects exerted on the IRR by taking inflation progress rate from 0 to 0% to 10%.

Table II-31(3) Summary of Investment Unit, Production Cost & Profitability of each Process Plant & Total Complex - Case 3

Purpose of Study: North Sumatra
Price of NG : 63 ¢/MMBTU @1974
Cal Number : @ R-0
Case Number : No. 3
Ethylene Production Capacity: 300,000 MTA

			Complex Total	Ethylene	Chlorine	V C M	L D P E
Plant Capacity		MTA		298,000	61,600	104,000	120,000
Investment		10^6 $	791.7	172.5	62.0	63.4	184.3
I.R.R.		%	21.8	15.0	15.0	15.0	24.8
Break Down of Unit Production Cost @ 1980	Variable Cost			23.3	18.7	285	275
	Fixed Cost			112	213	128	293
	Distri. & Admini.			5.22	9.0	14.0	39.9
	Total Production Cost			140	241	426	608
Average Sales Price $/t				174	301	466	814

			H D P E	P V C	E G	P P
Plant Capacity		MTA	50,000	100,000	100,000	69,200
Investment		10^6 $	62.5	66.9	91.0	89.1
I.R.R.		%	22.4	21.7	28.8	29.8
Break Down of Unit Production Cost @ 1980	Variable Cost		280	505	164	258
	Fixed Cost		277	151	176	272
	Distri. & Admini.		37.4	38.1	16.7	39.4
	Total Production Cost		594	694	356	569
Average Sales Price $/t			728	752	505	794

Table II-59 Summary of Investment Unit, Production Cost & Profitability of Each Process Plant & Total Complex. Price of Raw Material Based on Minas Crude Oil, Capacity 300,000 MTA

Purpose of Study: Correction of Raw Materials and Fuel Price, North Sumatra
Cal Number : No.A-1
Case Number : No. 3
Ethylene Production Capacity: 30,000 MTA

		Complex Total	Ethylene	Chlorine	V C M	L D P E
Plant Capacity	MTA	300,000	300,000	62,000	104,000	120,000
Investment	10^6 $	802	176	62.6	64.5	185.9
I.R.R.	%	17.0	15.0	15.0	15.0	17.8
Break Down of Unit Production Cost @ 1980	Variable Cost		63	26.7	328	342.4
	Fixed Cost		125	234.9	140.8	325.7
	Distri. & Admini.		6.8	9.7	15.5	39.9
	Total Production Cost		194.8	271.4	484.3	708.0
Average Sales Price $/t			225.9	324	517.2	814.1

		H D P E	P V C	E G	P P
Plant Capacity	MTA	50,000	100,000	100,000	69,000
Investment	10^6 $	63.1	67.7	91.8	90.0
I.R.R.	%	15.2	12.3	21.6	22.7
Break Down of Unit Production Cost @ 1980	Variable Cost	343.1	560.5	206.0	315.1
	Fixed Cost	303.1	164.5	194.9	299.0
	Distri. & Admini.	37.4	38.1	16.7	39.3
	Total Production Cost	683.5	763.1	417.6	653.4
Average Sales Price $/t		727.9	752.4	505.3	794.3

Table II-61 Summary of Investment. Production Cost & Profitability of Each Process Plant & Total Complex. Price of Raw Material -Ethane- Based on Minas Crude Oil, Capacity 450,000 MTA

Purpose of Study: Correction of Raw Materials and Fuel Price, North Sumatra
Cal Number : No.B-1
Case Number : No.4
Ethylene Production Capacity: 453,000 MTA
Price of NG: : 100 ¢/MMBTU @1974

		Complex Total	Ethylene	Chlorine	V C M	L D P E
Plant Capacity	MTA		453,000	86,000	145,600	180,000
Investment	10^6 $	920.1	225.4	78.3	81.0	243.8
I.R.R.	%	18.07	15.0	15.0	15.0	18.5
Break Down of Unit Production Cost @ 1980	Variable Cost		120.64	47.13	332.03	375.15
	Fixed Cost		102.96	202.70	121.84	277.59
	Distri. & Admini.		7.72	9.20	14.95	38.52
	Total Production Cost		231.33	259.04	468.82	691.26
Average Sales Price $/t			257.41	306.73	498.47	766.71

		H D P E	P V C	E G	P P
Plant Capacity	MTA	120,000	140,000	100,000	0
Investment	10^6 $	114.4	85.2	92.0	0
I.R.R.	%	26.9	16.5	19.1	0
Break Down of Unit Production Cost @ 1980	Variable Cost	376.13	541.01	228.67	
	Fixed Cost	207.55	140.98	195.16	0
	Distri. & Admini.	37.91	36.93	16.66	0
	Total Production Cost	621.58	718.92	440.49	
Average Sales Price $/t		746.18	713.68	505.30	0

Table II-34 Financial Comparison of Asahan Electric Power (Olefin Total Complex)

	Profit at 1980	Total Inves-tment	R.O.I* at 1980	I.R.R.
Case 3	72.7	721 MM$	10.1%	21.8%
Profitable Electric Power of ASAHAN (1)	71.2	743	9.6%	21.2%
Profitable ASAHAN Power (2)	76.9	743	10.3%	21.9%

Note: Case (1) Caustic Soda price is 20.6¢/kg, and I.R.R. of electrolysis is 15%.
(2) Caustic Soda price is 30.1¢/Kg which is the same price at case 3.

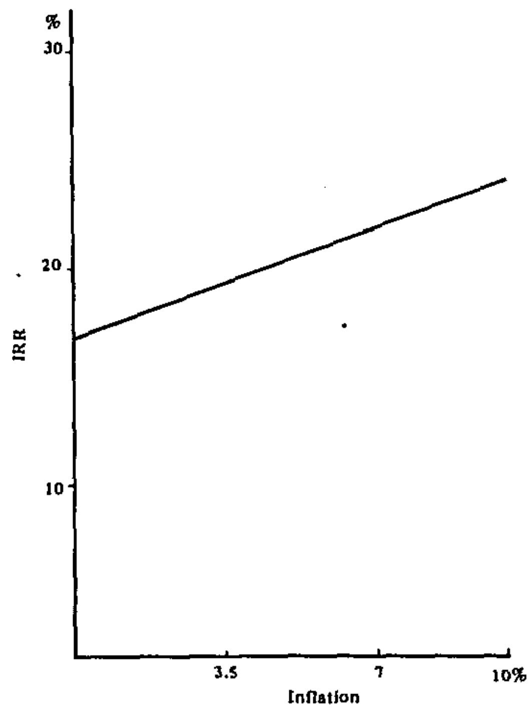


Figure II-11 Sensitivity of Internal Rate of Return of Total Complex to Inflation rate Changes

If the inflation rate is 7% per year, the IRR will be 22%. This IRR will become 17% if the inflation factor is deemed as being 0%, and will be 24% if the inflation should progress at a rate of 10% every year.

III-6 Petrochemical Industry of the Present Day World

Since the last half of the decade of 1960s until the first half of 1970s, approximately 80% of the total petrochemical industrial products were produced in the so-called advanced countries.

Due to the advent of the "oil crisis" and the intensification of pollution problems in the recent years, along with the subsequently emerged impeding factors such as difficulties in securing production sites, etc., it is forecast that the rate of growth of petrochemical industry in the advanced nations will have to stagnate in the future to a considerable degree.

This having been the general background, it is likely that the industrialized countries will effect facility installation or expansion projects merely to fulfill the growth in their own domestic demands, thereby decreasing the product export potential to a considerable extent.

On the other hand, the oil producing countries will develop export-oriented petrochemical industries by taking the advantage of raw material availability, for a period from the last half of 1970s throughout the decade of 1980s. Also, those countries in which the domestic demand level is likely to exceed a 200,000 t/y level in terms of ethylene during the decade of 1980s, are now beginning to study the feasibility of petrochemical industrialization.

It is therefore likely that the material flow trend of petrochemical industrial products in the world in 1980s will be largely different from what it is at present.

Table AVIII-4-11 shows the ethylene supply/demand balance in the ECAFE countries which will bear a close relationship with the future of the Indonesian petrochemical industrialization projects.

According to an estimate made by the Petrochemical Industrial Association of Japan, the domestic demand for ethylene in Japan in 1980 will be 530,000 tons. However, four units of either 300,000 t/y or 400,000 t/y plants are being planned. Therefore, the production capacity in 1980 together with the presently existing output will attain a level of approximately 6,000,000 t/y, thereby presenting 700,000 t/y over-supply. This signifies that Japan in 1980 will have an export potential of approximately 15% of the total ethylene production.

As far as the five ASEAN countries are concerned, the conspicuous ones are 450,000 t/y of Indonesia, 300,000 t/y of Singapore, and 250,000 t/y of the Philippines as forthcoming projects. It has been reported, however, the 130,000 t/y product of Thailand which has so far been studied, will be postponed for some time. This signifies that 120,000-ton over-supply will be present in these countries.

For the whole ECAFE countries, the over-supply will amount to approximately 1,200,000 tons. This brings up the necessity of exportation to countries in this area not enumerated in Table AVIII-4-11, and also to other ECAFE Countries

Due to the recently made abrupt price increase in crude oil, the overall price hike of petrochemical industrial products has since been drastic, thereby inviting demand stagnation and an extreme degree of change in the demand structure. As the above-mentioned forecasts do not take this fact into account, an overall review of the estimates seems imperative.

Table AVIII-4-11 Future Ethylene Consumption and Production (Estimate) in ECAFE Countries

(Unit: 10^3 tons)

Areas and countries		Ethylene Consumption for the domestic use in 1980	Ethylene production capacity			
			Present	Planned	Future	Balance
Far East	Japan	5,259	4,814	1,200	6,014	755
	Korea	573	100	450	550	- 23
	Hongkong	386	-	-	-	- 386
	Sub-total	6,218	4,914	1,650	6,564	346
Asian	Indonesia	176	-	450	450	274
	Philippines	239	-	250	250	11
	Malaysia	70	-	-	-	- 70
	Singapore	170	-	300	300	130
	Thailand	223	-	-	-	223
	Sub-total	878	-	1,000	1,000	122
South West Asia	India	257	105	283	388	131
	Sri-Lanka	38	-	-	-	- 38
	Iran	148	12	588	600	452
	Sub-total	443	117	871	988	545
Oceania	Australia	431	276	360	636	205
	New Zealand	64	-	-	-	- 64
	Sub-total	495	276	360	636	141
	Grand Total	8,034	5,307	3,881	9,188	1,154

III-7 International Competitiveness

The cases of light condensate with the gas price at US¢63/MMBTU and US¢100/MMBTU were compared with the cases of equivalent production effected by newly constructed plants in Japan, Korea, and in Singapore. All the cases are for ethylene production capacity of 300,000 t/y. The light condensate in the Middle East case was taken at a price level of US¢40/MMBTU, and the naphtha price in Japan, Korea, and in Singapore has been based on the CIF Japan price of Middle East crude at US$9.36/bbl.

A graphic illustration of the production cost comparison of ethylene and low-density polyethylene are as shown by Figure AIX-5-1 and Figure AIX-5-4. Regarding other items, refer to the main portion of the report. The advantage priority in the case of the price at US¢63/MMBTU becomes highly deteriorated when the price is increased to US¢100/MMBTU. In the case of some products, no significant difference becomes present from the Singaporean case. In view of the consideration that the international competitiveness derives not only from the production cost factors, but affected by various other elements, and also in view of a number of prerequisites established for calculating the production cost, it seems necessary to conduct a re-scrutinization of this point when the pertinent conditions have been further confirmed.

