THE REPUBLIC OF INDONESIA SURVEY REPORT

ON

THE DEVELOPMENT OF RAW MATERIALS INDUSTRY FOR SYNTHETIC FIBERS

OCTOBER 1974

Prepared for

JAPAN INTERNATIONAL COOPERATION AGENCY

by

UNICO INTERNATIONAL CORPORATION

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PREFACE

The Government of Japan, in compliance with the request made by the Government of Indonesia, decided to conduct studies for the preparation of the industrialization plan and the project plan for constructing plants to establish the synthetic fiber raw materials industry in Indonesia and entrusted the execution of the survey to the Overseas Technical Cooperation Agency (which was integrated into the Japan International Cooperation Agency on August 1st, 1974).

The Agency, in line with the above, organized a Survey Team headed by Mr. Y. Nakagawa (Vice President, UNICO International Corporation) comprising eight experts and dispatched it to the Republic of Indonesia on November 19th, 1973.

During the survey work for a period of 26 days in Indonesia the Team had meetings with the Indonesian Governmental Authorities concerned, i.e., Directorate General of Chemical Industry, Directorate General of Textile Industry, Directorate General of Petroleum and Natural Gas (MIGAS), PERTAMINA, etc., and carried out on-the-spot surveys covering such areas as Jakarta, Bandung, Cilacap, Surabaya, Semarang, Cilegon, Yogyakarta, etc. in Java Island, Medan, Palembang, etc. in North and South Sumatra.

It is my sincere hope in presenting this report that it will contribute to the development of Indonesian Synthetic Fiber Raw Materials Industry and eventually help promote the economic exchange between two our countries.

Finally, I wish to take this opportunity to express my gratitude to the Indonesian Governmental Authorities concerned and Japanese Embassy in Indonesia 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

We are pleased to submit herewith a report on the survey of the industrialization of the raw materials for synthetic fiber in Indonesia, the execution of which was requested by your office this year as a follow-up survey to the Survey on Synthetic and Rayon Fiber Industry Development in the Republic of Indonesia which we had the privilege of conducting last year.

As you are well aware, the recent synthetic fiber situation has become entirely different from that of the time when the previous survey was made. Due to the acute shortage of the raw materials for synthetic fiber caused and accelerated by the oil problem in the Middle East, and the worldwide supply shortage of the raw materials due to the increase in the synthetic fiber demand. The increase in the production of synthetic fiber and the raw materials thereof are strongly anticipated throughout the world. These circumstances have been well taken into consideration during the course of the present survey.

The Republic of Indonesia is one of the few oil producing countries in Southeast Asia. In view of the fact that a number of industrialization projects in the synthetic fiber field have consecutively been announced in various Southeast Asian countries in the recent years, the forthcoming shortage of the synthetic fiber raw material supply is highly obvious. Therefore, the effects of the implementation of this project upon the synthetic fiber industry of the Southeast Asian countries will be profound.

This report was compiled on the basis of the on-site surveys during one month from November 19, 1973. Upon the foundation of the data, information and knowledge obtained during this period, technical and economic studies were made in Japan. This report has been compiled chiefly concerning the demand, technology and economic viability of the raw materials for nylon and polyester fibers both of which are forecast to have a great extent demand potential in Indonesia.

On submitting this report, we would like to express our deep appreciation for the kind and effective cooperation and assistance extended by the Directorate General of Chemical Industry, Directorate General of Textile Industry of Departemen Perindustrian, the Offices of Governmental Authorities of the Republic of Indonesia, the Ministry of International Trade and Industry of the Government of Japan, the Japanese Embassy in Indonesia, during the on-site surveys and the preparations of this report.

We would like to take this opportunity to express our appreciation for your continuous cooperation during the period of the survey.

The Republic of Indonesia,
The Survey Team for the Development
of Raw Materials Industry for
Synthetic Fibers

Y. Nakagawa

Y. Nakagawa, Team Leader,
Vice President,
UNICO INTERNATIONAL CORPORATION

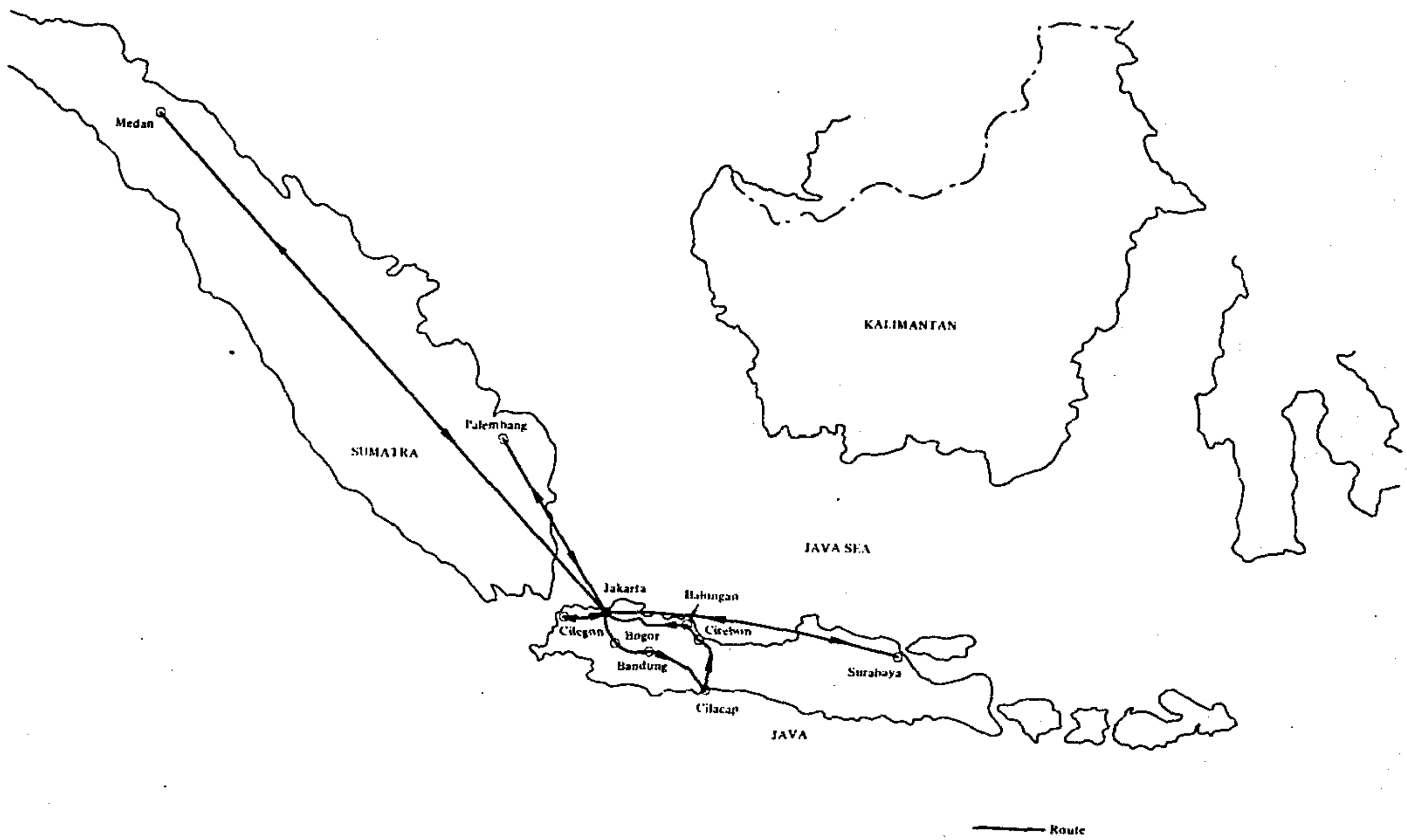

Figure I-1 Itinerary of Survey Team, Group A

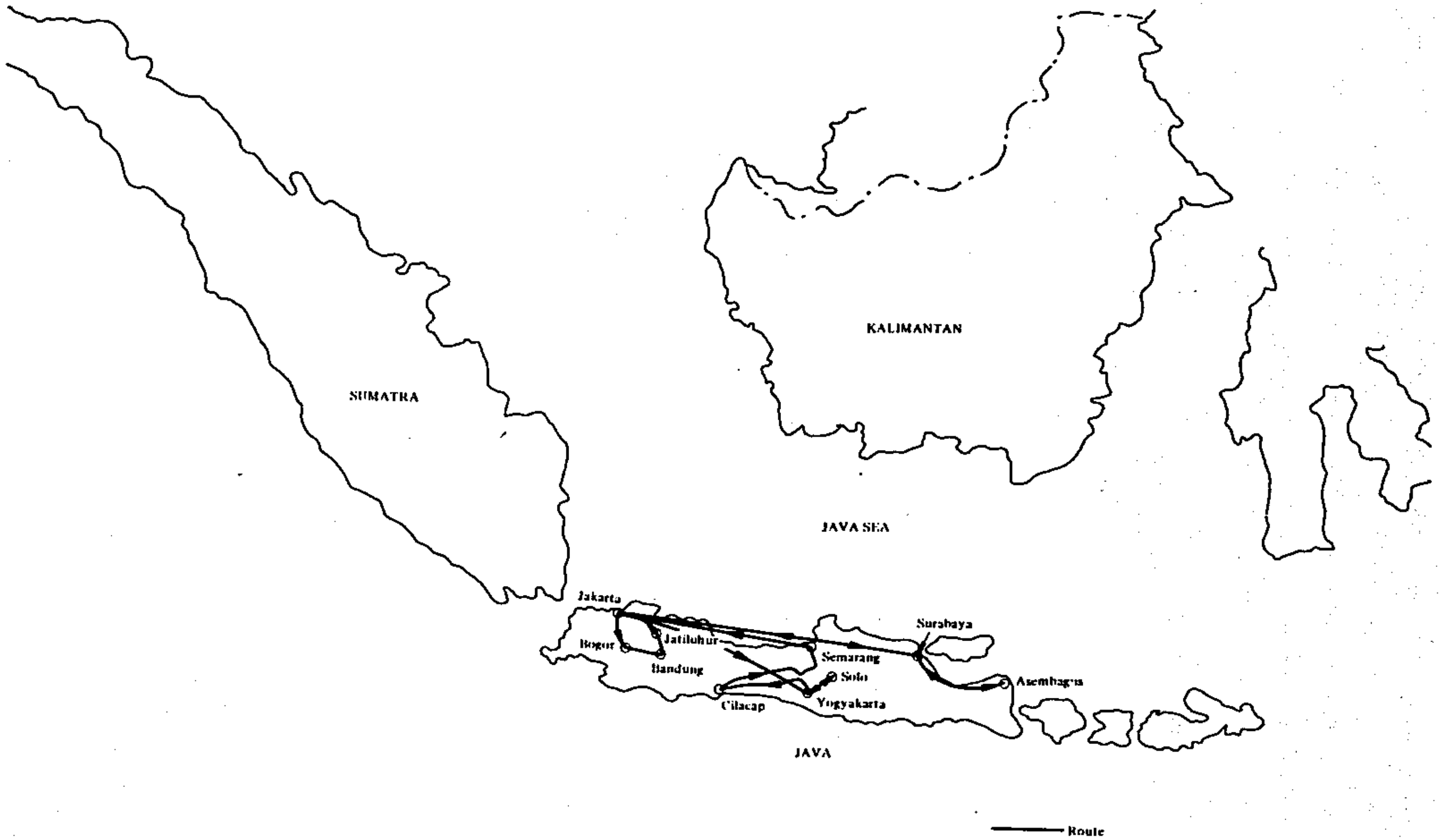

Figure I-2 Itinerary of Survey Team, Group B

Abbreviations

BTX	Benzene, Toluene, Xylene
p-Xylene	Paraxylene
m-Xylene	Metaxylene
o-Xylene	Orthoxylene
TPA	Terephthalic Acid
p-TPA	Pure Terephthalic Acid
c-TPA	Crude Terephthalic Acid
DMT	Dimethylterephthalate
EG	Ethylene Glycol
EO	Ethylene Oxide
AN	Acrylonitrile
AH-Salt	Nylon 66 Salt
SF	Staple Fiber
FY	Filament Yarn
IRR	Internal Rate of Return
bbl	Barrel
BPSD	Barrel per Stream Day
Ton	Metric Ton, unless Particularly Remarked
$	U.S.$, unless Particularly Remarked
Exchange Rate	1971 — 1 US$=360 Yen; 1 US$=415 Rupiah
	After the End of 1973 — 1 US$=300 Yen; 1 US$=415 Rupiah

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I. Introduction

1. The Objectives of the Survey

The objectives of this survey are to prepare a master plan which is necessary for the implementation of the industrialization of raw materials (monomer) production for synthetic fiber in Indonesia as well as to prepare a guideline necessary for the promotion of this project on the basis of the request made by the Directorate General of Chemical Industry, the Government of the Republic of Indonesia.

The scope of this survey is as follows.

(1) Survey on the textile situations in Indonesia and the formulation of a long-term demand forecast on the synthetic fiber demand

(2) Survey on the worldwide demand/supply situation for the raw materials for synthetic fiber

(3) Survey on the feasibility of the industrialization of raw materials for synthetic fiber production

(4) Preparation of the outline scheme for the plants to be constructed (Survey on the assessment of construction cost and site conditions and economic evaluation of the project)

(5) Evaluation of the contribution to Indonesian national economy by the project implementation and preparation of a long-term development plan

2. Organization of the Survey Team

Members	Title	Allocation of Responsibility
A Team		
Yoshikazu Nakagawa Team Leader	Executive Managing Director, UNICO International Corp.	General Management
Taneo Maeda Team Leader of On-Site Survey	Manager, Synthetic Fiber Department, UNICO International Corp.	General Management of On-Site Survey and Assistance to Team Leader
Atsuo Kanai	UNICO International Corp.	Raw Materials for Synthetic Fiber
Yoshinori Nakagawa	UNICO International Corp.	Raw Materials for Nylon Fiber
Satoshi Nagai	UNICO International Corp.	Raw Materials for Polyester Fiber
Tadanori Mohri	UNICO International Corp.	Civil Works
Osamu Chisaki	Basic Chemical Products Division, Basic Industries Bureau, Ministry of International Trade and Industry	Policy for Raw Materials for Synthetic Fiber
B Team		
Tadashi Imai	Manager, Textile Processing Department, UNICO International Corp.	Processing of Textile Fiber
Motonori Nishida	UNICO International Corp.	Textile Market Survey

3. Survey Schedule

	Date	Itinerary: A Team	Itinerary: B Team	Activities: A Team	Activities: B Team
1.	19th Nov. (Mon.)	Tokyo-Jakarta*		Traveling	
2.	20th Nov. (Tues.)	Jakarta		Visited Japanese Embassy, OTCA, D.G. of Chemical Industry, Japanese Manufacturers	
3.	21th Nov. (Wed.)	Jakarta		Visited D. G. of Chemical Industry and D. G. of Textile Industry, CENTEX	
4.	22nd Nov. (Thurs.)	Jakarta		Visited D. G. of Chemical Industry, Japanese Manufacturers	Visited D. G. of Textile Industry, P. N. SANDANG, Head Office, Bureau of Statistics
5.	23rd Nov. (Fri.)	Jakarta		Visited PERTAMINA	Visited Bureau of Statistics
6.	24th Nov. (Sat.)	Jakarta		Visited MIGAS, Japanese Manufacturers	Visited PATAL BEKASI
				Visited D. G. of Chemical Industry	
7.	25th Nov. (Sun.)	Jakarta-Bandung		Traveling	
8.	26th Nov. (Mon.)	Bandung-Cilacap (Mr. Kanai, Bandung-Jakarta)	Bandung (Mr. Nishida, Bandung-Jakarta)	Traveling (Mr. Kanai: Traveling)	Visited ITT, C. V. LANGSUNG (Mr. Nishida: Traveling)
9.	27th Nov. (Tues.)	Cilacap-Cirebon	Bandung	Visited Port Administration (CILACAP), Site Survey (CILACAP)	Visited PATAL CIPADUNG, PATAL BANJARAN Market Survey (Bandung)
		(Mr. Kanai, Jakarta)	(Mr. Nishida, Jakarta)	(Mr. Kanai: Visited D. G. of Chemical Industry and Japanese Manufacturers)	(Mr. Nishida: Visited Japanese Embassy, D. G. of Textile Industry and Bureau of Statistics)
10.	28th Nov. (Wed.)	Cirebon-Balongan -Jakarta	Bandung	Visited Port Administration (CIREBON), PERTAMINA (BALONGAN), Traveling	Visited DASATEX, NAINTEX
		(Mr. Kanai, Jakarta)	(Mr. Nishida, Jakarta-Tokyo*)	(Mr. Kanai: Visited PERTAMINA, MIGAS and etc.)	(Mr. Nishida: Traveling)
11.	29th Nov. (Thurs.)	Jakarta-Palembang*	Bandung-Jakarta	Traveling, Visited P. T. PUSURI	Visited TEXFIBER, Traveling

	Date	Itinerary: A Team	Itinerary: B Team	Activities: A Team	Activities: B Team
12.	30th Nov. (Fri.)	Palembang	Jakarta-Yogyakarta*	Visited PERTAMINA (PLAJU, SUNGAI GERONG)	Traveling, Visited Institute of Batik Handicraft, PRIMISSIMA and Batik Mill
13.	1st Dec. (Sat.)	Palembang-Jakarta*	Yogyakarta	Visited Branch Office of D. G. of Chemical Industry (Palembang), P. T. PUSRI, Traveling	Visited PATAL SECANG, Market Survey (Solo)
14.	2nd Dec. (Sun.)	Jakarta-Surabaya*	Yogyakarta-Cilacap	Traveling	Traveling
15.	3rd Dec. (Mon.)	Surabaya	Cilacap-Semarang	Visited P. N. PETROKIMIA, Site Survey (Surabaya)	Visited PATAL CILACAP, Traveling
16.	4th Dec. (Tues.)	Surabaya-Jakarta*	Semarang	Visited P. N. SODA, Site Survey (Surabaya), Traveling	Visited PINDA SANDANG, Head Office, PPK JANTRA
17.	5th Dec. (Wed.)	Jakarta-Medan*	Semarang-Jakarta*	Traveling, Visited Branch Office of D. G. of Chemical Industry (Medan), PERTAMINA, Site Survey (Medan)	Market Survey (Semarang), Traveling
18.	6th Dec. (Thurs.)	Medan-Jakarta*	Jakarta-Surabaya*	Site Survey (Medan) Traveling	Traveling, Visited PERUM PERKEBUNAN KAPAS (Institute of Cotton Plantation), Market Survey (Surabaya)
19.	7th Dec. (Fri.)	Jakarta	Surabaya (Asembagus)	Visited P. T. PEMBANGUNAN JAYA, Department Perhubungan	Visited PATAL GRATI, UNIT ASEMBAGUS (GINNERY)
20.	8th Dec. (Sat.)	Jakarta (Cilegon)	Surabaya-Jakarta*	Site Survey (Cilegon)	Traveling
21.	9th Dec. (Sun.)	Jakarta		Summarizing Survey Results (and Compilation of Interim Report)	
22.	10th Dec. (Mon.)	Jakarta		Visited P. N. PELNI Visited D. G. of Textile Industry	Visited P. N. SANDANG, Head Office, P. N. SENAYAN
23.	11th Dec. (Tues.)	Jakarta		Visited P. U. T. L., Collecting Data	Visited D. G. of Textile Industry, P. N. SENAYAN, Market Survey (Jakarta)
24.	12th Dec. (Wed.)	Jakarta		Explained Interim Report	
25.	13th Dec. (Thurs.)	Jakarta		Visited D. G. of Chemical Industry and Collecting Data	
26.	14th Dec. (Fri.)	Jakarta-Tokyo*		Traveling	

* signifies traveling by plane

4. Acknowledgment

Throughout the course of this survey, extremely effective cooperation and assistance have been extended by the governmental organizations concerned of the Republic of Indonesia, by the Directorate General of Chemical Industry, the Directorate General of Textile Industry, MIGAS, the Ministry of Agriculture as well as by the government-owned and state-owned spinning mills. Without the kind collaboration of these authorities and organizations, a successful survey as experienced by the Survey Team would have been impossible. The writers of this report take this opportunity to express their profound gratitude to all the personnel concerned.

During the on-site surveys, the Team was greatly assisted by their Indonesian counterparts who accompanied the Team and cooperated with the team members in collecting necessary data, guiding the survey trip, etc. The writers also express hereby their deep appreciation for the valuable assistance. The Indonesian counterpart personnel are as follows.

Mr. Nico Kansil,	Directorate General of Chemical Industry
Mr. Supraptama,	"
Mr. Kusmono,	"
Mr. Simanungkalit,	"
Mr. Asnawi,	Directorate General of Textile Industry
Mr. Yusuf,	"

II. Conclusion

1. Summary

The synthetic fiber production in Indonesia for the period from 1977 to 1978 is estimated to be 80,000 to 110,000 t/y of polyester, 24,000 to 31,000 t/y of nylon, totalling 100,000 to 140,000 t/y. It is further forecast that the production will increase from then onward. The required amount of monomer to produce this amount of fiber is estimated to be 80,000 to 110,000 t/y of TPA/DMT (converted in terms of TPA), 26,000 to 33,000 t/y of caprolactam and 28,000 to 39,000 t/y of ethylene glycol.

It is forecast that raw material for synthetic fiber will suffer from a supply shortage in a global scale in the future. This signifies that for Indonesia to develop synthetic fiber industry within the country, it is imperative that the production of raw materials for synthetic fiber from basic raw material onward be carried out inside Indonesia.

The monomer to be produced in Indonesia in the meantime should include p-TPA/DMT and caprolactam. These monomers are amply exportable and therefore the production scale was determined on the basis of including the exportable extent. It was also assumed that the commencement of the operation be undertaken in mid-1977.

As far as caprolactam is concerned, the economic evaluation was made for the cases of 60,000 t/y and 40,000 t/y production scales. The internal rates of return were 11.8% and 10.6% respectively and by taking into consideration the future demand increase in Indonesia, it is deemed that the construction of 60,000 t/y capacity plant be recommended. In order to increase the internal rate of return, the low cost fuel should be used. In the case of using natural gas instead of heavy oil as fuel, internal rate of return will increase to 14.5% in 60,000 t/y caprolactam production. Regarding the process, it is desirable that the process with least extent of by-production of ammonium sulfate be selected. As far as the site conditions are concerned, Gresik and Palembang are considered to be suitable.

The raw material for polyester production should be undertaken by adopting the p-TPA process which is superior to the DMT process in view of economic and in other aspects. The p-TPA process is now increasingly adopted in the world, thereby increasing the share in this field of production. Therefore, it is considered to be desirable to employ the p-TPA process in Indonesia in view of the future prospects of domestic as well as export market development.

It was assumed that the domestic demand will consist of 1/2 each of p-TPA and DMT and on this basis, the production scale was tentatively set at 150,000 to 210,000 t/y in order to carry out the economic evaluation. As a result, it was concluded that the highest advantages were to be obtained by employing a process which the production of p-TPA and DMT can be undertaken via c-TPA. The IRR for total p-TPA and DMT at 147,000 t/y production was 24.3%. However, if it is assumed that the production scale is maintained unchanged and the domestic demand is restricted to either p-TPA or DMT, it is more advantageous to carry out the production of p-TPA alone. In view of the site conditions, Palembang seems to be the most suitable in the raw material supply.

2. Conclusion

2-1 Synthetic Fiber Demand Forecast

(1) It is forecast that the total textile demand in Indonesia in the year 1981 will attain a level of approximately 380,000 t/y or the per capita consumption of 2.4 kg/y. This corresponds to a 11% growth per year which is almost analogous to the results of forecast obtained through the previous surveys. The total textile consumption in 1971 is forecast to be at 135,000 t/y, or the per capita consumption of 1.1 kg/y.

(2) The share of synthetic fiber in Indonesia in the year 1981 will attain approximately 40% and it is further forecast that the synthetic fiber demand will be at 150,000 t/y (0.96 kg per capita per year).

(3) On the other hand, on the basis of the synthetic fiber production projects contemplated by various companies, the synthetic fiber production attainable in Indonesia for the period from 1977 to 1978 was forecast (Refer to Table II-1).

Table II-1 Synthetic Fiber Production Forecast in Indonesia (10^3t/y)

	1977 - 1978			1981		
	Production	Domestic Demand	Export 1)	Production	Domestic Demand	Export 1)
Nylon FY	24 ~ 31	24 ~ 27	- ~ 4	47	35	12
Polyester SF	60 ~ 80	38 ~ 49	22 ~ 31	127	72	55
Polyester FY	20 ~ 30	18 ~ 22	2 ~ 8	55	37	18
Acrylic SF	5 ~ 6	5 ~ 6	- ~ -	12	9	3
Total	109 ~ 147	85 ~ 104	24 ~ 43	241	153	88

Notes: Refer to Table IV - 58
1) Export includes exportation of SF, FY and processed goods

The production will attain to the level of 60,000 to 80,000 t/y of polyester SF, 20,000 to 30,000 t/y of polyester FY, 24,000 to 31,000 t/y of nylon totalling 100,000 to 140,000 t/y. The demand for acrylic fiber is forecast to be 5,000 to 6,000 t/y encompassing both domestic and export markets. There is a considerable extent of increment in the figure of synthetic fiber production over the forecast figure concluded through the previous survey. This has been due to the fact that a drastic change has taken place in raw material for the synthetic fiber supply/demand situation in the world.

(4) The required raw materials for carrying out the above-mentioned extent of synthetic fiber production will be as follows:

		(t/y)
TPA/DMT (as TPA):	80,000 to	110,000
Caprolactam:	26,000 to	33,000
Acrylonitrile:	5,000 to	6,000
Ethylene Glycol:	28,000 to	39,000
Ethylene Oxide:	23,000 to	32,000
p-Xylene:	57,000 to	78,000
Cyclohexane:	26,000 to	33,000

2-2 Supply/Demand Situation of Raw Materials for Synthetic Fiber

2-2-1 BTX

Globally, the aromatics shortage centering around benzene will persist for some time to come. Therefore, it will be necessary for Indonesia to produce BTX within the country in the event of embarking upon the production of raw materials for synthetic fiber in Indonesia.

2-2-2 Raw Materials for Polyester

p-TPA and DMT are the polyester raw materials and at present these two items are finding themselves in competition with each other. However, the following points should be noted in this respect.

(1) The p-TPA process is superior to the DMT process in view of production cost, pollution problems, resources conservation, etc. Therefore, it is forecast that the p-TPA will assume the main trend in this field in the future all over the world. If it is contemplated that a long-term fostering of polyester fiber industry inside Indonesia and if it is intended that Indonesia supply raw materials to the neighboring countries, it is highly desirable that Indonesia adopt the p-TPA process.

(2) The world wide trend shows a direction of shortage of p-TPA and DMT. The shortage of p-TPA in the Southeast Asian area is particularly conspicuous. The DMT will attain a plateau during the period from 1979 to 1980 and it is forecast that the demand will assume a greater downtrend thereafter. Therefore, in the event of producing polyester raw materials in Indonesia, it is much more advantageous to adopt the p-TPA process. The DMT process seems to involve certain problems in view of the export marketing.

(3) As far as the production of p-xylene in the Southeast Asian areas is concerned, the demand can be fulfilled by the p-TPA/DMT facilities expansion now being projected. However, there would be no further surplus in the production capacity, the p-xylene to be used in the newly constructed p-TPA/DMT facilities will have to be procured independently.

(4) As it is forecast that a certain extent of shortage is inevitable in the supply of ethylene glycol in the future, it is recommended that the self-supply capability be established as soon as possible in Indonesia.

2-2-3 Raw Materials for Nylon

(1) It is forecast that caprolactam will suffer from a supply shortage in view of the shortage in the supply of benzene and also of the ammonium sulfate problems. This caprolactam shortage is expected to persist for a long time. This being the case, it seems necessary for Indonesia to be self-sufficient in the supply of caprolactam.

(2) Regarding cyclohexane, the supply will be sufficient to cover the demand originated from the caprolactam plants now being projected in the South-east Asian area, however, no surplus in capacity in excess thereof is available. Further, because of the decline in the export surplus capacity in the United States, it is also forecast that cyclohexane supply shortage is inevitable in the future. Therefore, the cyclohexane for the production of caprolactam in Indonesia will have to be produced within Indonesia.

2-2-4 Raw Materials for Acrylic Fiber

Acrylonitrile will also suffer from global supply shortage. In view of the fact that the domestic demand inside Indonesia for acrylonitrile is small, it seems unnecessary to expedite the self-supply substantiation for sometime to come, however, it seems feasible to carry out acrylonitrile production for export, in view of the future market prospect.

2-3 Selection of Monomers to be Produced by Industrialization

2-3-1 Raw Materials for Polyester

Concerning p-TPA/DMT, the existing demand is sufficient to justify the domestic production. Further, supply shortage in these materials, are forecast and the exportation to the neighboring countries is also possible. Therefore, p-TPA/DMT are the monomers the domestic production of which should be carried out inside Indonesia. Regarding ethylene glycol, the production of ethylene will firstly be necessary. Therefore the production of ethylene glycol should be commenced after the substantiation of ethylene production in Indonesia.

2-3-2 Raw Materials for Nylon

When compared with p-TPA/DMT, the demand for caprolactam is not significant, however, in view of the future potential for demand increase and the prospect for exportation, this is also a monomer which should be produced in Indonesia.

2-3-3 Raw Materials for Acrylic Fiber

The present level of demand for acrylonitrile is low and therefore this is not a monomer for which the industrialization is necessary at this stage. The production of acrylonitrile is recommended to be contemplated along with the ethylene and propylene production projects.

2-4 Raw Materials for Polyester

(1) p-TPA and DMT are the raw materials for the production of polyester. Further, in order to produce these raw materials, there are three cases as follows.

p-TPA production only

DMT production only

Production of both p-TPA and DMT via c-TPA

The selection of one case from the above three shall be decided upon the basis of the expected demand extent and the economic viability of the operation.

(2) Studies were conducted regarding the economic viability on the basis of a forecast on the raw material prices and product prices by taking into consideration a vast extent of price increase in crude oil, together with an assumption that the production operation of p-TPA and DMT will be commenced sometime around mid-1977.

An assumption was made regarding the purchasing price of the raw materials and the ex-factory prices of the products for the year 1977 as follows.

Raw Material Prices (Purchasing Price)

p-Xylene	US¢42.6/kg
Acetic Acid	US¢42.8/kg
Methanol	US¢20.8/kg

Product Prices (Ex-Factory Price)

p-TPA, DMT: for domestic market	US¢73.2/kg
p-TPA, DMT: for export market	US¢52.2/kg

(3) The following table shows an estimate for the production cost including interests for the case of turning out the above-mentioned products by means of identical scale plants in order to compare the merits and demerits of the three different raw material production processes. As is shown in the table, the highest advantage will be gained by producing p-TPA alone. However, the difference between the p-TPA production and the case of simultaneous production of p-TPA and DMT via c-TPA is extremely slight.

p-TPA	100,000 t/y	59.5 US¢/kg
DMT (Witten Process)	110,000 t/y	68.2 US¢/kg
p-TPA via c-TPA	(50,000 t/y	60.4 US¢/kg
DMT via c-TPA	55,000 t/y)	

It is deemed that the production of Witten Process DMT will involve a high extent of fuel consumption in view of the process structure, thereby increasing the production cost. The above calculations were made on the basis of the evaluation of the fuel on the basis of heavy-oil price, however, the production cost of the Witten Process DMT will come close to that of the p-TPA process if low-cost natural gas utilization should become possible. Therefore, if the extent of demand corresponds to either one of the production process for p-TPA alone or DMT alone, it would be the most advantageous to turn out p-TPA.

(4) Generally speaking, however, the demand for p-TPA and for DMT cannot be specified to either one of these two materials. Therefore, the demands for p-TPA and DMT are tentatively assumed as being 1/2 each in terms of conversion into textile amount and further, priority was given to the domestic demand as far as the product shipment is concerned, thereby allocating the remaining amount of the products for exportation. The economic evaluation was therefore conducted on the basis of these conditions.

(5) Regarding the plant scale for the production of p-TPA and DMT, consideration was given to the extent of the domestic demand as well as to the scope of the export markets and, studies were made on the basis of the p-TPA and DMT total amount as being approximately 150,000 t/y (equivalent to approximately 100,000 t/y of p-xylene) and 210,000 t/y (corresponding to approximately 150,000 t/y p-xylene). The following table shows the total investment amount, production cost including interests, and internal rate of return (IRR) in the case of producing 150,000 t/y of p-TPA, DMT. As is shown in the table, the best advantage will be obtained by the production of p-TPA and DMT via c-TPA (Case A-2).

Case		A - 2	B - 1	C - 1
Product	p-TPA (t/y)	70,000	70,000	-
	DMT (t/y)	77,000	-	77,000 (Witten Process)
Total Investment Amount (10^6 US$)		129	74	80
Production Cost Including Interests (US¢/kg)		58.9	62.2	70.9
IRR (%)		24.3	18.7	10.5

Further, in the case of a production of 210,000 t/y of p-TPA, DMT, the results are as shown in the following table. It is also shown here that the best advantage will be obtained by the production of p-TAP and DMT via c-TPA.

Case		A - 3	B - 2	C - 2
Product	p-TPA (t/y)	100,000	100,000	-
	DMT (t/y)	110,000	-	110,000 (Witten Process)
Total Investment Amount (10^6 US$)		169	93	98
Production Cost Including Interests (US¢/kg)		57.5	59.5	68.2
IRR (%)		23.8	19.8	11.4

(6) Concerning the plant site selection, Palembang seems to be the best suited location in view of the raw material supply aspect. However, in view of the fact that a new large-sized oil refinery is to be constructed in Cilacap, this location seems to become another potential candidate.
If the p-TPA and DMT are not produced in Palembang and Cilacap, p-xylene must be transported from these sites to the p-TPA/DMT plant sites. In this case, the areas in the vicinity of Cilegon (West Java) seems suitable in view of the geographic proximity to the market area.

2-5 Raw Materials for Nylon

(1) There are a number of available processes for the production of caprolactam. The direction of the improvement in the production process now undertaken in the world to reduce the extent of by-produced ammonium sulfate. Although several announcements have been made regarding the processes in which no ammonium sulfate is by-produced. However, none of them has so far been industrialized. The PNC and the new DSM process are the ones which involve a low extent of ammonium sulfate by-production amongst the processes which have so far been actually industrialized. The by-production is 1.7 kg per kg of caprolactam in the case of the PNC process and 1.8 kg per kg of caprolactam in the case of the New DSM process. The third place in this respect goes to the New Inventa process which involves 2.6 kg per kg of caprolactam, followed by the BASF process the by-production of ammonium sulfate of which is 2.7 kg per kg of caprolactam.

All the above enumerated processes have already achieved records of large-scale industrial production. Therefore, the selection of the process for the Indonesian project should be made from these candidates. Further, by taking into consideration the fluctuation in the ammonium sulfate price in the future and the future increase in urea production by several new plants, the selection should be made on the basis of the minimum extent of the by-production.

(2) Taking into consideration a vast price increase of crude oil, the raw material prices and product prices have been forecast. On the basis of the obtained results two alternatives were studied on the basis of the target onstream in mid-1977, i.e., the caprolactam production of 60,000 t/y and 40,000 t/y

The raw material price (purchasing price) in 1977 may be forecast as follows. U.S. ¢30.5/kg for cyclohexane, U.S. ¢4.5/kg for sulfuric acid, U.S. ¢15/kg for ammonia.

The selling prices of the products are; US¢100.1/kg for domestic market, US¢74.6/kg for export market for caprolactam and US¢8.3/kg for ammonium sulfate. These selling price levels have been taken as the basis for the evaluation of the project.

The total investment amounts will be U.S. $124 million in the case of 60,000 t/y production and U.S. $95 million in the case of 40,000 t/y production. These figures have been taken as the basic values for evaluation. Regarding the products, the economic evaluation was conducted on an assumption that priority is given to the fulfillment of the domestic demands and the remaining balance will be allocated for exportation.

The production cost with interest is U.S. ¢88.0/kg in the case of 60,000 t/y production and U.S. ¢93.6/kg in the case of 40,000 t/y production.

The internal rate of return (IRR) is 11.8% for 60,000 t/y production and 10.6% for 40,000 t/y production. This signifies that a higher advantage is available for the 60,000 t/y production alternative. Therefore, it is recommended that a plant with capacity of 60,000 t/y be constructed.
In order to increase the internal rate of return, the low cost fuel should be used. In the case of using natural gas, the price of which is 1/2 of heavy oil price, instead of heavy oil as fuel, internal rate of return will increase to 14.5% in 60,000 t/y cparolactam production.

The factor which exist the most serious effect to the IRR is the selling price of the products.

(3) Regarding the site conditions for plant, it has been judged that Gresik and Palembang are considered to be the most prospective candidates in view of the plant site conditions for the present Indonesian fertilizer industry and also in view of all the other relative conditions.

2-6 Evaluation of the Contribution to the Indonesian National Economy

Scrutinizations were made concerning the extent of the contribution to the national economy afforded by the implementation of this project in view of such points as the attainable saving in foreign currency and the economic viability assessment by utilizing the shadow pricing method.

2-6-1 Saving in Foreign Currency

When the production of 60,000 t/y of caprolactam is conducted, the foreign currency saving extent for a period of ten years will be U.S. $378 million and this figure will become U.S. $173 million when discounted by 15%/y.