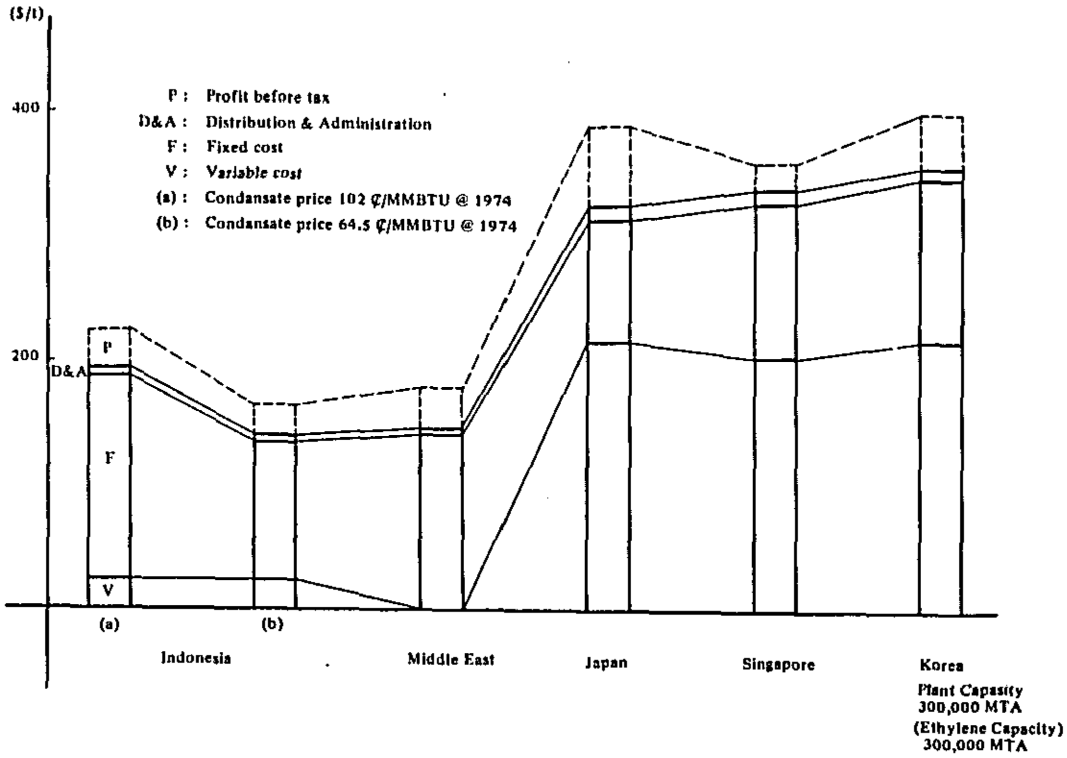


Figure AIX-5-1 Comparison of International Competitiveness (Ethylene)

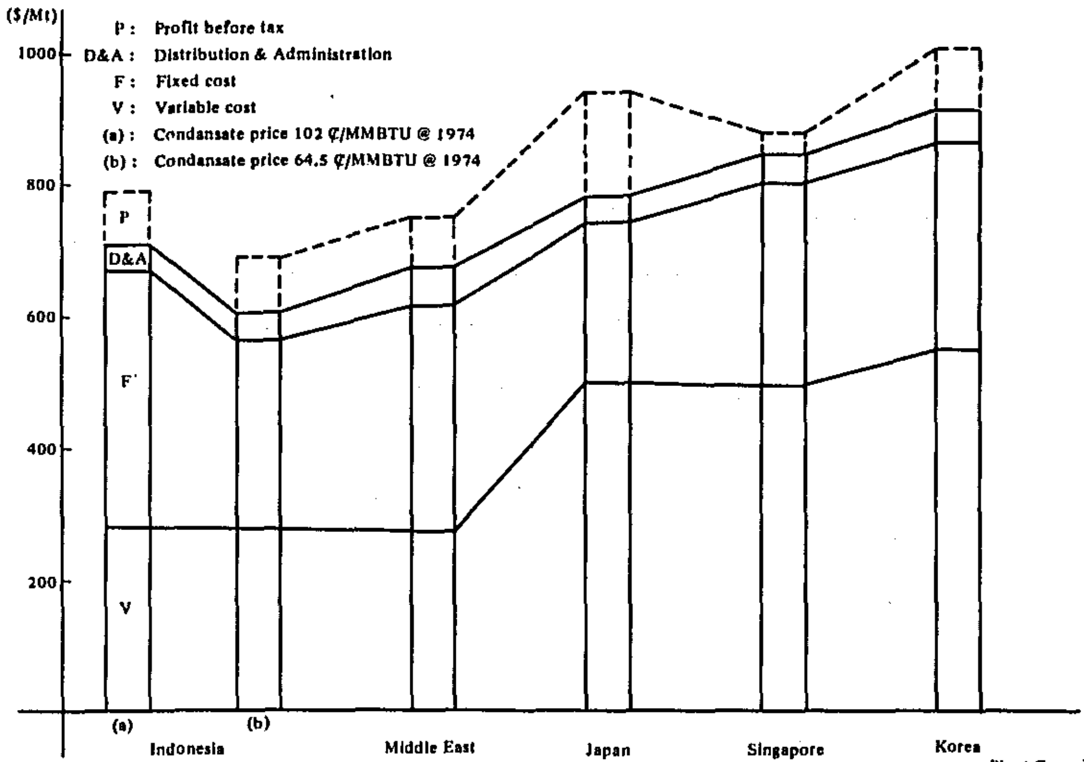


Figure AIX-5-4 Comparison of International Competitiveness (LDPE)

Plant Capacity
300,000 MTA
(LDPE Capacity)
120,000 MTA

III-8 Production Schemes

The studied production schemes have been described in Figures II-6 through II-8 and in Figure II-16.

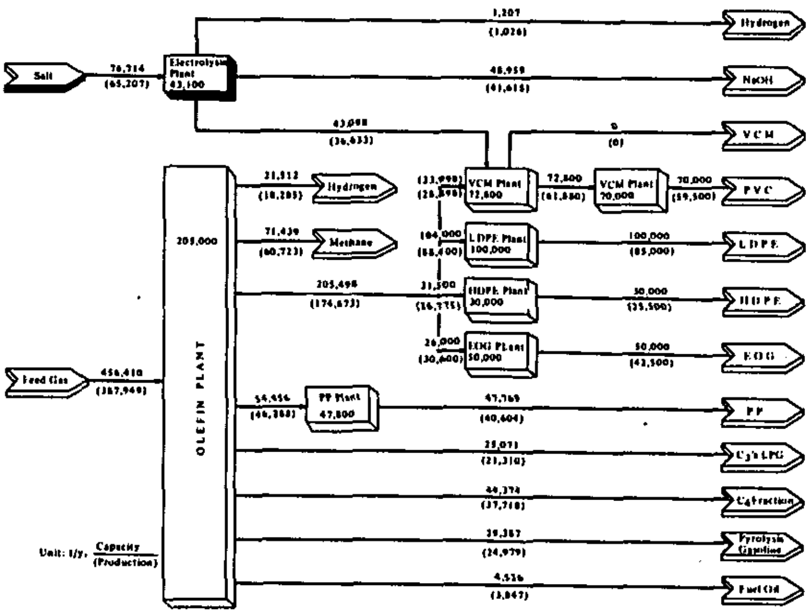


Figure II-6 Process Flow and Balance for Case - 1

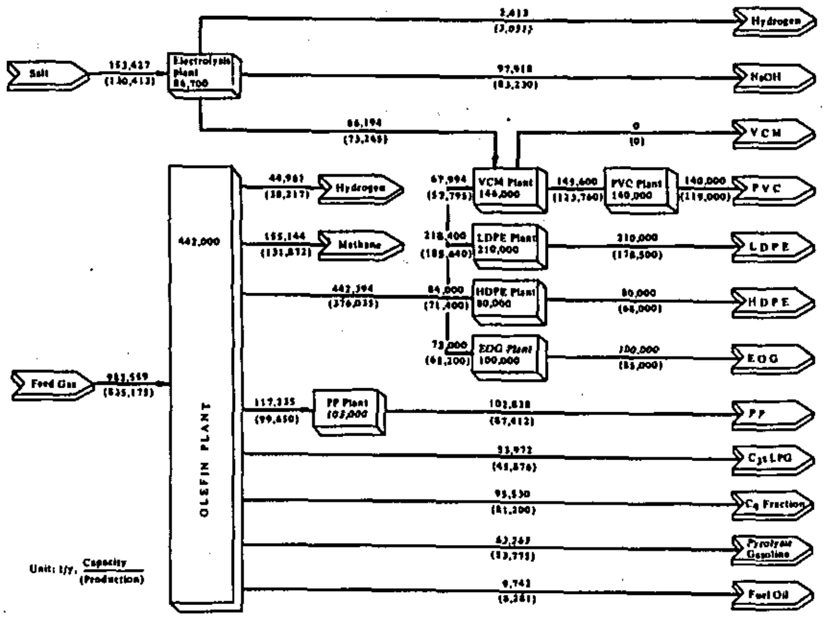


Figure II-7 Process Flow and Balance for Case - 2

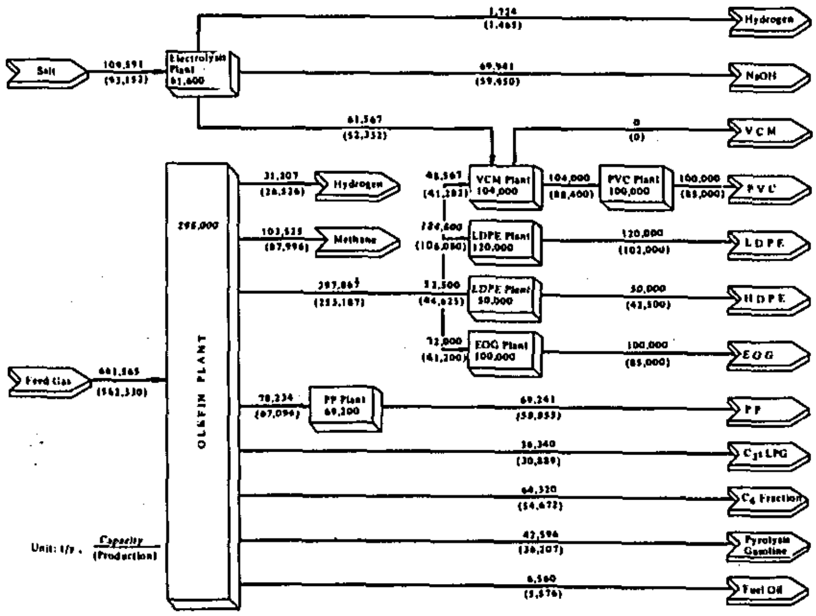


Figure II-8 Process Flow and Balance for Case - 3

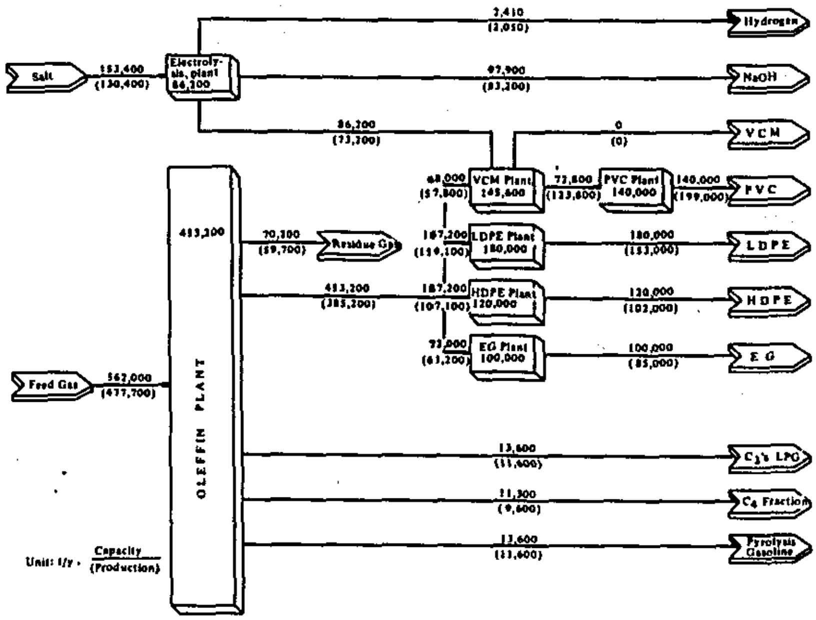


Figure II-16　　Process Flow and Balance for Ethylene Feed Complex

III-9　　Various Data and Information in the Case of North Sumatra with 300,000 t/y Ethylene Complex on Light Condensate Basis

(1) Breakdown of the investment amount

Refer to Table II-16.

(2) Economic Evaluations

Refer to Table II-15.

As is evident from this table, the foreign exchange saving extent for a period from 1979 to 1989 will be US$2.2 billion which is an extremely large amount. Also, the national benefit assessed by employing the Shadow Price Method is expressed in terms of IRR, the 20.9% IRR on the private enterprise basis will be improved to 27.9%. This has also been due to the fact that the economic evaluation has been made without taking into consideration the protective measures such as importing country's duty barriers upon the product. Tables II-42, II-44 and II-45 show the foreign exchange balance and the financial balance.