Also, the foreign currency saving for a period of ten years in the case of producing total 147,000 t/y of p-TPA and DMT via c-TPA will be U.S. $573million, and U.S. $258 million when discounted by 15%/y.

2-6-2 Economic Viability Assessment by Employing the Shadow Pricing Method

By evaluating that the purchasing price of raw materials and the selling price of the products are equal to CIF Jakarta of imported materials, the economic viability assessment was conducted by employing the exchange rate of Rp 519/U.S. $ and also by employing 40% of the actually prevailing level for the labor cost. As a result, it was revealed that in the case of producing 60,000 t/y of caprolactam, the rate is 14.5% and, when producing a total of 147,000 t/y of p-TPA and DMT via c-TPA, the rate is 27.1%, thereby indicating that in both cases, the target values are satisfied.

The points of emphasis in the Second Five-year Plan in Indonesia starting in April 1974 are as follows.

Sufficient supply of food and clothing in accordance with the purchasing power of the people

Construction of housing facilities for the people

Development and Improvement of Infrastructure

Substantiation of social welfare

Expansion of employment opportunities

Supply shortage of raw materials for synthetic fiber is forecast for the future. Therefore, if the supply of raw materials are smoothly undertaken by the implementation of this project and if the development of the Indonesian synthetic fiber industry is realized, thereby achieving a sufficient supply of clothing, the external effect of such an accomplishment is evidently high.

III. Survey Method

1. General Survey Method and Scope of Work

The Terms of Reference of this survey is as shown in the following paragraphs.

The contents of this survey is required to include at least the under-mentioned three survey items. The present survey has been conducted regarding the production of monomer which utilizes as the basic raw materials p-xylene, cyclohexane, propylene, etc., e.g., the production of TPA/DMT, caprolactam, acrylonitrile, etc., while considering the coordination with the Synthetic Fiber Survey which was conducted last year by yourselves and with the Petrochemical Industrialization Survey which is now being undertaken by UNIDO.

(1) Preparation of the Industrialization Plan

Economic and technological feasibility will be studied regarding the industrialization of raw materials for synthetic fiber after studying the domestic consumption extent and the export possibility of the raw materials for synthetic fiber for Indonesia by taking into consideration the supply/demand situation of the raw materials for synthetic fiber in the world on the basis of the synthetic fiber demand trend (including the forecast on the future growth of the processing capacities). At the same time, a long term plan will be established for the promotion of this project in view of the optimum production scale and the basic raw material availability (including the comparative studies between the importation of the basic raw materials with the procurement thereof from the presently projected petrochemical industrial plants).

(2) The Recommendable Project Plan for Constructing Plants

On the basis of the above conclusion, a preparation of a guideline will be made regarding the selection of the monomer to be produced, the production schedule of the plant to be constructed, the marketing project for the products to be turned out, the procurement of the basic raw materials such as p-xylene, cyclohexane, propylene, etc., the selection of the plant sites, the selection of the production processes to be adopted, the construction schedule, the formulation of the organization of the enterprise as well as the finalization of the required number of personnel, the training program to be given to the personnel, the required extent of investment and other various points which are necessary for the promotion of this project.

(3) Extent of Contribution of this Project to the Socio-Economic Development of the Country

Project appraisal will be made regarding the extent of the contribution afforded to economic and social development of the Republic of Indonesia in the event that the above-mentioned project is actually implemented, in view of such points as the enhancement of income, the saving in the foreign currency, expansion of the employment opportunities, the consequential development of the related industries, etc. by employing the shadow-pricing method.

Figure III-1 shows the outline of the survey method.

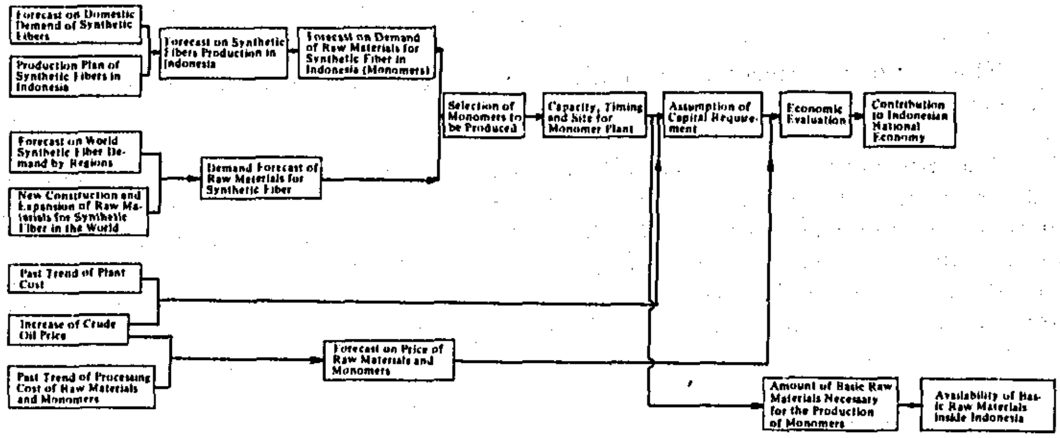


Figure III-1 Outline of Survey Method

Firstly, a forecast on the Indonesian domestic synthetic fiber demand extent will be undertaken. This forecast was formulated by re-checking and revising the survey results obtained by OTCA in 1972, by incorporating the factors of changes since then took place. The forecast on the synthetic fiber production extent was undertaken by incorporating the results of the above demand forecast as well as the present status of various synthetic fiber production projects for which applications have been submitted to the government of Indonesia, as well as on the basis of the forecast made on the future development of the textile processing capacities in Indonesia. Further, the extent of the demand for monomer corresponding to such an extent of production will be calculated.

On the other hand, on the basis of the area-wise demand forecast for synthetic fiber in the whole world as well as on the synthetic fiber raw material new installation or expansion projects now existing in the world, the synthetic fiber raw materials supply/demand forecast will be formulated. By combining the results of this supply/demand forecast and demand forecast of raw materials for synthetic fiber in Indonesia, as well as the minimum economic production scale for monomer production, the selection of monomers to be produced in Indonesia in the future will be undertaken. Regarding these selected monomers, the scrutinization will be made on such points as the time and period for the construction of the plants, the scale of the plants and the site selection for the plant construction.

Then, the computation of the extent of investment required for the plant construction will be made by taking into consideration the future price increase caused by the vast price increment in the crude oil price, together with the past trend of the plant construction cost increase. Also, by incorporating the past trend of the raw material prices and processing cost, the influence exerted by the price increase in the crude oil will be assessed in order to forecast the raw material prices.

By utilizing the results of such a price forecast and the investment amount computation, the economic viability evaluation of the project will be conducted. Further, in order to assess the extent of contribution given to Indonesia as a nation by the implementation of this project, the project evaluation was conducted on the basis of the possible foreign currency saving amount and also by the introduction of the shadow pricing method. Also, the amount of the required basic raw materials necessary for the production of monomers was calculated and a brief description was made concerning the availability thereof inside Indonesia.

2. Synthetic Fiber Demand Forecast

As far as the synthetic fiber demand forecast is concerned, a study was already made by the OTCA survey team in 1972. Therefore, in this report, descriptions will be made centering around the points to which a particular consideration has been incorporated while conducting the present survey.

Concerning the period for the demand forecast, new data were incorporated and the studies were based on the 1971 data, thereby, setting the forecast term for a decade up to 1981.

2-1 Forecast Method for the Area-Wise and Material-Wise Synthetic Fiber Production in the World

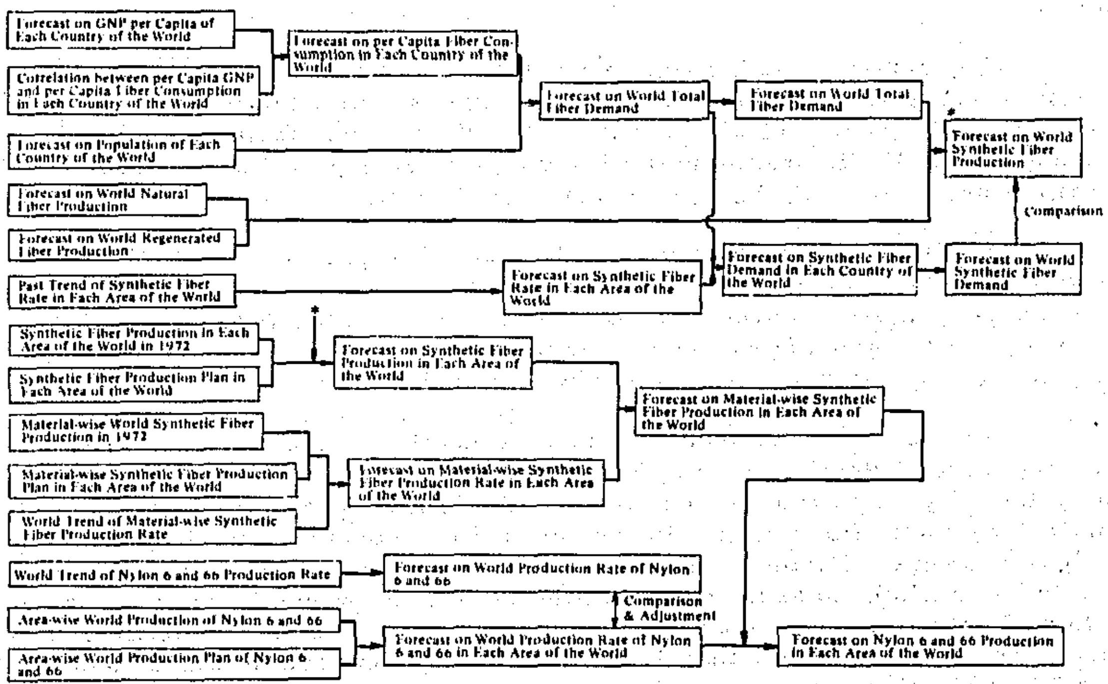


Figure III-2 Forecast Method of Area-wise and Material-wise Synthetic Fiber Production in the World

Figure III-2 shows the methods employed for the formulation of forecasts on the area-wise and raw material-wise synthetic fiber production in the world. Firstly, the data obtained from FAO were employed in order to forecast the future population increase and the per capita GNP growth of the world. Then the whole world was classified into six groups (Developed countries, Near and Middle East, Central and South America, Asia, Africa and the Centrally Planned countries) and by utilizing the data compiled by FAO and AID for the year 1970, the per capita GNP and per capita textile consumption amount, and, the correlation between the two were studied for each one of the above six groups.

On the basis of the obtained correlation data and the above-mentioned per capita GNP forecast, the forecast on the textile consumption per capita of each country of the world was made for the years 1975 and 1980. Again, on the basis of this obtained per capita textile consumption and on the above-mentioned population forecast, a forecast of the total textile consumption extent of each country of the world was made for the years 1975 and 1980. By summarizing the obtained results, the total textile consumption of the whole world for the years 1975 and 1980 was finally compiled.

On the other hand, the production trend of the natural fibers (cotton, wool, linen and silk) and that of the regenerated fiber were studied in accordance with the area-wise groups in order to conduct a forecast on the production amount of the whole world for the years 1975 and 1980. The total synthetic fiber production of the world is obtained by subtracting the above-mentioned natural and regenerated fiber production amount from the above-mentioned world total textile demand. The obtained synthetic fiber production amount was compared with the synthetic fiber demand of the world which was forecast on the basis of the share of synthetic fiber.

Thus obtained synthetic fiber production amount was further classified into the material-wise production amount for Southeast Asia, the U.S.A., West Europe and "Others". Here, the classification "Southeast Asia" includes such countries as Indonesia, the Philippines, Thailand, Malaysia, Singapore, Laos, South Viet-Nam, Japan, Korea, Rep. of, Taiwan, Khmer and Hong Kong.

Firstly, the synthetic fiber production in the year 1975 was forecast on the basis of the above-mentioned synthetic fiber production in the year 1972 by the world area groups, the synthetic fiber production capacity for the period from 1973 to 1974 (obtained from the Textile Organon), as well as on the projected production capacities announced in published information.

On the basis of the synthetic fiber production figures for each area group, the area-wise synthetic fiber production ratio to total world production was computed. By employing this obtained synthetic fiber production ratio, the already obtained synthetic fiber production amount for the world was divided into the pre-designated areas. Further, the area-wise production for the year 1980 was obtained by making an assumption that the area-wise production rate for the year 1975 will be maintained almost unchanged up to 1980. The synthetic fiber production for the years other than 1975 and 1980 was also obtained on an assumption that the production will increase almost proportionally from year to year.

On the other hand, a summary was made for the material-wise synthetic fiber production projects (including the existing plants) in accordance with the areas and the forecast on the material-wise synthetic fiber production rate in accordance with the area groups of the world was obtained by incorporating the past trend in the material-wise synthetic fiber production rates in the world. By integrating thus obtained results with the already forecast synthetic fiber production amount of the area groups of the world, the forecast on the material-wise synthetic fiber production of the area groups of the world was formulated.

Further, nylon was classified into nylon 6 and nylon 66. This was undertaken due to the fact that the main objective of the present survey was to conduct the studies on the raw materials for synthetic fiber.

Firstly, the trend of production rates in the world in the past has been obtained for nylon 6 and nylon 66. On the basis of the obtained rates, a forecast was made on the production rates of these two nylon materials in the future world. On the other hand, the whole world was devided into U.S.A., West Europe and "Others" and the future production amount of nylon 6 and nylon 66.

While coordinating the weight average of these production figures in such a manner that average figure will coincide with the already forecast nylon 6 and nylon 66 production rates of the world, the forecast on the production rates of nylon 6 and nylon 66 of the already designated areas of the world have been formulated. Together with the obtained results and the already forecast nylon production extent in the predesignated areas of the world, nylon 6 and nylon 66 production amounts were forecast concerning the designated areas of the world.

2-2 The Method for the Estimating Material-Wise Textile Consumption in Indonesia for the Year 1971

2-2-1 The Method for Estimation

(1) Figure III-3 shows the estimation method employed for forecasting material-wise textile consumption in Indonesia for the year 1971.
The portion enclosed by the dotted line in Figure III-3 represents the items to which a particular revisions have been incorporated in the present survey. In other words, when studying the export statistics of various countries, the subject countries were selected for Japan, Singapore and the U.S.A. in "The Republic of Indonesia, Survey Report on Synthetic and Rayon Fiber Industry Development (OTCA, February, 1973)" (hereinafter referred to as the "previous report"), however, in the present survey, the number of the subject countries were increased to include Japan, Singapore, Hong Kong, Taiwan, Korea, Rep. of, the U.S.A., U.K., West Germany, France, Italy and Holland, totaling 11 countries.

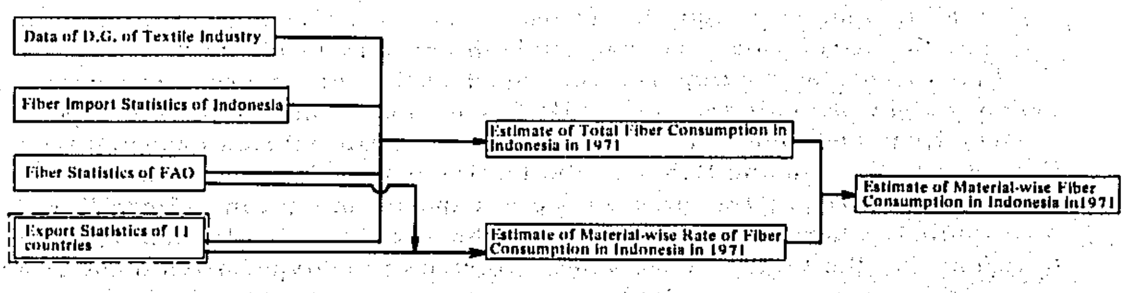


Figure III-3 Estimation Method of Material-wise Textile Consumption in Indonesia in 1971

(2) The method employed for formulating the forecast was identical to that employed in the previous report except for the above-mentioned revised points. The outline of the method can be stated as follows.

Firstly, studies were made on the groups of data consisting of the information obtained from the Directorate General of Textile Industry, the Departemen Perindustrian, Indonesian Import statistics, textile statistics of FAO and the export statistics of the above-mentioned 11 countries (hereinafter referred to as the 11-country export statistics) and these data were separately compiled. Then, these findings were compared with each other in order to estimate the total textile consumption in Indonesia for the year 1971.

(3) Then on the basis of the extent of exportation made to Indonesia of regenerated fibers and synthetic fibers obtained from the above-mentioned 11-country export statistics, and also on the basis of the natural fiber consumption amount obtained from the FAO textile statistics, the material-wise rates were computed and the obtained data were deemed as the material-wise textile consumption of Indonesia. By incorporating this result with already obtained total textile consumption, an estimate was made on the material-wise textile consumption extent for the year 1971.

The reason for employing the FAO textile statistics for obtaining material-wise rate of natural fiber, is that it is quite likely that the exportation destined to Indonesia of natural fibers from the countries other than 11 countries.

2-2-2 *Processing Method for the 11-Country Export Statistics*

(1) Statistical Data

Regarding Japan, Singapore, Hong Kong, Taiwan, Korea, Rep. of and the U.S.A., the export statistics were studied. Further, regarding the man-made fiber exports from the above-mentioned five European countries, the survey was made on the basis of the materials compiled by the International Rayon and Synthetic Fibers Committee.

(2) Woven Fabrics Weight

In the export statistics, except for Japan, Korea, Rep. of and the five European countries, the amount of woven textile statistics are stipulated in terms of "area" instead of "weight". (Concerning the 1972 export statistics of Taiwan, the stipulations are made in both areas and weights.) Therefore, the Japan Exports and Imports were used as the data in order to obtain the yearly weight per unit area of textile fabrics concerning Japanese exports to Hong Kong and Singapore. For the woven textile fabrics exported from Hong Kong, Taiwan and U.S.A., the textile conversion criterion, in weight per square meter, in the case of export from Japan to Hong Kong was applied, whereas for the textile material exportation from Singapore to Indonesia, the textile conversion criterion of the exportation made from Japan to Singapore was applied.

(3) Singaporean Export Statistics

Regarding the exportation made from Singapore to Indonesia, no mention is made on the side of Singaporean export statistics because of the arrangements made between the two countries. However, these two countries are close to each other geographically and, in view of the fact that a considerably large quantity of textile exportation is being made, the estimate of such an export quantity has been made in this report. The method employed in achieving such an estimate is identical to the one employed in the "Republic of Indonesia, Survey Reports on Synthetic and Rayon Fiber Industry Development (OTCA, Feb. 1973)," and an assumption is made that 70% of the balance obtained by subtracting export amount (except for wear products) from import amount (except for wear products), will be exported to Indonesia.

(4) Classification of the Materials

(a) Export Statistics of Japan, Hong Kong, Korea, Rep. of, and U.S.A.

In the case of export statistics of the above-mentioned countries, the material and form of the textile products are almost clearly known, so that the classification of the exports were made into the materials employed and the form of the products. Concerning the blended products, the classification was made by estimating the blending ratio as much as possible. Those items for which no classification could be made concerning the materials and therefore enabling merely the classification into either synthetic fiber or man-made fiber items, the classification was made in a form of a summary into the synthetic fiber, or man-made fiber items (the same processing method equally applies to the other export statistics).

(b) Exportation from Singapore

A survey on the synthetic fiber importation made into Singapore revealed that for the years 1970 and 1971, 83% on average of the total had been imported from Japan. Therefore, the material-wise ratio of the synthetic fiber exported from Singapore to Indonesia can be assumed as being identical to the case of the exportation from Japan to Singapore. It was deemed, therefore, that no serious deviation will take place by establishing such an assumption. Therefore, in accodance with the material-wise ratio of synthetic fiber export from Japan to Singapore, a classification into the material-wise categories of the synthetic fiber was made concerning those exported from Singapore to Indonesia.

(c) Statistics of Taiwan

Concerning the export statistics of Taiwan, it is only possible to classify the man-made fibers into "synthetic fiber", "regenerated fiber", and "man-made fibers". (Those which are not clearly classifiable into synthetic fiber or regenerated fiber). Therefore, no processing was made to the Taiwan export statistical data.

(d) Exportation from the five European Countries

According to the data obtainable from the International Rayon and Synthetic Fiber Committee, a classification was made concerning the materials only into synthetic and regenerated fiber categories and no clear stipulation was made on the materials. Therefore, no processing was made to these data.

(e) Classification into Each Material

After carrying out classifications as much in detail as possible as mentioned, a two-dimensional table as shown in Table III-1 has been made out by summarizing the man-made fiber exportation from the various countries in accordance with the material-wise and form-wise classifications. On the basis of the above table, the consumption of polyester in the form of staple fiber, for instance, was obtained in accordance with the following formula.

$$b_1 + \frac{b_1}{a_1 + b_1 + c_1} \times (e_1 + f_1 \times \frac{A+B+C+D}{A+B+C+D+E})$$

Table III-1 2-Dimentional Table for Material-wise and Form-wise Classification of Man-Made Fiber Exportation

	Nylon	Polyester	Acrylic	Regenerated	Synthetic 1)	Synthetic 1) & regenerated	Total
SF	a_1	b_1	c_1	d_1	e_1	f_1	g_1
Spun Yarn	a_2	b_2	c_2	d_2	e_2	f_2	g_2
Spun Fabric	a_3	b_3	c_3	d_3	e_3	f_3	g_3
FY	a_4	b_4	c_4	d_4	e_4	f_4	g_4
Filament Fabric	a_5	b_5	c_5	d_5	e_5	f_5	g_5
Total	A	B	C	D	E	F	G

Note: 1) Unclassifiable

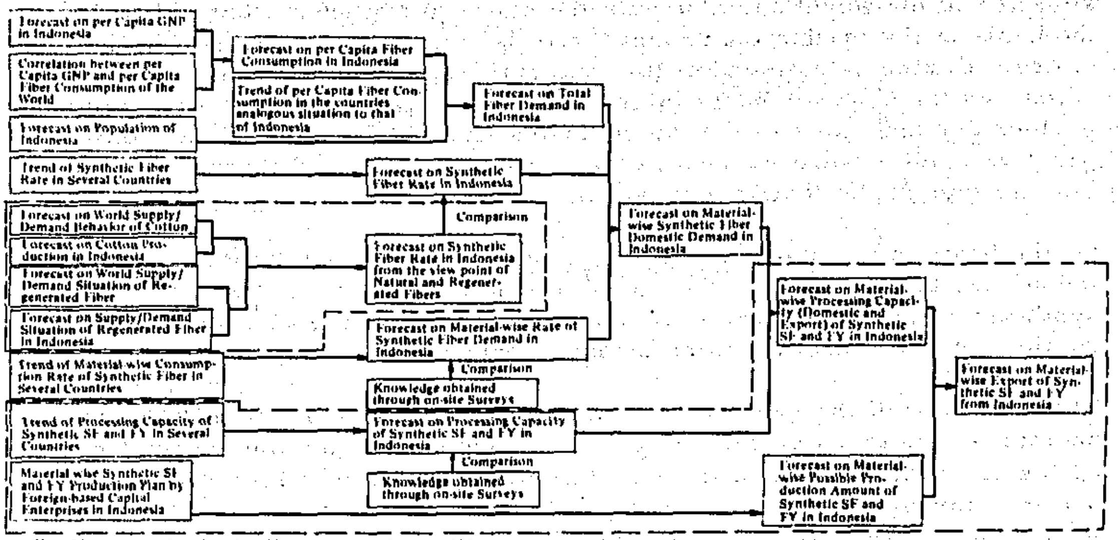
2-3 Forecast on the Synthetic Fiber Demand in Indonesia

Because of the nature of the data available for the present survey, the forecast was made by mainly employing the cross section method. In this case, the future economic growth (GNP growth) of Indonesia and the forecast on the Indonesian population increase will be necessary. As far as these items are concerned, the survey results obtained from the World Bank and AID, etc. have been employed.

Also, concerning the method of proceeding the material-wise demand forecast, the total textile consumption amount was firstly forecast. On the basis of the results, a forecast could be made from the actual records of the past material-wise consumption rates in the subject country as well as of other countries for comparison. Also, in this respect, another available method is to firstly forecast the application-wise demand of textile products and then another forecast on the material-wise demand is made on the textile products to finally obtain the total textile demand by integrating the results.

As far as the method of forecast is concerned, it is desirable to employ both of the above-mentioned methods and to enhance the accuracy of the forecast by carrying out comparative studies of the separate results. However, in many cases, due to the lack of adequate data, only one of the two methods can be made available.

In the present survey, it was not possible to obtain the necessary data for conducting a forecast on the application-wise demand extent. Therefore, the total textile demand was firstly forecast and the classification of the results into the material-wise categories have been employed. Figure III-4 shows the outline of this method.



Note: The portion enclosed by a dotted line represents the items to which a particular revisions have been incorporated in the present survey

Figure III-4 Forecast Method of Synthetic Fiber Demand in Indonesia

(1) In Figure III-4, the portion enclosed by a dotted line represents the points to which revisions were incorporated through the present survey. In other words, when forecasting the synthetic fiber rate in Indonesia, the previous survey formulated a forecast simply on the scrutinization of the synthetic fiber aspect alone, however, in the present survey, the share of synthetic fiber in view of the natural fiber and regenerated fiber aspects have also been made and comparative studies were conducted on forecast of the share of synthetic fiber on the basis of the trend of the share of synthetic fiber in various countries of the world. Also, in the present survey, along with the formulation of the quantitative forecast on the synthetic fiber processing capacity growth in Indonesia, a separate forecast on the synthetic SF and FY exportation amount and the synthetic fiber processed commodity exportation amount will be made.

(2) The employed forecast method is almost identical to that employed in the previous survey except for the above-mentioned revised points. The outline of the method is as follows:

Firstly, the correlation between the per capita GNP and per capita textile consumption was obtained regarding the various countries of the world and the obtained results were incorporated with the Indonesian per capita GNP forecast in order to estimate the Indonesian textile per capita consumption. At the same time, comparative studies were made with the per capita consumption trends in other countries which find themselves in an analogous situation to that of Indonesia. With the obtained results and the population forecast, the trend of Indonesian domestic total textile consumption was forcast.

On the other hand, on the basis of the trend shown by the share of synthetic fiber in the various countries, the trend of the share of synthetic fiber in future Indonesia was estimated. This forecast on share of synthetic fiber was compared with the future natural and regenerated fiber supply/demand situation in the world and also with the share of synthetic fiber estimated on the basis of the production prospects of these fibers in Indonesia in the future. Further, the trend of the material-wise synthetic fiber consumption rates was taken as the basis in order to forecast the material-wise synthetic fiber demand rates in the future Indonesia. At the same time, comparative studies were made with the knowledges obtained through the on-site surveys of the textile markets in Indonesia.

On the basis of the above-mentioned domestic total textile consumption in Indonesia, the forecast on the share of synthetic fiber and the material-wise synthetic fiber demand rates were made, and the material-wise domestic synthetic fiber consumption of Indonesia was also estimated.

Then, in view of the synthetic SF and FY processing capacity of the various countries, the trend of those in the future Indonesia was also estimated. At the same time, comparative studies were conducted with the knowledges obtained through the on-site surveys of the textile processing factories in Indonesia. On the basis of this obtained Indonesian synthetic SF and FY processing capacity forecast data and the already obtained Indonesian material-wise domestic synthetic fiber demand forecast, the estimation was made on the future trend of material-wise synthetic SF and FY processing capacity was made. At this time, an assumption was made that the processed products of FY and SF will be firstly allocated to fulfill the domestic demand and the portion exceeding the domestic demand will be allocated for the exportation. Therefore, the possibility of such exportation was studied.

Also, on the basis of the published information on the material-wise synthetic SF and FY production projects (including the existing plants) to be conducted by the foreign capital enterprises in Indonesia announced by the published information, the future Indonesian trend of the production possibility of material-wise synthetic SF and FY were estimated. Together with this obtained results and the already forecast Indonesian material-wise synthetic SF and FY processing amount forecast, the Indonesian material -wise synthetic SF and FY exportation amount was estimated. At the same time, the exportation possibility of the synthetic SF and FY from Indonesia was studied on the basis of the worldwide synthetic fiber supply/demand situation.

3. Trend of Synthetic Fiber Raw Material Supply/Demand Position

As has been discussed in the main volume of this report, the raw materials for synthetic fiber are different from the other types of raw materials in various points. The most conspicuous point of difference is the fact that the raw materials for synthetic fiber have almost no other application field than for the production of synthetic fiber products. Therefore, the supply/demand trend of raw materials for synthetic fiber is vitally affected by the supply/demand trend of synthetic fiber itself. In the chapter pertaining to synthetic fiber demand survey, the synthetic fiber demand forecast for the world was conducted. On the basis of the obtained results, the supply/demand forecast of the raw materials for synthetic fiber was formulated. Figure III-5 shows the method employed for the relative studies.

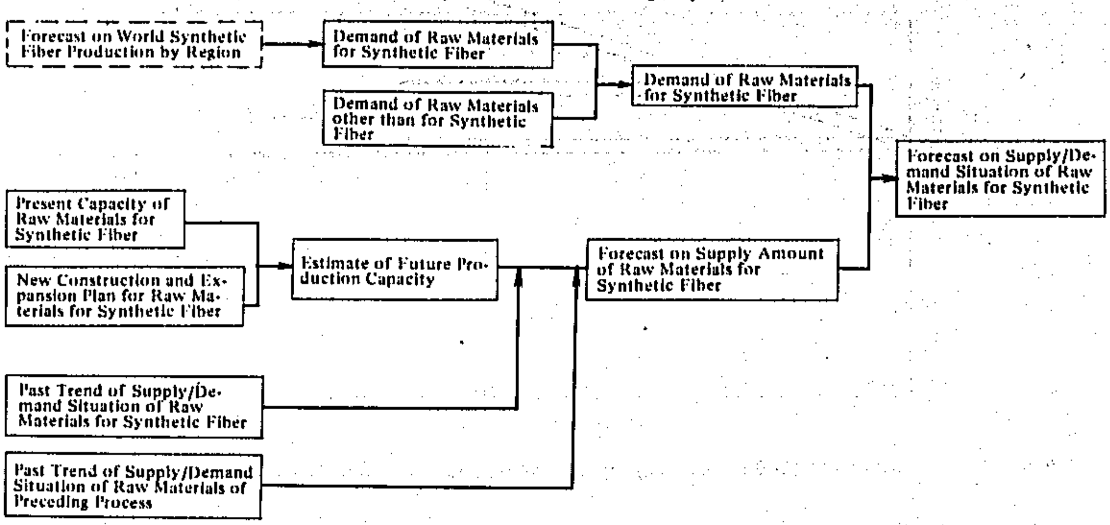


Figure III-5 Forecast Method of Demand/Supply Situation of Raw Materials for Synthetic Fiber (1)

Firstly, the raw materials for synthetic fiber demand (caprolactam, p-TPA, DMT, etc.) was obtained by multiplying respective unit consumption by the area-wise synthetic fiber production forecast figures of the world obtained in the previous chapter. The demand for raw materials for synthetic fiber was obtained on the basis of this obtained data together with the demand for the application fields other than for the production of synthetic fiber.

On the other hand, the capacity for the production of raw materials for synthetic fiber and the new installation or expansion of the facilities projected up to 1978 were studied in order to estimate the production capacity trend up to 1978. Thus, the future supply forecast of raw material for synthetic fiber was conducted by taking into consideration the past supply/demand trend of raw materials for monomers such as cyclohexane, p-xylene, etc., as well as considering the future production capacity of caprolactam, etc. The obtained results were compared with the already made demand forecast values of raw materials for synthetic fiber in order to estimate supply/demand situation of the raw materials for synthetic fiber.

The above described method can be simply illustrated as shown in Figure III-6. In other words, the future shortage portion was determined by taking the difference (the diagonally lined portion) between the demand extent and the capacity available after the completion of the presently announced new installation or capacity expansion. This shortage portion will eventually be fulfilled by the formulation of new projects which will come out soon or later and, this is the very area into which Indonesia will have an opportunity of expansion.

Due to the fact that the majority of raw materials for synthetic fiber are being produced by the U.S.A., West European countries and Japan, the further study was conducted by paying due attention to the future supply/demand trend of the raw materials for synthetic fiber in these countries.

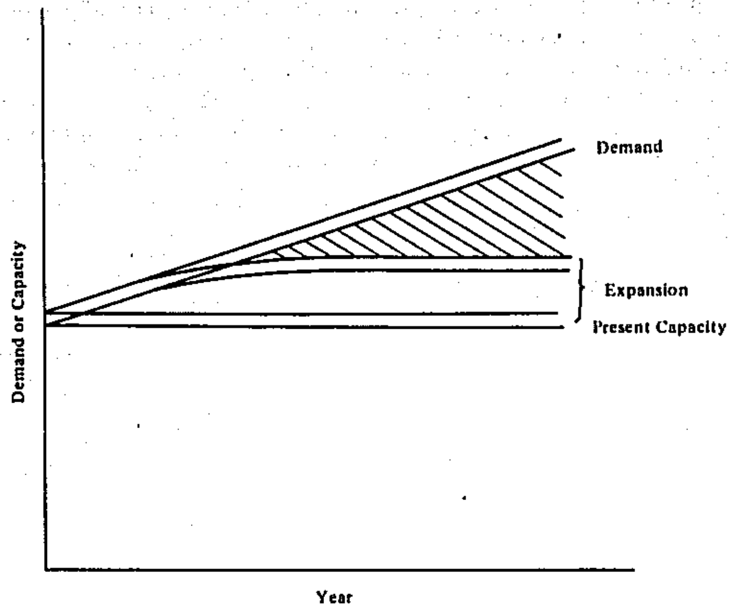


Figure III-6 Forecast Method of Demand/Supply Situation of Raw Materials for Synthetic Fiber (2)

4. Price Forecast

4-1 Plant Construction Cost

The U.S.A., the European countries and Japan are the only ones who are capable of manufacturing and delivering the machinery and equipment for use in raw material for synthetic fiber plants. Amongst those countries, there exists not only a difference in the machinery and equipment manufacturing cost, but also relative potential of countries has been changing along with the progress of inflation and the fluctuation or alteration of foreign exchange rates.

Further, since the price increase of crude oil carried out by the oil producing countries, such general changes have evidently been accelerated and also intensified. Due to the vast increment in the crude oil price enacted in 1973, the wholesale price and the consumer price levels in various countries of the world have conspicuously increased as shown in Table III-2. However, at the time of compilation of the table, the crude oil prices did not attain as yet the new price level of US$11.65/bbl which was announced on 23rd December 1973 by the OAPEC countries. Therefore, it seems inevitable that inflation will progress in the future in all the countries of the world.

Figure III-7 shows the trend of the wholesale price levels of machinery and equipment for the period from 1970 to the present time concerning the U.S.A., European countries and Japan. As is evident from this figure, Japan showed the

Table III-2 Increase in Consumers' Price Index and Wholesale Price Index (1973)

(%)

	Whole Sales Price	Consumer's Price
Japan	29.0 (Dec.)	17.0 (Dec.)
U.S.A.	18.2 (Dec.)	8.4 (Nov.)
U.K.	9.5 (Nov.)	10.3 (")
W. Germany	8.1 (")	7.4 (")
France	15.4 (")	8.4 (")
Italy	21.1 (Oct.)	11.4 (")

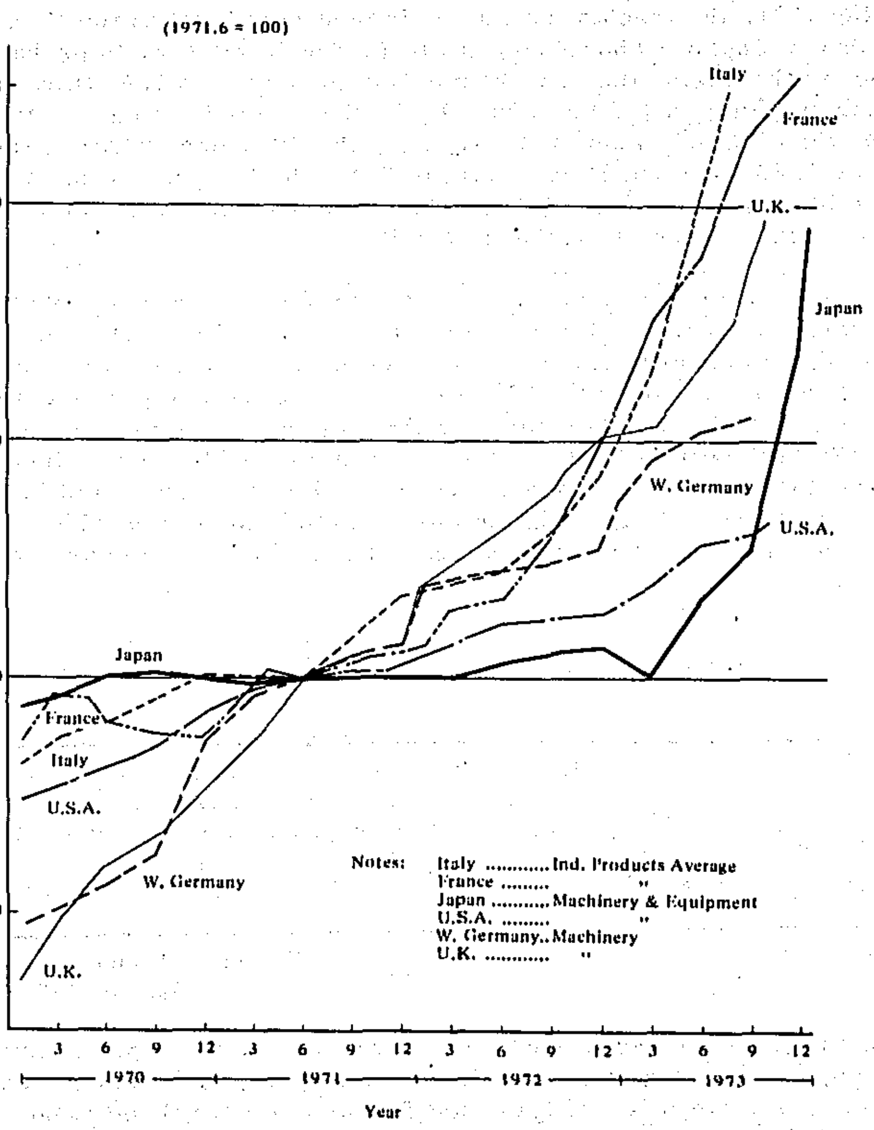


Figure III-7 Wholesale Price Index of Machinery and Equipment most stable trend up to 1971. Thereafter, Japan displayed a downtrend towards the end of 1972 and then, achieved a quick increase. On the other hand, the U. S. A. has been showing the most stable trend from 1971 onward.

In addition to these changes displayed by the various countries, the alteration of the foreign exchange rates has been vastly carried out twice since 1971. In other words, US$1.00 corresponded to ¥360 during the early part of 1971. This was changed to ¥260 thereafter and the present position shows a level of approximately ¥300. If an assumption is made that US$1.00 is equivalent to ¥300, the change represents an up-valuation of Japanese yen by 1.2 times. The change on the basis of conversion in terms of U. S. dollars based on the year 1971 alone shows that the Japan's index is 1.19. When multiplied the above-mentioned foreign exchange rate index of 1.2 by 1.19, it becomes evident that the Japanese yen achieved an actual up-valuation of approximately 1.43 times. On the other hand, the index achieved by the U. S. A. was 1.08 times.

During 1971, the machinery and equipment cost level in the U. S. A. was 1.19 times that of Japan. Therefore, if the Japanese level which prevailed during 1971 is taken as the basis, the present position for Japan is 1.43 times, whereas the U. S. A. is standing on 1.19 x 1.08 = 1.29, thereby indicating that the American cost is lower than that of Japan by 0.14, i.e., the difference between the indices. The rate 0.14/1.43 approximately equals to 0.1, which signifies that the American cost is lower by approximately 10% than that of Japan. By the same token, the West German cost is higher than that of the U. S. A.

The above-mentioned cost pertains to the cost of general machinery and equipment. For chemical industrial use items, the Nelson's Refinery Inflation Index compiled on the American refineries is as shown in Table III-3 which reveals that the increment for the period from 1962 to 1970 was 3.4% per year and that from 1970 onward was 7 to 11%. Therefore, in this report, the Japanese cost level during the year 1971 will be taken as the basis in view of the maintained stability of the level during then. The Japanese price level will be converted in terms of the American cost level. Regarding the changes took place from 1971 onward, the figure of 7%, which is the American increment rate, will be employed as the basis in this report.

Table III-3 Nelson's Refinery Inflation Index

	1954	1962	1970	1971	1972	Mar. 1972	Mar. 1973
Index	179.8	237.6	364.9	406.0	438.5	429.5	458.8
Average Annual Change(%)	-	3.5	3.4	11.3	8.0	-	6.8

Source: Oil and Gas Journal
Aug. 6, 1973

As has been discussed in the above paragraphs, the Japanese machinery cost is on a higher level than the American counterpart, however, as and when the crude oil price, etc. attain a stability, the Japanese level will no longer stay on a higher degree than that of the U. S. A. This assumption derives from the fact that in Japan, the vast extent of investments to steel mills, etc. have already been carried out and also, to the fact that the labor cost is definitely lower than the

U. S. A. level, and further, because of the fact that the Japan's dependency upon exportation is much higher than that of the U. S. A.

This being the circumstance, the machinery and equipment cost obtained on the basis of this assumption may be taken as the future Japanese cost level. Further, the price increase of the crude oil is now being undertaken and, along with such a price hike, the energy cost, and steel materials as well as labor cost will also progress. Although it is not clear at this stage as to how much the general situation will affect the cost level of machinery and equipment, tentative assumptions are made in this report that the extent of such an effect will result in a vast increment as high as 20%. Also, it was assumed that the future cost increment rate is at 7% per year. The above-mentioned computation method can be illustrated as shown in Figure III-8.

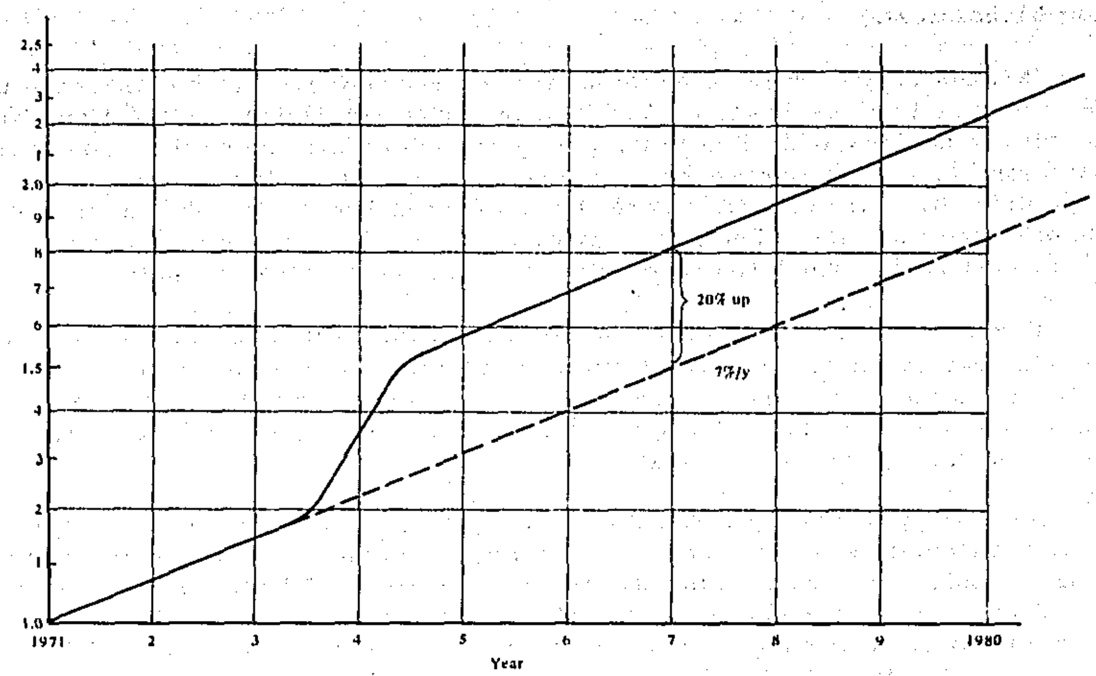


Figure III-8 Increase Rate of Plant Cost

The present Japanese machinery cost reflects the process of the general increase in the cost of living and the general economic instability, thereby making it impossible for the manufacturers to compile any realistic estimates in practice. Therefore, the actual present prices must be on a much higher level than the above-mentioned assumed figure. Therefore, should the orders be placed immediately, it would be absolutely impossible to directly apply the stipulations made in this figure.

4-2 Price Forecast

Up to 1972, the prices of petrochemical products including raw materials for synthetic fiber continued to decline. Nevertheless, an unpredicted increase of crude oil price by four-fold in a year and shortage of raw material supply caused a vast extent in price increase of the raw materials. The increase in the crude oil price is temporary but is forecast to continue at least in the same extent as to the rate of inflation.

Therefore, the conventional method of analysis of the past trend of price, production and demand has become unapplicable. The crude oil price increase involves not only the increase in the processing cost for the production of raw materials for synthetic fiber. Crude oil price hike affected not only on the price increase of raw materials but also on wholesale price, consumers' price index, etc. and as a result processing cost for the production of raw materials for synthetic fiber has increased considerably. The increase in the prices of products caused by the crude oil price hike can be categorized into the direct effects and indirect effects.

The price forecast methods will be made in the above two effect aspects. The direct effect pertains to the higher prices for raw materials, and the indirect effects consist of the increase in various processing costs such as increased raw material and construction cost for the construction of a plant as well as the increased labor cost.

It is not easy, however, to forecast the direct effect, i.e., the increase in the raw material prices due to the fact that the prices of various oil fractions from crude oil are decided according to the policy of each country or on the basis of the demand structure. This being the circumstance, the rate of increase caused to naphtha price by crude oil price increase was assumed to be the same as that of crude oil price increase. The period prior to the crude oil price increase was taken as 1971 during which the crude oil price was comparatively stable.

Concerning the BTX prices, the yield and composition of BTX to come out of naphtha was assumed, and taking into consideration the past price trend, the price computation was made on such a basis as, toluene and xylene being the same in price; benzene being 1.3 times the price of toluene; and raffinate price being on the same level as reformate.

As to the prices of cyclohexane and p-xylene, the costs (direct effect) of their raw materials were obtained by multiplying the unit consumption by the prices of benzene and xylene obtained through the above method. Then, the processing cost (indirect effect) was obtained by multiplying the processing cost in 1971 by the same coefficient (Figure III-8) as the increase rate of the plant cost. The prices of caprolactam and p-TPA/DMT were computed by the same calculation method that was used for the computation of the prices of cyclohexane and p-xylene by employing the cyclohexane and p-xylene prices. The above may be stipulated as the following formula:

The price of a product in a year after the price increase = The main raw material price after the crude oil price increase X unit consumption X α_1 + The processing cost in 1971 X α_2

Where, α_1 and α_2 : Price increase rates, the α_1 represents an annual increase of 7%, with the assumption that crude oil price increase took place in 1974, while α_2 is considered to be completely the same as the plant cost increase rate so that the coefficient used in Figure III-8 was used.

For example, if the cost of a product in 1977 is desired to be calculated, α_1 represents 1.07^3 covering the three years from 1974 until 1977, while, α_2 represents the 1.07^6 x 1.2 covering the six years from 1971 until 1977. The manufacturers' ex-factory prices of both Japan and the U.S.A. were used for the calculations of the prices and processing costs in 1971 which are used for the relative calculations based on the above-mentioned method.

These prices are considered as the international prices (CIF Jakarta). The prices essentially represent the manufacturers' ex-factory prices in their own countries, however, as has been already explained in the clause pertaining to price trend, the export price was lower by 10% to 20% than the domestic price in the case of Japan in the past. For this reason, it is considered that there was no significant difference between the CIF Jakarta price and the domestic price. Further, the domestic prices were different between that in Japan and in the U. S. A. The latter was lower by more than 10% than the former. As they were not constant as mentioned above, average values were obtained from the raw material costs and processing costs of both Japan and the U. S. A. Then, the prices derived therefrom were considered as the international prices (CIF Jakarta).

Based on the thus obtained international prices, the ex-factory prices both for the domestic market and for exportation were obtained. The goods landed at Jakarta port are brought to the Indonesian markets after the imposition of import duties and other various expenses. The amount of the charges used here are shown in Table III-4. In other words, 1.29 times the CIF price is the domestic sales price of imported goods in Indonesia.

Table III-4 Miscellaneous Expenses for Importation into Indonesia

Bank Charge + Cable Charge	CIF x 1%
Import Commission	CIF x 3%
MPO	CIF x 3%
Import Duty	CIF x 15%
Sales Tax	CIF x 5%
Clearance Charge	CIF x 2%
Total	CIF x 29%
Final Sales Price	CIF x 1.29

On the other hand, when the goods are produced domestically the sales prices of the product should be competitive with the sales prices of the imported goods. As the ex-factory price with handling charges and sales tax is the market price, the following formula will ensue. Here, it is assumed that the handling charge rate is at 3% and sales tax at 5%, totalling 8%.

(Ex-Factory Price for Domestic Market) x 1.08 = (CIF Jakarta) x 1.29

Consequently, the above can be restated as follows in which it is evident that the ex-factory price for domestic markets is equivalent to 119% of the CIF price.

(Ex-Factory Price for Domestic Market) = (CIF Jakarta Price) x 1.19

For caprolactam, p-TPA and DMT, however, the following formula is applied:

(Ex-Factory Price for Domestic Market) = (CIF Jakarta Price) x 1.19 - US¢2.5/kg

The reason for the application of the above formula is as follows:

The consumption area of caprolactam, p-TPA and DMT is Jakarta, however, the plant is not planned to be erected in Jakarta. For this reason, the ex-factory price for supply to the domestic markets must be calculated by subtracting the transportation charge from the plant site to Jakarta. Assuming that Palembang is the plant site, the transportation charges can be calculated as follows.

The transportation charges from Palembang to Jakarta in 1977 was obtained as mentioned in the following formula on the basis that the commodity classification GOL AA (Bagged Product) of the Indonesia ocean transportation is applicable.

$$0.8 \times 1.52 \times 107 \times 1/0.65 \times \sqrt{345} = 3.7 \text{ Rp/kg}$$

Where : 0.8 : Coefficient Factor

1.52 : Escalation (1.25×1.05^4)

107 : Rupiah

0.65 : Bulk Density (t/m^3)

345 : Miles (Palembang to Jakarta)

Loading and unloading charges at 6.8Rp/kg was added to the above transportation charges in order to obtain the total of 10.5Rp/kg=US¢2.5/kg as the total transportation charges from Palembang to Jakarta in 1977. Further, the export price from Indonesia was considered to be identical to the international price when the ocean freight and marine insurance premium are added to the ex-factory price. Thus, the following formula will ensue.

(Ex-Factory Price for Overseas Market) + (Freight) + (Insurance) = (CIF Jakarta), i.e.,

(Ex-Factory Price for Overseas Market) = (CIF Jakarta) - (Freight) - (Insurance)

The above ocean freight was obtained as follows.

Japan - Indonesia ocean freight figures in 1973 for raw materials for synthetic fiber were as follows.

BTX, Cyclohexane, p-xylene:	US¢3.3/kg
Ethylene glycol:	US¢5.0/kg
Caprolactam, p-TPA, DMT:	US¢5.0/kg

The ocean freight cost, however, are forecast to increase in a vast extent due to the recent crude oil price increase. Therefore, the freight charges were categorized into fuel cost, ship-building cost and labor cost. Then, the increase rates of each item was calculated and the ocean freight charges for 1977 was forecast as follows.

BTX, Cyclohexane, p-xylene: US¢7.1/kg

Ethylene glycol: US¢10.8/kg

Caprolactam, p-TPA, DMT: US¢10.8/kg

The annual increase rate of prices after 1977 was assumed as being 7%. As the purchasing prices for cyclohexane, etc. which are required for the production of caprolactam, etc., the previously obtained ex-factory price for domestic market was used otherwise stated. Ammonia and sulfuric acid are considered to be purchased at international prices as almost no importation of these items is likely. For the calculation of the ex-factory price of ammonium sulphate the price subtracted US¢1/kg bagging cost from international price was employed.

5. Scope of Construction Cost Estimate

The scope of construction cost estimate is described in the following paragraphs. In this case, it must be understood as a pre-requisite condition that the site of construction shall be inside Indonesia where the infrastructures have comparatively been substantiated. In other words, it is understood as the given conditions that substantiation of parts, trunk-line roads, traffic network, schools, churches and other community facilities as well as hospitals and clinics are already made.

5-1 Process Plant

5-1-1 Caprolactam

The scope shall include all the production facilities which receives, as main raw materials, cyclohexane, ammonia, sulfuric acid, fuming sulfuric acid, etc. and other sub-raw materials (chemicals) in order to convert the received materials into flake caprolactam and into the by-produced ammonium sulfate. Such facilities shall consist of the production machinery, equipment, pipings, wirings, structures, etc. In other words, the scope shall consist of the following two categories:

(1) Facilities for synthesis and refining of caprolactam

(2) Ammonium sulfate manufacturing facilities

5-1-2 p-TPA/DMT

The scope shall include all the equipment, machinery, pipings, wirings, structures, etc. which are necessary for the production of the powder-p-TPA and DMT by receiving p-xylene, acetic acid and methanol as well as other sub-raw materials (chemicals).

In other words, the scope shall consist of the following two categories:

(1) The p-TPA and/or refined DMT production facilities via c-TPA and/or,

(2) The refined DMT facilities without going through c-TPA

5-2 Instrumentation Facilities

The scope shall include the instrumentation facilities for carrying out the operation administration of the process plant, as well as the compressed air generating facilities, dryers, etc., for use with the instruments.

5-3 Utility Facilities

5-3-1 Steam and Electricity

Regarding electrical power, there is an expansion and substantiation plan at the PLN so that outside purchasing of electrical power can be considered as a possibility. However, in a chemical plant, a large amount of low-pressure steam will be necessary so that it is more economical to generate high-pressure steam by boilers for electrical power generation and then to re-utilize the steam in the form of low-pressure steam.

On the other hand, electrical power failure will cause a serious impediment in carrying out plant operation. Therefore, it is a normal practice to install an in-plant power station in order to ensure the electrical power supply. Therefore, in this project, an in-plant power station including boilers, steam turbines, etc. shall be included. In this connection, electrical power distribution facilities to various plants will also be included.

Further, in the event that the outside purchasing of electrical power is impossible, the installation of diesel power generator will become necessary in order to start the operation of the above-mentioned in-plant power station facilities. However, in this estimate the installation of diesel generator will be excluded from the scope on an assumption that the outside purchase of electrical power will be feasible.

5-3-2 Water In-Take and Water Treatment Facilities

Concerning industrial water, the surface layer of flowing water of river of a considerably high turbidity will be received by means of water pipes and will be held in a pond for primary sedimentation. Thereafter, the water shall be treated by the coagulation sedimentation process and filtration. When an assumption is made that the construction site is on a seashore area, it would be necessary to in-take the water from up-stream where no intrusion of sea-water into the river water is present. As to the water in-take and water treatment facilities, the installation of water pipes, primary sedimentation pond and the coagulation sedimentation and filtration devices will be made.

5-3-3 Cooling Tower

While it is possible to utilize sea water or river water by 1-pass method for cooling water, it is more appropriate to install a system for circulation-type cooling water in view of the low extent of water utilization amount for this purpose. Therefore, the installation of a cooling tower will be made.

5-3-4 Pure Water Facility

Pure water facilities shall be installed in view of the necessity for pure water produced by ion-exchange treatment to be used as the feed-water to the boilers.

5-3-5 Nitrogen Generating Facilities

An inactive gas will be necessary for blanketing the inflammable materials and for other miscellaneous purposes. In the case of TPA, the installation of these facilities is not necessarily required because of the stability of TPA. However, in the case of caprolactam and DMT, high purity nitrogen will be necessary in order to prevent the deterioration of the product quality. Therefore, installation of nitrogen generating facilities on the basis of air separation will be undertaken.

5-3-6 Air Compressors

5-3-7 Refrigerators

Due to the fact that comparatively low temperature reactions are included at the hydroxylamine process in the caprolactam manufacturing facilities, there are a number of cases in which refrigerators become necessary. Therefore, the installation of refrigerators shall be included within the scope of the estimate.

5-3-8 Liquid Ammonia Evaporation Facilities

On the assumption that the ammonia used for the production of caprolactam will be supplied in the form of liquid, the installation of facilities for evaporating liquid ammonia will be carried out.

5-4 Maintenance Facilities

The maintenance works tend to become congested during a certain period for undertaking repair of the plant facilities and, the work often becomes slow during the rest of the period. Therefore, it is economically inefficient to possess all the maintenance facilities and maintenance crew necessary to upkeep the plant operation. Also, such a complete substantiation of maintenance facilities, etc. will cause a serious burden in terms of cost consideration.

Therefore, the desirable arrangement is to install large-scale maintenance facilities and necessary workers with joint arrangements with other plants in the same area. On the basis of this arrangement, the facilities and crews for maintenance necessary for daily repair works will only be included within the scope of this project. The skilled workers necessary for carrying repair of the plants will be undertaken by the above-mentioned daily-maintenance crew and a large number of unskilled laborers and large size maintenance servicing equipment will be temporarily brought in from the outside when required. The outline of the maintenance facilities will be as follows:

(1) Maintenance Shop

The maintenance shops shall consist of work areas, offices and a shop possessing lathes, drilling machines, milling machines, cutters, grinders, welders, compressors, etc. together with electrical equipment, instrumentation servicing equipment, testors, meters, etc.

5-5 Analysis, Inspection and Technological Laboratory

A laboratory equipped with gas chromatographs, polarographs, spectograms, and other analyzer equipment, balances, weights, beakers and other apparatuses in full set shall be installed for the purpose of carrying out process administration and quality inspection tests, etc. A technological laboratory shall also be installed in order to carry out technological studies such as process improvements, etc.

5-6 Warehouses and Shipping Facilities

An assumption is made that all the products will be shipped in paper bags of 30 kg capacity. In the case of caprolactam, liquid-state transportation after melting will also be possible. However, unless the caprolactam plant is constructed in the vicinity of Jakarta, the liquid transportation is not practical in view of the difficulties in keeping and controling temperature in tank lorries and the deterioration prevention of the product quality during transit. Therefore, in this writing, the liquid-state transportation of caprolactam was excluded from the scope of scrutinization.

In the case of p-TPA and DMT, the other possible method of shipping is the utilization of hopper vehicles or the utilization of rubber or poly-propylene containers of one to two tons capacity. Also, DMT tank lorry shipment in the melted state will be possible. However, due to the same reason as for the case of caprolactam, the adoption of such a shipping method will be possible unless the DMT plant be constructed in the vicinity of Jakarta.

For exportation of these products, paper bags are generally used. The by-produced ammonium sulfate in the case of caprolactam production will be shipped in paper bags.

As has been described in the above paragraphs, it is deemed that the best suited shipping method is to utilize paper bags, so that the following facilities for this purpose will be installed.

(1) Bagging machines

(2) Flakers

(3) Paper-bagged product warehouses (p-TPA, DMT for 15 days shipment quantity ; caprolactam for 30 days shipping quantity)

(4) Bag storage silo (for 15 days shipping quantity of p-TPA and DMT)

(5) Ammonium sulfate warehouse

For the shipment of the above products, the transportation by trucks from the warehouses to the nearby port of shipment will be undertaken from where the transportation to domestic or overseas destinations will be undertaken.

5-7 Tank Yard

An assumption is made here that the raw materials such as cyclohexane, p-xylene, sulfuric acid, ammonia, etc. and the fuel (heavy oil) shall be transported through pipes from the adjacent refining plant so that the required storage amount can be on a small size. Regarding raw materials such as acetic acid, methanol and other chemicals, they shall, for the time being, be imported from overseas or otherwise must rely on transportation from geographically distant locations. Therefore ample storage capacity for these items must be installed.

Capacity of Tank Yark

Cyclohexane	: for 10 days
p-xylene	: for 10 days
Sulfuric Acid	: for 10 days
Ammonia	: for 10 days
Fuel	: for 10 days
Acetic Acid	: for 60 days
Methanol	: for 60 days
Other chemicals	: for 60 days
Ammonium sulfate	: for 90 days

The receiving facilities shall consist of 1 km transportation pipes.

5-8 Spare Parts

The scope shall include the spare parts for machinery, equipment and materials necessary for the process plants and utility plants.

5-9 Machinery Warehouse

Installation of a warehouse to store spare parts for the machinery, catalysts, chemicals, etc. will be made.

5-10 Waste Treatment Facilities

5-10-1 Incineration Furnace

An incineration furnace for burning the residues from plants and the sludge, dirt, dust, etc. produced from the waste water treatment facilities described in Clause 2 of the following paragraphs will be necessary. An electrical dust and soot collector and stacks will be necessary as the auxiliary facilities to the furnace. However, in a site away from residential areas, these items will not necessarily be required. Therefore, these have been excluded from the scope of the estimate.

5-10-2 Waste Water Treatment Facilities

A certain extent of organic substances will be contained in the waste water discharged from the plant. Normally, the waste water is released into rivers or oceans, however, in the event that the water eutrophication presents problems in the case of rivers or inland ocean, it is possible to reduce the organic substance contents by means of the reactivated sludge process. In this respect the oil separation and neutralization facilities will also become necessary. These necessary facilities shall be included in the scope of the estimate.

5-11 Safety Equipment

As to the safety equipment, the water pumps to be used for feeding water to the fire hydrants in each plant, fire engines and ambulances shall be included.

5-12 Communications Equipment

The communications equipment shall include telephone systems and in-plant communication systems.

5-13 Offices, etc.

The necessary facilities inside the plant in this respect are, office buildings, cafeteria, locker rooms, shower rooms, clinic, motor car garages, parking lots, plant fences and lighting equipment in and around the plant.

5-14 Others

Other items to be included within the scope of the estimate are roads inside the plant, water drainage ditches, lighting equipment, gardening, partition fences, general pipings, etc.

5-15 Welfare Facilities

5-15-1 Housing Colony

The plant site will be geographically away from the traditional residential areas. As a part of the local development relating to the plant construction, the housing colony accommodation should be well and amply equipped and substantiated for the purpose of ultimate expansion and reinforcement of living environments in the industrial area. Especially in view of the future development of the community, the emphasis should be placed upon the substantiation of the housing for middle-class personnel. On the basis of this philosophy, the housing colony accommodation rates have been established as follows:

Unit Superintendent: all the section chiefs shall be allocated to company housing

Section Superintendent and Staff Members: - ditto -

Foreman: - ditto -

Operators: 40% of the workers shall be housed in company accommodation and 40% shall be in bachelor's dormitories.

Laborers: 50% shall be housed in company accommodations and in dormitories.

5-15-2 Guest House

A guest house having ten rooms shall be built. This accommodation will also be used as the lodging for the expatriates at the time of construction, test-run, etc.

5-15-3 Others

A playground with a tennis court size will be prepared and a game room, etc. will also be furnished.

6. Basic Conditions and the Method Employed for Economic Viability Assessment

6-1 Finance

(1) Category:

Owned capital: 30% of the total investment

Foreign borrowings: 70% of the total investment

Working capital is to be borrowed in Indonesia.

(2) Financiers:

Foreign borrowings: International Financial Organizations.

Local borrowings: Official Indonesian Financing Institutes.

(3) Interests:

Foreign borrowings: 7.5%/y

Local borrowings: 12%/y

6-2 Repayment:

Foreign borrowings: Equally divided installments for seven years after a five year grace period.

Local borrowings: Equally divided installments for three years without grace period.

As the investment required for the purchase of the plant is assumed to be arranged 16 months prior to the time of starting operation, the grace period for the repayment of the foreign borrowings will be four years after the commencement of operation.

6-3 The Amount for Investment

All the investments are categorized as follows:

Battery Limit

Auxiliary and Off-Site

Buildings and Housing Colony

Royalty (Paid-up), Engineering Fee and Technical Expenses

Pre-operating Expenses

Interest during Construction

Land

Working Capital

The above items include the following:

(1) Battery Limit:

Machinery and equipment cost, material cost, transportation cost

Local construction cost

Spare parts cost

Supervision expenses for local construction

(2) Auxiliary and Off-Site:

Machinery and equipment cost, transportation cost

Construction cost

Spare parts cost

(3) Buildings and Housing Colony:

Machinery and equipment cost

Construction cost, transportation cost

(4) Royalty, Engineering Fee and Technical Expenses:

Royalty (Paid-up)

Detailed design cost, procurement service cost, etc.

The expenses for technical training required after the commencement of operation

(5) Pre-operating Expenses:

The loss of variable cost estimated on three month test operation period, 50% operational rate and 40% rejection rate, or

the variable cost for three months x 0.5 x 0.4

(6) Interest during construction:

The above items from(1) to (5) and the land cost (referred to as A)

The interest rate: 7.5%

Construction period: 30 months (The period for the interest payment, 15 months)

The owned capital: 30%

Thus; $A \times 0.7 \times 0.075 \times 30/12 \times 1/2$

(7) Land:

Includes land preparation cost

(8) Working Capital:

Production cost for four months computed on the basis of the variable cost for the first year.

(9) Total Capital Requirements:

The total of the above items from(1) to (8).

6-4 Operation Conditions:

Plant Life: 10 years

Number of operation days: 330 day/y

6-5 Fixed Cost

(1) Battery Limit: 10 year straight line depreciation

(2) Auxiliary and Off-Site: 15-year straight line depreciation

(3) Buildings and Housing Colony:30-year straight line depreciation

(4) Royalty, Engineering Fee and Technical Expenses:

5-year straight line depreciation

(5) Pre-operating Expense: 5-year straight line depreciation

(6) Interest during Construction: 5-year straight line depreciation

(7) Maintenance and Insurance: 4%/y on the total investment for Battery Limit, Auxiliary and Off-Site, and Buildings and Housing Colony

(8) Municipal Property Tax: 0%

(9) Plant Overhead Cost: Equivalent to labor cost

(10) Labor: The 1977 annual labor cost was assumed as follows with 7% annual labor cost increase.

Plant Manager:	9,300 US$/y
Production Manager:	6,500 US$/y
Unit Superintendent:	5,500 US$/y
Section Superintendent:	4,600 US$/y
Foreman:	3,400 US$/y
Operator:	1,300 US$/y
Laborer:	1,000 US$/y

6-6 Variable Cost

As far as the raw materials are concerned, the values summarized in the separate clause were applied. Regarding the utilities cost, the stipulation was made in terms of variable cost only. The required amount of fuel alone was summarized for stipulation.

The fixed cost incurred for the utilities are entirely included within the scope of the investment amount.

In Indonesia, the crude oil price and the heavy oil price were almost identical per barrel. The posted price of the Minas Crude after the crude oil price increase in 1974 is quoted at US$10.8/bbl. Therefore, the heavy oil price was assessed as being on the same level, hence US¢6.8/kg. In case that the yearly average increase rates is 7%, the price in 1977 is 8.3 US¢/kg.

6-7 General Administrative Expenses, Selling Expenses

(1) Selling Expenses: Up to 1977, US¢1.4/kg.

(2) General Administrative Expenses: 3% of the total of Production Cost and Selling Expenses

6-8 Corporate Tax

For areas other than Java, 45% on profit after 5 years of tax holiday period.

6-9 Internal Rate of Return

Calculated on the basis of the following formula:

$$I + W - L = \sum_{n=1}^{10} \frac{Rn}{(1+r)^n} + \frac{S+W}{(1+r)^{10}}$$

Where ; I : Total Capital Investment Excluding Working Capital

W: Working Capital

L: Land Price

Rn: Net Cash Flow in n-th Year

S: Salvage Value

r: Internal Rate of Return

7. Economic Evaluation of the Project in View of National Economy

7-1 Balance of Foreign Currency

Calculation of foreign currency balance in the event of project implementation was made in accordance with the following formula which shows the extent of foregn currency saving attainable by domestically producing DMT, p-xylene and caprolactam in contrast with a case in which the entire quantity of the products is exported. (In this calculation, Rp519/US$ exchange rate is employed.)

F = A - B - C + D - E

Where, A: The sales value corresponding to the domestic demand for DMT, p-TPA, caprolactam and ammonium sulfate. (The FOB Jakarta price was used in the calculation.)

B: The export value of p-xylene, cyclohexane, and methanol in a quantity corresponding to the domestic demand thereof. (The FOB Jakarta price was used in the calculation.)

C: Repayment of foreign borrowings and payment of interests

D: The export value of DMT, p-TPA and caprolactam (FOB Jakarta)

E: The import value of sub-raw materials used for the production of DMT, p-TPA and caprolactam, the CIF Jakarta prices were employed for acetic acid, etc. and the FOB Jakarta prices were employed for sulfuric acid and ammonia.

F: Foreign currency saving.

7-2 Evaluation of The Project in View of National Economy

For evaluation of the project in view of the national economy, the respective shadow prices for the following four items are generally employed.

(1) Foreign currency

(2) Labor

(3) Resources

(4) Capital

The Rp519/US$ exchange rate is applied to the foreign exchange and 40% of the prevailing wage level to labor cost. As the evaluation will be made on the monomer production process alone, the raw material prices (for instance, for cyclohexane) were estimated on CIF Jakarta. The DCF method was employed for the evaluation with the following conditions.

(1) Exchange rate: Rp519/US$

(2) Labor: 40% of prevailing wage level

(3) Raw material price

The main raw materials as well as the sub-raw materials were estimated on the international prices (CIF Jakarta) in foreign currency.

(4) Prices of utilities

The heavy oil was estimated on FOB Jakarta price in foreign currency.

(5) Fixed costs

As the amount of the investment is already divided into the foreign currency portion and the local currency portion, these portions were used for the calculations.

(6) Tax

Tax imposition rate was assumed as nil.

(7) Market price

Domestic sales were estimated on the international prices (CIF Jakarta) and were assumed as the foreign exchange revenue. Export sales were estimated on the export prices (FOB Jakarta) and were assumed as the foreign exchange revenue.

IV. Synthetic Fiber Demand Forecast

1. Introduction

The objectives of the present forecast made on the synthetic fiber demand are as follows.

(1) To review and revise the forecast results made in the previous report, the Republic of Indonesia, Survey Report on Synthetic and Rayon Fiber Industry Development (OTCA, Feb. 1973) (Hereinafter referred to as the previous survey);

(2) To formulate a forecast on the area-wise and material-wise synthetic fiber production in the world;

The reason for reviewing and revising the forecast results of the previous survey are as follows.

(1) Since the completion of the previous survey, the textile situation of the world displayed a considerable extent of change in such points as the export prohibition enforced by several cotton producing countries, the change in the raw materials for synthetic fiber situation caused by oil crisis, etc. Also, a number of applications have since been made to the Indonesian Government concerning the industrialization of synthetic SF and FY production. At the same time a vast extent of production facility expansion projects have consecutively been announced by synthetic fiber processing industries, thereby presenting a industrialization rush in textile industries.

(2) More than 12 months have elapsed since the end of the previous survey and therefore new data has since been collected and the methods of forecast. have also been improved or newly developed. Therefore, it is now possible to improve the forecast accuracy over the previous survey.

Due to the above reasons, the following improvements have been incorporated into the present survey when compared with the previous report.

(1) In the previous survey, the basic year taken was 1970 for formulating various forecast, however, in the present survey the basic year selected was 1971 by incorporating newly obtained data.

(2) When studying the export statistics for various countries as the estimation materials for assessing the material-wise textile consumption in Indonesia in 1971, Japan, Singapore and the U. S. A. were the only countries which were the subjects in the previous survey. However, in the present survey, the subject countries were increased to 11 countries including the above three. This was undertaken due to the fact that it has since been recognized that a considerable extent of textile exportation destined to Indonesia has been carried out by these countries as well.

(3) In the previous survey, forecasts were made on the Indonesian share of synthetic fiber by studying only the synthetic fiber aspect based on the trend of the share of synthetic fiber of countries in the world and the correlation between the per capita GNP and per capita synthetic fiber consumption amount of countries in the world. In the present survey, however, the forecast on the share of synthetic fiber was made in view also of the natural fiber and regenerated fiber aspect. This was undertaken due to the fact that the future supply/demand balance of the natural fiber and regenerated fiber will evidently become tight.

(4) In the present survey, along with the quantitative forecast of the growth in the synthetic fiber processing capacities in Indonesia, the forecast on the exportation from Indonesia concerning synthetic SF and FY as well as the synthetic fiber processed products were conducted.

At present in Indonesia, the textile industrialization is presenting a status of a rush as mentioned in the foregoing, and, amongst the enterprises there must be some which are projecting the exportation of synthetic SF and FY as well as the synthetic fiber processed products.

Also, the reason for having forecast the area-wise and material-wise synthetic fiber production of the world is that the present project concerns itself with the industrialization of raw materials for synthetic fiber and the survey was focused on this subject in Indonesia. Such a forecast was absolutely necessary for studying the area-wise supply/demand balance of the raw materials for synthetic fiber stated in Chapter V. Further, the area-wise and material-wise synthetic fiber production of the world was forecast because of the fact that the future synthetic fiber demand and production in Indonesia will have a close relationship with the area-wise and material-wise synthetic fiber production in the world.

2. Area-wise and Material-wise Synthetic Fiber Production Forecast of the World

2-1 Future Textile Situation in the World

The following paragraphs will discuss the past trend in per capita textile fiber consumption as well as the past trend in the material-wise textile fiber production in the world.

Figure IV-1 shows the trend in the material-wise textile fiber production amount in the world for the period from 1960 to 1972. The total textile fiber production increased by approximately 1.6 times from 14.9 million tons in 1960 to 24.3 million tons in 1972. However, growth achieved by cotton, wool and regenerated fiber have been small, whereas an acute increase has been displayed by synthetic fiber alone. In other words, the production of synthetic fiber increased by 9-fold over the past 12 years with an average annual growth rate of 20.2%. The trend of the share of synthetic fiber is shown in Table IV-1.