Table II-16 Investment Details of Olefin Complex (Case-3)

(Unit: 10^3 US$)

ISBL	366,807
Licence and Know-How	30,810
Catalyst & Chemicals	6,654
Spare parts	17,845
Contingency	37,269
Process Plant	459,385
Utilities Facilities	139,746
Storage	36,613
Service Facilities	72,675
Housing, Jetty, Road	78,299
Construction Cost Total	786,718
Land	21,250
Pre-operational Cost	30,252
Interest During Construction	94,300
Fixed Capital Total	932,530
Working Capital Total	24,870
Investment Total	957,400

Table II-15 Summary of Economic Evaluation of Total Complex

Case	Case 3
Site	North Sumatra
Complex Scale	Ethylene 300,000 t/y
Date of Start up	Sept. 1979, Start-up of commercial operation
Investment cost	Fixed capital 932,530 x 10^3 \$ Working capital 24,870 x 10^3 \$ 957,400 x 10^3 \$
I.R.R.	20.9 %
Effects of saving foreign currency	Sept. 1979 to Sept. 1989 2,236,494 x 10^3 \$
National Benefit	Sept. 1979 to Sept. 1989 3,822,382 x 10^3 \$ I.R.R. 27.9 %

Table II-42 Financial Balance of Olefin Complex (Case-3)

(Unit: 10^3 US$)

Fiscal Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
III. Financial Balance										
(1) Profit & Loss										
Sales	257,437	289,065	307,023	329,855	354,772	381,516	410,726	442,436	474,224	508,446
Production cost	99,243	195,047	195,119	197,926	195,026	192,461	190,279	188,402	186,969	185,958
Profit before Tax	58,193	94,018	111,904	131,930	159,745	189,055	220,447	254,035	287,255	322,488
Corporate Income Tax	- Tax exemption period -					85,075	99,201	114,316	129,265	145,119
Net Profit after Tax	58,193	94,018	111,904	131,930	159,745	103,980	121,246	139,719	157,990	177,368
Accumulation	58,193	152,211	264,115	396,045	555,790	659,770	781016	920,736	1,078,725	1,256,093
(2) Capital Payback										
Capital payback *2)	132,157	167,982	185,868	205,894	233,709	177,944	195,210	213,683	231,954	251,332
Capital Unrecovered *1)	957,400	825,243	657,261	471,393	265,499	31,790	-146,154	-341,364	-555,047	-787,001
(3) Repayment of Loan										
Repayment of loans for fixed assets	- Grace period -			93,251	93,251	93,251	93,251	93,251	93,251	93,251
Repayment of loans for working capital	8,290	8,290	8,290	0	0	0	0	0	0	0
	8,290	8,290	8,290	93,251	93,251	93,251	93,251	93,251	93,251	93,251
Outstanding Balance of loans for Fixed assets	652,760	652,760	652,760	652,760	559,509	466,257	373,006	279,755	186,503	93,251
Outstanding Balance of loans for Working Capital	24,870	16,580	8,290	0	0	0	0	0	0	0
	677,530	669,340	661,050	652,760	559,509	466,257	373,006	279,755	186,503	93,251

Notes : *1) Initial Investment (957,400) = Fixed Capital (652,760) + Working Capital (24,870), minus sign indicates accumulation of capital

*2) Net profit after Tax + Depreciation

Table II-44 Foreign Currency Balance of Olefin Complex

(Unit: 10^3 US$)

Fiscal Year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
I. Inflow of Foreign Currency										
(1) Acquisition of Foreign Currency by Export	76,397	56,243	33,420	31,126	27,737	23,062	16,358	7,884	4,894	1,242
(2) Saving of Foreign Currency by Substitution of Import	181,040	232,822	273,603	298,729	327,035	358,454	394,368	434,552	469,330	507,204
(3) Indirect Effect of Foreign Currency Saving	31,606	33,805	36,143	38,680	41,342	44,227	47,339	50,706	54,260	58,063
	289,043	322,870	343,166	368,535	396,114	425,743	458,065	493,142	528,484	566,509
II. Outflow of Foreign Currency										
(1) Opportunity loss of Raw & Auxi. Material Export	40,964	43,843	46,869	50,207	53,686	57,443	61,489	65,756	70,373	75,288
(2) Import Material										
Catalyst and Chemicals	6,888	7,370	7,886	8,438	9,029	9,661	10,337	11,061	11,835	12,664
Materials for Maintenance	16,135	17,264	18,473	19,766	21,150	22,630	24,214	25,909	27,723	29,664
(3) *Payment of Foreign Currency*										
Technical Assistance Fee	13,279	6,816	4,859	5,199	5,563	5,952	6,369	6,815	7,292	7,802
Repayment of Foreign Currency Loans	5,760 *1)	- grace	period -	93,251	93,251	93,251	93,251	93,251	93,251	93,251
Interest on Foreign Currency Loans	48,957	48,957	48,957	48,957	41,963	34,969	27,975	20,982	13,988	6,994
	131,983	124,250	127,044	225,818	224,642	223,906	223,635	223,774	224,462	225,663
III. Blance of Foreign Currency (I - II)	157,060	198,620	216,122	142,717	171,472	201,837	234,430	269,368	304,022	340,846
Accumulation	157,060	355,680	571,802	714,519	885,991	1,087,828	1,322,258	1,591,626	1,895,648	1,236,494

Note: *1) Payment of Foreign Currency Shortage by Own Capital

Table II-45 Olefin Complex, National Benefit on Shadow Price

(Unit: 10^3 US$)

Fiscal year	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
I. Sales										
(1) Export	95,496	70,304	41,775	38,908	34,671	28,828	20,448	9,855	6,118	1,553
(2) Domestic	226,300	291,028	342,004	373,411	408,794	448,068	492,960	543,190	586,663	634,005
Total Sales	321,796	361,332	383,779	412,319	443,465	476,896	513,408	553,045	592,721	635,558
II. Production Cost										
(1) Variable costs										
Raw material & fuel	51,205	58,804	58,586	62,759	67,108	71,804	76,861	82,195	87,966	94,110
Packing expense	5,867	6,278	6,717	7,188	7,691	8,229	8,805	9,421	10,081	10,787
Catalyst & chemicals	8,610	9,213	9,858	10,548	11,286	12,076	12,921	13,826	14,794	15,830
By-products	-39,508	-42,256	-45,179	-48,350	-51,678	-55,284	-59,174	-63,383	-67,825	-72,579
(2) Fixed Cost										
Labour & plant overhead	2,240	2,396	2,564	2,744	2,936	3,141	3,361	3,596	3,848	4,118
Maintenance	20,169	21,580	23,091	24,708	26,438	28,288	30,268	32,386	34,654	37,080
Foreign supervisor	16,599	8,520	6,074	6,499	6,954	7,440	7,961	8,519	9,115	9,753
Administration	7,723	8,672	9,211	9,896	10,643	11,445	12,322	13,273	14,227	15,253
Total Production Cost	72,905	69,207	70,942	75,992	81,442	87,139	93,325	99,833	106,860	114,352
III. Benefit	248,891	292,125	312,837	336,327	362,023	389,757	420,083	453,212	485,921	521,206
Accumulation	248,891	541,016	853,853	1,190,180	1,552,203	1,941,960	2,362,043	2,815,255	3,301,176	3,822,382

III-10 Other Data and Information

Utility tables, labour force tables, organization chart, etc. for each scheme are respectively explained in detail in the separate volumes.

III-11 Action to be Taken in Immediate Future and Recommendations

The nature of the on-site surveys has inevitably been of overall and general character due to the reason that no finalization had been made regarding the sites when the survey was actually conducted. Even regarding ethane which is the basic raw material, the relationship between the LNG project is still remaining to be clarified, and in thie respect, further adjustment seems imperative.

Petrochemical industry is a gigantic and facility-intensive industry. It is scheduled that the pattern of the management for the ethylene plant, utility facilities and the infrastructures will be undertaken by an organization fully affiliated with Pertamina, and each one of the production processes thereafter will be undertaken by a plural number of joint venture enterprises to be hereafter established.

Because of the above circumstance, it is necessary that preparations of the design standards, etc. be thoroughly made regarding such portions as are common to all the enterprises concerned, together with much further detailed on-site surveys.

As has already been stated (ref. Paragraph III-5-4), this will greatly influence the extent of the construction cost saving. Also, the same paragraph states the importance of the systematic preparations of such aspects as the training of the personnel concerned, the development of plastics market, etc. which will altogether contribute to the improvement of the operational rate of the industry.

IV Aromatics Complex

It was indicated by the Indonesian authorities at the meeting held in January, 1974 that, the naphtha obtained from Minas crude will not be utilized for aromatics production, and further, that production of 60,000 t/y of cyclohexane and 100,000 t/y of p-xylene will be produced. Thereafter, it was notified by the authorities that a vast alteration would be made to the present project.

However, no clarifications was made regarding the nature of the alteration. This having been the circumstance, various economic calculations were made by establishing a number of schemes on an assumption that naphtha utilization for the amount of 14,900 bbl/d is possible.

The results of these economic calculations are as reported in the following portion herein.

Further, at a meeting held in August, 1974, it was revealed by the authorities that a plan had already been made for the production of 400,000 t/y of benzol (including 60,000 t/y of cyclohexane), and 320,000 t/y of p-xylene (of which 170,000 t/y for domestic market allocation consisting of 100,000 t/y for DMT and 70,000 t/y for p-TPA) by using 40,000 bbl/d of naphtha.

In view of the fact that this lateration caused an extremely drastic change in the context of the project, no survey was conducted regarding the new conditions.

IV-1 Market

There are several viewpoints to the assessment of the domestic market as follows:

i) The extent corresponding to the Indonesian domestic textile consumption.

ii) The extent corresponding to the Indonesian textile production (by taking into consideration the textile export from Indonesia).

iii) The extent corresponding to the possible production amount of caprolactam, DMT/PTA inside Indonesia (including the export portion of caprolactam, DMT/PTA).

The last above pertains to production of caprolactam, DMT/PTA (including the exportation of DMT/PTA or caprolactam) on a higher level than in the case of (ii) during the initial stage of production. The above approaches can be illustrated in Figures III-1 and III-2.