Figure IV-2 shows the past trend in the per capita textile fiber consumption in the world. Although per capita textile fiber consumption increased to 6.4 kg/y in 1972 from 5.0kg/y in 1960, the consumption per capita of textile fibers other than synthetic fiber has been showing a little increment, thereby clearly indicating

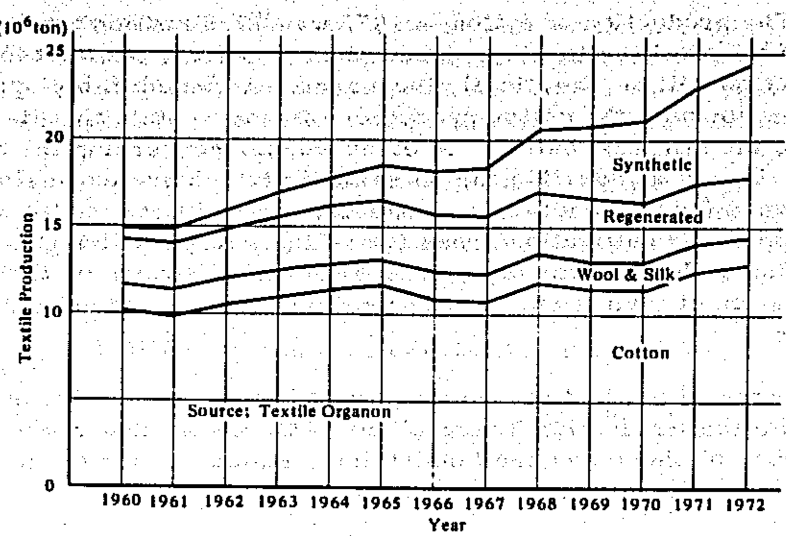


Figure IV-1 Trend of Textile Production in the World

Table IV-1 Trend of Share of Synthetic Fiber in the World

(%)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Share of Synthetic Fiber	4.7	5.6	6.8	7.9	9.5	11.1	13.1	14.9	17.4	20.1	22.2	24.3	26.1

Source: Textile Organon

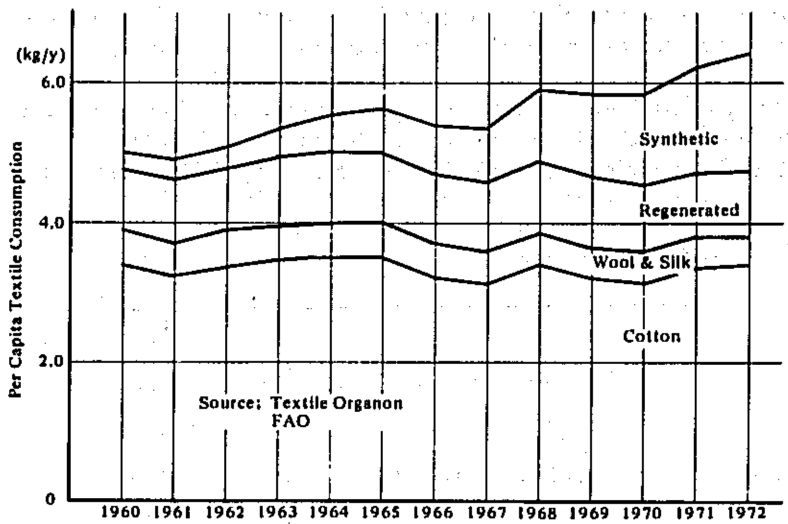


Figure IV-2 Trend of Per Capita Textile Consumption in the World

the increment in the synthetic fiber consumption resulted in the over-all increase in the textile fiber consumption level.

Observation will be made here concerning the possible trend in the production of various types of textile fibers. The production of natural fiber is expected to suffer from the limitations imposed by the natural conditions as well as the conflict with the food production increase necessity intensified along with the population increase. The production of cotton in 1972 was 12.8 million tons which represented 53% of the total textile fiber production, however, it is not expected that the cotton production will be drastically increased. A considerably optimistic forecast in connection with the cotton production seems to state that the increment will be limited to the slightest extent. In other words, concerning the cultivation lands for cotton, it may be possible for some areas to achieve expansion, however, the above-mentioned food production increase problem will constantly interfere with the expansion of the cultivation areas for cotton. Also, although a slow pace of increase will be made in terms of per unit area yield because of technical innovation or substantiation of irrigation, no directed improvement or enhancement seems likely to be made.

Concerning wool production, no increment in this respect is anticipated. In accordance with the Production Yearbook by FAO, the amount of the wool production and the number of sheep has been maintaining status quo for the past several years and there is no sign of increase in this respect in the future.

It seems that the production of the regenerated fibers has already attained the saturation point and no increase will be made in the future. This has been concluded due to the difficulties in procuring the raw material pulp as well as to the generation of pollution problems accompanied by the production of the regenerated fiber. This being the circumstance, the production is showing a decrease in Japan, U.S.A. and West Europe. Even in the areas in which the production facility expansion is being undertaken, similar problem will sooner or later manifest themselves.

In view of the above consideration, the increment portion of the textile fiber demand in the future accelerated by the population increase and income level improvement will have to be covered by the production increase in synthetic fiber.

The following paragraphs will stipulate representative forecast data concerning the material-wise textile fiber production (or demand) in the future for the world. Table IV-2 shows the forecast made by Dr. R. Kleber of Hoechst. The annual

Table IV-2 Forecast on the Total Fiber Demand in the World

(10^3 ton)

	1970	1972	1974	1976	1980
Cotton	11,550	11,700	12,000	12,300	13,000
Wool	1,650	1,700	1,800	1,900	2,000
Regenerated	4,000	4,100	4,200	4,300	4,400
Synthetic	5,300	6,600	7,900	9,300	12,000
Nylon	2,050	2,500	2,800	3,200	4,100
Polyester	1,750	2,300	2,900	3,450	4,600
Acrylic	1,000	1,250	1,500	1,800	2,300
Others	500	600	700	800	1,000
Total	22,500	24,100	25,900	27,800	31,400

Source: Dr. R. Kleber (Hoechst)
Chemiefasern, July (1972)

average growth rate of material-wise textile fiber for the period of 1970 to 1980 will be 1.2% for cotton, 1.9% for wool, 1.0% for regenerated fiber and 8.5% for synthetic fiber. Of the synthetic fiber, polyester shows the highest rate of 10.2%. The share of synthetic fiber is estimated at 33% by 1976 and 38% by 1980.

Table IV-3 shows the data published in Textile Mitteilunger which stipulates the material-wise average annual growth rate as 1.2% for cotton, 0.7% for wool, 0.3% for regenerated fiber and 8.5% for synthetic fiber. Also, it is estimated in the same article that the share of synthetic fiber will attain a level of 38% by 1980.

Table IV-3 Forecast on the Total Fiber Demand in the World

(10^3 ton)

	1971	1980
Cotton	11,600	12,900
Wool	1,600	1,700
Regenerated	3,510	3,600
Synthetic	5,372	11,000
Nylon	2,110	4,100
Polyester	2,097	4,300
Acrylic	1,165	2,600
Total	22,082	29,200

Source: Textil Mitteilunger, Aug. 9 (1973)

Table IV-4 shows a forecast on the material-wise textile fiber production of the world in 1985 compiled by Mr. Greene of Monsanto. In this forecast it is estimated that the material-wise average annual growth rate will be 0.7% for cotton, 0.5% for wool, 1.1% for regenerated fiber and 7.5% for synthetic fiber. The forecast estimates that the share of synthetic fiber will attain a level of 47% by 1985.

Table IV-4 Forecast on the Textile Production in the World

(10^3 ton)

	1972	1985
Cotton	12,300	13,500
Wool	1,500	1,600
Regenerated	3,400	3,900
Synthetic	6,600	16,800
Nylon FY	2,000	4,100
" SF	400	800
Polyester FY	1,100	3,500
" SF	1,400	3,800
Acrylic SF	1,200	3,100
Others	500	1,500
Total	23,800	35,800

Source: Mr. Greene (Monsanto Textile) C. E. N., Feb. 19 (1973)

As has been mentioned in the above paragraphs, all the forecast data show that the future growth in synthetic fiber will be great. On the contrary, it is forecast that the growth rate of natural fiber and regenerated fiber will be both small, thereby indicating that the increment portion in the textile fiber demand in the future will, for the most part, be covered by the supply of synthetic fiber. Along with such a trend, the share of synthetic fiber will acutely increase from the level of 25% or slightly less in 1971 up to approximately 35% by 1975. It is further estimated that the level will attain 40% by 1980.

2-2 Area-wise and Material-wise Synthetic Fiber Production of the World

Table IV-5 shows the forecast of the material-wise synthetic fiber production of the world and Table IV-6 through IV-9 illustrates the area-wise production amount of each of the above-mentioned materials. Also, Table IV-10 displays the area-wise production amount of nylon 6 and nylon 66. The synthetic fiber production amount of the world is expected to grow from 5.45 million tons in 1971 to 15.3 million tons by 1981, thereby achieving an average annual growth rate of 10.9%. The material-wise average annual growth rates are; 6.7% for nylon, 13.3% for polyester SF, 15.9% for polyester FY (14.5% for total polyester fiber) and 9.7% for acrylic fiber, thereby showing an outstandingly high growth rate in the case of polyester FY.

Table IV-5 Forecast on Material-wise Synthetic Fiber Production in the World

(10^3 ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon (SF+FY)	2,156	2,425	2,653	2,826	3,062	3,272	3,478	3,653	3,814	3,975	4,115
Polyester SF	1,164	1,375	1,620	1,800	2,050	2,340	2,610	2,920	3,390	3,800	4,050
Polyester FY	957	1,133	1,470	1,740	2,000	2,300	2,560	3,060	3,490	3,850	4,170
Acrylic (SF+FY)	1,170	1,269	1,510	1,650	1,847	2,040	2,220	2,435	2,600	2,780	2,960
Total	5,447	6,202	7,253	8,016	8,959	9,952	10,868	12,068	13,294	14,405	15,295

Source: UNICO Estimate

Table IV-6 Forecast on the Area-wise Production of Nylon SF and FY

(10^3 ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	372	375	427	453	509	580	645	690	730	775	810
(Indonesia)	0	0	427	453	509	580	645	690	730	775	810
(Others 1))	372	375									
U. S. A.	724	696	990	1,040	1,090	1,140	1,180	1,210	1,230	1,250	1,270
Western Europe	675	722	760	810	860	890	930	970	1,010	1,040	1,070
Others	385	432	476	523	603	662	723	783	844	910	965
Total	2,156	2,425	2,653	2,826	3,062	3,272	3,478	3,653	3,814	3,975	4,115

Note: 1) the Philippines, Thailand, Malaysia, Singapore, Laos, Khmer Viet-Nam, Rep. of, Japan, Korea, Rep. of, Taiwan, Hong Kong

Source: UNICO Estimate

Table IV-7 Forecast on the Area-wise Production of Polyester SF

(10^3 ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	234	253	325	420	480	550	620	670	780	900	950
(Indonesia)	0	0	325	420	480	550	620	670	780	900	950
(Others 1))	234	253									
U. S. A.	518	624	710	710	780	850	900	970	1,050	1,100	1,150
Western Europe	254	326	380	430	460	550	610	640	670	700	730
Others	158	172	205	240	310	390	480	640	890	1,100	1,220
Total	1,164	1,375	1,620	1,800	2,050	2,340	2,610	2,920	3,390	3,800	4,050

Note: 1) See Table IV-6

Source: UNICO Estimate

Table IV-8 Forecast on the Area-wise Production of Polyester FY

(10³ ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	226	225	300	405	480	560	620	710	810	880	950
(Indonesia)	0	0	300	405	480	560	620	710	810	880	950
(Others 1))	226	225									
U. S. A.	308	432	595	680	750	850	900	1,030	1,100	1,150	1,200
Western Europe	332	328	400	440	480	530	580	630	680	720	760
Others	91	148	175	215	290	360	460	690	900	1,100	1,260
Total	957	1,133	1,470	1,740	2,000	2,300	2,560	3,060	3,490	3,850	4,170

Note: 1) See Table IV-6

Source: UNICO Estimate

Table IV-9 Forecast on the Area-wise Production of Acrylic SF and FY

(10³ ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	326	320	392	435	500	560	600	680	740	810	850
(Indonesia)	0	0	392	435	500	560	600	680	740	810	850
(Others 1))	326	320									
U. S. A.	247	284	340	340	360	380	400	460	480	500	530
Western Europe	477	522	603	660	720	780	830	870	900	920	950
Others	120	143	175	215	267	320	390	425	480	550	630
Total	1,170	1,269	1,510	1,650	1,847	2,040	2,220	2,435	2,600	2,780	2,960

Note: 1) See Table IV-6

Source: UNICO Estimate

Table IV-10 Forecast on Area-wise Production of Nylon 6 and Nylon 66

(10³ ton)

		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon 6	U. S. A.	261	332	372	406	436	456	472	484	492	500	508
	Western Europe	331	361	388	421	447	463	484	504	525	551	567
	Others	658	738	820	869	954	1,077	1,166	1,240	1,310	1,414	1,476
	Sub-Total	1,250	1,431	1,580	1,696	1,837	1,996	2,122	2,228	2,327	2,465	2,551
Nylon 66	U. S. A.	463	564	618	634	654	684	708	726	738	750	762
	Western Europe	344	361	372	389	413	427	446	466	485	489	503
	Others	99	69	83	107	158	165	202	233	264	271	299
	Sub-Total	906	994	1,073	1,130	1,225	1,276	1,356	1,425	1,487	1,510	1,564
Total		2,156	2,425	2,653	2,826	3,062	3,272	3,478	3,653	3,814	3,975	4,115

Source: UNICO Estimate

The above-mentioned tendency is considerably different from the several forecast results stated in 2-1. Particularly, this tendency shows a high extent of polyester production growth. However, the time at which the forecast was made differ by one year or more and it must be noted also that the textile situation in the world has gone through a considerable change over the past 12 months. Particularly in Europe and the U. S. A., it is expected that the polyester demand will drastically increase in the near future and this is the reason why the above-mentioned discrepancy between forecasts should manifest itself as the said drastic polyester demand increment has been fully taken into consideration.

Table IV-11 shows the material-wise synthetric fiber production amount for the Southeast Asian areas (including Indonesia, the Philippines, Thailand, Malaysia, Singapore, Laos, Khmer, Viet-Nam, Rep. of, Japan, Korea, Rep. of, Taiwan, Hongkong). The production amount of the total synthetic fiber in the Southeast Asian areas is forecast to increase from 1.16 million tons in 1971 to 3.56 million tons in 1981, thereby comprising an annual average growth rate of 11.9%. The material-wise analysis of the annual average growth rate reveals 8.1% for nylon, 15.1% for polyester SF, 15.5% for polyester FY and 10.1% for acrylic fiber. These data are approximately identical to the trend of the whole world.

Table IV-11 Forecast on Material-wise Synthetic Fiber Production in Southeast Asia 1)

(10^3 ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon (SF+FY)	372	375	427	453	500	580	645	690	730	775	810
Polyester SF	234	253	325	420	480	550	620	670	760	900	950
Polyester FY	226	225	300	405	480	560	620	710	810	880	950
Acrylic (SF+FY)	326	320	392	435	500	560	600	680	740	810	850
Total	1,158	1,173	1,444	1,713	1,969	2,250	2,485	2,750	3,060	3,365	3,560

Note: 1) Indonesia, the Philippines, Thailand, Malaysia, Singapore, Laos, Khmer, Viet-Nam, Rep.of, Japan, Korea, Rep. of, Taiwan, Hong Kong

Source: UNICO Estimate

From the stipulations made in Table IV-10, it can be estimated that the nylon production in the "Others" including Southeast Asian areas is mostly Nylon 6 in the future.

3. The Present Status of Textile Consumption in Indonesia

In Indonesia, no adequate information is available by means of which the textile situation of the country, such as the total textile consumption, material-wise consumption etc. can be analysed. However, such information is definitely necessary as the basic data for formulating the forecast on the future synthetic fiber demand in Indonesia. This being the circumstance, an estimate is made concerning the present total textile consumption and the classification of the estimated figure into material-wise and form-wise consumption has been made. Further, comparison was made with the counterpart figures of other Southeast Asian countries in order to clarify the characteristics of textile consumption in Indonesia.

3-1 Total Textile Consumption

In order to estimate the total textile consumption, individual analysis of the presently available statistical data was undertaken and the comparative scrutinizations of the obtained results were made.

3-1-1 Survey concerning the Past Total Textile Consumption up to the Present

In this respect, the date issued by the Directorate General of Textile Industry, the Departemen Perindustrian concerning the production, importation and consumption of textile products were employed along with the Indonesian Import Statistics, FAO's textile statistics and export statistics of relative foreign countries.

(1) Data obtained from the Directorate General of Textile Industry, the Departemen Perindustrian

"The Data about the Textile Industry in Indonesia, 1970" which was issued by the Directorate General of Textile Industry as well as other data obtained from the authority have been scrutinized and then were compiled in Table IV-12 regarding the total amount of the textile consumption and the rates comprized in the total amount of the textile consumption in Indonesia by the domestically produced spun yarn, imported yarn and the imported fabric.

Table IV-12 Textile Production, Importation and Rates thereof on the Total Textile Consumption in Indonesia

(ton)

	1967	1968	1969	1970	1971
Domestic Spun Yarn Production	20,356	24,062	33,077	39,500	43,221
	(18.9)	(20.2)	(29.0)	(32.8)	(28.8)
Imported Yarn	11,476	21,879	41,237	44,600	55,950
	(10.6)	(18.3)	(36.3)	(37.1)	(37.3)
Imported Fabric 1)	76,118	73,332	39,648	36,218	50,932
	(70.5)	(61.5)	(34.7)	(30.1)	(33.9)
Total Textile Consumption	107,950	119,273	113,962	120,318	150,103

Source: Departemen Perindustrian

Notes: ( ) ---- % on total textile consumption
1) Estimated by using conversion figure 140 g/m^2

The annual total textile consumption for the period from 1967 to 1970 was 110,000 to 120,000 tons and, although the change in the amount has been slight, an acute increment up to 150,000 tons was achieved in 1971. Therefore, the growth rate against the previous year was 25%. This has been greatly supported by the sudden increase in the amount of imported yarn and the imported fabric.

(2) Import Statistics of Indonesia

Table IV-13 shows the total import amounts with the categorization of import statistics compiled and issued by the Indonesian Bureau of Statistics (concerning FY, SF, spun yarn and fabric) into the categories of natural fiber, and man-made fiber and also in accordance with the form of the textile materials. Concerning the years 1971 and 1972, only the outline of the import statistics was obtainable, so that the total import amounts alone are stipulated. Compared with the previous year, the total import for the year 1968 displayed a considerable extent of decrease, however, from 1968 until 1972, the amount kept increasing. By 1972, the quantity attained a level of 129,000 tons.

Table IV-13 Textile Import into Indonesia

(ton)

		1967	1968	1969	1970	1971	1972
Natural	Raw Fiber	17,375	13,723	21,280	19,115		
	Spun Yarn	11,730	22,107	31,382	31,423		
	Fabric	52,823	28,886	23,994	17,522		
	Sub-Total	81,928 (74.2)	64,716 (77.4)	76,656 (76.2)	68,060 (65.3)		
Man-made	SF, FY	2,290	3,929	3,822	2,675		
	Spun Yarn	1,538	2,927	9,733	14,524		
	Fabric	24,695	12,075	10,436	18,907		
	Sub-Total	28,523 (25.8)	18,931 (22.6)	23,991 (23.8)	36,106 (34.7)		
Total		110,451	83,647	100,647	104,166	116,941 1)	128,963 1)

Source: Indonesia Imports Statistics

Notes: ( ) ----- % on total textile importation
1) Details are not clear

Concerning the convertion method from the area into the weight of fabric, a method identical to the one employed in the case of Singapore (which will be described in III 2-2-2 (2)) was adopted and the assumptions were made from the Japan exports and Imports.

(3) Textile Statistics of FAO

Table IV-14 is an illustration of material-wise textile consumption in Indonesia in accordance with FAO's textile statistics.

Table IV-14 Material-wise Textile Consumption in Indonesia (FAO)

(10^3 ton)

	1967	1968	1969	1970	1971
Natural	99.4(81.2)	99.3(84.7)	100.9(86.3)	86.7(83.6)	94.0(86.3)
Regenerated	8.0(6.5)	6.7(5.7)	5.8(5.0)	5.4(5.2)	4.2(3.9)
Synthetic	15.0(12.3)	11.2(9.6)	10.2(8.7)	11.6(11.2)	10.7(9.8)
Total	122.4	117.2	116.9	103.7	108.9

Note: ( ) ----- % on total textile consumption

Source: FAO

From 1967 to 1970, the total textile consumption displays a slight extent of decrease. However, according to the results of integration of export statistics of various foreign countries which will be explained later, the annual increase in the textile consumption is obvious. Therefore, the above-mentioned decreasing trend is difficult to understand.

(4) Export Statistics of various Foreign Countries

Except for some quantity of cotton, Indonesia is importing all the textile materials from overseas. Therefore, survey of export statistics from foreign countries destined to Indonesia concerning textile has been conducted in order to utilize the results as the data to estimate Indonesian textile consumption.

The subject countries of investigation are the following 11 countries, such as Japan, Singapore, Hongkong, Taiwan, Korea, Rep. of, U. S. A., England, West Germany, France, Italy and Netherland.

The above studies have been conducted in view of the fact that, internationally speaking, it is considered that the above-mentioned countries are the only ones who are in a position to carry out exportation of regenerated and synthetic fibers to Indonesia. Also, as far as the natural fiber is concerned natural fiber consists for the most part of cotton. In this connection, the U. S. A. is undertaking a large quantity of cotton exportation to Indonesia under PL-480. Naturally, it is probable that exportation to Indonesia from countries other than the above-mentioned concerning cotton and cotton products must be present, however, the quantity of such export is likely to be small.

Table IV-15 shows the material-wise exportation destined to Indonesia made from the 11 countries. The total exportation has been steadily growing from 102,000 tons in 1967 to 149,000 tons in 1972. When the export amounts from the countries other than Japan, Singapore and the U. S. A., all of which have been the study subjects of the previous survey, is obtained on the basis of Table IV-15, the result reveal 8,500 tons for natural fiber, 5,000 tons for regenerated fiber, 15,800 tons for synthetic fiber and 600 tons for man-made fibers (those items which cannot be clearly classified into either synthetic fiber or the regenerated fiber), totalling 29,800 tons. This amount corresponds to 20% of the total exportation amount from the 11 countries which amounts to 148,900 tons.

This being the case, it can be stated that the employment of the export statistics of the 11 countries (hereinafter referred to as the 11-country export statistics) in the present survey was fully meaningful.

3-1-2 Total Textile Consumption for the Year 1971

Figure IV-3 shows an aggregate incorporation of the above-mentioned four categories of statistical data. Of these groups of data, there is a high possibility that FAO's textile statistics have been compiled on the basis of the data collected by the Directorate General of Textile Industry, the Departemen Perindustrian so that the FAO data cannot be considered as being completely independent by themselves. Also, the textile consumption is displaying an yearly decrease and, in view of the above-mentioned reason, the FAO data cannot be accepted as being completely appropriate. Naturally, therefore, the FAO data show a completely different trend from those indicated by the other three.

This being the circumstance, comparative analyses of the mutually independent groups of data, i. e., the data obtained from the Directorate General of Textile Industry, the Indonesian Import Statistics and the 11-country export statistics were made.

Table IV-15 Textile Exportation to Indonesia from Japan, Singapore, Hong Kong, Taiwan, Korea, Rep. of, The U.S.A. and Five European Countries

(ton)

Exports from		1967	1968	1969	1970	1971	1972
Natural	Japan	7,916	5,393	2,769	2,592	1,897	2,418
	Singapore 1)	14,978	26,865	33,651	35,083	26,347	20,126
	Hong Kong	29,730	21,785	11,414	3,952	5,193	5,160
	Taiwan	10,694	326	764	456	993	2,877
	Korea, Rep. of	43	-	23	100	170	427
	U. S. A.	16,452	26,845	39,557	59,310	47,708	54,324
	Sub-Total	79,813 (77.9)	81,214 (80.2)	88,178 (74.4)	101,493 (74.9)	82,308 (62.5)	85,332 (57.3)
Regenerated	Japan	3,261	2,430	2,192	1,948	2,650	3,114
	Singapore 1)	1,999	2,533	3,298	3,463	4,096	1,840
	Hong Kong	5,002	3,142	3,236	1,510	1,910	2,470
	Taiwan	54	401	1,413	2,249	940	2,020
	Korea, Rep. of	33	-	-	-	-	228
	U. S. A.	76	322	68	-	93	50
	Europe	114	50	4	14	412	247
	Sub-Total	10,539 (10.3)	8,878 (8.8)	10,211 (8.6)	9,184 (6.8)	10,101 (7.7)	9,969 (6.7)
Synthetic	Japan	5,055	2,178	4,971	6,186	11,087	15,852
	Singapore 1)	3,639	6,447	10,306	12,109	16,123	14,422
	Hong Kong	1,223	875	902	379	1,395	3,082
	Taiwan	-	-	1,378	3,889	5,362	11,212
	Korea, Rep. of	241	157	88	342	680	1,261
	U. S. A.	-	46	-	30	829	2,225
	Europe	9	57	223	62	466	235
	Sub-Total	10,167 (9.9)	9,760 (9.6)	17,868 (15.1)	22,997 (17.0)	35,942 (27.3)	48,289 (32.4)
Regenerated and Synthetic (unclassified)	Japan	916	360	302	396	960	1,684
	Singapore 1)	729	766	969	948	1,914	2,986
	Hong Kong	255	284	265	21	47	113
	Taiwan	-	-	-	85	20	34
	Korea, Rep. of	-	-	365	304	466	472
	U. S. A.	-	-	412	7	32	-
	Sub-Total	1,900 (1.9)	1,410 (1.4)	2,313 (1.9)	1,761 (1.3)	3,439 (2.5)	5,289 (3.6)
Total	Japan	17,148	10,361	10,234	11,122	16,594	23,068
	Singapore 1)	21,345	36,611	48,224	51,603	48,480	39,374
	Hong Kong	36,210	26,086	15,817	5,862	8,545	10,825
	Taiwan	10,748	727	3,555	6,679	7,315	16,143
	Korea, Rep. of	317	157	476	746	1,316	2,388
	U. S. A.	16,528	27,213	40,037	59,347	48,662	56,599
	Europe	123	107	227	76	878	482
	Total	102,419	101,262	118,570	135,435	131,790	148,879

Notes: ( ) ----- % on total textile export
1) Assumed by 0.7 x (Imports - Exports) of Singapore

Source: Exports Statistics

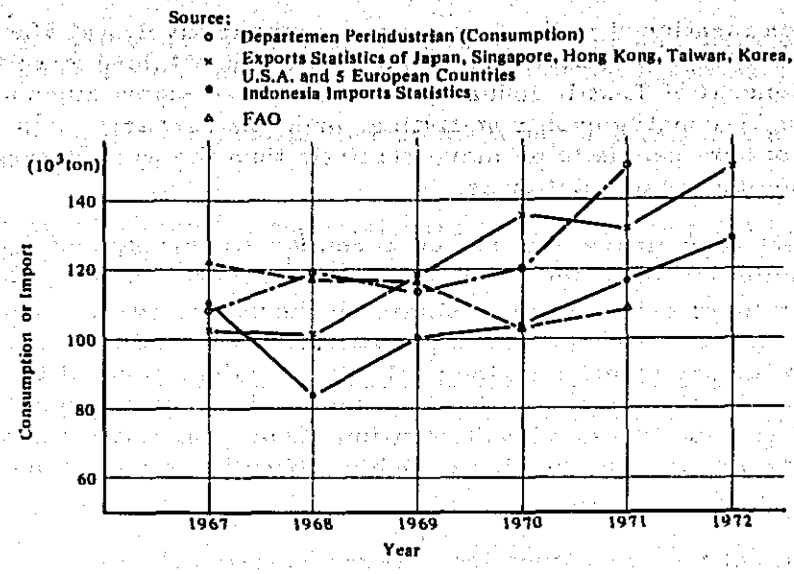


Figure IV-3 Comparison of Various Data on Textile Consumption and Import in Indonesia

Of these groups of data, the ones obtained from the Directorate General of Textile Industry alone are the statistics concerning consumption.

As far as the data of the Directorate General of Textile Industry are concerned, the textile consumption for the year 1971 shows as high a growth rate as 25% against the consumption of 1970, thereby showing a conspicuous difference from the growth rates obtained over the years upto 1970. Although it has been felt by the survey team through the on-site surveys that a wholesome growth has so far been achieved in Indonesian textile industry, the above-mentioned 25% increase seems to be an extremely large in extent when compared with the remaining two groups of data. Therefore, the direct adoption of this figure as the total textile consumption for the year 1971 seems to involve some degree of inadequacy.

The total textile import according to the Indonesian Import Statistics shows a great decrease for the year 1968 when compared with the previous year and it was only 1971 when the level of 1967 was exceeded. In this respect, the Indonesian import statistics show a trend which is vastly different from the ones shown by the rest of the data groups and also, the total textile import for the year 1971 is stated as having been 117,000 tons which is on a level considerably lower than the indication made by the other groups of data. When this total textile import amount is compared with the textile export amount obtained from the 11-country export statistics, it was revealed that approximately 20,000 tons of negative discrepancy can be noted for every year. Due to the fact that the subject countries were limited to a certain number as far as the textile exportation statistics are concerned, some degree of exclusion must have been allowed in this respect. Therefore, a lower figure should rather be displayed by the textile export amount statistics than the total import statistics. In view of these facts, it seems that there are some questionable points in the Indonesian import statistics.

The export amount to Indonesia obtained from the 11-country export statictics displays a trend which is comparatively analogous to the data compiled by the Directorate General of Textile Industry, thereby showing a steady growth. Further, by 1971, the textile export amount attained a level of 132,000 tons.

As has been mentioned in the foregoing, a comparatively satisfactory analogy can be found between the textile consumption amount obtained from the data of the Directorate General of Textile Industry and the textile export amount compiled on the basis of the 11-country export statistics, and, the past trend represented by these two groups of data seems to be more realistic than the one obtained on the basis of the Indonesian import statistics.

The respective primary regression formulae were obtained from this total textile consumption data and from the textile export amount data in order to carry out preliminary calculations to obtain the figure for 1971. According to the results, the respective figures were approximately 139,000 tons and 137,000 tons. The reason for having effected the preliminary calculations of the 1971 data by means of regressional analyses is that both the total textile consumption data and textile export amount data display fluctuations from year to year and do not indicate a steady trend, thereby making it highly difficult to pinpoint the figure as of 1971.

On the basis of the above-mentioned regressional analyses, it is considered that the total textile consumption for the year 1971 must have been at least on the level of 135,000 tons.

The Indonesian population in 1971 was 124.4 million and when the total textile consumption of 135,000 tons is converted in terms of per capita figure, the result becomes 1.09 kg/y. If the unit weight of woven fabric is tentatively taken as 140 g/m, the per capita consumption of woven fabric becomes 7.8 meters. This figure seems to be appropriate as the consumption amount in view of the per capita figure of 7.0 meter for the year 1970 confirmed by the Directorate General of Textile Industry.

On the basis of the above studies, an assumption is made that the total textile consumption for the year 1971 was 135,000 tons and this figure will hereafter be employed as the basis for formulating the relative demand forecast.

3-2 Material-wise and Form-wise Textile Consumption

3-2-1 Surveys Conducted in the Past on Material-wise and Form-wise Textile Consumption

The largest problem encountered when surveying the material-wise and form-wise textile consumption in Indonesia is the fact that it is not possible to obtain information in which the materials are clearly stipulated. In other words, in the case of the data available from the Directorate General of Textile Industry, the Departemen Perindustrian, no material name is described in the data and in the case of the Indonesian import statistics the only classification made in the data is the natural fiber man-made fiber categorization.

As far as the above-mentioned 11-country export statistics are concerned, although there are several items for which the clarification of the materials is difficult, clarification in this respect can be made for the most part and even concerning those ambiguous items, it is possible to formulate a fairly accurate estimation concerning the materials employed.

This being the circumstance, the material-wise and form-wise textile consumption in Indonesia was estimated on the basis of the 11-country export statistics.

(1) The Material-wise Textile Consumption on the Basis of the 11-country Export Statistics:

Table IV-16 shows the material-wise textile consumption in Indonesia for the period from 1967 to 1972.

Table IV-16 Material-wise Textile Consumption in Indonesia

(ton)

	1967	1968	1969	1970	1971	1972
Natural	99,400 (81)	99,300 (83)	100,900 (77)	86,700 (72)	94,000 (65)	97,449[1] (60)
Regenerated	11,540 (10)	9,550 (8)	11,051 (8)	9,687 (8)	10,856 (8)	10,873 (7)
Synthetic	11,066 (9)	10,498 (9)	19,341 (15)	24,255 (20)	38,626 (27)	52,674 (33)
Total	122,006	119,348	131,292	120,642	143,482	160,996

Notes: ( ) ----- % on total textile consumption.
1) Estimated by the ratio of FAO/Exports Statistics in 1971

Source: Exports Statistics, FAO

The natural fiber consists mostly of cotton, however, the absolute amount has been almost unchanged over the past five years. The same applied to the case of regenerated fiber.

On the other hand, as far as the synthetic fiber is concerned, 4.8-fold increment from 11,000 tons in 1967 to 53,000 tons in 1972 has been achieved. In this respect, the increment achieved during the years 1971 and 1972 is particularly conspicuous. In other words, it can be stated that the textile consumption increment in Indonesia achieved over the past five years has been the result of the increment made in the synthetic fiber consumption. As a result, the rate comprised by natural fiber in the total textile consumption has been reduced to 65% in 1971 from 81% in 1967 and further, was lowered to 60% by 1972.

On the contrary, the share of synthetic fiber (share comprized by synthetic fiber in the total textile consumption) grew from 9% in 1967 to 27% in 1971 and further up to 33% by 1972. Concerning the ratio comprized by the regenerated fiber, a slight reduction trend has been noted.

Tables IV-17 through IV-19 show the material-wise consumption and the rates thereof obtained on the same method as applied to Indonesia concerning the Philippines, Thailand and Malaysia. It must be noted here that the production of synthetic fiber is being carried out in the Philippines and Thailand so that the production amount was obtained on the basis of the Textile Organon and the consumption level was assessed by adding the production amount to the export amount obtained from the 11-country export statistics. In the case of these three countries, the consumption of natural fiber and regenerated fiber has been maintaining over the past four years either status quo or a slight uptrend.

Table IV-17 Material-wise Textile Consumption in The Philippines

(ton)

	1967	1968	1969	1970	1971
Natural	40,100 (57)	46,900 (52)	46,200 (50)	43,700 (50)	40,600 (40)
Regenerated	22,223 (31)	26,599 (30)	27,800 (30)	25,315 (29)	27,306 (27)
Synthetic	8,508 (12)	15,798 (18)	18,218 (20)	18,942 (21)	33,696 (33)
Total	70,831	89,297	92,218	87,957	101,602

Note: ( ) ----- % on total textile consumption

Source: Exports Statistics, FAO, Textile Organon

Table IV-18 Material-wise Textile Consumption in Thailand

(ton)

	1967	1968	1969	1970	1971
Natural	71,800 (79)	65,500 (78)	62,500 (75)	66,600 (73)	71,200 (68)
Regenerated	9,032 (10)	7,942 (10)	8,039 (10)	8,416 (9)	9,330 (9)
Synthetic	9,983 (11)	9,972 (12)	12,583 (15)	16,894 (18)	24,016 (23)
Total	90,815	83,414	83,122	91,910	104,546

Note: ( ) ----- % on total textile consumption

Source: Exports Statistics, FAO, Textile Organon

Table IV-19 Material-wise Textile Consumption in Malaysia

(ton)

	1967	1968	1969	1970	1971
Natural	17,100 (72)	23,500 (76)	21,800 (70)	23,000 (72)	21,700 (62)
Regenerated	3,693 (16)	2,733 (9)	3,225 (10)	2,197 (7)	4,840 (14)
Synthetic	2,805 (12)	4,475 (15)	6,273 (20)	6,720 (21)	8,274 (24)
Total	23,598	30,708	31,298	31,917	34,814

Note: ( ) ----- % on total textile consumption

Source: Exports Statistics, FAO

On the contrary, the consumption of synthetic fiber has grown over the past four years by approximately 4 times in the case of the Philippines, 2.4 times in Thailand and approximately 3 times in Malaysia, thereby displaying an analogous trend to the case of Indonesia. In the case of the Philippines in particular, the ratio taken up by regenerated fiber in the total textile consumption has been displaying a high level of 30% over the past four years and in this respect, the Philippines shows a unique trend.

(2) Form-wise Synthetic Fiber Consumption on the Basis of the 11-country Export Statistics:

Table IV-20 shows the classification of Indonesian synthetic fiber consumption into the categories of FY, SF, spun yarn and fabric.

Table IV-20 Form-wise Synthetic Fiber Consumption in Indonesia

(ton)

	1967	1968	1969	1970	1971	1972
SF, FY	236 (2)	718 (7)	5,249 (27)	5,473 (23)	8,534 (22)	16,125 (31)
Spun Yarn	- (-)	282 (3)	1,470 (8)	3,337 (14)	8,186 (21)	11,829 (22)
Fabric	10,830 (98)	9,498 (90)	12,622 (65)	15,445 (63)	21,906 (57)	24,720 (47)
Total	11,066	10,498	19,341	24,255	38,626	52,674

Note: ( ) ----- % on total synthetic textile consumption

Source: Exports Statistics

For the year 1967, the consumption in the form of FY, SF and spun yarn was extremely small and most of the consumption was taken up by that of fabric. However, the consumption in the form of FY, SF and spun yarn has since been showing yearly growth so that by 1972 the consumption displayed the levels of 16,000 tons for SF and FY, and 12,000 tons for spun yarn, thereby increasing the rate of FY and SF together in the total synthetic fiber consumption up to 31% and that of spun yarn to 22%. The rate taken up by fabric on the contrary was reduced to 47%.