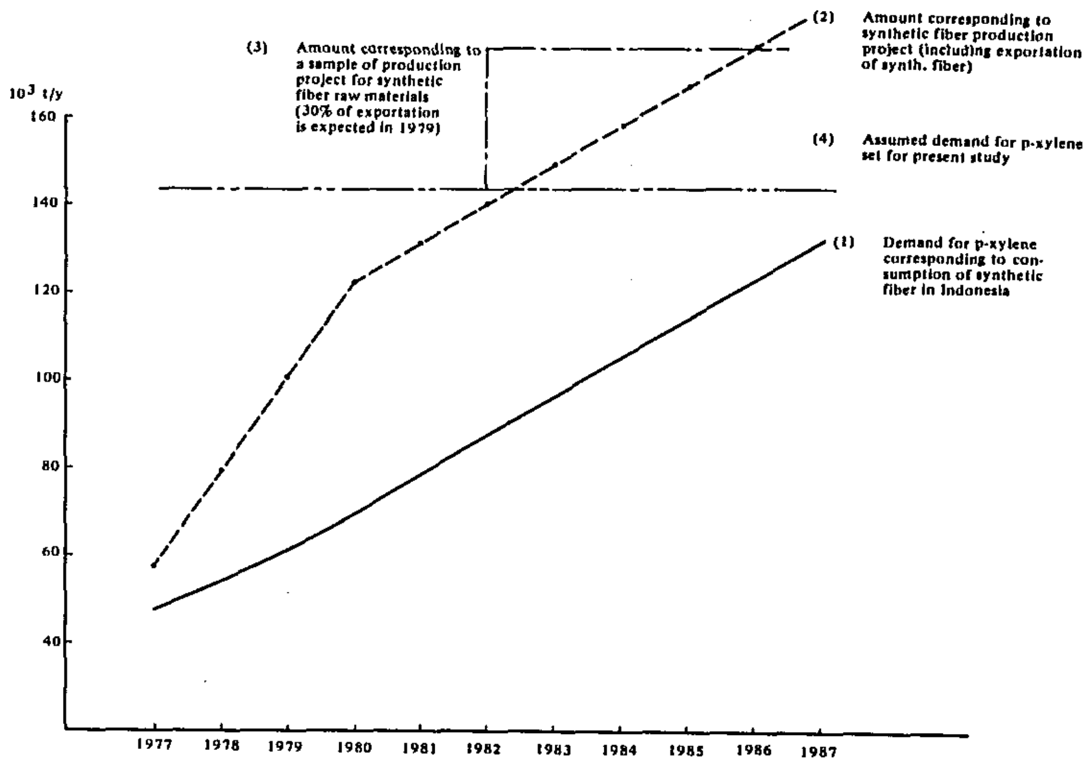


Figure III-1 Forecast of Domestic Demand in Indonesia for p-Xylene

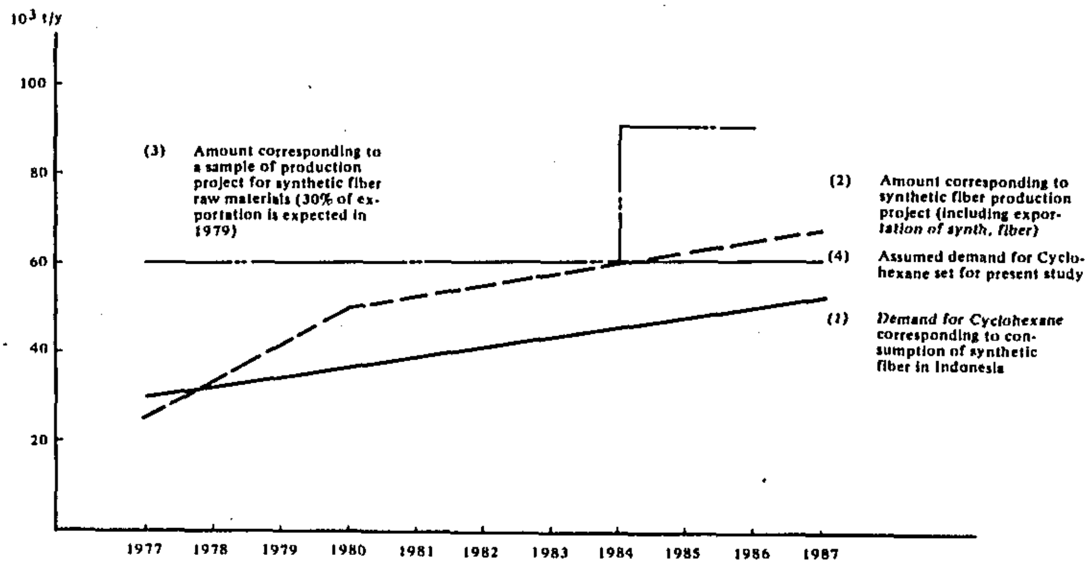


Figure III-2 Forecast of Domestic Demand in Indonesia for Cyclohexane

Regarding the domestic demand for xylene and cyclohexane, the following assumption was established:

The Indonesian domestic demand will be 60,000 t/y of cyclohexane and 144,000 t/y of p-xylene which correspond to a caprolactam, DMT/PTA production project of producing 60,000 t/y of caprolactam and 200,000 t/y of DMT/PTA as TPA, which includes the Indonesian domestic synthetic fiber production for the year 1979 plus 30% of exportation. This trend is shown in the Figures III-1 and III-2 as item (iv).

This assumption takes into consideration the growth in the domestic demand for textile products, the active and positive investment projects for textile industries, and the step-investment to be effected to the project and the project life.

IV-2 Prices of Raw Materials, Products and Utilities

(1) Prices of Naphtha

The price of naphtha in Japan was taken as the Indonesian price, so that the price estimation of naphtha in Indonesia was made by subtracting the ocean freight and other costs up to Japan from the Japanese price level of naphtha.

(2) Prices of Products

(a) The prices of cyclohexane and p-xylene were taken from the data used in the Synthetic Fiber Raw Material Survey which was conducted prior to the present survey.

In this case, estimated international price was increased by import duty of 15% and handling charges, and thus obtained price was adopted as the price to be applied to the domestic market.

Concerning the export price, the Philippines was deemed to be the representative export market, and the ocean freight up to the Philippines was subtracted from the international price level.

(b) The gasoline price was estimated by evaluating the octane value and the level was set as being 1.8 times the naphtha price.

(c) The toluene price was assumed to be equivalent to the lowest price of reformate gasoline on an assumption that toluene will be used as a blender into high octane gasoline.

(d) Estimations were made that the price ratio of benzene, toluene and xylene is 1.3:1:1 in view of the actual records obtained in Japan and the U.S.A. Further, concerning the surplus benzene, the exportable price level was adopted.

The results of calculations on the above is shown in Table III-1.

(3) Prices of Utilities

Prices of utilities are estimated in terms of return on investment during the initial year for common utility facilities which attained a 4% level, and the results are shown below for two alternative cases. (as fuel, right column is for fuel oil and the left is for fuel gas corresponding to US¢63/MMBTU as of January, 1974).

IV-3 Evaluation of Project Alternatives

(1) Various Project Schemes

Each one of the project schemes has been established by the combination of process plant and plant capacity on the basis of the given naphtha.

Such schemes were selected on the basis described before. The point in which the present Palembang project differs from the other aromatics complexes is that the sale of the product in the form of gasoline is also planned. In other words, the Minas naphtha portion shall not be processed through the BTX extraction, but will be sold in the form of gasoline after going through the reformer.

Concerning the aromatics complex, various schemes can be established depending on how to treat the toluene for which the demand is not very great. However, when sale of gasoline is intended, toluene can also be evaluated on the basis of the octane value and can therefore be sold by being blended into gasoline.

In view of the above considerations, the following cases of 4-1001 through 4-6001 as well as case 4-1001A were established as the combinations of firstly whether gasoline is extracted from the reformer or not and secondly how to treat toluene. Refer to Figures III-5 through III-11 regarding the process flow and production amount for each case.

(a) Case 4-1001 (Figure III-5)

This case assumes the production of gasoline and the total quantity of the toluene extracted from the BTX extraction process shall be fed to the disproportionating process in order to transform it into benzene and xylene. In this case, the production quantity will exceed the assumed extent of Indonesian domestic demand for p-xylene and cyclohexane, i.e., 144,000 t/y and 61,200 t/y respectively, both corresponding to 200,000 tons of PTA/DMT as TPA and 60,000 tons of caprolactam.

In this respect, the surplus p-xylene is assumed to be allocated for exportation and the excess portion of cyclohexane shall not be produced, and instead, the intermediate product benzene will be allocated for exportation.

(b) Case 4-2001 (Figure III-6)

In this case, gasoline production will be undertaken and the toluene obtained from the BTX extraction process shall be exported in the form of toluene, or shall be sold domestically in the form of gasoline. In this case, neither p-xylene nor cyclohexane will be able to fulfill the assumed Indonesian domestic demand and the total amount of these products shall be destined to the domestic market.

(c) Case 4-3001 (Figure III-7)

In this case, gasoline production shall be carried out, and the toluene obtained from the BTX extraction process will be totally converted into benzene by the hydro-dealkylation process. In this case, the p-xylene production amount will be short of fulfilling the Indonesian domestic market, and shall be totally destined for domestic sales. Regarding cyclohexane, the production amount will exceed the scope of the domestic market, thereby realizing a large quantity of benzene exportation.

(d) Case 4-4001 (Figure III-8)

In this case, no gasoline production will be undertaken and the total amount of the toluene obtained through the BTX extraction process will be converted into benzene and xylene through the disproportionation process. As in the case of the above Case 4-1001, a certain extent of benzene and p-xylene exportation will be realized, however, in view of the fact that the gasoline portion has also been processed through the BTX extraction process, the exportation amount will obtain a considerably high level.

(e) Case 4-5001 (Figure III-9)

In this case, no gasoline production will be conducted and the total amount of the toluene obtained through the BTX extraction will be allocated for sales outside the complex. The production amount will be slightly short of the Indonesian domestic demand for cyclohexane and p-xylene.

(f) Case 4-6001 (Figure III-10)

In this case, no gasoline production will be undertaken and the total amount of toluene obtained through the BTX extraction process will be fed to the hydro-dealkylation process. The excess

Table III-10 Price of Utilities (Stream Factor 93%)

In 1978
In Palembang

			Fuel Oil	Fuel Gas
			9.03 US$/ MMKcal	3.28 US$/ MMKcal
Electric Power	30,000 KW	US$/KWH	0.0509	0.0324
30 K Steam	155 t/h	"	11.7	5.81
18 K Steam*	-	"	10.6	5.39
10 K Steam*	-	"	7.87	4.02
7 K Steam*	-	"	7.25	3.71
River Water	1850 m^3/h	"	0.081	0.077
Filtered Water	1750 m^3/h	"	0.194	0.183
Deminerized Water	420 m^3/h	"	0.421	0.383
Instrument Air	2400 Nm^3/h	"	0.029	0.025
Inert Gas	480 Nm^3/h	"	0.064	0.062

* These steam prices are estimated based on effective enthalpy difference between 30 K steam

Table III-1 Estimated Price of Product & Raw Material

Upper column : for domestic
Lower column : for export

Product	Paraxy-lene	Cyclo-hexane	Benzene	Toluene	Xylene	Reformate	Gasoline	Naphtha
Estimated based on :	Interna-tional Price	Interna-tional Price	IRR of BTX Plant as 15%	IRR of BTX Plant as 15%	IRR of BTX Plant as 15%	IRR of Reformate Plant	Naphtha Price	Japanese Price
International Price in 1974	292.4	208.4	199.2					*99.1
International Price in 1978	383	273	261					*129.8
Exfactory Price in Indonesia in 1974	348.1 251.9	245.8	 167.9	149.2 126.6	149.2	100.1	**146.6	81.6
Exfactory Price in Indonesia in 1978	456 330	322	 220	195.5 165.9	195.5	131.1	**192	106.9

* Japanese Price
** 1.8 times of Naphtha Price

benzene amount will become exceedingly high and a particularly difficult problem will be present in the way of exporting such excess benzene.

(g) Case 4-1001A (Figure III-11)

This case is a transformation of Case 4-1001. In this case, the domestic demand for p-xylene and cyclohexane is firstly satisfied, and thereafter, the establishment of the conditions was made by targeting at the enhancement of the level of overall value addition. In other words, gasoline production will be undertaken, and then, in order to obtain sufficient amount of xylene and benzene to satisfy the Indonesian domestic demand for p-xylene and cyclohexane, a part of toluene shall be fed to the disproportionator. However, in this case it must be noted that a slight extent of excess in benzene will take place when intending to obtain the necessary amount of xylene, and such an excess portion of benzene shall be allocated for exportation.

(2) Comparison of Economic Viability for Each Case

Economic viability comparison studies were undertaken by using the price factor described in IV-2, regarding various schemes mentioned in (1) above. The obtained results are shown in Table III-2.

This table show, together with the production amount of the products in each case and the estimated export amount thereof, the construction cost figures for each case. Concerning the economic viability (expressed in terms of IRR), two cases have been established, i.e., the utilization of fuel oil as the fuel, and the employment of natural gas (US¢63/MMBTU, as of 1974) as the fuel.

In the case in which the natural gas is employed, all the IRR indications display a level of 16%; however, in the case of using fuel oil as the fuel, the IRR figure was 8.7% for both 4-4001 and 4-6001, thereby failing to attain the economic viability.

In 4-1001A, the necessary amount of cyclohexane (c-x) and p-xylene (p-x) has been made for carrying out the production of caprolactam or polyester. Also, the IRR on the basis of fuel oil is attainable at 20.6%, and at 26.7% on natural gas basis. Therefore, in view of these advantages, this case may be classified as being a desirable scheme.

(3) Foreign Exchange Balance (Table III-21)

Table III-21 shows the foreign exchange balance regarding the case 4-1001A. During a period from 1978 to 1987, the foreign exchange saving will be made available in the amount of approximately US$280 million.

(4) Financial Balance

Annual cash flow for Case 4-1001A is as shown in Table III-19.

(5) Influence of variation of Main Factors

Variation of the internal rate of return in the event where the prices change of naphtha and product should take place is shown in Table III-3 for Case 4-1001A.

The 20.6% IRR for naphtha will become 16.6% if the naphtha price is increased by 10%, and will become 24.5% if decreased by 10%.

Also, if the prices of p-xylene, cyclohexane, toluene, gasoline. etc. were shifted to the price bases of production by Japanese existing plants and newly constructed plants, the IRR level will become 32.2% and 37.9% respectively from the original 20.6%. It must be noted here, however, that the Japanese product prices were assumed to be identical for both domestic market and export market. Therefore, in the event of adopting the lowest possible price for coping with the keenest competition, the export price will be on a much lower level.

Thus, the effects of the raw material prices and the product prices on the economic viability of the plants are extremely profound. As is evident from the tables concerning the production costs inserted in IV-6, the significance of these effects have been due mainly to the fact that the importance of the fixed cost is extremely small, and that of variable cost extremely great within the production cost.

IV-4 Investment Cost Details

Detailed initial investment cost for the complex of Case 4-1001A as a representative case is shown in Table III-26(1) and Table III-26(2).

IV-5 Utilities and Labour Requirements

Utilities requirements and Operating personnel requirements for a complex of Case 4-1001A as a representative case are shown in Table III-27 and Table III-25 respectively.

IV-6 Production Cost and Profitability of Each Plant

For cases 4-1001, 4-2001, 4-5001 and 4-1001A, each of which showing reasonable profitability as a whole complex, profitability of each plant is shown in Tables III-14(1) through (4).

Table III-3 Internal Rate of Return by Variable Factors

	Naphtha	Fuel	Para-xylene	Cyclo-hexane	Benzene	Toluene	Gasoline	Total
	$/t	$/MMKcal	$/t	$/t	$/t	$/t	$/t	IRR %
Base Case 4-1001 A	106.9	6.29* 9.03	456.0	326.0	220.0 (For Export)	195.5	192	20.6
Naphtha Price 10 % up	117.6							16.6
Naphtha Price 10 % down	97.2							24.5
Price of Products Japan min. Price Base			568.5	402.4	256.7 (For Export)	241.7 (For Export)		32.2
Price of Products Japan max. Price Base			618.8	418.3	277.7 (For Export)	256.7 (For Export)		37.9
Gasoline is sold as the same Price as reformate						165.9 (For Export)	147.6	17.4

* For Process Plant, shortage of fuel is covered by Fuel Oil

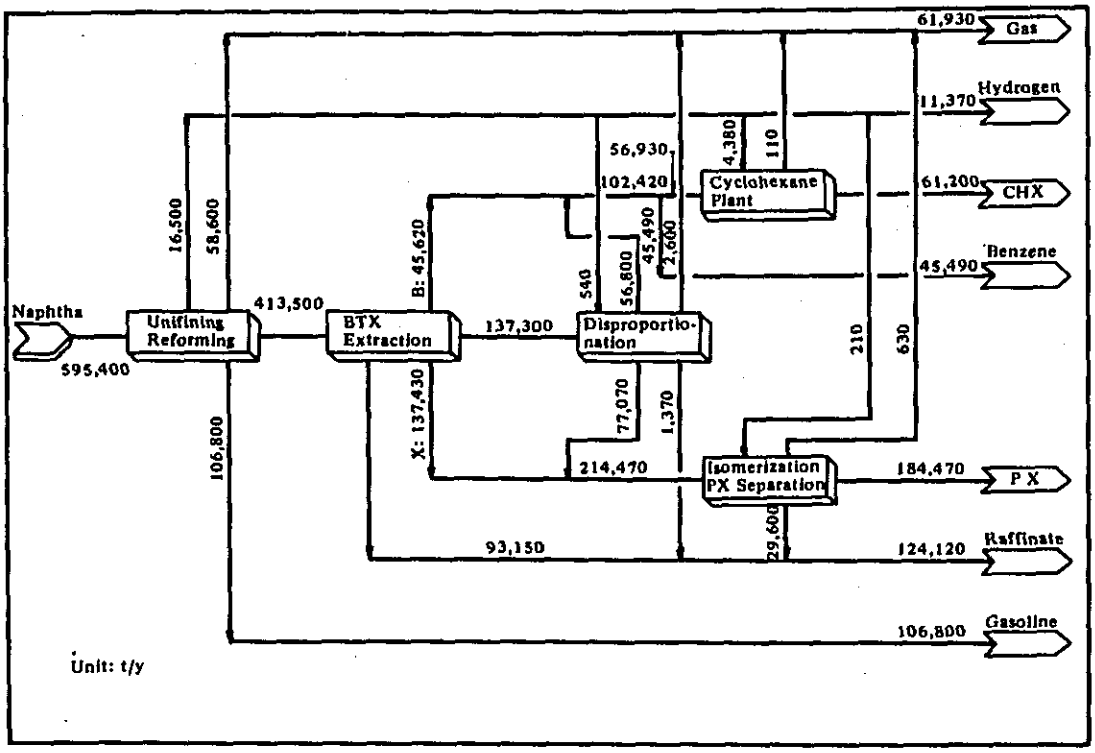


Figure III-5 Aromatics Complex, Project Scheme for Case 4-1001

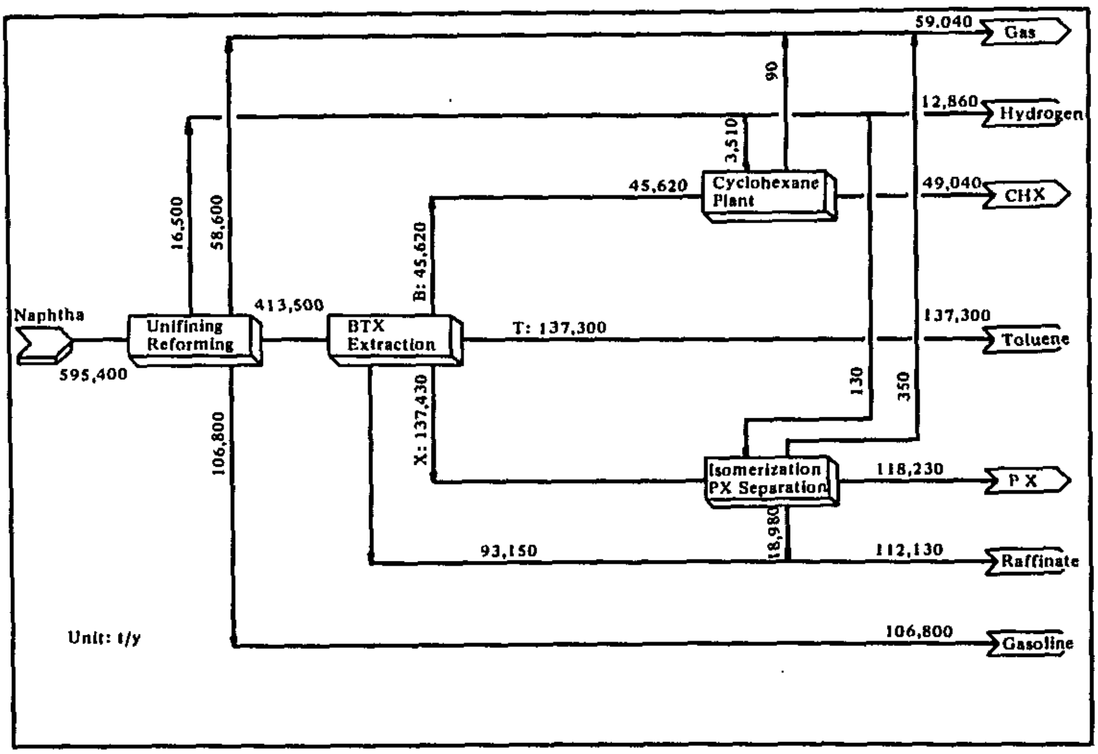


Figure III-6 Aromatics Complex, Project Scheme for Case 4-2001

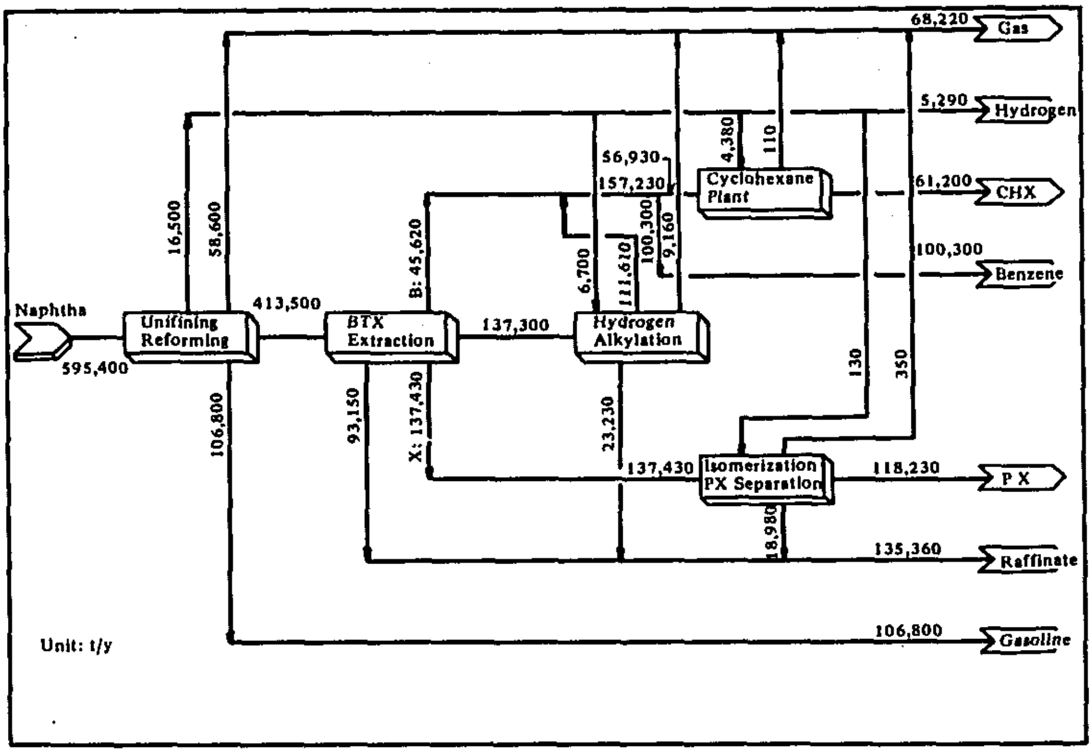


Figure III-7 Aromatics Complex, Project Scheme for Case 4-3001

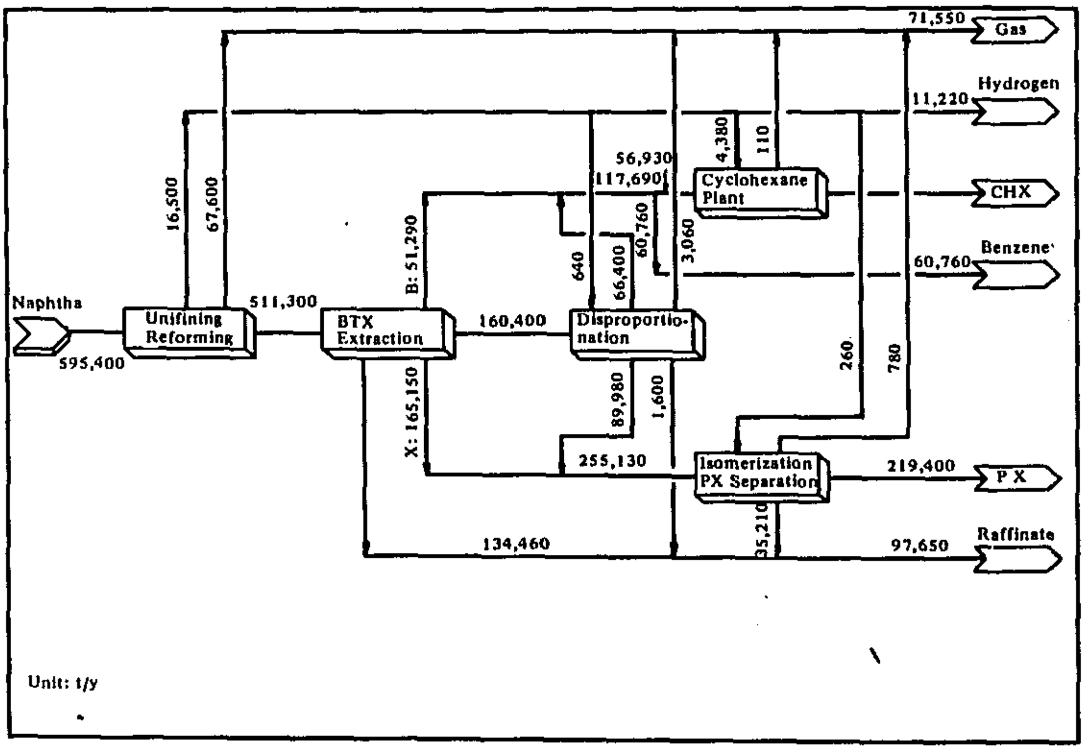


Figure III-8 Aromatics Complex, Project Scheme for Case 4-4001

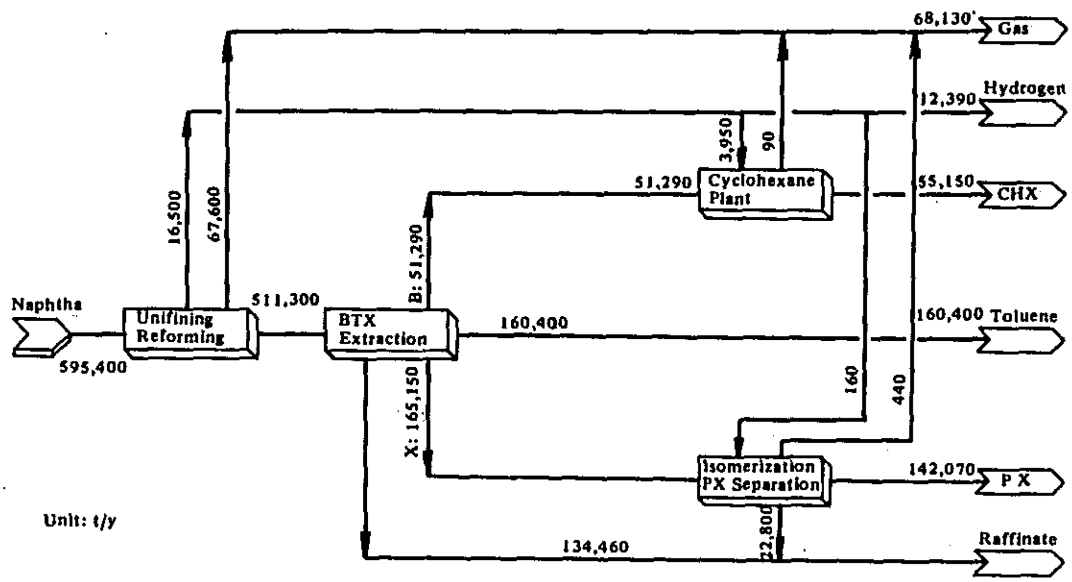


Figure III-9 Aromatics Complex, Project Scheme for Case 4-5001

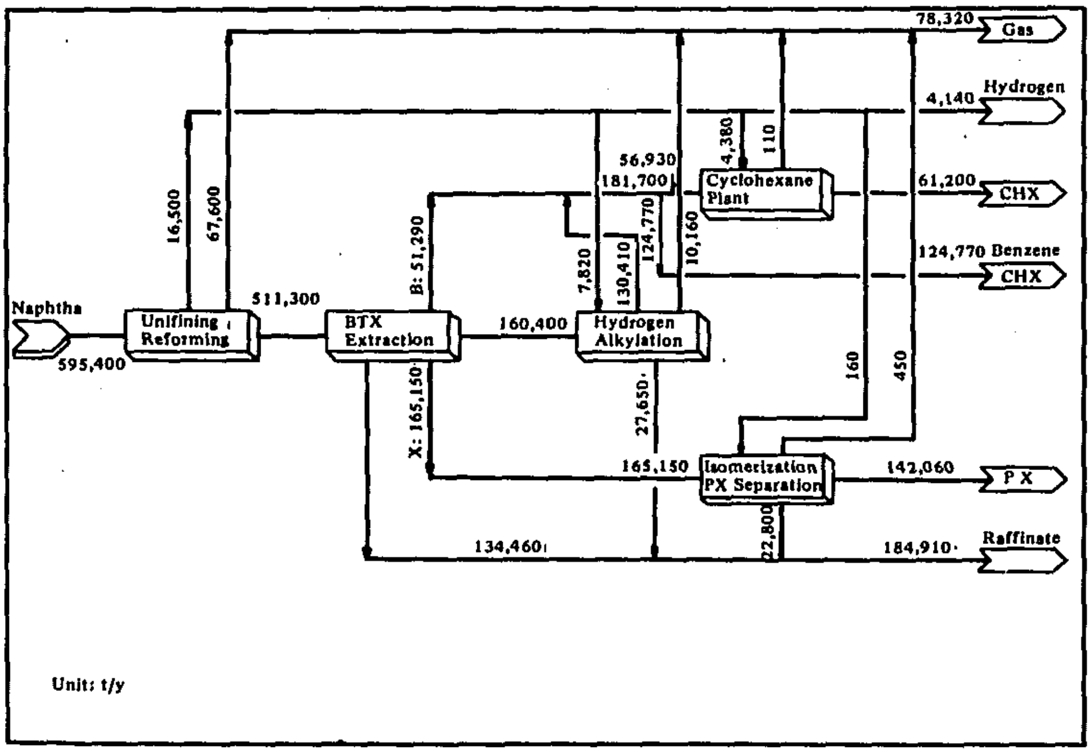


Figure III-10 Aromatics Complex, Project Scheme for Case 4-6001

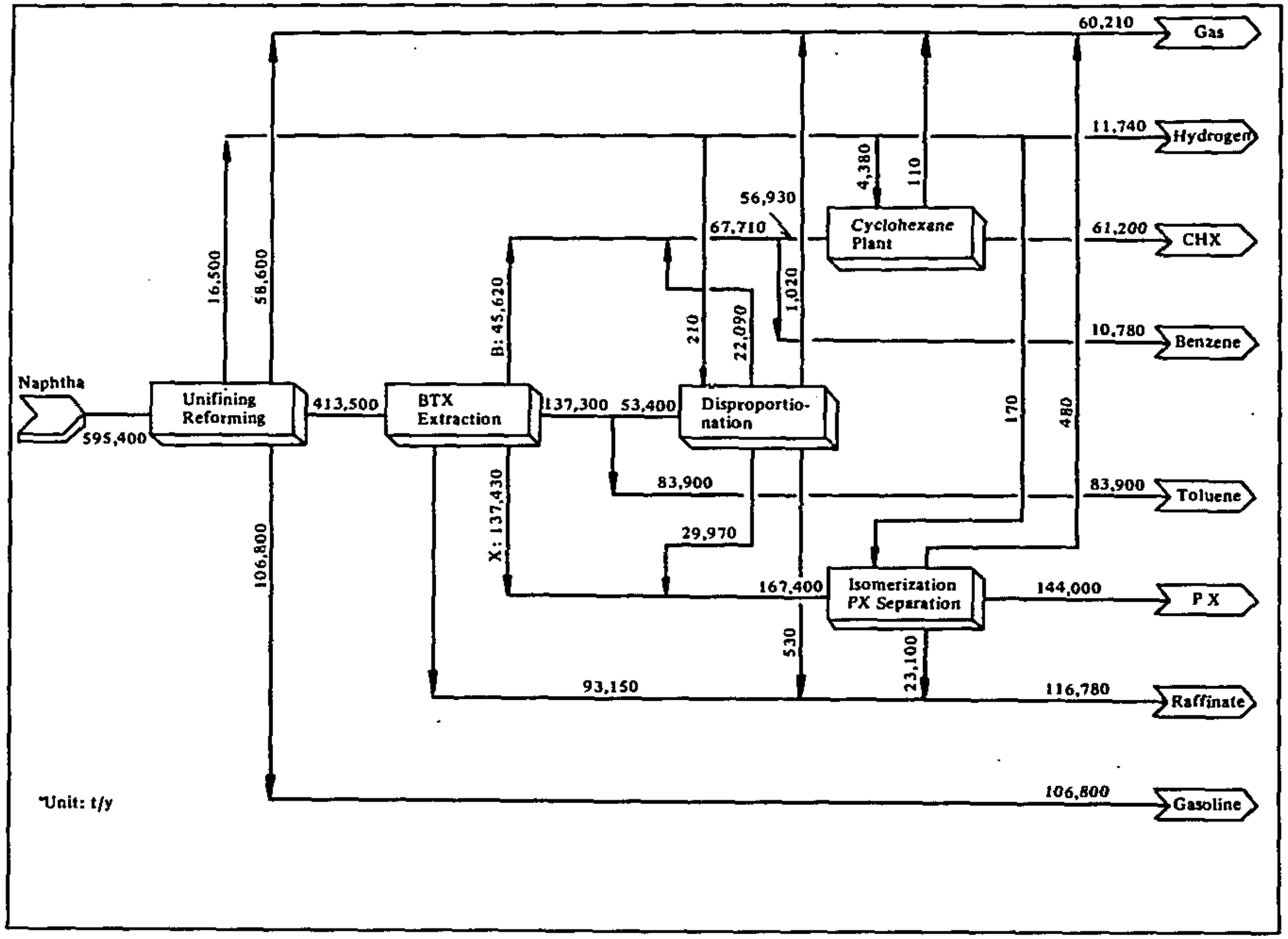


Figure III-11 Aromatics Complex, Project Scheme for Case 4-1001A

Table III-2 Aromatic Complex Comparison of Economic Viability for Each Case

Items		Unit / Case No.	4-1001	4-2001	4-3001	4-4001	4-5001	4-6001	4-1001A
Gasoline Sales		t/y	106,800	106,800	106,800	-	-	-	106,800
Domestic Market	PX	t/y	144,000	144,000	144,000	144,000	144,000	144,000	144,000
	CHX	t/y	61,200	61,200	61,200	61,200	61,200	61,200	61,200
Production Capacity	PX	t/y	184,500	118,230	118,230	219,400	142,060	142,060	144,000
	CHX	t/y	61,200	49,040	61,200	61,200	55,150	61,200	61,200
Export	PX	t/y	40,500	*-25,770	*-25,770	75,400	*-1,940	*-1,940	0
	CHX	t/y	0	*-12,160	0	0	*-6,050	0	0
Toluene			Disproportionation	-	Hydro Dealkylation	Disproportionation	-	Hydro Dealkylation	Disproportionation
Toluene Sales		t/y	0	137,300	0	0	160,400	0	83,890
Benzene Sales		t/y	45,488	0	100,305	60,730	0	124,780	10,780
**Total Investment		10^3\$	210,218	151,953	175,310	231,166	166,820	192,494	179,361
Profit in 1978	Fuel Oil	10^3\$	14,488	21,532	12,902	6,143	18,005	7,400	20,466
I.R.R.	Base	%	14.6	24.1	13.5	8.7	19.7	8.7	20.6
Profit in 1978	Fuel Gas	10^3\$	24,879	28,768	21,382	18,592	26,442	17,635	28,757
I.R.R.	Base	%	21.2	30.4	20.1	16.2	26.5	16.2	26.7

Note * - (minus) to be imported

** Total investment does not cover the construction cost of utility facility.

Table III-21 Foreign Currency Balance of Aromatic Complex

(Unit: 10^3 US$)

Fiscal Year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
I. Inflow of Foreign Currency										
(1) Acquisition of Foreign Currency by Export	582	625	668	714	765	819	876	938	1,003	1,073