Tables IV-21 through IV-23 show the form-wise consumption in the Philippines, Thailand and Malaysia.

Table IV-21 Form-wise Synthetic Fiber Consumption in The Philippines

(ton)

	1967	1968	1969	1970	1971
SF, FY	4,221 (50)	10,111 (64)	11,474 (63)	13,019 (69)	28,280 (84)
Spun Yarn	434 (5)	1,246 (8)	1,149 (6)	327 (2)	880 (3)
Fabric	3,853 (45)	4,441 (28)	5,595 (31)	5,596 (29)	4,536 (13)
Total	8,508	15,798	18,218	18,942	33,696

Source: Exports Statistics, Textile Organon

Note: ( ) ----- % on total synthetic textile consumption

Table IV-22 Form-wise Synthetic Fiber Consumption in Thailand

(ton)

	1967	1968	1969	1970	1971
SF, FY	2,207 (22)	2,502 (25)	5,680 (45)	9,812 (58)	18,682 (78)
Spun Yarn	834 (8)	986 (10)	1,858 (15)	1,751 (10)	1,648 (7)
Fabric	6,942 (70)	6,484 (65)	5,045 (40)	5,331 (32)	3,686 (15)
Total	9,983	9,972	12,583	16,894	24,016

Source: Exports Statistics, Textile Organon

Note: ( ) ----- % on total synthetic textile consumption

Table IV-23 Form-wise Synthetic Fiber Consumption in Malaysia

(ton)

	1967	1968	1969	1970	1971
SF, FY	225 (8)	289 (6)	292 (5)	536 (8)	1,083 (13)
Spun Yarn	- (-)	40 (1)	101 (1)	303 (5)	134 (2)
Fabric	2,580 (92)	4,146 (93)	5,880 (94)	5,881 (87)	7,057 (85)
Total	2,805	4,475	6,273	6,720	8,274

Source: Exports Statistics

Note: ( ) ----- % on total synthetic textile consumption

The trend in the form-wise synthetic fiber consumption rate in the Philippines and Thailand shows analogy with that in Indonesia, however, both the Philippines and Thailand show a considerably higher level of consumption rate in the form of FY and SF when compared with the case of Indonesia so that by 1971, the rate in the case of the Philippines was 84% and 78% in Thailand. Also, the consumption rate in the form of spun yarn is considerably low in both cases of the Philippines and Thailand and a trend of slight decrease in this respect year after year is noted.

Further in the case of Malaysia, an overwhelming portion is taken up by the consumption in the form of fabric even in the year 1971 and consumption in the form of FY, SF and spun yarn is extremely low.

(3) Material-wise Synthetic Fiber Consumption on the Basis of the 11-country Export Statistics

Table IV-24 shows the synthetic fiber consumption in Indonesia in accordance with materials. The material-wise consumption in the year 1972 reveals the highest extent in the case of polyester SF at 22,000 tons followed by 15,000 tons of nylon FY and 12,000 tons of polyester FY. In view of the material-wise consumption growth over the past five years, it is revealed that nylon FY (including SF) increased by 4.5 times, while polyester SF by 3.6 times, polyester FY by 10.3 times and acrylic SF by 8.0 times.

Table IV-24 Material-wise Synthetic Fiber Consumption in Indonesia

(ton)

	1967	1968	1969	1970	1971	1972
Nylon SF	145 (1.3)	62 (0.6)	474 (2.5)	124 (0.5)	71 (-)	16 (-)
" FY	3,170 (28.6)	2,919 (27.8)	8,262 (42.7)	9,097 (37.5)	10,943 (28.3)	14,881 (28.3)
Polyester SF	6,185 (55.9)	6,019 (57.3)	7,784 (40.2)	11,089 (45.8)	18,217 (47.4)	22,491 (42.7)
" FY	1,183 (10.7)	974 (9.3)	1,908 (9.9)	2,967 (12.2)	6,533 (16.9)	12,221 (23.2)
Acrylic SF	383 (3.5)	524 (5.0)	913 (4.7)	978 (4.0)	2,862 (7.4)	3,065 (5.8)
Total	11,066	10,498	19,341	24,255	38,626	52,674
Share of SF(%)	60.7	62.9	47.4	50.3	54.8	48.5

Note: ( ) ----- % on total synthetic textile consumption

Source: Exports Statistics

Polyester FY in particular shows a high extent of growth over the past two years. Because of this fact, the rate comprized by polyester FY in the total synthetic fiber consumption increased drastically from 12% in 1970 to 23% in 1972. In the meantime, the rate comprized by nylon FY displayed a diminishing trend, while polyester SF and acrylic SF rates maintaining the status quo. The rate taken up by SF in the total synthetic fiber consumption is approximately 50%.

Tables IV-25 through IV-27 show the material-wise synthetic fiber consumption regarding the Philippines, Thailand and Malaysia. It can be seen from these tables that the consumption rate of the materials vary considerably from country to country. As far as the material-wise consumption rate for the year 1971 is concerned, the Philippines shows the highest rate of 44% in polyester SF, followed by 37% for nylon FY and 9% for polyester FY.

Table IV-25 Material-wise Synthetic Fiber Consumption in The Philippines

(ton)

	1967	1968	1969	1970	1971
Nylon SF	49 (0.6)	21 (0.1)	115 (0.6)	116 (0.6)	89 (0.3)
" FY	3,662 (43.1)	7,149 (45.3)	8,350 (45.9)	7,348 (38.8)	12,567 (37.3)
Polyester SF	2,862 (33.6)	4,823 (30.6)	5,892 (32.4)	8,042 (42.5)	14,986 (44.4)
" FY	1,014 (11.9)	1,851 (11.7)	1,722 (9.4)	1,748 (9.2)	3,035 (9.0)
Acrylic SF	921 (10.8)	1,954 (12.3)	2,139 (11.7)	1,688 (8.9)	3,019 (9.0)
Total	8,508	15,798	18,218	18,942	33,696
Share of SF(%)	45.0	43.0	44.7	52.0	53.7

Source: Exports Statistics, Textile Organon

Note: ( ) ----- % on total synthetic textile consumption

Table IV-26 Material-wise Synthetic Fiber Consumption in Thailand

(ton)

	1967	1968	1969	1970	1971
Nylon SF	116 (1.2)	68 (0.7)	11 (0.1)	81 (0.5)	-
" FY	3,812 (38.2)	4,459 (44.8)	4,322 (34.3)	4,807 (28.4)	6,901 (28.7)
Polyester SF	4,531 (45.4)	3,985 (39.9)	7,113 (56.6)	9,479 (56.1)	13,124 (54.7)
" FY	832 (8.3)	1,028 (10.3)	622 (4.9)	1,872 (11.1)	3,116 (13.0)
Acrylic SF	692 (6.9)	432 (4.3)	515 (4.1)	655 (3.9)	875 (3.6)
Total	9,983	9,972	12,583	16,894	24,016
Share of SF(%)	53.5	45.9	60.8	60.5	58.3

Source: Exports Statistics, Textile Organon

Note: ( ) ----- % on total synthetic textile consumption

Table IV-27 Material-wise Synthetic Fiber Consumption in Malaysia

(ton)

	1967	1968	1969	1970	1971
Nylon SF	- (-)	3 (0.1)	9 (0.1)	6 (0.1)	2 (-)
" FY	1,073 (38.3)	1,961 (43.9)	2,256 (36.1)	2,715 (40.4)	3,574 (43.2)
Polyester SF	879 (31.3)	1,277 (28.5)	1,929 (30.7)	2,083 (31.0)	2,355 (28.5)
" FY	688 (24.5)	1,071 (23.9)	1,820 (29.0)	1,747 (26.0)	2,175 (26.3)
Acrylic SF	165 (5.9)	163 (3.6)	259 (4.1)	169 (2.5)	168 (2.0)
Total	2,805	4,475	6,273	6,720	8,274
Share of SF(%)	37.2	32.2	34.9	33.6	30.5

Note: ( ) ----- % on total synthetic textile consumption   Source: Exports Statistics

In the case of Thailand, the highest rate of 55% is taken by polyester SF, followed by 29% for nylon FY and 13% for polyester FY. Malaysia on the other hand shows the highest of 43% for nylon FY, followed by 29% for polyester SF and 26% for polyester FY, thereby showing an order which is different from those of the other countries. This is due to the fact that in Malaysia, approximately 1/3 of nylon FY consumption every year has been comprised by tyrecord fabrics and fishing nets.

3-2-2 Material-wise Textile Consumption in 1971

On the basis of the results of the scrutinizations made in the foregoing paragraphs, an estimation is made on the material-wise textile consumption in Indonesia which was achieved in the year 1971. It was already estimated in 3-1-2 that the total textile consumption in Indonesia was 135,000 tons. Concerning the rates of each one of the materials, Table IV-16 shows that in 1971, natural fiber took up 65%, regenerated fiber comprised 8% and 27% by synthetic fiber. In view of the trend of these rates, it seems reasonable to apply these material-wise consumption rate for the year 1971 directly to the present scrutinization. In other words, the share of synthetic fiber is therefore estimated as having been 27%.

As shown in Table IV-24, the material-wise rate of synthetic fiber consumption displays a considerable extent of fluctuation from year to year. Therefore, in this case, the average of 1970 and 1971 figures was adopted as the material-wise synthetic fiber consumption rate for the year 1971. This signifies that the rates are 33.1% for nylon FY, 46.6% for polyester SF, 14.6% for polyester FY and 5.7% for acrylic SF.

On the basis of the above data, the consumption of each of the materials and the rates comprised in the total textile consumption in the year 1971 can be obtained and stipulated as shown in Table IV-28. It must be noted here that the separation into SF and FY concerning the regenerated fiber was undertaken in accordance with the method stipulated in III 2-2-2 (4). Also, for the most part, the regenerated fiber consists of rayon.

Table IV-28 Material-wise Textile Consumption in Indonesia (1971)

	Quantity (t/y)	Ratio (%)	
Cotton, Other Natural Fibers	87,750	65.0	
Nylon FY	12,060	8.9	27.0
Polyester SF	16,990	12.7	
Polyester FY	5,320	3.9	
Acrylic SF	2,080	1.5	
Regenerated SF	8,640	6.4	8.0
Regenerated FY	2,160	1.6	
Total	135,000	100.0	

Source: UNICO Estimate

Comparison with the Previous Survey Results

In accordance with the forecast results made in the previous survey, the material-wise textile consumption in 1971 (in the case of 12%/y growth rate for the total textile) is as shown in Table IV-29. The total textile consumption amount revealed by the present survey was, as mentioned earlier, 135,000 tons which exactly coincides with the result obtained through the previous survey. However, the rates comprised by regenerated fiber and synthetic fiber in the total textile consumption have shown a considerably higher level than the ones obtained in the previous survey.

Table IV-29 Material-wise Textile Consumption in Indonesia Obtained by Previous Survey (1971)

	Quantity (t/y)	Ratio (%)	
Cotton	99,800	74.3	
Nylon FY	7,900	5.9	21.2
Polyester SF	12,700	9.4	
Polyester FY	4,900	3.6	
Acrylic SF	1,200	0.9	
Others	1,900	1.4	
Regenerated SF	5,100	3.8	4.5
Regenerated FY	900	0.7	
Total.	134,400	100.0	

Note: Average annual growth rate is 12.0%

Source: The Republic of Indonesia, Survey Report on Synthetic and Rayon Fiber Industry Development (OTCA, Feb. 1973)

As far as this point is concerned, it is considered that in the previous survey, estimates of share of the regenerated fiber and the synthetic fiber were made on the basis of the exportation made from Japan and Singapore, while in the present survey, the study was made on the basis of the 11-country export statistics as mentioned above. Therefore, the accuracy of the present survey results is considered to be much higher than that of the previous survey.

4. Synthetic Fiber Demand Forecast in Indonesia

The population forecast figures and the per capita GNP forecast figures shown in Table IV-30 were employed as the basic data for the demand forecast. These figures are identical to those stipulated in the previous survey and the calculations have been made on an assumption that the growth rate of the population and the per capita GNP will be maintained up to 1981.

Table IV-30 Forecast on Population and Per Capita GNP in Indonesia

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Population (10^6 men)	124.4	127.5	130.9	134.0	137.1	140.3	143.5	146.8	150.2	153.6	157.1
Per Capita GNP (US$/y)	114	120	127	133	141	148	156	165	173	183	193

Source: Departemen Perindustrian, A.I.D., World Bank's Report

4-1 Domestic Total Textile Consumption

As stated in the previous survey generally speaking, there is a positive correlation between per capita textile consumption and per capita GNP in a given country.

Figure IV-4 shows the results of plotting, on the basis of FAO's textile statistics and AID's per capita GNP, the correlation between the per capita GNP and the per capita textile consumption concerning the developing 29 countries having more than one million population and with less than US$500 level of per capita GNP as of 1971.

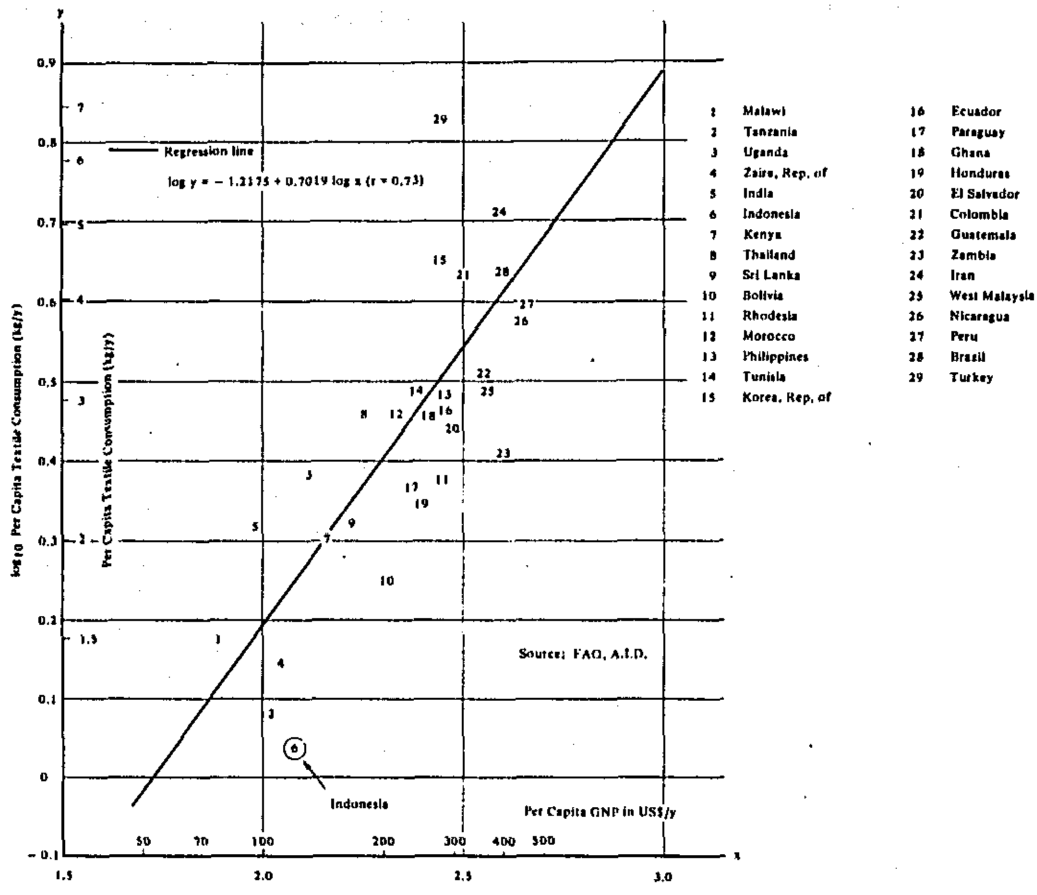


Figure IV-4 Relationship between Per Capita Textile Consumption and Per Capita GNP in Developing Countries (1971)

A detailed study of per capita textile consumption in Indonesia revealed, as has been mentioned earlier, that a figure 1.09 kg/y can be taken as a reasonable estimate. Therefore, this figure has been adopted in plotting Figure IV-4. The regression formula can be stated as follows:

$$\log y = -1.2175 + 0.7019 \log x \quad (r=0.73)$$

Where: y: per capita textile consumption (kg/y)

x: per capita GNP (US$/y)

Figure IV-5 on the other hand shows the results of plotting the data covering approximately pust 10 years up to the present regarding the countries belonging to the same area as Indonesia, i. e., the Philippines, Thailand and Malaysia together with the Indonesian counterpart data.

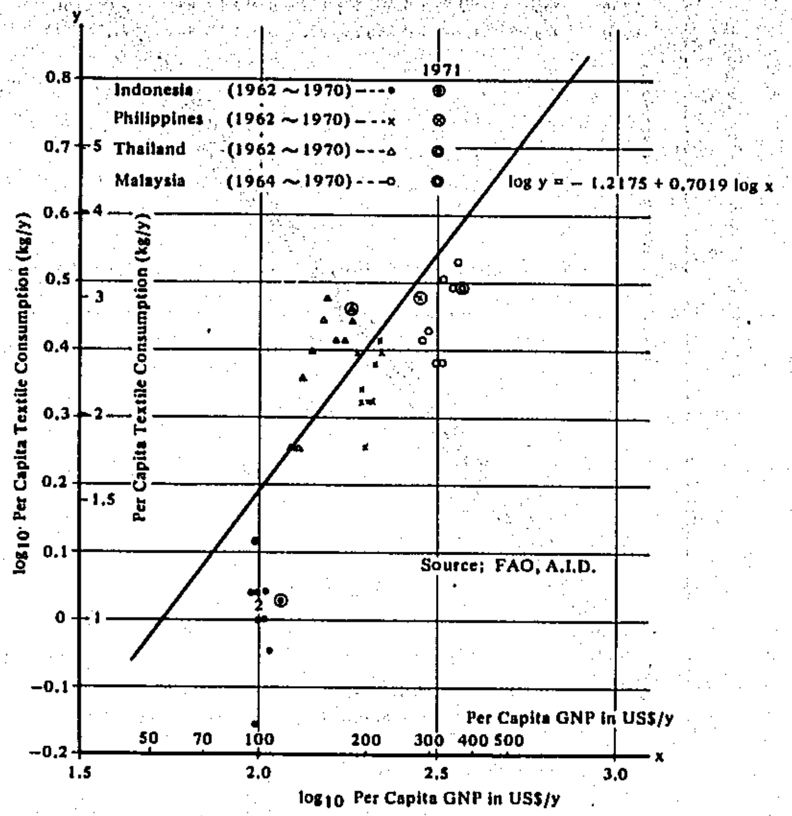


Figure IV-5 Relationship between Per Capita Textile Consumption and Per Capita GNP in Southeast Asian Countries

In the case of Indonesia, little increase has been achieved in terms of per capita GNP during the period from 1962 to 1971 according to the AID material, thereby presenting a certain extent of doubt as to the reliability of this material. However, regarding the Philippines and Malaysia, the plotted points align themselves in the vicinity of the regression line obtained from the plotting made in Figure IV-4.

In the case of Southeast Asian countries, it has been revealed that the per capita textile consumption and the per capita GNP relationship can be clearly represented by the above-mentioned regression formula.

Further, Figure IV-6 shows the regression line regarding the correlation between the yearly per capita textile consumption in the various countries of the world and the GNP per capita. The regression line remains almost unchanged from year to year. Therefore, it is assumed that the correlation between the per capita textile consumption and per capita GNP illustrated in Figure IV-4 should be maintained in the future.

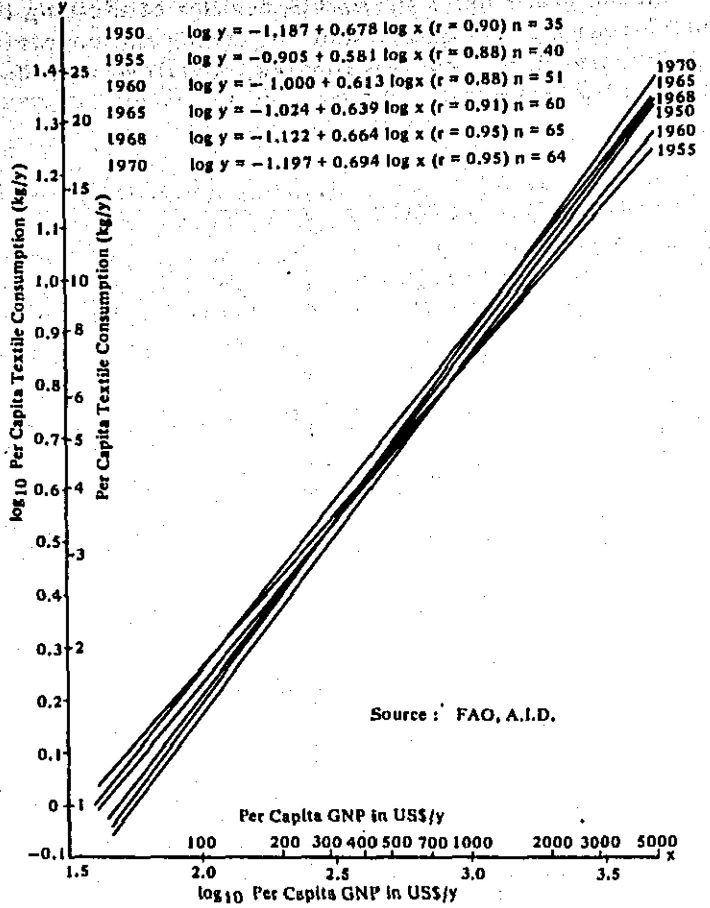


Figure IV-6 Relationship between Per Capita Textile Consumption and Per Capita GNP in the World

Here, the key point in the formulation of the demand forecast for Indonesia in terms of per capita textile consumption is to forecast the time factor as to when the per capita textile consumption in Indonesia will attain the similar status to those displayed by the other countries as shown in Figure IV-4.

As is evident from Figure IV-5, there must have been some reason for the fact that the actual record values of Indonesia have invariably been staying downward from the regression line for the past decade.

However, in the First Five-year plan, the textile industry of Indonesia accomplished results exceeding the originally set target figures and the Second Five-year Plan which starts this year also involves the emphasized target of further substantiation in the clothing supply. In view of the results obtained through the on-site surveys, the facility substantiation is now positively undertaken both in the case of P. N. Sandang and Pinda Sandang and highly active facility expansions are being undertaken at foreign joint-venture companies, local-capital private industries, etc.

Also, a number of applications for the industrialization of synthetic SF and FY productions are being submitted. It is therefore strongly anticipated that the textile consumption level of Indonesia will quickly approach the level of the other countries.

In the following paragraphs, examples of textile consumption increment in various countries will be described.

Table IV-31 shows the trend of per capita textile consumption during a 9-year period from 1962 to 1971, concerning those countries in which the per capita textile consumption level is comparatively low and at the same time, the increment thereof has been conspicuous. According to Table IV-31 the per capita textile consumption in Togo increased from 0. 7 kg/y in 1962 to 2. 2 kg/y in 1971, thereby displaying an increase by 3. 1 times. The per capita textile consumption growth is also high in the cases of Cameroon and Congo where the consumption grew by 2. 3 times and 2. 0 times respectively during the period from 1962 to 1971.

Table IV-31 Trend of Per Capita Textile Consumption in Developing Countries

(kg/y)

	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	Times (1971/1962)
Togo	0.7	1.1	2.3	2.1	2.5	2.6	2.6	1.7	2.0	2.2	3.1
Cameroon	1.3	1.1	1.6	1.3	1.4	2.0	1.9	2.2	2.7	3.0	2.3
Congo, People's Rep. of	1.1	1.5	1.0	1.3	1.0	2.6	2.7	2.4	2.1	2.2	2.0
Equador	1.7	2.1	2.3	2.3	2.3	2.2	2.4	2.7	2.8	3.0	1.8
Central African Rep.	1.4	1.5	2.1	1.7	1.7	2.0	2.1	2.5	2.3	2.3	1.6
Thailand	1.8	1.8	2.3	2.5	2.8	3.0	2.6	2.6	2.8	2.9	1.6

Source: FAO

In these countries, the per capita textile consumption was low in the outset so that in the case of Indonesia, it is amply anticipated that a sudden increment will be achieved in the forthcoming decade in per capita textile consumption towards the level of 2 to 3 kg/y.

If an assumption is made that from Table IV-30 the per capita GNP will be US$193/y, in 1981, and if per capita textile consumption for the same year is obtained in accordance with the above-mentioned regression formula, the result becomes 2.44 kg/y. As the per capita textile consumption in 1971 was 1.09 kg/y, the expected increment rate for the forthcoming decade will be approximately 2. 2 times. The achievement of 2. 2-fold increment in per capita textile consumption during a decade represents a considerably drastic increase. However, as has already been mentioned, the per capita textile consumption for the year 1971 was estimated to have been 1. 09 kg/y and therefore, the level is on especially low level amongst the developing countries. Also in view of the fact that there are several examples in foreign countries in which the above-mentioned drastic rate of growth has been already achieved, it is highly possible that such a growth in the consumption will be attained in Indonesia in view of the active present status of textile industry in Indonesia.

It is well known that Indonesia is rich in oil production and the industrialization is also advancing rapidly so that a remarkable economic growth is being forecast for the future of Indonesia. An integral observation of these factors will almost surely lead to a forecast that per capita textile consumption will be 2 to 3 kg/y. Total textile consumption in Indonesia in 1981 is forecast as shown in Table IV-32.

Table IV-32 Total Textile Consumption and Per Capita Textile Consumption in Indonesia in 1981

	Per Capita Textile Consumption (kg/y)	Total Textile Consumption (t/y)	Growth Rate (%/y)
Minimum	2.2	351,000	10.1
Medium	2.4	383,000	11.1
Maximum	2.7	420,000	12.1

Notes: 1. Population 157 10^6 men
2. Per Capita GNP US$193/y

Source: UNICO Estimate

4-2 Domestic Synthetic Fiber Demand

4-2-1 Share of Synthetic Fiber

The share of synthetic fiber in Indonesia has been forecast on the basis both on the trend of share of synthetic fiber in other countries and on thė future supply/demand balance of natural fiber and regenerated fiber in the world.

(1) Forecast Based on the Share of Synthetic Fiber in Other Countries:

Figure IV-7 shows the trend of share of synthetic fiber in Indonesia as well as in the Philippines, Thailand, Malaysia all of which are located in Southeast Asia. In 1967, the share of synthetic fiber in these four countries were approximately 10%, however, the growth of share of synthetic fiber in the Philippines attained a level of 33% in 1971 which is higher than the case of Indonesia, Thailand and Malaysia. Also the share of synthetic fiber in Indonesia in 1971 was 27% which is higher than the rates attained in Thailand and Malaysia.

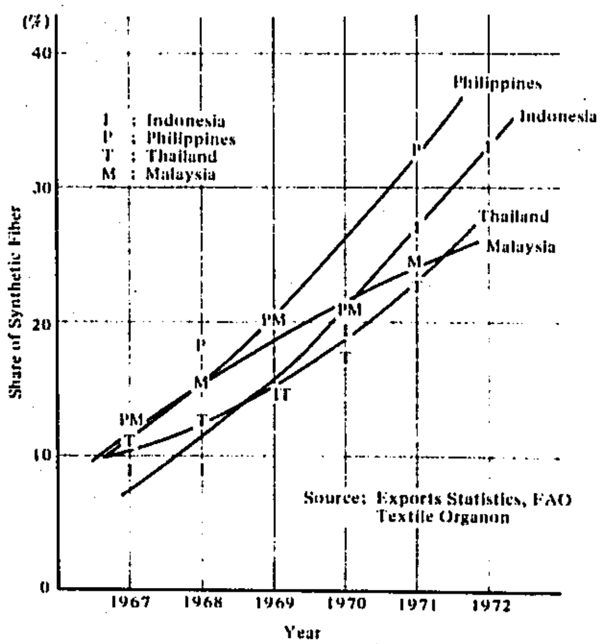


Figure IV-7 Trend of Share of Synthetic Fiber in Southeast Asian Countries

It is somehow difficult to understand that share of synthetic fiber in Indonesia is higher than that of Thailand, as the synthetic fiber processing industry of Indonesia began much later than that of Thailand where the industry has better progressed. Therefore, the share of synthetic fiber in Indonesia should rather be lower than that of Thailand. The reason why the share of synthetic fiber in Indonesia in 1971 was higher than that of Thailand may be attributable to an assumption that the abovementioned exportation from Singapore to Indonesia was deemed to be on a level of 70% of the difference between the import of textile (except clothing) into Singapore and the export of textile (except clothing) from Singapore. Also, in this case, it may be due to the fact that the abovementioned 70% rate was uniformly applied to all the natural fiber, regenerated fiber and synthetic fiber.

On the other hand, the trends of share of synthetic fiber in the developed countries are shown in Figure IV-8. Share of synthetic fiber in these countries in 1962 were 10 to 15%, and then were increased to 35% to 40% by 1971, and no saturating trend has yet been noted in this respect. This being the circumstance, it is forecast that the share of synthetic fiber in Indonesia will further increase in the future.

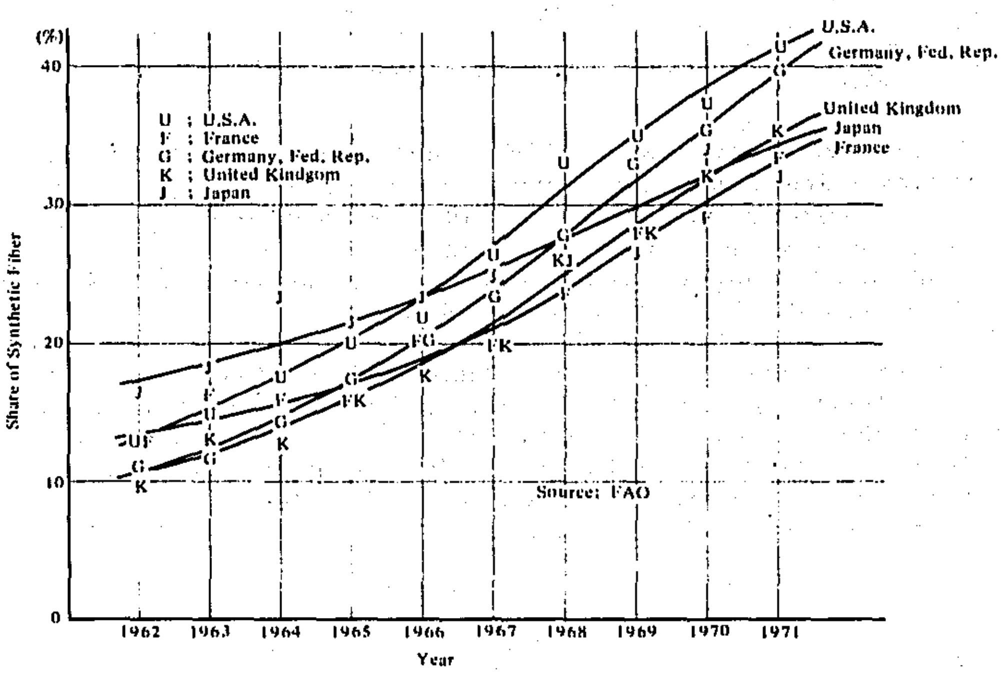


Figure IV-8 Trend of Share of Synthetic Fiber in Developed Countries

Due to the insufficiency of data on each one of the countries, it is difficult to forecast the future trend of share of synthetic fiber in Indonesia. Therefore, Figure IV-9 shows the integrated trend of share of synthetic fiber in the four countries.

In formulating this Figure, the rates of the Philippines have been shifted by one year, e.g., the 1970 figure was plotted in the 1971 position in the Figure, due to the fact that the rates of the Philippines are higher than those of other countries.

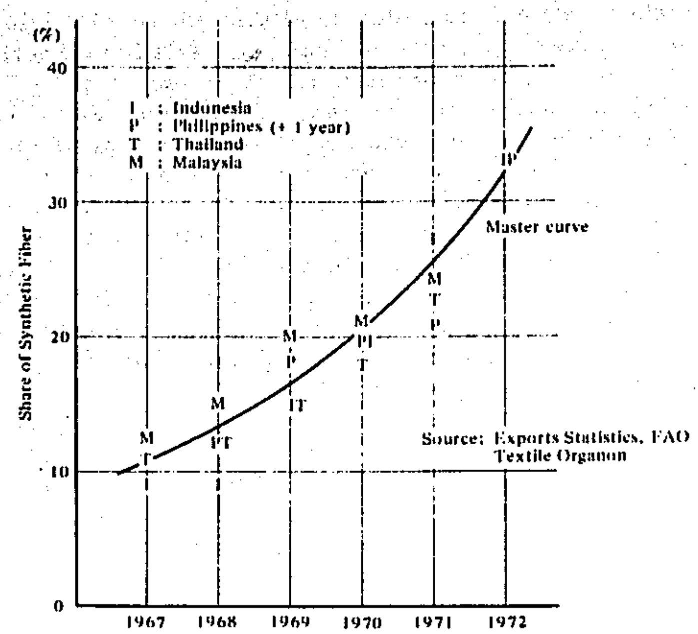


Figure IV-9 Master Curve of Share of Synthetic Fiber

As an almost distinctive trend is present in the Figure, the trend was approximated to the logistic curve. In this case, the upper limit of share of synthetic fiber was set at 40%, on the basis of the observations of the above-mentioned actual records of the other countries, weather conditions in Southeast Asia and also the forecast data on the synthetic fiber demands of the world mentioned in 2-1.

In the previous survey, the upper limit of share of synthetic fiber was set at 35%. However, in the present survey, the upper limit is forecast at 40% due to the fact that no trend towards saturation has yet been noted in the developed countries and that the supply/demand balances of natural fiber and regenerated fiber are deemed almost definitely to become tight. The regression formula is as follows;

$$\log\left(\frac{y}{40-y} \times 10^{8}\right) = -406.81 + 0.20807x \quad (r = 0.959)$$

Where ; y : Share of Synthetic Fiber (%)

x : Year (e. g. , 1975)

Figure IV-10 shows the forecast of share of synthetic fiber on the above-mentioned regression formula.

Table IV-33 shows the share of synthetic fiber in Indonesia up to 1981 estimated from the above-mentioned regression formula, i.e., 38.2% in 1976 and 40.0% in 1981.

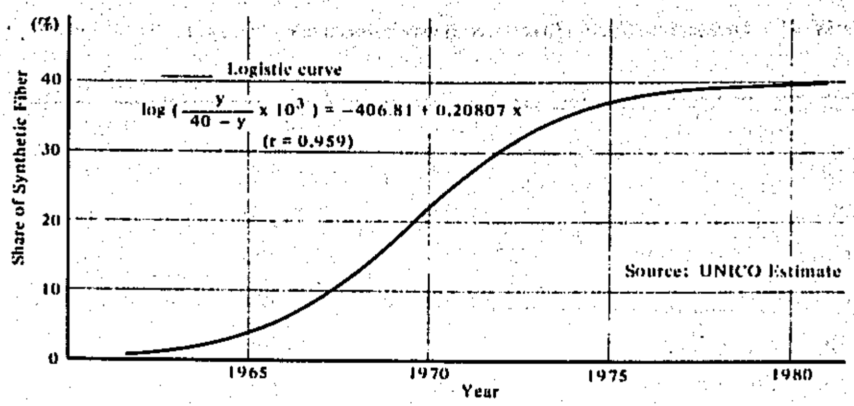


Figure IV-10 Logistic Curve of Share of Synthetic Fiber in Indonesia

Table IV-33 Forecast on Share of Synthetic Fiber in Indonesia

(%)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Share of Synthetic Fiber	27.0	30.4	33.5	35.7	37.2	38.2	38.9	39.3	39.6	39.8	40.0

Source: UNICO Estimate

(2) Forecast Based on Natural Fiber and Regenerated Fiber:

It would not be appropriate to take no account of supply/demand balances of natural fiber and regenerated fiber when formulating a forecast on synthetic fiber demand in a certain country.

The reason for such an assumption is that natural fiber or regenerated fiber and synthetic fiber are interchangeable in some uses. This being the circumstance, studies were made concerning the future availability of regenerated fiber and cotton which occupy most of the natural fiber demand in Indonesia.

(a) Availability of Cotton:

1) The Future Supply/Demand of Cotton in the World

It is generally understood that the prospect on cotton production expansion is poor throughout the world.

Table IV-34 shows an estimate on the extent of future cotton cultivation areas of major cotton producting countries and other countries on the basis of the "Cotton", published by the International Cotton Advisory Committee and the "Monthly Report of Japan Spinners' Association", published by the Japan Spinners' Association.