(2) Saving of Foreign Currency by Substitution of Import*1)	73,671	78,749	84,311	90,106	96,458	103.221	110,416	118,150	126,493	135,374
(3) Indirect Effect of Foreign Currency Saving	54,717	58,561	62,648	67,052	71,730	76,748	82,139	87,874	94,027	100,618
	128,970	137,935	147,627	157,872	168,953	180,788	193,431	206,962	221,523	237,065
II. Outflow of Foreign Currency										
(1) Opportunity loss of Raw & Auxi. Material Export	87,671	94,195	100,247	107,622	115,138	123.400	131.824	141,016	150,986	161,159
(2) Import Material										
Catalyst & chemicals	2,177	2,329	2,492	2,667	2,853	3,053	3,267	3,496	3,740	4,002
Materials for maintenance	2,880	3,081	3,297	3,528	3,775	4.039	4,321	4,624	4,948	5,294
(3) Payment of Foreign Currency										
Technical assistance fee	1,392	1,489	1,594	1,705	1,825	1.952	2,089	2,235	2,392	2,559
Repayment of Foreign currency loans	6,720*2)	- grace	period -	17,723	17,723	17,723	17,723	17,723	17,723	17,723
Interest on Foreign currency loans	9,305	9,305	9,305	9,305	7,975	6,646	5,317	3,988	2,658	1,329
	110,145	110,399	116,935	142,550	149,289	156,813	164,541	173,002	182,447	192,066
III. Balance of Foreign Currency (I - II)	18,825	27,536	30,629	15,322	19,664	23,975	28,890	33,960	39,076	44,999
Accumulation	18,825	46,361	76,990	92,312	111,976	135,951	164,841	198,801	237,877	282,876

Note *1) Sales amount in domestic - import tax

*2) Payment of foreign currency shortage by own capital

Table III-19 Financial Balance of Aromatic Complex (Case 4-1001A)

(Unit: 10^3 US$)

III. Financial Balance										
(1) Profit & Loss										
Sales	84,883	90,737	97,145	103,822	111,141	118,935	127,225	136,136	145,747	155,981
Production cost	70,139	72,738	74,672	77,661	79,870	82,542	85,066	88,083	91,530	94,823
Profit before Tax	14,744	17,998	22,473	26,160	31,271	36,393	42,159	48,055	54,216	61,158
Corporate Income Tax	- Tax exemption period -					16,377	18,972	21,625	24,397	27,521
Net Profit after Tax	14,744	17,998	22,473	26,160	31,271	20,016	23,188	26,430	29,819	33,637
Accumulation	14,744	32,742	55,215	81,375	112,646	132,662	155,850	182,280	212,099	245,736
(2) Capital Payback										
Capital Unrecovered*1)	192,799	163,621	131,189	94,283	53,689	7,985	-26,465	-67,329	-108,193	-152,446
Capital Payback*2)	29,178	32,432	36,906	40,594	45,704	34,450	37,621	40,864	44,253	48,071
(3) Repayment of Loan										
Outstanding Balance of loans for Fixed assets	124,060	124,060	124,060	124,060	106,337	88,614	70,891	53,169	35,446	17,723
Outstanding Balance of loans for Working Capital	15,568	10,379	5,189	0	0	0	0	0	0	0
	139,628	134,439	129,250	124,060	106,337	88,614	70,891	53,169	35,446	17,723
Repayment of loans for fixed assets	- Grace Period -			17,723	17,723	17,723	17,723	17,723	17,723	17,723
Repayment of loans for working capital	5,189	5,189	5,189	0	0	0	0	0	0	0
	5.189	5.189	5.189	17,723	17,723	17,723	17,723	17,723	17,723	17,723