Table IV-34 Forecast on Cotton Plantation Areas in the World

(10^3 ha)

	1971	1976	1981
Mexico	494	450	450
U. S. A.	4,221	4,000	4,000
North, Central America 1)	256	200	150
Brazil	2,606	2,500	3,000
South America 2)	891	1,100	1,300
Western Europe	259	150	50
Eastern Europe	65	50	50
U. S. S. R.	2,565	2,700	3,100
China, People's Rep. of	4,689	4,700	4,700
India	7,683	7,300	7,000
Pakistan 3)	1,845	2,000	2,200
Turkey	641	600	500
Asia 4)	1,040	1,100	1,200
Oceania	36	50	100
Egypt	659	650	650
Sudan	512	550	600
Africa 5)	3,414	4,000	4,500
World Total	31,967	32,100	33,550

Source: Cotton (ICAC),
Monthly Report of Japan Spinners' Association

Notes:
1) Excluding Mexico, U.S.A.
2) " Brazil
3) Including Bangladesh
4) " China, People's Rep. of, India, Pakistan, Turkey
5) " Egypt, Sudan

According to this estimate, the cultivation areas in 1976 is approximately the same as the areas in 1971. It is also estimated that even in 1981, the cultivation areas will be increased by only 5% when compared with 1971. In other words, the future cotton cultivation area expansion is hardly feasible.

It is expected that the cotton yield per unit area will increase due to species improvements and progress in irrigation technique. Table IV-35 shows a forecast on future cotton production. The estimate was made by calculating the expected increases in the yield, on the basis of the data taken from the "Production Yearbook", published by FAO, and by incorporating the calculation results into the above-stated cultivation area data.

Table IV-35 Forecast on the Cotton Production in the World

		1971	1976	1981
Acreage	(10^3 ha)	31,967	32,100	33,550
Yield	(ton/ha)	0.365	0.380	0.395
Production	(10^3 ton)	11,668	12,200	13,250

Source: FAO, Table IV-34

On the other hand, Table IV-36 shows a forecast on future world cotton demand. The estimate was made by calculating the expected per capita cotton consumption on the basis of the trend in the data taken from the above-stated Figure IV-2, and by incorporating the calculation results into the expected world population estimated by FAO.

Table IV-36 Forecast on Cotton Demand in the World

	1971	1976	1981
Per Capita Consumption (kg/y)	3.14	3.01	2.88
Population (10^6 men)	3,797	4,208	4,671
Consumption (10^3 ton)	11,923	12,666	13,452

Source: Textile Organon, FAO

According to Table IV-35 and Table IV-36, demand in 1976 will exceed supply by 470,000 tons, and in 1981, by 200,000 tons. Therefore, it is expected that cotton supply position will be tight in the future, and therefore circumstance will not easily allow cotton import.

2) Future of Domestic Cotton Production in Indonesia

In Indonesia at present, cotton is cultivated in East Java and the Lombok Island, however, the output is low. It is understood that there are a large amount of areas in Central Java, South Sulawesi or the Bali Island which are suitable for cotton cultivation, and positive efforts have been exerted there in order to promote cotton production.

Nevertheless, according to the draft of "Pola Pembangunan Industri Tekstil Repelita Tahap II", the cotton production during the Second Five-year Plan is as shown in Figure IV-11. The figure shows that the output in the final year of the plan (1978/1979) is approximately 14,000 tons which corresponds to only 0.09 kg/y per capita cotton consumption. Therefore, it seems inevitable that Indonesia will have to depend on import from other countries regarding the cotton supply for some time to come, and the circumstance will not allow Indonesia to achieve a vast increase in the cotton demand.

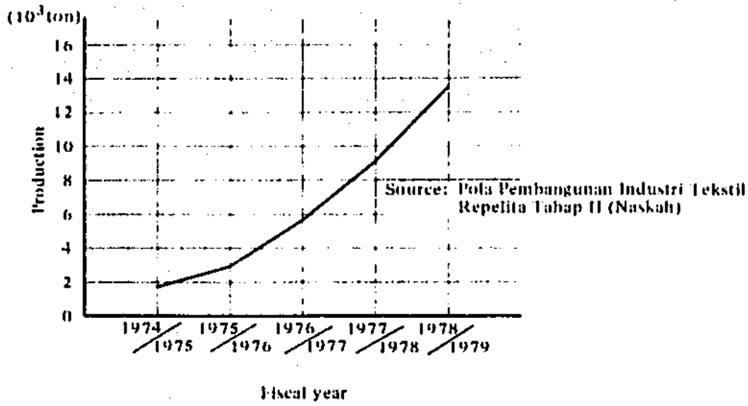


Figure IV-11 Cotton Production Plan in Indonesia

(b) Availability of Regenerated Fiber

It is understood that the prospect on regenerated fiber production expansion is not bright throughout the world. In the developed countries, regenerated fiber production is already declining due to the increase in the production cost caused by the price hike of material wood and increase in anti-pollution expenses. In the developing countries, on the other hand, inspite of the efforts for enhancing the production capacity, no significant production increase seems feasible.

Figure IV-12 shows the export surplus of major regenerated fiber producing countries and others. The figures were obtained by deducting domestic consumption from production. The only countries which possess comparatively large export surplus in 1971 are those in West Europe and Japan. In the West European countries, however, the export surplus is rapidly declining, and also in Japan, the export surplus shows a slight downtrend.

Table IV-37 shows the destination-wise rates of regenerated fiber exportation from Japan. Also, Table IV-38 shows the same rates in the case of exportation from West European countries. Approximately 60% of the exports made from Japan is destined to Asian countries and rates display a trend of slight increase. The exports from West Europe are dispersed to various destinations with the major locations such as East Europe, the U.S.S.R., Asia and Africa. The rate of Asia-destined exports from West Europe is between 10% and 20% and, here again, a slight extent of uptrend is noted.

However, as has been mentioned earlier, the export surplus capacity of both West European countries and Japan is declining so that it would be difficult for Indonesia to drastically increase the regenerated

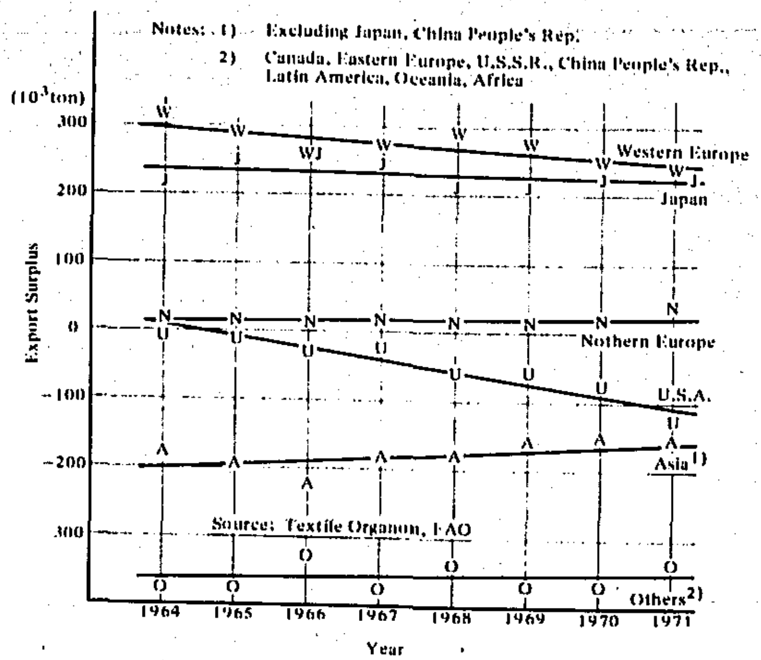


Figure IV-12 Trend of Export Surplus of Regenerated Fiber in the World

Table IV-37 Destination-wise Regenerated Fiber Exportation Rate From Japan

(%)

	1967	1968	1969	1970	1971
Canada	1.1	1.3	0.9	0.6	0.4
U.S.A.	5.8	5.7	5.3	3.7	3.6
Western Europe	2.3	2.8	4.7	4.1	3.3
Northern Europe	0.9	0.7	0.9	0.6	0.1
Eastern Europe	0.6	1.3	3.0	4.7	3.8
U.S.S.R.	3.5	3.0	3.5	1.9	2.3
China, People's Rep. of	9.3	6.5	5.3	10.0	3.8
Asia 1)	53.9	60.7	61.3	56.2	64.9
Latin America	4.8	4.6	4.5	5.8	6.7
Oceania	3.5	3.6	3.4	3.0	3.1
Africa	14.3	9.8	7.2	9.4	8.0

Note: 1) Excluding Japan, China, People's Rep. of   Source: Kasen Booeki Nenpoo

Table IV-38 Destination-wise Regenerated Fiber Exportation Rate from West Europe

(%)

	1967	1968	1969	1970	1971
Canada	0.7	1.0	1.1	1.5	1.0
U.S.A.	12.3	14.9	12.1	8.2	10.9
Northern Europe	5.3	5.2	4.7	4.1	2.8
Eastern Europe	13.2	16.9	22.1	24.8	21.0
U.S.S.R.	14.8	7.9	9.7	14.5	15.2
Japan	0.3	0.2	0.2	0.2	0.1
China, People's Rep. of	11.2	7.7	4.7	2.0	9.3
Asia 1)	15.7	16.3	14.7	15.9	17.2
Latin America	3.8	3.1	3.4	3.9	2.1
Oceania	3.5	2.4	2.6	3.5	2.7
Africa	19.2	24.4	24.7	21.4	17.7

Source: International Rayon and Synthetic Fibres Committee

Note: 1) Excluding Japan, China, People's Rep. of

fiber consumption unless the Indonesian domestic production of the item be undertaken.

At present, it seems that two or three companies are planning the introduction of rayon production industrial operations in Indonesia. However, nothing seems to be finalized concerning the commencement period of such planned operations and therefore, it seems difficult for sometime to come to fulfill domestic demand entirely by Indonesian domestic rayon production.

(c) Share of Synthetic Fiber in view of Natural and Regenerated Fibers

Table IV-39 shows the per capita consumption trends of cotton, regenerated fiber and total fiber in the developed countries, centrally planned countries, and developing countries. In the case of the developing countries, the consumption of both cotton and regenerated fiber is lower when compared with the developed and the centrally planned countries. As far as the per capita consumption of cotton is concerned, a downtrend is conspicuous in the developed countries, while a slight uptrend is noted in the centrally planned countries. The trend in the developing countries seems to maintain status quo.

Table IV-39 Trend of Per Capita Textile Consumption in the World

(kg/y)

		1964	1965	1966	1967	1968	1969	1970	1971
Developed Countries	Cotton	6.6	6.6	6.8	6.6	6.3	6.3	6.1	6.1
	Regenerated	2.9	2.9	2.8	2.7	2.9	2.9	2.6	2.7
	Total Fibers	13.2	13.7	14.2	14.0	15.0	15.6	15.4	16.1
Centrally Planned Countries	Cotton	2.8	2.9	3.0	3.0	3.1	3.0	3.1	3.2
	Regenerated	0.8	0.8	0.7	0.8	0.8	0.9	0.8	0.8
	Total Fibers	4.4	4.7	4.7	4.9	4.9	5.1	5.1	5.3
Developing Countries	Cotton	2.1	2.1	2.0	2.0	2.0	2.0	2.0	1.9
	Regenerated	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3
	Total Fibers	2.6	2.6	2.6	2.6	2.7	2.7	2.8	2.8

Source: FAO

On the other hand, concerning the regenerated fiber, the developed countries show a slight downtrend, while both the centrally planned and developing countries seem to maintain status quo. In the developed countries, the per capita textile consumption is already on a high level. Also, it is expected that in these countries the share of synthetic fiber will advance in the future, the per capita consumption amount of cotton and regenerated fiber will therefore continue to decline. Among the centrally planned and the developing countries, there will be some countries in which the per capita cotton and regenerated fiber consumption will rather increase than decrease.

Particularly concerning the developing countries, there are a number of countries in which a vast extent of economic development is anticipated in the near future and in such countries, the growth in the per capita textile consumption is amply expected. This being the circumstance, the per capita consumption of cotton and regenerated fiber will increase along with the increment achieved in the synthetic fiber consumption per capita.

The Indonesian per capita consumption of cotton and regenerated fiber in the year 1971 was 0. 71 kg/y and 0. 09 kg/y respectively. On the other hand, the per capita cotton consumption in the developing countries over the period from 1964 to 1971 was 2. 0 kg/y, while that for regenerated fiber was 0. 3 kg/y. This signifies that Indonesia displays a lower extent of figures than the average level of the developing countries by 1. 3 kg/y in the case of cotton and 0. 2 kg/y in regenerated fiber.

However, a vast degree of economic development is anticipated in Indonesia in the near future and the forecast is made for the year 1981 that the per capita textile consumption will grow approximately 2. 4 kg/y. Therefore, in spite of the fact that the environment by that time will be such that the procurement of both cotton and regenerated fiber will be much more difficult, in view of diversification in the clothing commodities, the consumption amount of such fibers is expected to gradually approach the average level of the developing countries.

4-2-2 Material-wise Synthetic Fiber Demand Rate

The past trend of material-wise synthetic fiber consumption rates in Indonesia have already been shown by Table IV-24, however, such material-wise synthetic fiber consumption rates must have been affected by the existing textile processing facilities, etc. Therefore, there would be some problems indirectly adopting the Indonesian data as the basis for formulating a forecast on the material-wise synthetic fiber demand rates in Indonesia.

Therefore, the synthetic fiber material-wise consumption rates were obtained over the period from 1967 to 1971 covering Indonesia, the Philippines, Thailand and Malaysia. On the basis of these obtained results, a forecast was formulated on the material-wise synthetic fiber demand rates in the future in Indonesia. The reason for taking the material-wise synthetic fiber consumption rates of above-mentioned countries is that, in spite of the fact that the material-wise synthetic fiber consumption rates vary from country to country as discussed earlier, it is still considered that an aggregation of the data from these countries will represent the structure of the material-wise synthetic fiber consumption rates unique to the Southeast Asian area.

The material-wise synthetic fiber consumption rates covering these four countries are shown in Table IV-40.

Table IV-40 Material-wise Synthetic Fiber Consumption Rates of the Four Countries (Indonesia, The Philippines, Thailand and Malaysia)

(%)

	1967	1968	1969	1970	1971
Nylon SF	1.0	0.4	1.1	0.5	0.2
Nylon FY	36.2	40.5	41.1	35.9	32.5
Polyester SF	44.6	39.5	40.3	45.9	46.5
Polyester FY	11.5	12.1	10.7	12.5	14.2
Acrylic SF	6.7	7.5	6.8	5.2	6.6
Share of SF	52.3	47.4	48.2	51.6	53.3

Source: Exports Statistics, Textile Organon

There is no conspicuous fluctuation in the rates of each one of the materials, thereby showing a considerably smooth trend. The average of the figures for the years 1970 and 1971 are converted in terms of the material-wise rates for the year 1971, the results are; 34.5% for nylon FY (including SF), 46.2% for polyester SF, 13.4% for polyester FY, and 5.9% for acrylic SF. This signifies that the rate structure is not showing much deviation from the case of those obtained for Indonesia alone.

Preliminary calculations were made on the material-wise synthetic fiber demand rate for the year 1981 on the basis of the data shown in Table IV-40 by utilizing the primary regression formula. The results are; 21.6% for nylon FY, 55.5% for polyester SF, 19.3% for polyester FY and 3.6% for acrylic SF. In other words, as far as the results of preliminary calculations are concerned, the share for nylon FY and acrylic SF show a decrease, while those of polyester SF and polyester FY display an increase. The increase in the share of polyester is the world-wide trend.

So far, no production has been undertaken in Indonesia for synthetic fiber FY and SF. Also, due to the fact that the extent of the synthetic fiber processing facilities is low, the import amount of synthetic fiber in the form of spun yarn and fabric has been high. Therefore, it seems that the past trend in Indonesia in the material-wise synthetic fiber consumption rates does not necessarily reflect the likes and dislikes of the consumers.

However, at present, as will be explained later, a successive application for industrialization are being filed concerning the production of synthetic fiber SF and FY covering such subject product items as nylon FY, polyester SF and polyester FY.

Also, the substantiation and expansion of the synthetic fiber processing facilities are rapidly carried out. In view of such a circumstance, it seems highly possible that in the near future, a considerably free selection can be made amongst the synthetic fiber products in Indonesia by the consumers in accordance with their tastes. Therefore, the future Indonesian material-wise synthetic fiber demand rates will show a different result from the above-mentioned preliminary calculation results.

In the following paragraphs, scrutinizations on the future Indonesian demand trends will be undertaken concerning each one of the material items. Compared with polyester FY, nylon FY is superior in the colour of the dyed products so that nylon FY is suitable for the clothes for the Southeast Asian market in which comparatively clear and bright colors are preferred. However, in Europe and the USA, polyester FY has already gained much higher popularity over nylon FY. Therefore, in Indonesia also, the polyester FY demand will grow and eventually supersede the nylon FY demand in view of the diversification of clothing commodities on a certain level of the synthetic fiber FY demand growth. This can also be supported by the fact that the polyester FY importation rapidly increased in the year 1972.

Polyester SF has already penetrated well into the Indonesian consumers. At present it seems that the consumption rate thereof has already attained a saturating point. Therefore, it seems reasonable to assume that the consumption rate of polyester SF will evolve on the presently achieved level.

On the other hand, the consumption of acrylic SF is still low and in view of the application of this material, it is not expected that a drastic demand increase will be achieved in Indonesia in the future. However, depending upon the localities, an ample use of acrylic clothes can be made in Indonesia. It must also be noted that the superior performance of acrylic SF in the color of the dyed products can be considered as one of the merits. Therefore, it is assumed that the consumption rate attained at the present stage will be maintained for the future.

On the basis of the above scrutinizations, a forecast was made on the Indonesian material-wise synthetic fiber demand rates up to the year 1981 as shown in Table IV-41.

Table IV-41 Forecast on Material-wise Synthetic Fiber Demand Rate in Indonesia

(%)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon FY	33	32	31	30	29	28	27	26	25	24	23
Polyester SF	47	47	47	47	47	47	47	47	47	47	47
" FY	14	15	16	17	18	19	20	21	22	23	24
Acrylic SF	6	6	6	6	6	6	6	6	6	6	6

Source: UNICO Estimate

4-2-3 Material-wise Domestic Synthetic Fiber Demand

In the light of the results obtained through the above scrutinization, Table IV-42 was compiled for the material-wise domestic synthetic fiber demand in Indonesia for the case of the total textile demand growth being 11.1% per year, based on the share of synthetic fiber shown in Table IV-33 and the material-wise domestic fiber demand rates shown in Table IV-41. In other words, the domestic total synthetic fiber consumption would be 153,000 t/y for the year 1981.

Table IV-42 Forecast on Material-wise Synthetic Fiber Demand in Indonesia

(10^3 ton)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon FY	12.0	14.6	17.3	19.8	22.1	24.3	26.5	28.7	30.8	33.0	35.3
Polyester SF	17.2	21.5	26.2	31.0	35.8	40.9	46.2	51.8	57.9	64.6	72.0
Polyester FY	5.1	6.8	8.9	11.2	13.7	16.8	19.6	23.1	27.1	31.6	36.8
Acrylic SF	2.2	2.7	3.3	3.9	4.6	5.2	5.9	6.6	7.4	8.2	9.2
Total	36.5	45.6	55.7	65.9	76.2	86.9	98.2	110.7	124.4	137.4	153.3

Source: UNICO Estimate

When viewed on the basis of the material-wise classifications, nylon FY comprises 35,000 t/y, polyester SF 72,000 t/y, polyester FY 37,000 t/y and acrylic SF 9,000 t/y. Further, the average annual growth rate over the period from 1971 to 1981 will be 15.4% for the total domestic synthetic fiber demand, 11.4% for nylon FY, 15.4% for polyester SF, 21.9% for polyester FY and 15.4% for acrylic SF, thereby showing a particularly conspicuous growth in polyester FY.

This represents an analogous trend to the material-wise synthetic fiber production growth of the world discussed in 2-2.

Comparison with the Previous Survey Results

In the previous survey, the total textile consumption was forecast for the year 1980 as follows.

Upper limit: 407,000 t/y (total textile growth rate : 13%/y)

Mean value : 373,000 t/y (-ditto- : 12%/y)

Lower limit: 341,000 t/y (-ditto- : 11%/y)

The total textile consumption for the year 1980 on the basis of the present survey can be quoted from the above-mentioned Table IV-32, at a level of 345,000 t/y which corresponds to the lower limit value obtained through the previous survey. The material-wise fiber demand rates for the year 1980 obtained in the previous survey in the form of a forecast are as shown in Table IV-43 in which it is obvious that the share of synthetic fiber is 35.0%.

Table IV-43 Material-wise Textile Demand Rate in Indonesia by the Previous Survey (1980)

	Ratio (%)			
Cotton	59.4			
Nylon FY	9.2		26.3	
Polyester SF	16.6		47.4	
Polyester FY	6.6	35.0	18.9	100.0
Acrylic SF	1.2		3.4	
Others	1.4		4.0	
Regenerated SF	4.9	5.6		
Regenerated FY	0.7			
Total	100.0			

Source: The Republic of Indonesia, Survey Report on Synthetic and Rayon Fiber Industry Development (OTCA, Feb. 1973)

By the present survey, it is forecast that the share of synthetic fiber for the year 1980 is approximately 40% as shown in Table IV-33. The reason for formulating such a forecast has already mentioned in 4-2-1 (1). The material-wise synthetic fiber demand rates stipulated in the previous survey was as shown in Table IV-43 in which it is displayed that the highest level was gained by polyester SF at the rate of 47%, followed consecutively by 26% for nylon FY, 19% for polyester FY, 4% for "Others" and 3% by acrylic SF. This increase in the share of polyester is the worldwide trend.

In the present survey, as shown in Table IV-41, the highest rate was gained by polyester SF on the level of 47%, followed consecutively by 24% for nylon FY, 23% for polyester FY and 6% by acrylic SF. In other words, the present survey forecasts the demand rate for polyester FY on a higher level than that conducted in the previous survey. This is due to the fact that the present survey incorporates the change took place during the past 12 months into the future trend of material-wise synthetic fiber demand rate. Also, the present survey took into consideration the sudden increase in the importation of polyester FY into Indonesia.

4-2-4 Knowledge Obtained through On-site Surveys

In the schedule of the present on-site surveys, the five major textile markets of Indonesia have been included as the subject for paying visits, i. e., Jakarta, Bandung, Solo, Semarang, and Surabaya. Due to the fact that the visits were made shortly after the Moslem New Year, all the markets visited were showing a rather slow status with a small number of buyers, however, it was observed that the amount of the commodities carried by the shops was high. It was also noted that many shops were specialized in its operation to a considerable extent. A high rate of imported goods were noted concerning the woven fabrics, ready-made commodities and hand knitting yarn.

It seemed that the majority of the Indonesian consumers have already recognized the merits of synthetic fiber products. However, at present stage, the prices of synthetic fiber products are higher than that of cotton items, thereby making it rather difficult for the mass consumers to easily carry out the purchase. In fact, a number of people pointed out the price factor as the primary element upon the textile products purchase on the side of the consumers. The same opinion was also voiced at the head office of P. N. Sandang. Also, a comparison of the analogous products of the imported origin and domestic origin revealed that the price for the imported items was generally higher.

In spite of such a circumstance, synthetic fiber products have already been popularly consumed to a certain extent. The shirts made of T/C particularly gained conspicuous popularization. Traditionally in Indonesia, polyester SF and nylon FY products have been widely consumed as the synthetic fiber products. In the recent years, however, the items made of polyester FY has been growing. Along with the increment in the textile consumption in the future, the consumption of clothing will inevitably diversify. For the diversification of the commodities, the products made from polyester textured yarn seems to be suitable. It is reported that in Indonesia at present, approximately one hundred units of false twisters are in existence so that the production of false twist yarn of approximately 5,000 t/y covering both polyester and nylon is possible.

It is also reported that a considerable extent of new installation projects of false twisters are being contemplated. Therefore, it is expected that in the near future, an acute increment in the knitted or woven products employing polyester false twist yarn will be achieved.

Acrylic fibers are employed mostly for the hand knitting yarn, blankets, sweaters, etc., however, the finished products by employing this material is fewer in number than those made from other materials. In a hotel in Bandung, acrylic blankets are being employed and, in spite of the fact that Indonesia is located in the tropic area, these blankets were comfortably used in the highlands. However, in view of the material-wise consideration, it is not expected that the demand for acrylic products will show a significant growth as far as the whole Indonesian market is concerned.

On the basis of the above-mentioned knowledge, an estimate can be made as follows concerning the material-wise rates in the future synthetic fiber demand in Indonesia. While the demand for polyester SF and acrylic SF will evolve on the analogous rate as achieved at present, polyester FY will greatly grow and will eventually attain a comparable level as that achieved by nylon FY. This coincides with the forecast results already discussed in 4-2-2.

4-3 Possible Extent of Synthetic Fiber SF and FY Production

The possible extent of production of SF and FY in a given country is determined by the existing processing capacity for the SF and FY and the exportability of these commodities. In other words, the relationship can be illustrated as follows:

FY and SF producible extent = SF/FY processing amount + SF/FY exportable amount

4-3-1 Processing Capacity for Synthetic Fiber SF and FY

(1) Surveys conducted so far regarding the Synthetic Fiber SF and FY Processing Capacity

Figures IV-13 and IV-14 show the graphic illustrations of the form-wise synthetic fiber consumption over the period from 1967 to 1972 by classifying the subject into SF and FY.

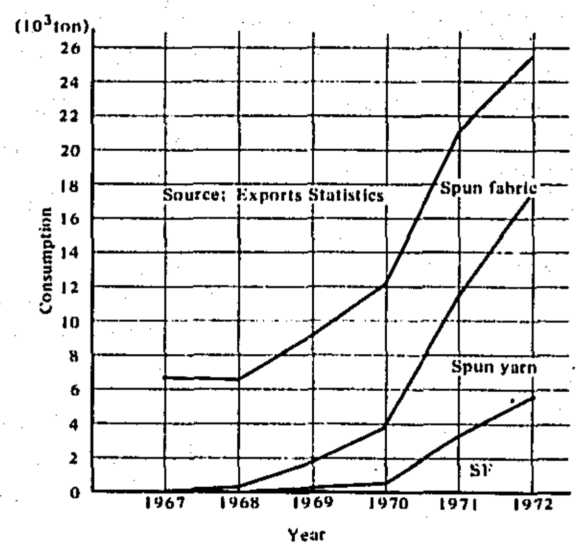


Figure IV-13 Trend of Form-wise Synthetic SF Consumption in Indonesia

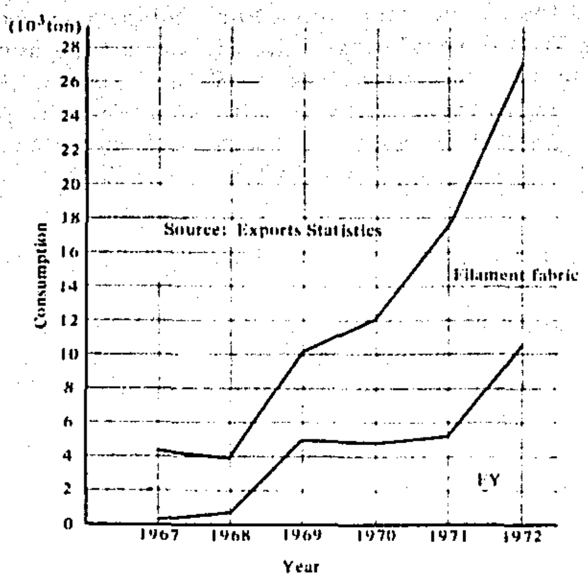


Figure IV-14 Trend of Form-wise Synthetic FY Consumption in Indonesia

As far as SF is concerned, a conspicuous growth has been achieved in the consumption in the form of SF and spun yarn, while the consumption in the form of fabric maintained status quo. This signifies that a rapid expansion of spinning and weaving and knitting capacities are being conducted.

On the other hand, regarding FY, the consumption in the form of FY of the period from 1969 to 1971 displayed a stagnation; however, a record growth was achieved in the year 1972. Unlike the case of SF, the consumption in the form of fabric is still continuing the growth trend.

In other words, a sign was noted for the vast expansion in the weaving and knitting capacity for FY in the year 1972; however, in spite of such a substantiation, the level is still less than 1/2 of the required capacity to fulfill the FY synthetic fiber consumption. Table IV-44 shows the rates of the SF spinning capacity and the weaving and knitting capacity as well as the FY weaving and knitting capacity as respectively against the SF or FY synthetic fiber consumption amount (hereinafter referred to as the spinning capacity rate, SF weaving and knitting capacity rate and FY weaving and knitting capacity rate, respectively.)

In the case of Indonesia, the SF weaving and knitting capacity rate shows the highest degree. However, even so, the rate figure is 0.68. Both the spinning capacity rate and FY weaving and knitting capacity rate are on a much lower level than 0.68.

Table IV-44 Spinning, Weaving and Knitting Capacity Rates in Indonesia

	1967	1968	1969	1970	1971	1972
A	0	0.01	0.03	0.05	0.16	0.22
B	0	0.05	0.19	0.32	0.54	0.68
C	0.05	0.17	0.49	0.41	0.30	0.39

Source: Exports Statistics

Notes: A: Spinning capacity of synthetic fiber / Synthetic SF consumption amount

B: Production capacity of synthetic spun fabric / Synthetic SF consumption amount

C: Production capacity of synthetic filament fabric / Synthetic FY consumption amount

(2) Forecast on the Processing Capacity for Synthetic Fiber SF and FY

The history of Indonesian synthetic fiber processing industry is still short. Therefore, it is impossible to formulate any forecast on the synthetic fiber SF and FY processing capacity in the future on the basis of the data shown in Table IV-44.

Therefore, the past trend of processing capacity rate figures were obtained from the Philippines and Thailand both of which have already displayed a more advanced status of textile industries than Indonesia in the same Southeast Asian areas as well as from the case of Taiwan where a particular emphasis has been placed on the development of textile industry and already achieved a certain extent of exportation of processed textile products. The obtained results have been employed as the basis for formulating the Indonesian forecast.

This method was employed for the reason that the development of textile industry is also emphasized in Indonesia and that the new installation of textile processing facilities are showing a status of rush so that Indonesia is expected to develop along the analogous evolution which has already been displayed by the above-mentioned countries. The relative data as shown in Table IV-45 and IV-46.

Table IV-45 Spinning, Weaving and Knitting Capacity Rates in The Philippines and Thailand

		1967	1968	1969	1970	1971
Philippines	A	0.51	0.69	0.66	0.73	0.85
	B	0.63	0.87	0.80	0.76	0.90
	C	0.48	0.61	0.61	0.64	0.82
Thailand	A	0.20	0.23	0.44	0.64	0.82
	B	0.36	0.45	0.69	0.81	0.94
	C	0.25	0.27	0.47	0.50	0.72

Note: A, B, C: See Table IV-44 Source: Exports Statistics, Textile Organon

Table IV-46 Spinning, Weaving and Knitting Capacity Rates in Taiwan

	1962	1963	1964	1965	1966	1967	1968	1969	1970
A	0.94	1.02	0.98	1.04	1.20	1.23	1.44	1.60	1.96
B	0.94	1.01	0.95	1.01	1.18	1.24	1.51	1.60	1.70
C	0.93	0.93	0.91	0.91	1.13	1.23	1.45	1.65	1.83

Note: A, B, C: See Table IV-44

Source: The Trade of China, Textile Organon

In the year 1971, both the Philippines and Thailand displayed an approximately 0.8 to 0.9 level of spinning capacity rate and SF weaving and knitting capacity rate and displayed a small extent of difference between the spinning capacity rate and SF weaving and knitting capacity rate. Further, the extent of FY weaving and knitting capacity rate was slightly lower than that of SF.

In the case of Taiwan, both the spinning capacity rate and SF weaving and knitting capacity rate exceeded a level of 1.0 already in 1965 and since then all the capacity rates have been showing an uptrend. The development of FY weaving and knitting capacity rate showed a slight delay from the growth of that of SF so that the exceeding of 1.0 level was achieved in the year 1966. Further, in 1970, the FY weaving and knitting capacity rate exceeded the SF weaving and knitting capacity rate.

Figures IV-15 through IV-17 display the integration of the above-mentioned data by shifting the horizontal axis in accordance with the degree of the processing capacity rates of the countries except for Indonesia regarding each one of the present capacity rate items. According to these figures, it can be estimated that the years in which the processing capacity of Indonesia will attain the fulfilling point for the domestic synthetic fiber demand (the achievement of 1.0 rate for the present capacity rate) will be 1982, 1977, and 1979 for spinning, SF weaving and knitting and FY weaving and knitting respectively. At the present stage in Indonesia, the spinning capacity is small when compared with the weaving and knitting capacity in general.

However, efforts are being exerted particularly in view of the expansion substantiation of spinning capacity in the recent years and therefore, it is expected that the imbalance will be gradually corrected in the future. Therefore, by 1980, the spinning capacity will catch up to the SF weaving and knitting capacity and it is expected that the spun yarn importation will be entirely eliminated. Therefore, by taking into consideration the above-mentioned results of scrutinizations, it was assumed here that the spinning capacity rate will attain the same level as the SF weaving and knitting capacity rate by 1981. In other words, the spinning capacity rate is assumed to be expanded from 1976 onward along with the dotted line shown in Figure IV-15 (in this figure, the spinning capacity rate for the year 1981 is considered as being identical to the SF weaving and knitting capacity rate for the same year).

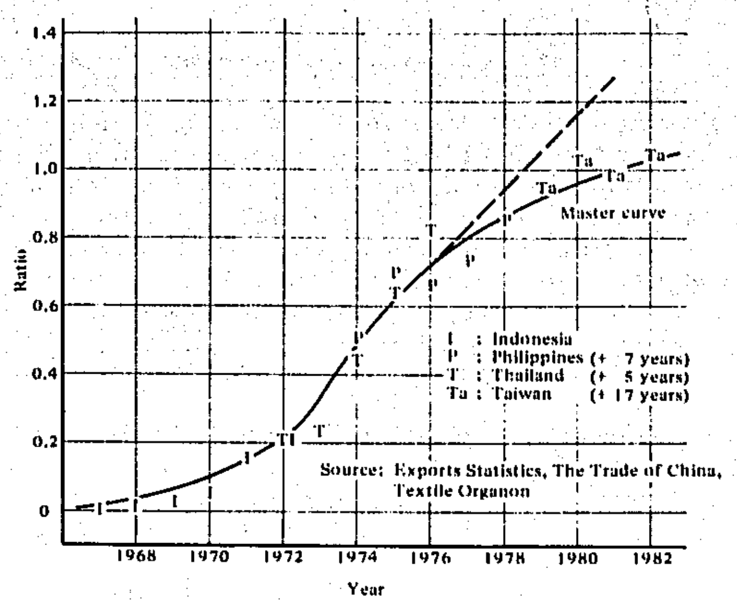


Figure IV-15 Spinning Capacity Rate in Indonesia

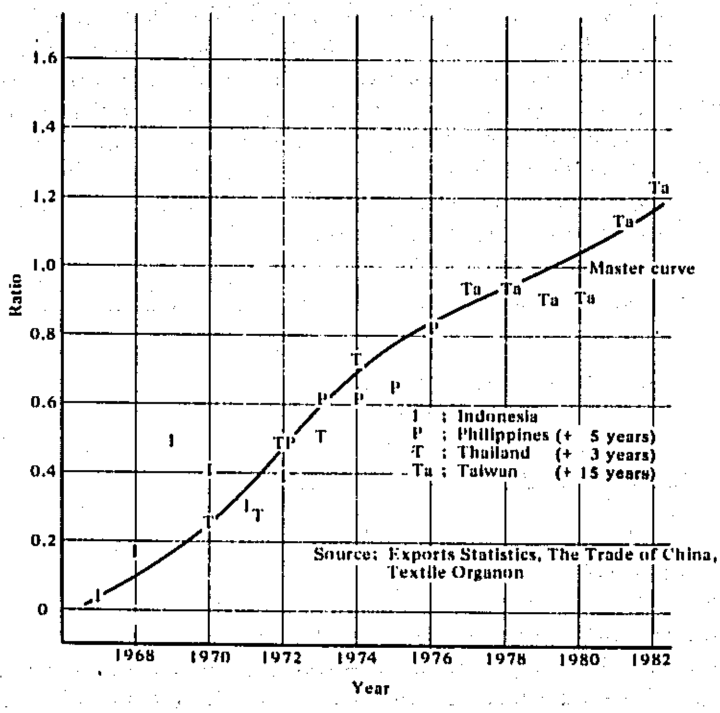


Figure IV-16 SF Weaving and Knitting Capacity Rate in Indonesia

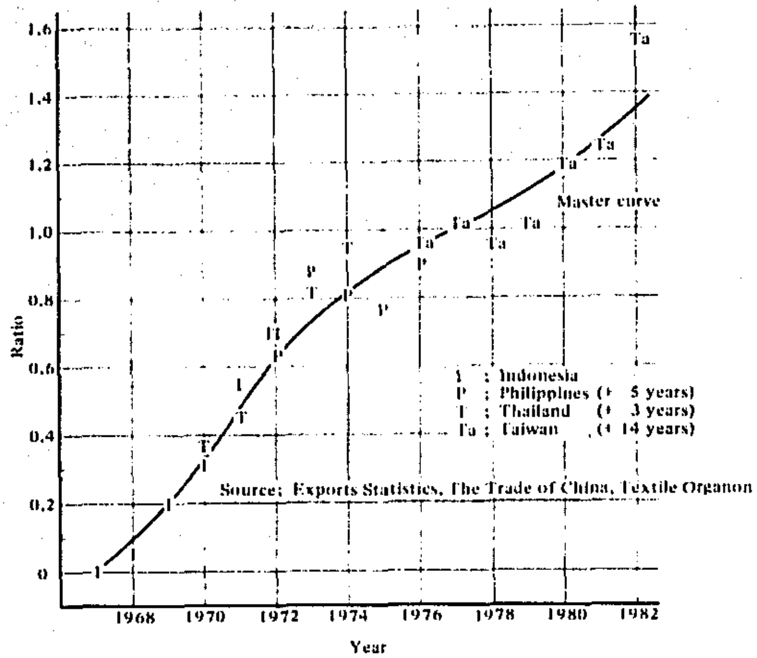


Figure IV-17 FY Weaving and Knitting Capacity Rate in Indonesia

Table IV-47 shows a forecast on the trends of the various processing capacity rates in Indonesia on the basis of the above discussion. In other words, it is forecast that, as far as the domestic synthetic fiber demand is concerned, the total amount will be covered by the domestic production from 1979 onward in the case of the spun fabric, and from 1980 onward concerning the filament fabric. (Here, the term "domestic products" signifies those items for which both the spinning and weaving and knitting have been undertaken inside Indonesia.)

Table IV-47 Forecast on Spinning, Weaving and Knitting Capacity Rate in Indonesia

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
A	0.16	0.20	0.33	0.48	0.61	0.72	0.83	0.94	1.05	1.16	1.27
B	0.54	0.61	0.73	0.82	0.89	0.95	1.00	1.05	1.12	1.18	1.27
C	0.30	0.45	0.60	0.70	0.77	0.84	0.89	0.94	0.99	1.04	1.10

Note: A, B, C: See Table IV-44 — Source: UNICO Estimate

As has been mentioned earlier, in the case of the Philippines and Thailand, approximately 80% of the total domestic synthetic fiber demand was accommodated by the domestic products already in 1971. Also in the case of Taiwan, the total domestic product accommodation was achieved as early as 1966. As has been mentioned, the facility expansion in the textile processing enterprises in Indonesia is highly active. Also, because of the fact that the emphasis is placed on the target of further substantiation of clothing supply in the Second Five-year Plan in Indonesia, it is hardly realistic to forecast that the future Indonesian processing capacity rates will stagnate on a lower level than those in these countries.

This being the assumption, it can be amply forecast that the future Indonesian trend in the processing capacity rates will be as shown in Table IV-47.

Comparison with the Previous Survey Results

In the previous survey, it was forecast that the synthetic fiber SF and FY processing amount from the period of 1976-1977 onward will be approximately 50% of the domestic demand, however, in the present survey, the forecast is made anew for 70 to 80% for the period from 1976 to 1977 and 100% for the year 1980. The reason for revising the forecast is as mentioned earlier and it is considered that the forecast made in the present survey is much more reasonable and realistic.

(3) Knowledge Obtained through On-site Surveys

During the course of the present survey, visits were paid to eleven spinning plants including ITT, two false twisting plants, three weaving plants, one knitting plant and five dyeing and finishing plants. The outline of the visited plants are shown in Table IV-48.

(a) Spinning Facilities

The spinners in Indonesia are managed by the one of the four administrators, i. e., the central government, the state government, national enterprise capital or foreign joint-venture enterprises. At present, P. N. Sandang owns nine plants as shown in Table IV-49, totalling 242,000 spindles. T/C and T/R yarns are being spun in Patal Banjaran, Cipadung, Secang and Grati.

The aggregate production undertaken by these plants will attain 3,300 tons in 1972 and the variety in the spun products is considerably rich. According to the projects contemplated by the headquarters of P. N. Sandang, further expansion will be undertaken involving 80,000 new spindles so that by 1976, the total number of the spindles will attain 322,000.

The headquarters predicted that the supply of the cotton will hit a certain limitation in the future so that a gradual shift is being undertaken in the spinning facilities towards the synthetic fiber spinning operation. Table IV-50 shows the rate of material-wise spinning projects to be undertaken by P. N. Sandang. The total production achieved by P. N. Sandang in 1972 was approximately 24,000 tons. As it is planned that by 1976, the spinning facilities will increase up to 322,000 spindles from the 242,000 spindles of 1972 level, a preliminary calculation was undertaken concerning the polyester SF consumption amount at P. N. Sandang on the basis of the planned expansion by the year 1976. The result obtained is 7,000 tons. Although nothing is clearly disclosed regarding the projects from the year 1976 onward, it is amply expected that the polyester SF spinning amount will further increase from this level.

As shown in Table IV-51, Pinda Sandang owns three plants at present, encompassing 128,000 spindles. Of these, T/C yarn is being spun by P. P. K. Cilacap, with the production extent of 730 t/y.

Table IV-48 Outline of the Visited Plants

Mill Name	Location	Equipment				Production			
		Spinning	Weaving	Knitting	Dyeing & Finishing	Yarn (t/d)		Fabric (m/d)	
Patal Bekasi	Bekasi	30,240				C^{100} 21/1, 42/1	6.3		
Patal Cipadung	Bandung	30,132				C^{100} 20/1, 42/1, T/C 40/1	7.1		
Patal Banjaran	"	30,784				C^{100} 20/1, 30/1, T/C 20/1, 40/1, 40/2, 44/1, T/R 40/1	8.9		
Patal Secang	Magelang	30,132				C^{100} 20/1, 30/1, 42/1, T/R 20/1, 40/1, 40/2	8.3		
Patal Grati	Pasuruan	30,132				C^{100} 30/1, T/R 20/1, 40/1, 40/2, 44/1	9.0		
Pabrik Tekstil Senayan	Jakarta	30,000	520		2 sets	C^{100} 16/1, 20/1, 30/1	12.6	C^{100}, T/C, T/R	35,850
P.P.K. Jantra	Semarang	31,140				C^{100} 1/1, 20/1, 32/1, 40/1	9.1		
P.P.K. Cilacap	Cilacap	60,000			Yarn dyeing 3	C100 12/1, 20/1, 32/1, 42/1, T/C 45	18.9		
I.T.T.	Bandung	8,000				C^{100} Ave. 30/1	2.2		
Primissima	Yogyakarta	9,072	180			C^{100} 50/1, 60/1	1.1	C^{100}	9,850
Dasatex	Bandung	15,000				C^{100} Ave. 20/1	8.0		
Naintex	"	False twisting 640	160		2 sets	T^{100}	?	T/R, T^{100}	6,320
C.V. Langsung	"			Raschel 27 Circular 5	Only heat-setting 1 set			N^{100}, T^{100}, R^{100}	4,680
Texfiber	Jatiluhur	False twisting 1,920			Yarn dyeing	N^{100}	4.0		

Further, 12.5 t/month of acrylic spun yarn production is being undertaken at Texin.

Table IV-49 Outline of the Spinning Facilities of P.N. Sandang

Mill Name	Capacity(spindle)	Production (t/y)	Yarn	Expansion Plan
Pabrik Tekstil Senayan	30,000	3,774	C100	30,000 spindles are planned to be installed in 1975
Patal Banjaran	30,784	3,327	C100, T/C, T/R	30,000 spindles are planned to be installed in 1974
Patal Cipadung	30,132	2,378	C100, T/C	
Patal Secang	30,132	3,023	C100, T/R	
Patal Grati	30,132	3,042	C100, T/R	
Patal Lawang	15,200	2,090	C100	20,000 spindles are planned to be installed in 1976
Patal Tohpati	15,200	2,060	C100, R100	
Patal Bekasi	30,240	1,667	C100	
Patal Palembang	30,384	2,120	C100	
Total	242,204	23,481		

Source: P.N. Sandang

Table IV-50 Material-wise Spinning Projects by P.N. Sandang

(%)

	1971 1)	1972 1)	1973	1974	1975	1976
Cotton	96.25	87.41	79.32	71.73	68.28	73.11
Rayon SF	0.93	3.55	6.10	6.11	5.42	4.60
Polyester SF	2.82	9.00	14.58	22.16	26.30	22.29
Acrylic SF	-	0.04	-	-	-	-

Note: 1) Actual

Source: P.N. Sandang

Table IV-51 Outline of Spinning Facilities of Pinda Sandang

Mill Name	Capacity(spindle)	Production (t/y)	Yarn	Expansion Plan
P.P.K. Cilacap	60,000	7,530	C100, T/C	
Texin	37,072	4,400	C100, AC100	
P.P.K. Jantra	31,140	4,040	C100	15,000 spindles are planned to be installed in 1975
Total	128,212	15,970		

Source: Pinda Sandang

At present, Pinda Sandang headquarters is contemplating the expansion of the facilities by additionally installing 15,000 spindles so that by 1975, the total spindle number will attain 143,000. It is also planned that the above-mentioned expanded portion will be partially allocated for synthetic fiber spinning operation, so that it is expected to carry out a much more increased quantity of synthetic fiber spinning at Pinda Sandang by 1975.

On the other hand, the spinning facility status of the Japanese joint-venture enterprises is as shown in Table IV-52 including the projected portion. It is expected that presently undertaken and projected facilities will be put on stream by mid 1975. If it is assumed in Table IV-52 that the spinning capacity for T/C, T/R and Ac^{100} are 0.08t, 0.14t and 0.24t per spindle per year respectively, the production will be: T/C spun yarn 11,830 t/y, T/R spun yarn 7,140 t/y, and acrylic spun yarn 2,880 t/y. If a further assumption is made that the polyester SF blending ratio into T/C and T/R spun yarn is 65%, the polyester SF consumption will attain 12,650 t/y.

Table IV-52 Outline of Spinning Facilities of Japanese Joint-Venture Companies

Name	Capacity (spindle)	Yarn
BELL·A·BELL TEXTILE	20,000	T/C
P.T. UNITEX	15,500	"
P.T. CENTEX	21,600	"
P.T. K.T.S.M.	20,368	"
P.T. EASTERNTEX	20,000	"
Mermaid Textile Industry Inc.	13,500	"
P.T. K.M.T.I.	36,900	"
SOUTHERN CROSS	30,000	T/R
ISTEM	21,000	"
Sub-Total	198,868	
PT INDONESIA ASAHI CHEMICAL INDUSTRIES	5,000	AC^{100}
P.T. ACTEM	2,000	"
(MITSUBISHI)	5,000	"
Total	210,868	

Note: Including plan   Source: Nihon Kasen Kyokai (Japan Chemical Fibers Association), Newspaper

Naintex which is a national-capital based enterprise to which the visit was paid by the survey team during the present survey is also planning the installation of 35,000 spindles for the spinning of synthetic fiber (consisting mostly of T/C), although this enterprise has been a specialized company for carrying out weaving, dyeing and finishing processing. Dasatex which is based on a 100% foreign capital is also contemplating an installation project of 5,000 spindles for spinning synthetic fiber (also consisting mainly of T/C). It is likely that many other similar projects are being fostered.

In view of the above findings, it is forecast that by 1976, the consumption of polyester SF will attain a level of approximately 30,000 tons while that of acrylic SF approximately 4,000 tons. The polyester SF domestic consumption by the year 1976 will have attained a level of approximately 40,000 tons while that of acrylic SF approximately 5,000 tons. This signifies that 75% and 80% respectively of the domestic demand for polyester SF and acrylic SF will by then be spun domestically.

(b) Weaving and Knitting Facilities

The weaving and knitting operations in Indonesia are mostly undertaken in private industrial sectors. Extremely limited number of looms are being owned and operated by P. N. Sandang and Pinda Sandang. The actual status of the private sector industrial operations is rather difficult to clarify and therefore it is difficult to forecast the future trend of the production facility capacities thereof.

At present, the government of Indonesia is receiving a considerable extent of applications for new installation or expansion projects pertaining to weaving and knitting facilities. It is reported that approximately 40,000 looms and 2,500 knitting machines involving various types are being submitted to the government. It is likely that most of these facilities are for processing synthetic fiber.

At Naintex to which a visit was paid during the present survey, it was revealed that an expansion plan is made in the synthetic weaving facilities, although the details of the project were not finalized. Also, at C. V. Langsung, the construction of a new plant involving a number of knitting machines is being undertaken for the purpose of processing synthetic fiber.

Therefore, a considerable portion of the above-mentioned new installation and expansion applications will be implemented in the near future. If an assumption is made that 1/2 of the applied projects were put on-stream in 1976 and that the production per loom is 2 t/y and that per knitting machine is 20 t/y, the total production will be 65,000 t/y with the looms and knitting machines together. If a further assumption is made that 1/2 of the above-mentioned production involves the employment of spun yarn and that 2/3 of the employed spun yarn consists of synthetic fiber in view of the fact that the spun yarn consists mostly of T/C and T/R, then the total synthetic fiber consumption will attain a level of approximately 54,000 t/y.

As is shown in Table IV-20, the consumption of synthetic fiber in the form of staple fiber, filament yarn and spun yarn in 1972 has already attained a level of 28,000 tons. If the above-mentioned 54,000 t/y is added to this amount, the weaving and knitting processing amount in 1976 will be approximately 82,000 t/y. The Indonesian domestic synthetic fiber demand by that year is forecast to be approximately 87,000 t/y, approximately 94% of the domestic demand will therefore be covered by domestically manufactured fabric supply.

Tables IV-53 and IV-54 show for reference the weaving facilities details of P. N. Sandang and Pinda Sandang as well as those of the Japan-Indonesia joint-venture enterprises (for the spun fabric only, including the projected plans).

Table IV-53 Outline of Weaving Facilities of P.N. Sandang and Pinda Sandang

	Mill Name	Capacity (No.)		Production (10^3m/y)	Fabric
P.N. Sandang	Pabrik Tekstil Senayan	N	320	6,726	C^{100}, T/C
		W	200	4,029	T/R
	Patun Madurateks	N	24	1,168	C^{100}
		W	144	2,810	C^{100}
	Patun Makateks	N	12	923	C^{100}
		W	48		
	Sub-Total		748	15,656	
Pinda Sandang	Texin	N	1,031	27,000	C^{100}, T/C
		W	233		
	Kurlatex	N	143	3,650	C^{100}, T/C
		W	53		
	Inpitex	N	191	4,800	C^{100}, T/C
		W	30		
	Sub-Total		1,681	35,450	
	Total		2,429	51,106	

Note: 1. N: Narrow loom
W: Wide loom

Source: P.N. Sandang, Pinda Sandang

Table IV-54 Outline of the Spun Yarn Weaving Facilities of Japanese Joint-Venture Companies

Name	Capacity (No.)	Fabric
BELL·A·BELL TEXTILE	700	T/C
P.T. UNITEX	400	" , C^{100}
P.T. CENTEX	580	T/C
P.T. K.T.S.M.	600	"
P.T. EASTERNTEX	500	"
P.T. K.M.T.I.	1,000 ?	"
Mermaid Textile Industry Inc.	504	"
SOUTHERN CROSS	200	T/R
ISTEM	200	"
Total	4,684	

Note: Including plan

Source: Nihon Kasen Kyokai (Japan Chemical Fibers Association), Newspaper

(4) Processing Amount of Synthetic Fiber SF and FY

As has been discussed in the foregoing paragraphs, there is no significant difference between the forecast values made for the synthetic fiber processing capacity for the year 1976 compiled on the past data and those obtained through the on-site survey. By employing the data as stated in Tables IV-42 and IV-47, a forecast is made on the material-wise synthetic fiber processing amount to be achieved by the year 1981. The forecast results are shown in Table IV-55.

Table IV-55 Forecast on Material-wise Synthetic Fiber Processing Capacity in Indonesia

(10^3 ton)

		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon FY	Domestic Demand	3.6	6.6	10.4	13.9	17.1	20.5	23.6	27.0	30.5	33.0	35.3
	Export of Processed Goods	-	-	-	-	-	-	-	-	-	1.3	3.5
	Total	3.6	6.6	10.4	13.9	17.1	20.5	23.6	27.0	30.5	34.3	38.8
Polyester SF	Domestic Demand	2.8	4.3	8.7	14.9	21.9	29.5	38.4	48.7	57.9	64.6	72.0
	Export of Processed Goods	-	-	-	-	-	-	-	-	2.9	10.3	19.4
	Total	2.8	4.3	8.7	14.9	21.9	29.5	38.4	48.7	60.8	74.9	91.4
Polyester FY	Domestic Demand	1.0	3.1	5.4	7.9	10.6	13.9	17.5	21.8	26.9	31.6	36.8
	Export of Processed Goods	-	-	-	-	-	-	-	-	-	1.3	3.7
	Total	1.0	3.1	5.4	7.9	10.6	13.9	17.5	21.8	26.9	32.9	40.5
Acrylic SF	Domestic Demand	0.4	0.6	1.1	1.9	2.9	3.8	4.9	6.2	7.4	8.2	9.2
	Export of Processed Goods	-	-	-	-	-	-	-	-	0.4	1.4	2.5
	Total	0.4	0.6	1.1	1.9	2.9	3.8	4 9	6.2	7.8	9.6	11.7

Source: UNICO Estimate

In Indonesia, for the purpose of increasing employment opportunities and for establishing justice in income distribution, it is necessary to foster medium and small-scale enterprises. This policy is included in the scope of the Second Five-Year Plan.

Therefore, it is forecast that a considerable number of medium and small-scale enterprises will be established in the near future in the synthetic fiber processing industrial field. As a result, the amount of synthetic fiber processed products shown in Table IV-55 will increase. Actually, in Japan, there is a great number of medium and small-scale enterprises in this field and they are successfully operating. In Japan, there is much knowledge and actual records concerning the fostering of medium and small-scale enterprises which will well contribute to the development of the Indonesian counterparts.

It must be noted that in Table IV-55, SF and FY processing amount in excess of the domestic demand is shown in terms of the export of processed goods. Also, the processing amount of polyester SF and acrylic SF have been calculated on the basis of the spinning capacity. The reason is that in the case of SF, a processing stage of spinning, weaving and knitting is called for, however, in the case of Indonesia as is shown in Table IV-47, the spinning capacity will be less than the weaving and knitting capacity up to the year 1981. The total export amount of the processed products covering all materials and the rates thereof as against the total processing amount were obtained. It was revealed that 3, 300 tons, i. e., 2. 6% will be achieved by 1979, while 14,200 tons, i.e., 9.4% in 1980, and 29,100 tons, i.e. 16.0% in 1981.

In Indonesia, abundant labor force is available and also in view of the fact that the latest machines will be introduced for the new installation and expansion of the facilities, it seems that the international competitiveness of synthetic fiber processed products is quite strong. Therefore, the above-mentioned extent of exportation will be sufficiently possible.

4-3-2 Export Amount of Synthetic Fiber SF and FY

In order to forecast the future export amount of SF and FY from Indonesia, it is necessary to confirm in detail the material-wise demand, production, etc. achieved in the neighboring countries. Therefore, in the present survey, a forecast of synthetic fiber production in Indonesia will firstly be made and on the basis of such a forecast, the processing amount in Indonesia of SF and FY will be subtracted in order to assume that the balance thus obtained would be the exportable extent. Then, study was made as to whether or not such an exportable amount can actually be exported.

4-3-3 Possible Extent of Synthetic Fiber SF and FY Production

The lowest limit of the quantity of synthetic fiber SF and FY production to be undertaken with in Indonesia is the level corresponding to the processing capacities available in Indonesia for SF and FY. However, Indonesia owns high-quality and rich amount of oil and has a population of more than 120 million. Therefore, a number of applications are being made to the Indonesian government by foreign enterprises regarding the industrialization of synthetic fiber production. In this respect, it is most likely that some of the applicant enterprises are contemplating the exportation of synthetic SF and FY. Therefore, the production amount of synthetic fiber inside Indonesia will exceed to a certain extent the processing capacity available in Indonesia for SF and FY.

A summary of the presently planned synthetic SF and FY production capacity (including the existing capacities) may be shown in Table IV-56 which have been compiled on the basis of public information. The table includes those for which no clarification has so far been made concerning the production capacity or the production operation commencement period. It also includes the ones for which a mere plan has so far been made. However, it is nevertheless expected that considerable extent of production will be implemented by 1976 to 1977. Table IV-57 shows the forecast on material-wise possible production amount for the years 1976 or 1977, and 1980 compiled on the basis of the above-mentioned information and by taking into consideration the economic production scale, and other relative factors.

Table IV-58 shows a forecast on the yearly attainable production extent on the basis of the above table. As to polyester SF for the years prior to 1975, polyester FY prior to 1976 and nylon FY prior to 1977, the processing capacity for SF and FY exceeds the possible extent of synthetic fiber production. This being the circumstance, the SF and FY processing amount is directly adoped as the possible production extent of synthetic fiber. It must also be noted here that the production amounts between 1976 and 1980 or between 1977 and 1980 are assumed to grow on a constant amount.

Table IV-56 Synthetic Fiber Manufacturing Projects (Including Existing Plants) of Foreign Enterprises in Indonesia

(t/d)

		~1974	1975	1976	1977	1978	1979	1980
Nylon FY	I T S	6		12[3]				
	ASAHI INDONESIA	12						
	UNITIKA				40[1]			
Polyester SF	I T S	12		36[3]				
	TEIJIN			50				150[1]
	KURARAY			30		60[1,3]		
	UNITIKA				30[1,2]			
	AKZO							
	HOECHST							
Polyester FY	TEIJIN			20				60[1]
	UNITIKA				20[1,2]			
	AKZO							
	ASAHI				15[3]			
Acrylic SF	ASAHI					20[3]		

Source: Japanese newspaper, Others

Notes: 1) Start-up date is not clear
2) Total amount is divided into SF and FY by estimation
3) Only plan

Table IV-57 Forecast on Possible Production Extent of Material-wise Synthetic Fibers in Indonesia

(10^3 ton)

	1976	1977	1980
Nylon FY	-	23	45
Polyester SF	40	-	120
Polyester FY	-	20	50

Source: UNICO Estimate

Table IV-58 Material-wise Possible Production Extent of Synthetic Fiber and Application Thereof in Indonesia

(10^3 ton)

		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Nylon FY	Production	3.6	6.6	10.4	13.9	17.1	20.5	23.6	30.7	37.9	45.0	47.3
	Domestic Demand	3.6	6.6	10.4	13.9	17.1	20.5	23.6	27.0	30.5	33.0	35.3
	Export of Processed Goods	-	-	-	-	-	-	-	-	-	1.3	3.5
	Export of FY	-	-	-	-	-	-	-	3.7	7.4	10.7	8.5
Polyester SF	Production	2.8	4.3	8.7	14.9	21.9	40.0	60.0	80.0	100.0	120.0	127.4
	Domestic Demand	2.8	4.3	8.7	14.9	21.9	29.5	38.4	48.7	57.9	64.6	72.0
	Export of Processed Goods	-	-	-	-	-	-	-	-	2.9	10.3	19.4
	Export of SF	-	-	-	-	-	10.5	21.6	31.3	39.2	45.1	36.0
Polyester FY	Production	1.6	3.1	5.4	7.9	10.6	13.9	20.0	30.0	40.0	50.0	55.2
	Domestic Demand	1.6	3.1	5.4	7.9	10.6	13.9	17.5	21.8	26.9	31.6	36.8
	Export of Processed Goods	-	-	-	-	-	-	-	-	-	1.3	3.7
	Export of FY	-	-	-	-	-	-	2.5	8.2	13.1	17.1	14.7
Acrylic SF	Production	0.4	0.6	1.1	1.9	2.9	3.8	4.9	6.2	7.8	9.6	11.7
	Domestic Demand	0.4	0.6	1.1	1.9	2.9	3.8	4.9	6.2	7.4	8.2	9.2
	Export of Processed Goods	-	-	-	-	-	-	-	-	0.4	1.4	2.5
	Export of SF	-	-	-	-	-	-	-	-	-	-	-

Source: UNICO Estimate

Concerning the production for the year 1981, calculation has been made on an assumption that the exportation for the year 1980 (processed product exportation + SF and FY exportation) would be achieved on an unchanged basis for the year 1981. Figures IV-18 through IV-21 show graphic illustrations of the material-wise possible production amounts.

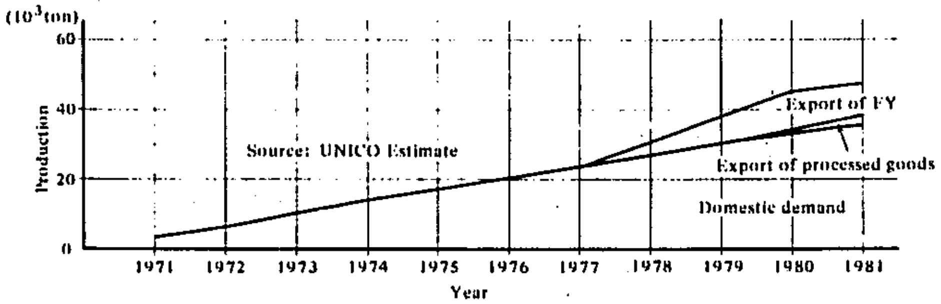


Figure IV-18 Possible Production and Application of Nylon FY in Indonesia

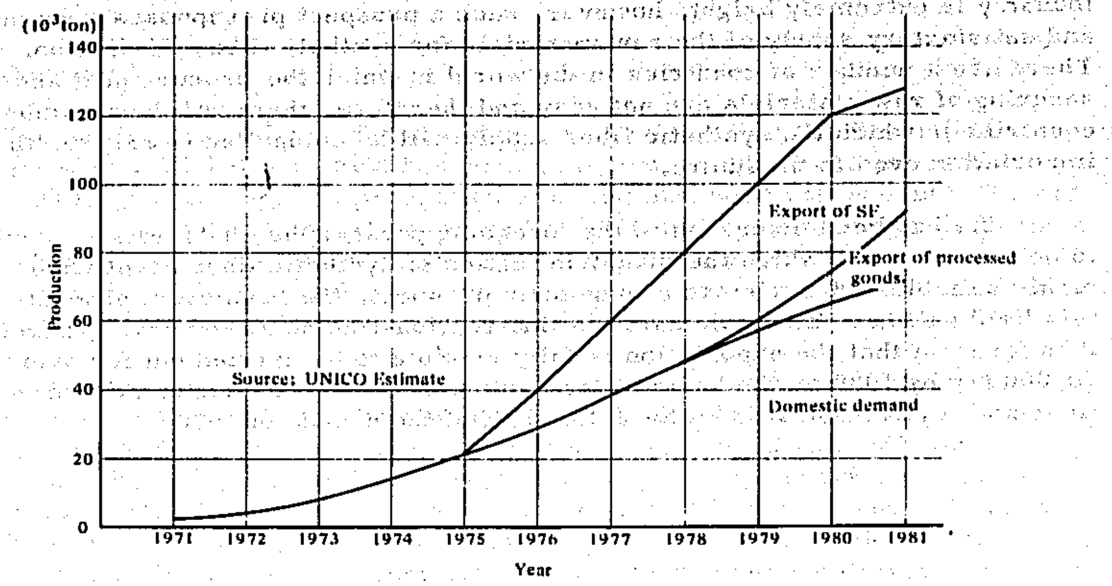


Figure IV-19 Possible Production and Application of Polyester SF in Indonesia

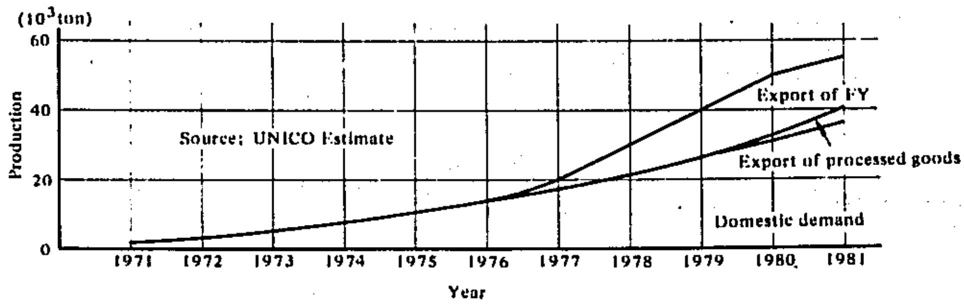


Figure IV-20 Possible Production and Application of Polyester FY in Indonesia

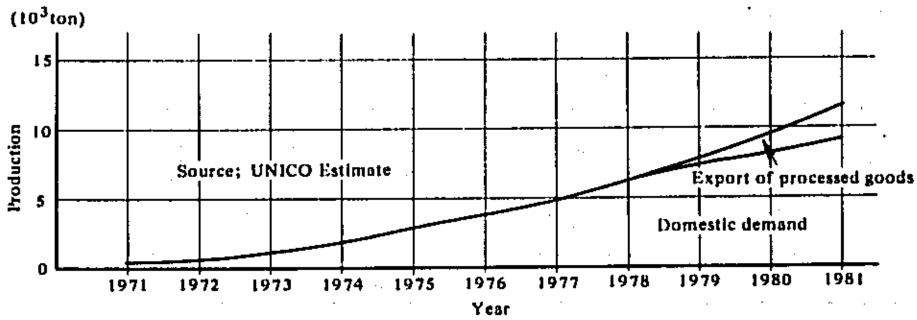


Figure IV-21 Possible Production and Application of Acrylic SF in Indonesia

It is evident that the exportation in the form of SF and FY will be commenced in 1976 as far as polyester SF is concerned, and in 1977 for polyester FY and 1978 for nylon FY. Then, by 1980, it is forecast a total exporation of approximately 73,000 tons will be realized including all the materials which corresponds to 32% of the total production.

Globally speaking, it is definite that the demand for synthetic fiber will maintain a high level of growth rate and therefore the future of synthetic fiber industry is extremely bright, however, such a prospect presupposes a smooth and satisfactory supply of the raw materials for synthetic fiber production. There are a number of countries in the world in which the procurement and securing of raw materials are not easy and therefore, there will be a number of countries in which the synthetic fiber supply will be compelled to rely on the importation even in the future.

As has been discussed in the foregoing paragraphs, Indonesia is deemed to be a country for which the industrialization of synthetic fiber production is highly suitable and in view of a long-term prospect, the Indonesian products in this field will have an ample extent of international competitiveness. Therefore, it is forecast that the exportation is fully feasible to be carried out for over 70,000 t/y by 1980 on the basis of the commencement of the exportation of staple fiber and filament yarn from the latter half of the decade of 1970s.

V. Supply/Demand Situation of Raw Materials for Synthetic Fiber

1. *Foreword*

The average annual growth rate of the production of all the fibers (both natural and man-made) of the world has been on a comparatively stable level of 4% p. a. On the other hand, the production of synthetic fiber in the world continued to increase and attained an annual growth rate of 20% throughout the decade of the 1960s. This has been due to the active demand for man-made fiber and the abundant supply of raw materials for synthetic fiber to support such a demand as well as to the ample supply of basic raw materials.

A rough illustration of the flow of raw materials for synthetic fiber can be made as shown in Figure V-1. As can be seen from the flow diagram, the basic supply depends on the primary energy sources such as natural gas, oil, or coal. As shown in Table V-1, the utilization rate of these primary energy sources differs from country to country to a considerable extent; however, approximately 50% of the supply is dependent upon oil. This signifies that the synthetic fiber industry is virtually and vitally affected by the supply/demand equilibrium of oil.

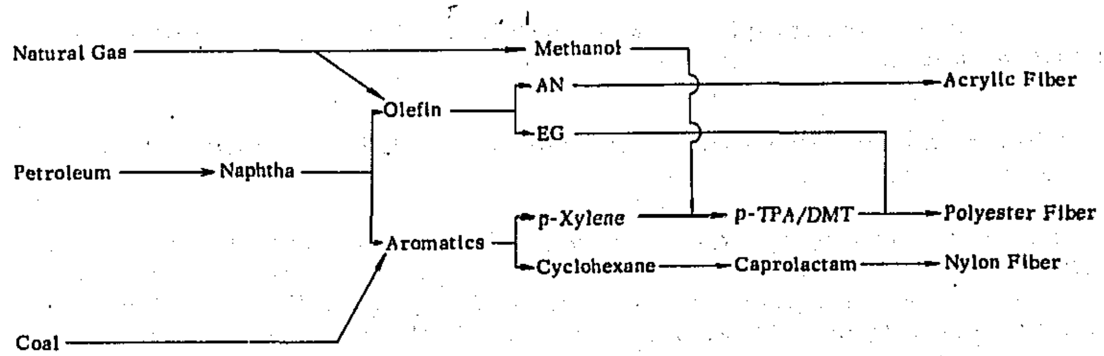


Figure V-1 Schematic Flowdiagram of Synthetic Fibers Production

Table V-1 Consumption of Primary Energy in 1972

	Total Consumption 1) (10^6 ton)	Component (%)				
		Petroleum	Natural Gas	Coal	Hydroelectric	Atomic
Japan	292	75.3	1.0	21.1	2.4	0.2
U.S.A.	1,634	43.8	34.1	20.6	1.3	0.2
West Europe	1,050	62.1	7.9	26.7	2.9	0.4

Note: 1) Equivalent to Petroleum

At least up to 1972, the oil supply was considered to be ample so that no impediment was present in the course of synthetic fiber production so long as the facilities shown in the flow of Fig. V-1 are free from bottlenecks. On the other hand, by setting a target of cost reduction by means of increase in the scale of production facilities, the manufacturers of raw materials for synthetic fiber continued active competition amongst themselves in the way of expansion and new erection of production facilities. This having been the circumstance, the supply/eemand of raw materials for synthetic fiber have persisted in oversupply situation constantly from a global point of view, although partial upsetting of the supply/demand balance has been present from time to time.

However, since the autumn of 1972, the situation has drastically changed, and as a global phenomenon, the shortage in the supply of raw materials for synthetic fiber became apparent. The raw materials which thus far been considered to be easily available became all of a sudden extremely difficult to obtain. The reasons for such a turn of the situation can be summarized as in the following three points.

(a) Stagnation in the expansion of the raw materials for synthetic fiber production facilities

(b) Shortage in the feedstock (aromatics) to be supplied to raw materials for synthetic fiber plants

(c) Frequent instances of accidents in petrochemical industrial plants

The following paragraphs will describe in detail the nature of the above-mentioned factors.

1-1 Stagnation of the Expansion of Production Facilities for Raw Materials for Synthetic Fiber

The price for raw materials for synthetic fiber displayed a down trend year after year till 1972 because of the world-wide over-supply position of the market, as well as of the scale enlargement tendency of facilities together with the technical innovations. Thus, during mid-1972, the Japanese market price of DMT was ¥105/kg (US¢ 38/kg); ¥ 135/kg for caprolactam (US¢ 48/kg). Enka illustrates such a situation of price down trend and the future price trend as shown in Figure V-2.

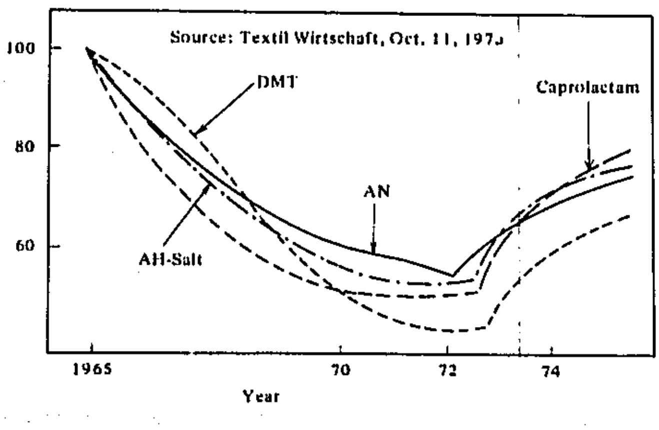


Figure V-2 Trend of Prices of Intermediates for Synthetic Fiber

Because of such a situation, the raw material for synthetic fiber manufacturers in general, those in the advanced countries in particular, felt detrioration of facility investment incentives. However, the production of raw material for synthetic fiber displayed a stable growth from a long-term viewpoint, although the evolution at times involved a fluctuations. This being the circumstance, the raw material production capacity surplus which has been on the over-supply side gradually diminished itself. Also, the delay in the implementation of new projects for the construction of raw material for synthetic fiber facilities in the developing countries also contributed to the worldwide shortage of the facility capacities. From the beginning of 1972 onward, the synthetic fiber market again showed active moves so that in advanced countries the production consequently increased and further, the production increment in the Southeast Asian and South American areas were also added to the general market. Therefore, the production globally showed an acute increment. Thus, since the summer of 1972, the shortage in the raw materials for synthetic fiber became a sudden and serious problem all over the world and, at the same time, the price which thus far has been showing stagnation on the bottom level began to turn into an up trend.

1-2 Shortage in the Feedstock to be Supplied to Raw Materials Plant for Synthetic Fiber

In addition to the production capacity shortage for raw materials for synthetic fiber, the shortage of feedstock to be supplied to the production facilities, i. e., BTX are also showing supply shortages. As to the reasons for such situation, the following two factors existing in the United States can be enumerated as the main factors.

1-2-1 Stagnation in the Oil Refinery Construction in the United States

Although abolished in 1973, there was a law in the United States which controlled the importation of crude oil. Such a control contributed to the deterioration of the incentive for constructing new oil refineries in the United States. Also, same effect was exerted by the low profitability because of the level of petroleum products prices. In addition to these adverse factors, the construction of refineries was suppressed further by the environmental regulations. This being the circumstance, the stagnation in the construction of oil refineries which are the supply sources of aromatics in the United States manifested itself.

1-2-2 The American Governmental Policy of Placing Special Emphasis on Fuel

Under the situation of the shortage in the refinery capacity in the United States, the government is undertaking policies of placing emphasis on the securing of fuel. The term "fuel" signifies that to be utilized as motor gasoline and household heating fuel. Because of this situation, in spite of the growth in the demand, the supply of petroleum products to be used as raw materials for chemical products has been suppressed. In addition to this, the advancement of the elimination of lead contents from motor gasoline is increasingly suppressing the supply situation of the aromatics to be used as the chemical raw materials.