Notes : *1) Initial Investment (192,799) = Faixed Capital (177,231) + Working Capital (15,568), minus sign indicates accumulation of capital

*2) Net profit after Tax + Depreciation

Table III-26(1) Construction Cost and Investment Summary

(Unit: 10^6 US$)

Items \ Currency Allocation	Foreign Portion	Local Portion	Total
* 1. Inside Battery Limit			
(a) Equipment & Materials	26.81	0.69	27.50
(b) Erection Work	-	7.6	7.6
(c) Civil Work	2.10	2.17	4.28
(d) Supervision	6.69	1.67	8.36
(e) Engineering & Contractor's Fee	8.48	6.48	14.96
* 1. ISBL Total	44.08	18.61	62.69
* 2. License & Know-How	10.57	-	10.57
* 3. Catalyst & Chemicals	8.22	0.22	8.44
* 4. Spare Parts	2.68	0.07	2.75
* 5. Storage & Handling	3.38	1.07	4.45
* 6. Process Cosntrol Laboratory	3.75	0.30	4.05
7. Contingency	4.41	1.87	6.28
** 8. Utility Facilities	20.76	7.14	27.9
9. Service Facilities & Jetty, Housing Road	14.33	9.55	23.88
Total Construction Cost	112.18	38.83	151.01
Land Preparation & Development	-	2.07	2.07
Pre-operation Cost	5.29	1.0	6.29
Interest during Construction	13.35	4.57	17.92
Total Fixed Capital	130.82	46.47	177.29
Working Capital	-	15.57	15.57
Total Investment	130.82	62.04	192.86

(Note) * Cost for each plant is shown in Table III-26(2)

** Cost for each utility is shown in Table III-26(3)

Table III-26(2) Construction Cost for Each Process Plant

Unit: 10^6US$

Plant Name	Unifining Reforming			BTX Extraction			Disproportionation			Isomerization & P-X Separation			Cyclo Hexane Plant		
Plant Capacity	444500t/y of Feed			49000t/y of Feed			23700t/y of Benzene			154800t/y of P-X			65800t/y of CHX		
Cost Allocation	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total	Foreign	Local	Total
1. Inside Battery Limit															
a. Equipment & Materials	7.74	0.20	7.94	4.44	0.12	4.56	3.15	0.08	3.23	10.80	0.28	11.08	0.68	0.02	0.70
b. Erection Work	-	3.00	3.00	-	1.43	1.43	-	0.67	0.67	-	2.30	2.30	-	0.20	0.20
c. Civil Work	0.45	0.46	0.91	0.51	0.53	1.04	0.24	0.25	0.49	0.82	0.85	1.67	0.09	0.09	0.18
d. Super Vision	2.04	0.51	2.55	1.18	0.30	1.48	0.75	0.19	0.94	2.54	0.64	3.18	0.18	0.05	0.23
e. Engineering & Contractor's Fee	2.45	1.87	4.32	1.40	1.07	2.47	1.00	0.76	1.76	3.42	2.61	6.03	0.22	0.17	0.39
1. ISBL Total	12.68	6.04	18.72	7.53	3.45	10.98	5.14	1.95	7.09	17.58	6.68	24.26	1.17	0.53	1.70
2. Licence & Know-How Fee	1.03	-	1.03	1.03	-	1.03	0.53	-	0.53	7.54	-	7.54	0.44	-	0.44
3. Caralysts & Chemicals	2.28	0.06	2.34	0.70	0.02	0.72	0.33	0.01	0.34	4.89	0.13	5.02	0.02	0	0.02
4. Spare Parts	0.77	0.02	0.79	0.44	0.01	0.45	0.32	0.01	0.33	1.08	0.03	1.11	0.07	-	0.07
5. Storage & Handling	1.91	0.60	2.51	0.98	0.31	1.29	-	-	-	0.29	0.09	0.38	0.20	0.07	0.27
6. Process Control Laboratory	0.75	0.06	0.81	0.75	0.06	0.81	0.75	0.06	0.81	0.75	0.06	0.81	0.75	0.06	0.81
7. Contingency	1.27	0.60	1.87	0.75	0.35	1.10	0.51	0.20	0.71	1.76	0.67	2.43	0.12	0.05	0.17
Grand Total	21.95	7.42	29.37	12.07	4.21	16.28	7.78	2.23	10.01	36.79	7.76	44.55	2.73	0.71	3.44

Table III-27 Utilities Requirement for Process Plant

Unit Name	Unifing Reforming	BTX Extraction	Disproportionating	Isomerization P-X Separation	CHX Plant	TPA/DMT	Process Total Requirement
Plant Capacity / Utilities	15,000 BPSD	413,500t/y Feed	53,400t/y Toluene	144,000t/y	61,200t/y		
Electricity KW	330	1,300	580	2,264	206	13,920	18,600 KW
STM 30 atg t/h	10	87	11	-			108 t/h
18 atg t/h	-	-	-	-	0.8		0.8 t/h
10 atg t/h	-	-	3	-		}	
7 atg t/h	-	-	-	-	-6.7	} 158	153.8 t/h
4 atg t/h	-	-	-	-1.5	-	}	
Filtered Water t/h (make up)	68.8	91.8	4.3	5.4	1.7	710	882 t/h
Demineralized Water t/h	-	-	-	1.5	6.7		8.2 t/h
Instrument Air m^3/h	200	150	150	100	150	800	1,550 Nm^3/h
Inert Gas m^3/h	Nil	Nil	Nil	Nil	Nil	400	400 Nm^3/h
Fuel Gas MMKCal/h	40						
Oil MMKCal/h		14*	5.5*	101*	-	55*	215.5 MMKCal/h

(Note) *Fuel gas and oil mixed

Table III-25 Required Operating Personnel

(Unit: man)

	Unifing Reforming	BTX Extraction	Disproportionating	Isomerization & P-X Separation	CHX Plant	Utilities	Total
Supervisor	2	2	2	3	1	3	13
Operator	13	12	10	21	8	19	83
Analyst	4	7	5	7	5	8	36
Labourer							
Total	19	21	17	31	14	30	132
Foreign Supervisor	2	2	2	3	1		10

Table III-14(1) Production Cost for each Products (Case 4-1001)

Plant Name	Unit	Reformer	BTX Extraction			Dispropo-rtionation	Isomerization & P-X separation	CHX Plant	Total
Total Investment	10^3\$	51,663	33,084			32,633	86,251	6,587	210,218
Profit	10^3\$/y	3,823	2,879			532	5,358	1,896	14,488
Internal Rate of Return		0.15	0.150			0.075	0.150	0.43	0.146
Product(s)		Reformate	Benzene	Toluene	Xylene	Xylene	P-X	CHX	
Variable Cost	\$/t	103.2	219.3	168.9	168.9	250.7	326.9	262.1	
Fixed Cost	\$/t	18.6	22.0	17.0	17.0	70.0	68.6	23.1	
Other Cost	\$/t	4.1	1.3	1.0	1.0	5.6	12.9	9.8	
Total Production Cost	\$/t	125.9	242.6	186.0	186.9	326.3	408.4	295.0	
Profit	\$/t	9.2	11.2	8.6	8.6	6.9	20.0	31.0	
Sales Price	\$/t	135.1	253.8	195.5	195.5	333.2	428.4	326.0	

Table III-14(2) Production Cost for each Products (Case 4-2001)

Plant Name	Unit	Reformer	BTX Extraction			Dispropo-rtionation	Isomeri-zation & P-X sepa-ration	CHX Plant	Total
Total Investment	10^3 $	51,663	33,084				61,831	5,375	151,953
Profit	10^3 $/y	3,823	2,879				12,181	2,649	21,532
Internal Rate of Return		0.15	0.150				0.33	0.59	0.241
Product(s)		Reformate	Benzene	Toluene	Xylene	Xylene	P-X	CHX	
Variable Cost	$/t	103.2	219.3	168.9	168.9		260.3	237.0	
Fixed Cost	$/t	18.6	22.0	17.0	17.0		79.0	25.2	
Other Cost	$/t	4.1	1.3	1.0	1.0		13.7	9.8	
Total Production Cost	$/t	125.9	242.6	186.9	186.9		353.0	272.0	
Profit	$/t	9.2	11.2	8.6	8.6		103.0	54.0	
Sales Price	$/t	135.1	253.8	195.5	195.5		456.0	326.0	

Table III-14(3) Production Cost for each Products (Case 4-5001)

Plant Name	Unit	Reformer	BTX Extraction			Dispropo-rtionation	Isomerization & P-X separation	CHX Plant	Total
Total Investment	10^3\$	51,147	39,034				70,715	5,924	166,820
Profit	10^3\$/y	3,988	308				12,002	1,706	18,004
Internal Rate of Return		0.151	0.028				0.294	0.378	0.197
Product(s)		Reformate	Benzene	Toluene	Xylene	Xylene	P-X	CHX	
Variable Cost	\$/t	120.8	240.5	185.5	185.5		283.6	261.3	
Fixed Cost	\$/t	14.9	21.1	16.4	16.4		74.2	24.0	
Other Cost	\$/t	4.1	1.3	1.0	1.0		13.7	9.8	
Total Production Cost	\$/t	139.8	262.9	202.9	202.9		371.5	295.1	
Profit	\$/t	7.8	13.7	11.1	11.1		84.5	30.9	
Sales Price	\$/t	147.6	280.0	215.5	215.5		456.0	326.0	

Table III-14(4) Production Cost for each Products (Case 4-1001A)

Plant Name	Unit	Reformer	BTX Extraction			Dispropo-rtionation	Isomerization & P-X separation	CHX Plant	Total
Total Investment	$10^3$$	51,663	33,084			16,220	71,905	6,489	179,361
Profit	$10^3$$/y	3,829	2,879			1,026	9,651	3,081	20,466
Internal Rate of Return		0.150	0.150			0.150	0.248	0.58	20.6
Product(s)		Reformate	Benzene	Toluene	Xylene	Xylene	P-X	CHX	
Variable Cost	$/t	103.2	219.3	168.9	168.9	250.7	301.0	242.9	
Fixed Cost	$/t	18.6	22.0	17.0	17.0	100.3	74.3	22.9	
Other Cost	$/t	4.1	1.3	1.0	1.0	5.6	13.7	9.8	
Total Production Cost	$/t	125.9	242.6	186.9	186.9	356.6	389.0	275.	
Profit	$/t	9.2	11.2	8.6	8.6	34.2	67.0	50.3	
Sales Price	$/t	135.1	253.8	195.5	195.5	390.8	456.0	326.0	

V Synthetic Rubber

For projecting the production of synthetic rubber in Indonesia, considerations were made to the fact that such a product should be of a character to supplement, rather than compete with, natural rubber, and also that such a synthetic rubber product must be of those which are being used in the Indonesian market. From this viewpoint, studies on the feasibility of SBR production were conducted.

The properties and characteristics of various synthetic rubbers and mutual comparison thereof are described in ANNEX attached to the separate volume of the Report.

V-1 Market Size

In order to forecast the future market size of SBR, the overall rubber market forecast should be made including both synthetic and natural rubbers. Within the framework of such an overall forecast, the application-wise directions of use of the materials must be studied. Then, a forecast may be made for the SBR market by assuming the synthetic rubber utilization rate. The individual figures in this respect are as shown below. As a conclusion, it has been forecast that the SBR demand for the years 1980 and 1985 in Indonesia will be 10,400 tons and 21,900 tons respectively.

(1) Domestic consumption of rubber and rubber products in Indonesia estimated by FAO is 40,000 tons in 1973.

(2) Through the international cross section method, future rubber demand in Indonesia is forecasted as follows:

	1975	1980	1985
Per capita consumption (Kg)	0.44	0.58	0.79
Total consumption (tons)	60,700	89,200	134,100

(3) Apparent consumption of automotive tires including importation is estimated to be 1,060,000 pieces in 1972.

(4) Demand for automotive tires is rising at an average annual rate of 13% since 1969. Supposing that an annual rate of 13% increase will be maintained until 1980, and that it will drop to 10% after 1981, then the predicted results will be obtained as follows:

1975	1,529,000
1980	2,818,000
1985	4,538,000

(5) Rubber consumption for automotive tires will be 28,000 tons in 1980, and 45,000 tons in 1985.

(6) Supposing that the percentage of synthetic rubber will have

been 20% in 1980, and 30% in 1985, then the required quantity of synthetic rubber will be 5,600 tons in 1980, and 13,600 tons in 1985.

(7) In the general industrial and non-industrial fields including bicycle tires and footwear, rubber consumption will be 61,000 tons in 1980, 88,700 tons in 1985, and synthetic rubber consumption will be 9,200 tons and 17,700 tons respectively.

(8) When the above figure are summarized the total demand for synthetic rubber in 1980 will be 14,800 tons, and 31,300 tons in 1985.

(9) Seventy percent of synthetic rubber used for automotive tires, and 60% of that for general industrial use are considered to be SBR (styrene-butadiene rubber), so that the total SBR demands in Indonesia will be 10,400 tons in 1980, and 21,900 tons in 1985.

(10) In the 1980s, exportation of synthetic rubber material and products from Indonesia is expected to be practicable due to supply shortage of natural and synthetic rubber in the world.

(11) However, it is better to consider import substituting production of SBR in Indonesia as being a producing and exporting country of natural rubber.

V-2 Price of Raw Material and Product

(1) Material price is assumed as follows:

	(US$/t)
Butadien	135
Styrene	640

Styrene monomer is supposed to be imported.

(2) SBR price in 1980 is estimated as US$1,160/ton.

V-3 Production Plan

An SBR plant having capacity of 25,000 ton/year is assumed to be constructed in accordance with the following plan:

Start of construction	July, 1978
Completion of construction	June, 1980
Operation startup	January, 1981

	Operational Ratio (%)	Production (t/y)
1981	50	12,500
1986	100	25,000

V-4 Investment Cost

		$(10^6$ US$)
(1)	Production facilities acquisition price	27.7
(2)	Auxiliary facilities acquisition price	8.3
(3)	Operation preparatory cost	1.3
(4)	Monetary interest during construction period	2.8
(5)	Total fixed capital	40.1
(6)	Operation capital	3.1
(7)	Total investment amount	43.2

V-5 Labour Requirement

Manpower required for operating the SBR plant is 84 persons.

V-6 Utilities Requirement

(1)	Electricity	500 KWH/t
(2)	Steam	2 t/t
(3)	Cooling water	300 t/t
(4)	Pure water	14 t/t

V-7 I.R.R.

I.R.R. calculated for the SBR plant under conditions mentioned above is 23.22%.

V-8 Recommendation and Future Schedule

The import substituting SBR plant construction is feasible from the economic stand-point to meet with the domestic demands. Thus it is desirable to conduct a 2nd stage economic study inclusive of the possibility of product exports.

As it was confirmed that ethane will be used as the basic raw material for the olefin complex, it became impossible to obtain butadiene from the same complex. Therefore, it is necessary to study available processes for butadiene production including the dehydrogenation process.

On the other hand, there is a possibility now that styrene production is carried out at the olefin complex, instead of originally planned importation. Although the effects of styrene production will be less significant than those of butadiene production requirements, the feasibility of the styrene production should also be included within the scope of re-scrutinization.

VI Synthetic Detergents

It was presumed in UNIDO Phase I studies that the demand for synthetic detergents would be low in view of a low extent of popularization of electrical washing machines. However, through the present survey, it was revealed that an unexpectedly large amount of cream form synthetic detergents are being consumed in Indonesia.

These cream detergents are so-called hard-type commodities consisting mainly of alkylbenzene sulphonate as the component. This being the circumstance, the demand forecast of this type of detergents were conducted, and at the same time, scrutinization of the raw material alkylbenzene production was made. No particular remark was made by the Indonesian authorities concerning the utilization of the hard-type synthetic detergents.

VI-1 Market Size

The consumption of cream-type synthetic detergent was grown extremely rapidly over the past few years. Therefore, it is not reasonable to formulate a future demand forecast on the basis of the past trend. Reference was made to the synthetic detergent consumption records of various countries of the world as against the GDP figures. Thus obtained forecast on the synthetic detergent demand for the years 1980 and 1985 are 90,000 tons and 150,000 tons respectively. The required amount of alkylbenzene for covering such demands will be 17,000 tons and 27,000' tons respectively.

(1) Domestic consumption of synthetic detergents in 1973 is estimated to be 40,000 tons, of which 10,000 tons is powder detergents and remaining is cream detergents.

(2) Domestic demands in the years 1980 and 1985 for synthetic detergents inclusive of powder and cream are estimated to be 90,000 tons, and 150,000 tons.

(3) Required alkylbenzene for the production of synthetic detergents will be approximately 17,000 tons for 1980, and 27,000 tons for 1985.

VI-2 Price of Raw Material and Product

(1) Material price is assumed as follows:

Propylene 139 US$/t

(2) Price of alkylbenzene in 1977 is assumed to be 560 US$/t.

VI-3 Production Plan

On an assumption that a production plant having a capacity of 15,000 ton/year is constructed respectively in 1977 or in 1980, the following two cases were studied.

	Case	
	I	II
Start of construction	July 1974	July 1977
Completion of construction	June 1976	June 1979
Startup of operation	January 1977	January 1980

VI-4 Investment Cost (in 1977)

		(10^6 US$)
(1)	Production facilities acquisition price	14.0
(2)	Auxiliary facilities acquisition price	4.2
(3)	Operation preparatory cost	0.5
(4)	Monetary interest during construction period	1.4
(5)	Total fixed capital	20.1
(6)	Operation capital	2.0
(7)	Total investment amount	22.1

VI-5 Labour Requirement

Manpower required for operating alkylbenzene is 20 persons.

VI-6 Utilities Requirement

(1)	Electricity	140 KWH/t
(2)	Steam	0.816 t/t
(3)	Cooling water	228 t/t
(4)	Fuel	5,550 x 10^3 Kcal/t

VI-7 I.R.R.

I.R.R. calculated for the alkylbenzene plant under conditions mentioned above is 20% both for Case I of the 1977 startup, and Case II of the 1980 startup.

VI-8 Recommendation and Future Schedule

For the production of 15,000 tons of alkylbenzene, 18,200 tons of propylene and 7,000 tons of benzene will be required. Startup date mainly depends on the availability of materials, especially of propylene, on the basis of which the selection of the plant site should be made.

A detailed 2nd stage economic study for the alkylbenzene plant is considered to be necessary.

No policy seems to have been established by the Government of Indonesia regarding the future administration of the hard-type synthetic detergents.

It is desired that the policy be established prior to the finalization of the investment plans for this project. In the event where the policy dictates against the use of hard-type synthetic detergents, studies on the feasibility of the soft-type synthetic detergent production will become imperative. If such should take place, the importance of the raw material studies will become extremely important.

VII Plastics Processing Industry

The UNIDO Phase I survey results were employed as materials for conducting the economic viability calculations for the present olefin complex. The UNIDO results indicate a vast discrepancy between the present market status (as well as the present plastics processing capacity) and the future forecast. This being the case, a great extent of investment seems necessary to be made to the plastics processing industrial field. From this viewpoint, studies were made on the present situation of the Indonesian plastics processing industry in order to clarify the points of problems. At the same time, analyses were made on the sectors of the industry in which future new construction or expansion of facilities is necessary. On these bases, studies were made regarding the required investment amount, necessary number of workers to be trained, governmental policies for organizing the labour forces, etc.

VII-1 Demand Structure of Indonesian Plastics Industry

(1) Estimated import of plastics raw materials and products is shown below:

(Unit: tons)

	Raw Materials	Products	Total
1968	28,136	4,190	32,326
1969	43,200	6,446	49,646
1970	47,567	7,999	55,568
1971	59,748	6,639	66,387
1972	79,169	8,797	87,966

(2) Resin-wise demand structure in 1972 is estimated as follows:

	t/y	%
Condensation Resins	5,900	7.4
PVC	7,500	9.5
LDPE	25,400	32.1
HDPE	15,200	19.2
PS	6,700	8.5
PP	8,900	11.2
Other polymerization resins	9,600	12.1
Total	79,200	100.0

Polyethylene shares more than 50% of the total, and together with the recently grown PP, the share exceeds 60%, so that highly intense dependence on polyolefin is present.

(3) Product-wise demand structure in quantity in 1972 is estimated as follows:

	%
Film, sheet	55.8
Daily utensils and sundry goods	22.0
Construction materials	7.6
Industrial use	8.4
Footware	6.1
Total	100.0

It is noted that more than half of plastics application is made to packaging materials. The extent of this application will be decreased, and on the other hand, industrial-use application will be increased in the future.

VII-2 Distribution of Plastics Processing Industry.

(1) Plastics processing industry is concentrated in Jakarta as shown below:

	Distribution of Processors (%)	Distribution of Production (%)
Jakarta	29.6	42.6
West Java	19.3	17.2
Central Java	7.1	5.2
East Java	28.9	23.4
North Sumatra	15.2	11.6
Total	100.0	100.0

Besides Jakarta, other concentrated locations are Surabaya, Medan and Bandung.

(2) The majority of plastics processing firms registered with the Department of Light Industry are on a scale of 100-500 million Rp.

Scale of the Capital Investment (1,000 Rp.)	Form of Investment		Total
	Domestic Law	Foreign Investment Law	
Less than 10,000	1		1
10,001 - 50,000	17		17
50,001 - 100,000	13		13
100,001 - 300,000	29	8	35
300,001 - 500,000	19	4	23
500,001 - 800,000	9	1	10
800,001 - 1,000,000	1		1
More than 1,000,000	2	3	5
Total	91	16	107

(3) Sixteen foreign firms have already started production, according to the Department of Light Industry, and it is noteworthy to state that the production carried out by these firms require a huge amount of capital investment on production facilities and also very high technical standards.

VII-3 Probems in Plastics Processing Industry

(1) As a result of unstable supply of raw materials, the stocks on hand of raw materials are growing very large, thereby creating heavy burden of capital and monetary interest.

(2) The shortage of engineers and skilled workers results in low productivity, and even though the wages and salaries are low, personnel costs become high. Table shown below is a comparison of Indonesian labour productivity with other countries in 1971.

	Indonesia	Singapore	Japan
Additive value (US$/firm/year)	10,106	48,026	801,092
Direct labourers(persons/firm)	24	36	70
Additive value per head(US$/year)	421	1,334	11,444
Wages per head of direct labourer (US$/year)	112	275	2,121
Ratio of additive value and wage	3.8	4.9	5.4

(3) The cause of low operational efficiency is due to the narrow market in Indonesia, and at the same time due to the dominance of commercial brokerage firms with long historical backgrounds.

VII-4 Capital Investment and Employees Required for Plastics Processing Industry

Potential market demand of approximately 300 thousand tons of plastics materials in Indonesia in 1980 is predicted by UNIDO. As present plastic consumption is about 80 thousand tons, huge amounts of capital investment and employees will be required for the development of plastics processing industries to meet this demand.

(1) Capital investment required

According to our preliminary estimation, approximately US$123 million for plastics processing equipment and US$278 million for the total including working capital will be required.

(2) Employees required

About 200 thousand workers will be additionally required by 1980. At this time, labour productivity should become US$1,500 person/year, which is about 3.5 times the present level. A training program for at least 1,000 persons/year will be required for improving labour productivity.

VII-5 Recommendation

For the settlement of the above problems and for the upgrading of plastics industries, it is imperative to perform the following measures:

(1) Establishment of National Plastics Industry Guidance Institute

It is recommended that the Government, for its own advantage establish National Plastics Industry Guidance Institute which is necessary for the upgrading of plastics processing industries.

The subjects that should be handled by said institute are as follows:

(a) Standardization of raw materials for plastics and the products

(b) Design improvement and R&Ds thereto of the plastics products

(c) Development of molding and processing techniques

(d) Upgrading of engineers

(e) Acceptance of R&D requests from the plastics molding industries, and further developmental activities concerning manufacturing technique on plastics products.

(2) Establishment of industrial complex

Plastics processing industries are by nature apt to become the source of pollution problems such as noises, strange odors, and plant waste disposal, etc. Therefore, the plant site should be sought in areas away from the housing district; and at the same time, a sufficient level of utilities should be made available.

(3) Investment policy

Required funds for the plastics processing industries will amount to a large sum of money as mentioned above. Thus, a part of said funds shall have to be procured from foreign capital sources.

It is also necessary to examine adequate financial policy for a case of managing and operating the plants with the domestic capital.