The consumption in the United States of the motor gasoline and the extent of oil refining definitely have a worldwide influence because of their scale and a slight fluctuation in the amount thereof will eventually affect greatly the quantitative problems of the supply of aromatics raw materials for chemical industry of the whole world.

1-3 Frequent Instances of Accidents in the Petrochemical Industrial Plants

During the year 1973, there were frequent cases of accidents in petrochemical industry. This gave a further acceleration to the overall shortage of supply of raw materials for synthetic fiber during the year.

In such plants as U. C. C. (U. S. A.), P. P. G. (U. S. A.), Jefferson Chemical (U. S. A.) the ethylene oxide/ethylene glycol production had to be reduced. Further, I. C. I. (U. K.), B. P. (U. K.), Idemitsu Petrochemical Industries (Japan), Osaka Petrochemical Ind. (Japan), Sumitomo Chemical (Japan) all suffered from ethylene plant accidents. Furthermore, the phenol plant accident took place in Phenol Chemie (Germany) was another example of the accident.

Because of the above-mentioned three causes, the supply of raw materials for synthetic fiber began to fall short and demand supply situation has became tight since the autumn of 1972. Concerning the prospect towards the future, observations will be made in accordance with each one of the raw material items in the following paragraphs. However, in the case of any of these raw materials, no over-supply situation is expected and the forecast shows a long-term persistence of supply shortage.

2. Features of Raw Materials Industry for Synthetic Fiber Production

Before entering into the discussion regarding the supply/demand problems, mention will be made concerning the specific features of the raw materials industry for synthetic fiber. Raw material industry for synthetic fiber has, when compared with the other sectors of chemical industries, the following specific features:

(1) The application of use of the product is limited almost to the production of synthetic fiber:

Figure V-3 shows the direction of use of raw materials for synthetic fiber in Japan. As evidnet from this figure, 90% of cyclohexane is used for the production of caprolactam and AH-Salt and further, 85% of which is used for the production of nylon fiber.

Also, in the polyester field, all the p-xylene is used for the production of p-TPA/DMT and 93% of p-TPA/DMT is destined for the production of polyester fiber. 70% of ethylene oxide is turned into ethylene glycol and 65% of which is destined for the production of polyester. In acrylic fibers, 70% of acrylonitrile is used for fiber production.

Therefore, it is highly difficult for these raw materials for synthetic fiber to find the outlet for supply/demand market other than fiber industry and the balance between supply and demand is mainly controlled by export and import.

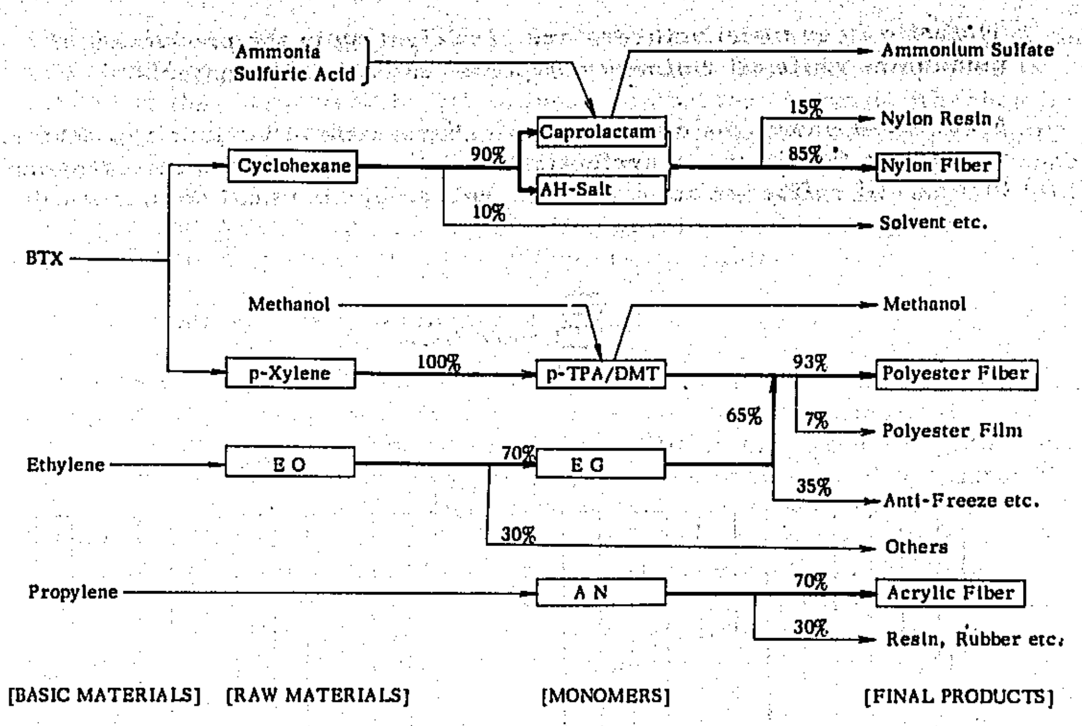


Figure V-3 Use of Synthetic Fibers Intermediates in Japan

(2) The leading chemical manufacturers of the world are participating in this field of raw materials for synthetic fiber production:

The raw material industry for synthetic fiber assumes an important position in chemical industry as a whole. Table V-2 shows the present situation of the participation into the raw material industry for synthetic fiber of the 12 world's leading chemical companies ranked by Chemical Age. Including all the affiliated or related companies, all the 12 leading manufacturers are having relations to the raw material industry for synthetic fiber by producing average two items of raw materials for synthetic fiber production.

Table V-2 Participation of World's Leading Chemical Companies in Synthetic Fibers Intermediates Industry

Ranking[1]	Company		Caprolactam	AH-Salt	p-TPA/DMT	AN
1	E. I. Du Pont de Nemours & Co.	(U. S. A.)		o	o	o
2	Imperial Chemical Industries Ltd.	(U. K.)		o	o	Δ
3	Farbwerke Hoechst AG	(W. Germany)			o	o
4	Farbenfabriken Bayer AG	(W. Germany)	o			
5	Montedison S. p. A.	(Italy)	o		o	o
6	BASF AG	(W. Germany)	o	o		o
7	Union Carbide Corp.	(U. S. A.)				o
8	Pechiney-Ugine-Kuhlmann	(France)				Δ
9	AKZO NV	(Holland)			o	
10	Rhone-Poulenc SA	(France)		o	o	
11	Monsanto Co.	(U. S. A.)		o		o
12	Dow Chemical Co.	(U. S. A.)	Δ			

Notes: o : Production by itself.
Δ : Production by its subsidiary company.
1) : Chemical Age 1972 July 28, p. S22

(3) Synthetic fiber manufacturers are participating in the production of monomer, while oil refinery companies in basic raw materials:

Figure V-4 shows the company-wise share ratio of various raw material production facilities for synthetic fiber owned by synthetic fiber manufacturers, oil refinery companies, as well as by chemical companies.

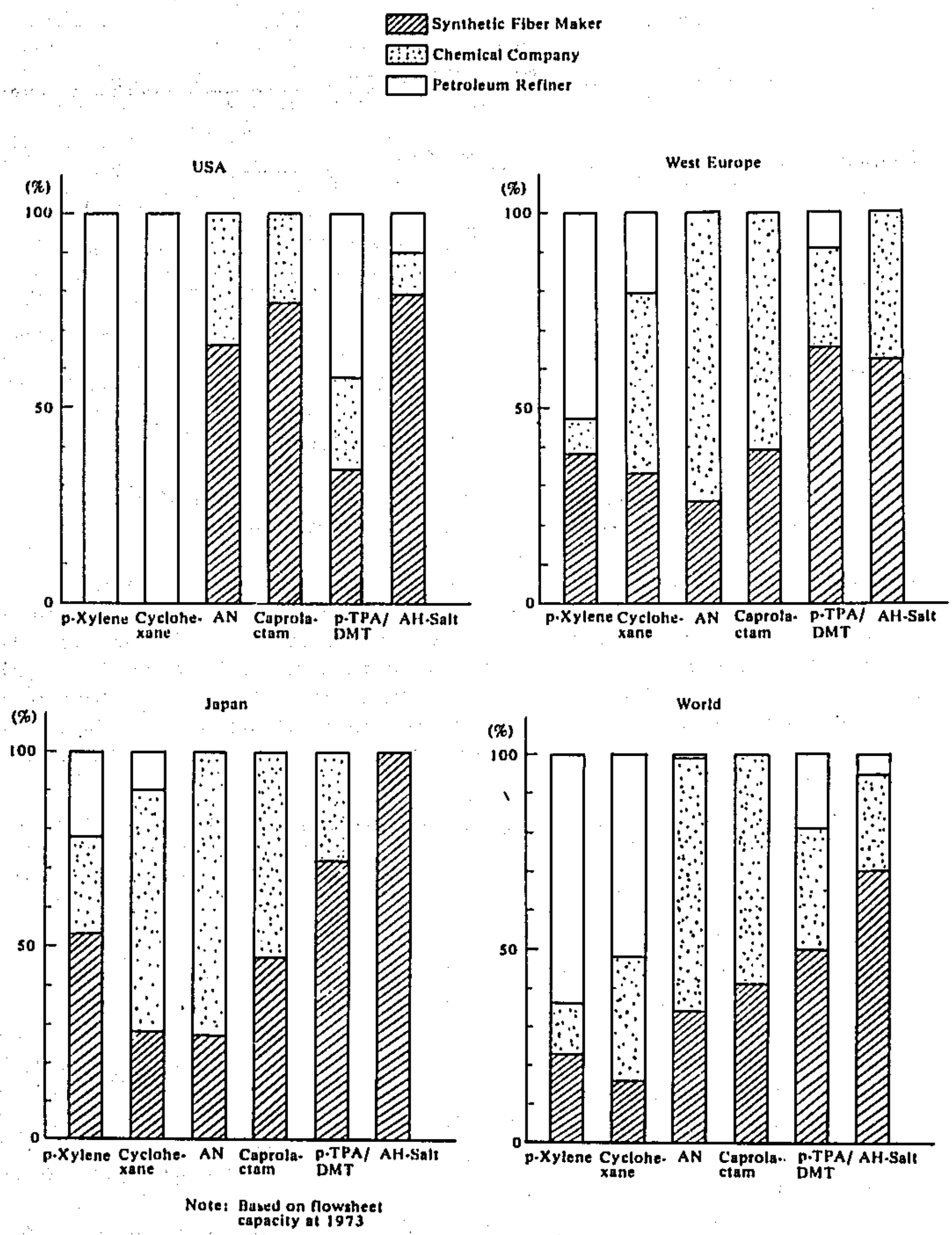


Figure V-4 Production Capacity of Intermediates for Synthetic Fiber by Company Type

Concerning caprolactam, AH-Salt, p-TPA/DMT and acrylonitrile, the share comprised by synthetic fiber manufacturers and chemical companies is large and that comprised by oil refinery companies is small, whereas in the case of cyclohexane and p-xylene, the share taken up by oil refinery companies is high. In the United States, it has been obvious that the share development made by oil refinery companies is conspicuously high, while in Japan and West Europe, the activities development displayed by synthetic fiber manufacturers have been remarkable.

(4) The distribution channel is highly stratified:

Although it is commonly noted in every facilities industries, there is a coincidence of interests between the supplier who wishes to maintain continuous and constant operation of the facilities and the users who desire to receive continuous and constant supply of the products. This being the circumstance, the distribution of raw materials for synthetic fiber is highly stratified. Particularly in the case of raw materials for synthetic fiber, the application other than the production of synthetic fiber is extremely limited as has already been discussed and, at the same time, due to the fact that the quality level of the product is an important point of issue, the stratification of the distribution of the product is highly conspicuous.

Also, as is evident from Table V-3, the synthetic fiber manufacturers are taking a positive attitude towards the reinforcement of own production of the raw materials.

Table V-3 Production of Synthetic Fiber Intermediates by Ten Largest Synthetic Fiber Makers in the World

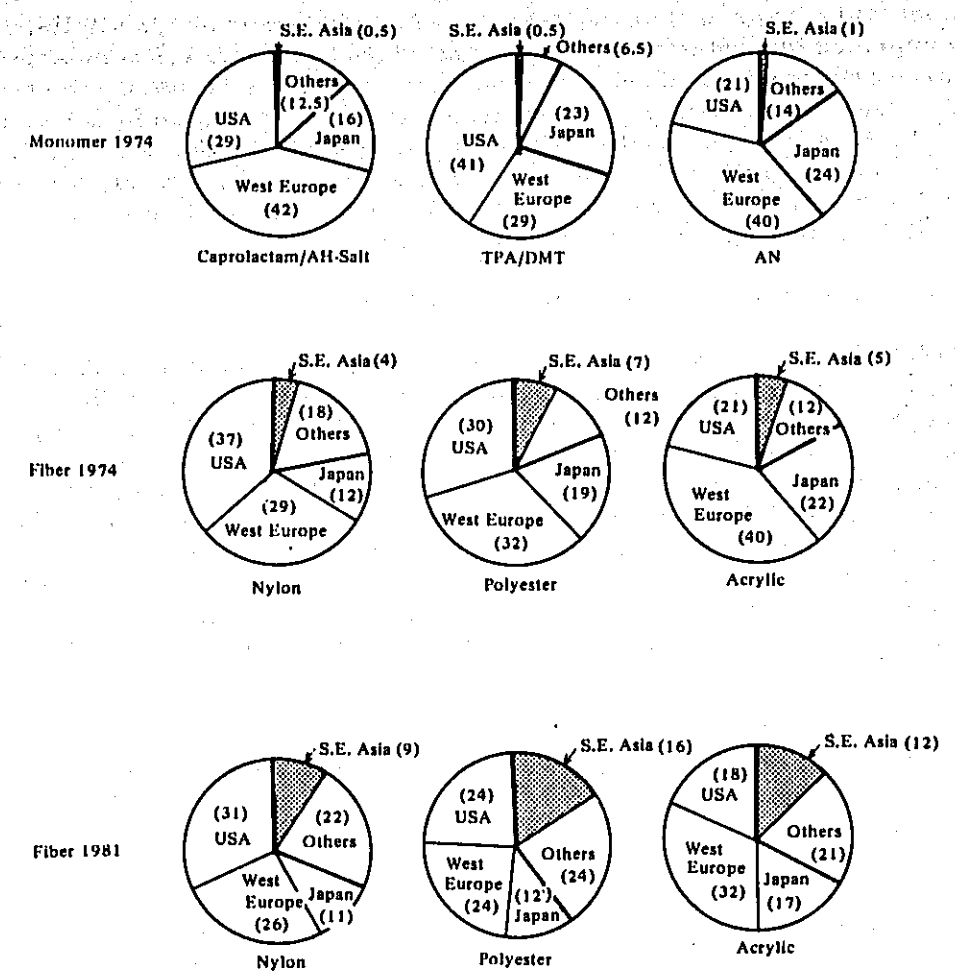
	Their Total Share of Synthetic Fiber Production in the World (%)	Monomer Production (Companies)	Raw Materials Production (Companies)
Nylon	48	7	2
Polyester	50	8	4
Acrylic	53	6	0

Therefore, the supply/demand relationship within the group will necessarily assume a direction towards equilibrium. It is considered therefore that the distribution in the market of the floating commodities will difinitely be a temporary phenomenon which manifests itself at the time when the demand balance inside the group is upset.

(5) The industry is heavily concentrated in advanced countries:

Figure V-5 shows the area-wise production ratio forecast concerning synthetic fibers and monomers.

For the year 1974, it is shown in the table that the production of caprolactam/AH-Salt in the U. S. A., West Europe and Japan will comprise 87% of the world's total production, while in the case of p-TPA/DMT the rate is as high as 93%. The acrylonitrile production comprised by these



Note: ( ) ..... %

Figure V-5 Production Forecast of Synthetic Fibers and Monomers in the World

advanced countries will attain 85%. These data clearly show the serious extent of the concentration of production of raw materials for synthetic fiber in the so-called advanced countries. The monomer production in the Southeast Asian areas except Japan is in every case of the items, less than 1 %.

On the other hand, as far as the production of fiber is concerned, the rate comprised by the advanced countries for the year 1974 regarding the three major synthetic fibers is in every case approximately 80% and, although not so conspicuous as in the case of monomer, the concentration on the advanced countries is still obvious. However, by 1981, the rate comprised by the advanced countries will decrease to 60% in every item and the weight of the ratio comprised by the other areas is expected to increase. Particularly in the case of the Southeast Asian areas except Japan, a conspicuous advancement in this respect will be achieved.

When the increment in the quantity is taken into account, the necessity for raw materials for synthetic fiber felt by the developing countries in the Southeast Asian areas will attain an enormous level and it will therefore become almost impossible quantitatively to accomodate the total supply of the raw materials for synthetic fiber from the advanced countries, the situation which has so far been prevailing. Therefore, it will eventually become evident that an advancement will be made in the self-sufficiency in the supply of raw materials for synthetic fiber in the developing countries.

3. Aromatics

The aromatics (benzene, toluene, mixed xylene), which are the basic raw materials for nylon and polyester production, are those which are suffering from an extreme supply shortage globally of all the petrochemical products at present. Especially in the case of benzene, the supply shortage is particularly conspicuous and therefore constituting the major cause for the supply shortage of styrene, phenol, cyclohexane, etc., which are the derivatives of benzene.

Also, in the United States and West Europe, the toluene shortage is prevailing and therefore, the production of benzene by means of dealkylation of toluene is also falling short. The shortage in the mixed xylene has firstly manifested itself in the form of the shortage in the o-xylene which is the raw material for phthalic acid anhydride and, particularly in West Europe, this shortage is also affecting the production of p-xylene.

In the following paragraphs, explanations will be made concerning the past production trend of BTX and the future demand therefor.

3-1 The Supply/Demand Situation in the U. S. A.

3-1-1 The Supply/Demand Situation of Benzene in the U. S. A.

Table V-4 shows the actual records of benzene production as well as the records of import and export of benzene in the U. S. A.

Table V-4 Benzene Production and Export/Import in U.S.A.

(ton)

	Production						Export	Import
	Petroleum			Coal	Total	Growth Rate (%)		
	1°	2°	Sub-Total					
1955	114,602	213,192	327,794	628,000	955,794	-	8,185	106,740
56	126,562	244,539	371,101	629,000	1,000,101	4.6	9,047	231,397
57	139,499	246,800	386,298	644,000	1,030,298	3.0	8,967	184,076
58	254,690	217,807	472,497	427,000	899,497	-12.7	38,211	148,215
59	450,622	243,578	694,200	433,000	1,127,200	25.3	24,306	190,774
60	653,271	374,818	1,028,088	489,000	1,517,088	34.6	78,424	126,860
61	1,073,177	299,400	1,372,577	433,000	1,805,577	19.0	154,613	64,400
62	1,075,091	324,631	1,399,722	410,000	1,809,722	0.2	137,281	76,518
63	1,402,373	358,076	1,728,697	407,000	2,135,697	18.0	215,393	24,053
64	1,640,563	405,786	2,046,348	398,000	2,444,348	14.5	290,420	51,856
65	1,877,671	482,341	2,360,012	405,000	2,765,012	13.1	150,750	84,593
66	2,417,329	399,114	2,816,443	380,000	3,196,443	15.6	322,615	76,115
67	2,538,926	402,595	2,941,522	378,000	3,319,522	3.8	339,674	84,903
68	2,679,963	358,113	3,038,075	308,000	3,346,075	0.8	276,648	109,598
69	3,258,493	369,110	3,627,602	338,000	3,965,602	18.5	305,326	202,180
70	-	-	3,481,564	310,000	3,791,564	-4.1	222,650	173,968
71	-	-	3,351,082	239,000	3,590,082	-5.3	141,706	255,161
72	-	-	3,925,248				96,498	316,310
73							98,515	172,565

Sources: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
U.S. Foreign Trade Exports Commodity by Country (Bureau of the Census)
U.S. Foreign Trade Imports Commodity by Country (")

Of all the production amount, the benzene from petroleum began to assume the main since 1959, so that by 1971, the ratio between the petroleum benzene portion and the coal benzene was 93:7.

During the decade of 1960s, the production showed a remarkable growth of average 13.5%. As is shown by Table V-5, the benzene production facilities have been expanding in order to meet the demand. However, since 1970, the benzene production began to display a decrease compared with the previous years. Due to this circumstance, the export which has been continued from 1961 onward began to fall and from 1971 onward, the importation amount exceeded exportation amount. On the other hand, as shown in Figure V-6, the demand has been centering around cyclohexane, phenol and styrene and the average yearly growth rate of 9.8% has been soundly displayed for the period from 1955 to 1966. As shown in Table V-6, the amount in the year 1972 was 4.4 million tons and 5.0 million tons in 1973.

Table V-5 Operating Rate of Benzene Production Capacity in USA (10^3 ton)

	1965	1967
Production Capacity 1)		
Petroleum	2,692	3,048
Coal	472	472
Total	3,164	3,520
Actual Production 2)		
Petroleum	2,360	2,942
Coal	405	378
Total	2,765	3,320
Operating Rate (%)		
Petroleum	87.7	96.5
Coal	85.8	80.1
Total	87.4	94.3

Notes: 1) Kagaku Keizai (Chemical Economy) (p.55, February 1965)
2) Table V-4

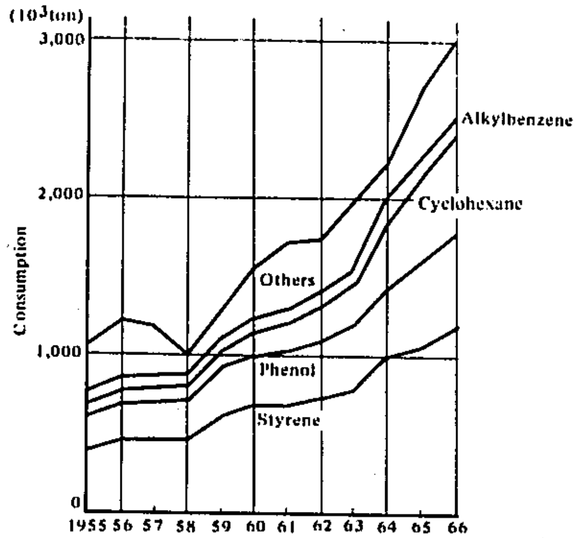


Figure V-6 Benzene Consumption in the U.S.A.

Table V-6 Benzene Supply and Demand Balance in USA

(10^3 ton)

		1972	1973
Supply	Reformate	-	2,600
	Dealkylation	-	1,270
	Pyrolysis Gasoline	-	500
	Coal Tar	-	330
	Total	4,180	4,700
Demand (Domestic)	Styrene	2,300	-
	Phenol	750	-
	Cyclohexane	770	-
	Alkylbenzene	100	-
	Aniline	150	-
	Maleic Anhydride	160	-
	Others	180	-
	Total	4,410	4,980
	Balance	-230	-280

On the other hand, the production was 5 million tons in 1972 and 4. 7 million tons in 1973. Therefore, it was estimated the benzene shortage must have attained a level of 220, 000 tons and 280, 000 tons respectively.

Especially in 1973, it was estimated that the benzene importation will greatly be reduced from the level of 1972 and the final consumption amount is expected to be forced to reduce to a considerable extent from the level of 5 million tons.

3-1-2 The Supply/Demand Situation of Toluene in the U. S. A.

The production and import as well as export of toluene in the U. S. A. is as shown in Table V-7. Of the production, more than 97% is comprized by petroleums. From 1969 onward, the position of the U. S. A. turned into that of an importing country. In 1972, net 410, 000 tons of toluene was imported, thereby clearly indicating that the domestic production is falling behind the demand.

In view of the operational rate shown in Table V-8, one of the reasons for the toluene shortage is the capacity shortage in the petroleum toluene production facilities. The demand is as shown Table V-9 in which it is evident that the demand consists of both for dealkylation and gasoline use. The demand for dealkylation which will be generated because of the worldwide benzene shortage and the demand for gasoline accelerated by the trend of lead-elimination will both be enlarged to a certain extent in the future. This being the circumstance, the toluene supply shortage in the U. S. A. is expected to persist for some time to come.

Table V-7 Toluene Production and Export/Import in USA

(ton)

	Production								Export	Import
	Petroleum					Coal	Total	Growth Rate (%)		
	Nitration grade 1°	Pure commercial grade 2°	Solvent grade 90%	All other	Sub-Total					
1955	177,977	191,126	-	101,865	470,968	138,000	608,968	-	38,121	22
56	173,323	164,827	-	91,313	429,463	140,000	569,463	-6.5	28,604	-
57	267,858	185,960	-	54,933	508,751	140,000	648,751	13.9	80,286	2,480
58	293,684	191,211	-	196,111	681,006	105,000	786,006	21.2	84,013	2,174
59	353,753	226,761	-	243,720	824,234	100,000	924,234	17.6	102,771	4,601
60	557,821	115,790	-	117,086	790,697	110,000	900,697	- 2.5	166,864	9,919
61	514,170	98,686	-	136,994	749,850	103,000	852,850	- 5.3	138,309	5,361
62	686,572	102,940	-	301,057	1,090,570	99,000	1,189,570	39.5	181,646	1,790
63	776,311	52,466	-	415,121	1,243,898	95,000	1,338,898	12.6	197,789	4,992
64	1,038,886	74,119	-	435,316	1,548,320	84,000	1,632,320	21.9	186,145	16,310
65	1,077,676	80,575	56,634	513,138	1,728,023	81,000	1,809,023	10.8	155,971	44,852
66	1,170,739	89,040	-	590,553	1,850,332	74,000	1,924,332	6.4	169,246	96,924
67	1,291,352	272,341	59,427	436,124	2,059,245	70,000	2,129,245	10.6	81,792	102,364
68	1,428,063	252,176	80,684	466,766	2,227,689	70,000	2,297,689	7.9	119,989	106,730
69	1,535,660	288,065	52,080	563,994	2,439,800	70,000	2,509,800	9.2	105,196	164,888
70	1,897,949	193,916	-	587,732	2,679,597	70,000	2,749,597	9.6	75,323	310,048
71	2,015,590	163,561	-	666,481	2,845,632	70,000	2,915,632	6.0	48,266	372,614
72	2,212,172	194,984	69,128	495,907	2,972,190	-			85,349	494,660
73									303,695	335,938

Note: Production from coal in 1967 - 1971 is estimated.

Sources: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
U. S. Foreign Trade Exports Commodity by Country (Bureau of the Census)
U. S. Foreign Trade Imports Commodity by Country (")

Table V-8 Operating Rate of Toluene Production Plants in USA

(10^3 ton)

	1965	1967
Production Capacity 1)		
Petroleum	1,816	2,036
Coal	164	164
Total	1,980	2,200
Actual Production 2)		
Petroleum	1,728	2,059
Coal	81	70
Total	1,809	2,129
Operation Rate (%)		
Petroleum	95.2	101.1
Coal	49.4	42.7
Total	91.4	96.8

Notes: 1) Kagaku Keizai (Chemical Economy) (p. 55, February 1965)
2) Table V-7

Table V-9 Toluene Consumption in USA

(10^3 ton)

	Dealkylation	Solvent	Gasoline	Others	Total
1965	755	164	542	246	1,707
66	-	-	-	-	-
67	-	-	-	-	-
68	-	-	-	-	-
69	-	-	-	-	-
70 (Estimated)	1,575	210	263	380	2,428

Source: Hydrocarbon Processing (45(2) p. 139, February 1966)

3-1-3 The Supply/Demand Situation of Mixed Xylene in the U. S. A.

Table V-10 shows the actual records of production and trade of this item. It is evident from the table that 99% of the products is derived from petroleum. The special feature of this commodity when compared with benzene and toluene is that there has been a remarkable fluctuation in the growth rate of production and the virtual lack of import and export. As is evident from Table V-11, the production facilities have so far been constructed with a considerable extent of allowance.

Table V-10 Mixed Xylene Production and Export/Import in USA

(ton)

	Production								Export	Import
	Petroleum					Coal	Total	Growth Rate (%)		
	3°	5°	Aviation grade	All other	Sub-Total					
1955	-	-	-	13,791	317,273	38,900	356,173	-	-	46
56	(64,166)[1]		102,741	238,874	405,781	39,900	445,681	25.1	-	21
57	-	-	84,201	292,215	376,417	39,500	415,917	- 6.7	-	174
58	-	107,804	-	518,515	626,319	29,400	655,719	57.7	-	933
59	199,995		-	563,522	763,517	26,100	789,617	20.4	-	4,737
60	438,009		-	458,151	896,160	27,800	923,960	17.0	-	9,350
61	412,666		-	402,423	815,089	26,400	841,489	- 8.9	-	5,314
62	618,358		-	515,159	1,133,517	24,800	1,158,317	37.7	-	2,523
63	245,471	256,701	-	568,771	1,070,943	24,200	1,095,143	- 5.5	-	1,700
64	165,472	-	-	933,659	1,099,131	23,200	1,122,331	2.5	-	-
65	201,790	-	-	887,477	1,089,267	21,900	1,111,167	- 1.0	-	-
66	304,891	-	-	750,027	1,054,918	19,900	1,074,818	- 3.3	-	-
67	423,710	-	-	1,045,866	1,469,576	18,000	1,487,576	38.4	-	-
68	303,198	257,404	-	1,177,587	1,738,189	18,300	1,756,489	18.1	244,914	-
69	256,580	169,920	-	805,141	1,231,641	17,000	1,248,641	-28.9	69,966	-
70	232,987	268,612	-	1,241,998	1,743,598	14,700	1,758,298	40.8	45,756	-
71	313,349	288,922	-	1,390,807	1,993,078	14,000	2,007,078	14.1	30,396	-
72	537,242	173,899	-	1,695,798	2,406,940				88,180	-
73									156,890	-

Note: 1) Nitration grade

Sources: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
U.S. Foreign Trade Exports Commodity by Country (Bureau of the Census)
U.S. Foreign Trade Imports Commodity by Country (")

Table V-11 Operating Rate of Mixed Xylene Production Capacity in USA

(10^3 ton)

	1965	1967
Production Capacity 1)		
Petroleum	3,087	3,167
Coal	33	33
Total	3,120	3,200
Actual Production 2)		
Petroleum	1,089	1,470
Coal	22	18
Total	1,111	1,488
Operation Rate (%)		
Petroleum	35.3	46.4
Coal	66.7	54.5
Total	35.6	46.5

Notes: 1) Kagaku Keizai (Chemical Economy) (p. 55, February, 1965)
2) Table V-10

The xylene situation in the U. S. A. cannot be clarified if the relationship of the industry with the gasoline industry is neglected. In other words, the production shown in Table V-10 shows only the portion which has been extracted and refined. This amount corresponds merely approximately 10% of the total xylene which was produced actually in the U. S. A. The remaining 90%* is directly consumed as gasoline in the form of reformate without being extracted. The consumption of xylene is shown in Figure V-7. Xylene is consumed in two directions, i. e., for use as o-xylene, m-xylene, p-xylene and for solvents. The remaining portion is destined for gasoline blending for domestic use and the amount allocated to exportation is extremely small. From a strict point of view, it would be sufficient for the U. S. A. if the o. m. p-xylene and the solvent use portion alone is extracted and the production beyond this level will be unnecessary for the country. Therefore, in the future, it seems that the American xylene will be balanced within the closed framework of the domestic consumption and therefore will will exert little influence upon the supply/demand balance of the world.

* The production of the mixed xylene in 1965 in the U. S. A. by means of reformate facilities was 3,500 to 4,000 million gallons, however, the actually extracted portion was 395 million gallons (Hydrocarbon Processing, 45 (4), p. 155, April, 1966).

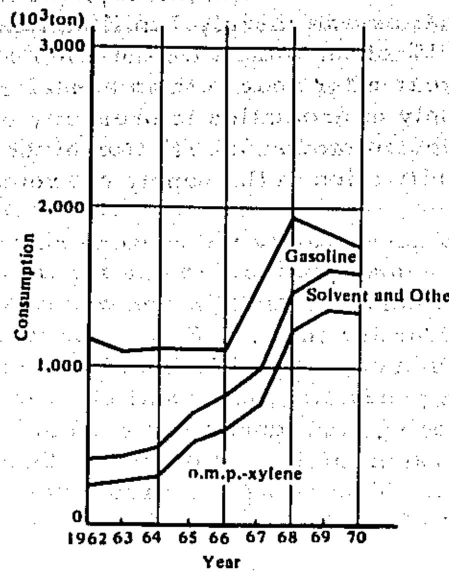


Figure V-7 Mixed Xylene Consumption in the U.S.A.

3-1-4 Causes for the Aromatic Shortage

As has been discussed in the foregoing, the supply/demand equibilium became tight especially centering around benzene since 1970. The following paragraphs will observe the possible causes which led such a situation.

(1) The oil refining capacity in the U. S. A. is generally falling short. For instance, the capacity expansion for crude oil refining during a period from 1970 to 1972 was merely 0.75 million BPSD in the U. S. A. in contrast to 2.71 million BPSD in the West Europe and 1.08 million BPSD in Japan. Further, over the past four years, no new construction of refining facilities has been undertaken. It seems that such a stagnation in the refinery construction is due to the following reasons.

(a) Instability in the oil supply securing because of import control

(b) Limitations exerted by the environmental controls

(c) Low extent of ROI

(2) The shortage in the refining capacity resulted in the shortage of naphtha which is the very basic raw material for petrochemical industry. In the U. S. A., most of the naphtha fractions including gasoline are being fed into the reformer and are applied for the production of gasoline and aromatics. However, at present in the U. S. A., the government is politically giving a priority to gasoline and household heating fuel including the fractions other than naphtha. Therefore, the naphtha production to be destined for aromatics manufacturing is being treated with the secondary importance.

The crude oil consumption of the U. S. A. in 1973 was approximately 600 million tons, of which 300 million tons, equivalent to 50% of the total was destined for gasoline use. On the contrary, the allocated portion for the production of aromatics was merely 7 million tons which comprizes only slightly more than 1% of the total. On the other hand, the gasoline demand has been growing year after year with an annual growth rate of 6 to 7%. Therefore, the supply of aromatics is presently extremely unstable, so that, unless the reinforcement and substantiation of the refining capacity be undertaken, no stabilization in the supply of aromatics will be achieved.

(3) The facter which is accelerating the benzene shortage is the shortage in the supply of toluene for dealkylation. In other words, the benzene production in the year 1972 by means of dealkylation was estimated to have comprised 21% of the total production in the U.S.A., however, in spite of the fact that at present, production capacity of 1.75 million tons/year is existing, the toluene for benzene production is not sufficient in supply because of the fact that the toluene is being sold more to be used for gasoline blending which entails to a higher extent of evaluation rather than for the allocation to conduct dealkylation. This being the circumstance, it is suspected that a considerable extent of dealkylation facilities are now standing idle in the U.S.A.

3-1-5 Prospect of Shortage Relaxation

When will be the shortage in the oil refining capacity which is constituting the major cause of the aromatics shortage relaxed?

(1) In accordance with the "Energy White Paper" published in April 1973, the reinforcement of the refining capacity by more than 3 million BPSD is being undertaken in the U.S.A., however, the completion of such reinforcement projects will be made sometime after 1976.

(2) Also, along with the construction of oil refineries, the expansion of ethylene plants is being undertaken. As a result of such construction, the benzene which are to be extracted from the by-produced cracked gasoline will eventually contribute to the enhancement in the supply capacity. However, the completion of these plants now being constructed will be made approximately during the same period as the completion of the refineries, i.e., sometime after 1976.

(3) As has been mentioned in the foregoing, during the period from 1976 to 1977 when the completion of the refinery construction will be achieved, according to some opinions, the relaxation of the tight supply/demand situation will be materialized. Nevertheless, in view of the fact that the demand itself will also increase year after year, the present prospect upon the future situation is that the oversupply position will not be achieved for some time to come.

3-2 The Supply/Demand Situation in West Europe

3-2-1 Background of Aromatics Shortage

The oil refining capacity shortage took place in the U.S.A. and the consequent shortage in the supply of aromatics caused thereby are severely affecting the aromatics balance in West Europe. In other words, the shortage in the refining capacity in the U. S. A. resulted in a further increase in the import for the fulfilment of the ever increasing demand for the gasoline and aromatics. This being the circumstance, the following took place as a result in West Europe.

(1) Increase in the demand in the West European market

(2) The active purchase activities within the West European market by American users.

(3) Decrease in the import from the U. S. A.

The above-mentioned factors have further accelerated the deterioration of the aromatics balance in West Europe. Further, the explosion accident took place in the ethylene plant (450, 000 t/y) in ICI and the fire took place in the ethylene plant (340, 000 t/y) in BP further contributed to the intensification of aromatics shortage.

3-2-2 The Supply/Demand Situation of Benzene in West Europe

Table V-12 shows the supply/demand balance of benzene in West Europe. During the year 1973, the actual production was 3. 78 million tons which corresponds to 80% operational rate as against the total operation capacity of 4. 74 million tons. On the other hand, it is forecast that the demand for the year is 4. 23 million tons, thereby indicating a supply/demand gap of 450, 000 tons as for the entire West Europe. Also, for the year 1974, it is forecast that the supply/demand gap of benzene will be 0. 5 million tons. These factors clearly indicate the seriousness of the benzene shortage in West Europe. In the light of the fact that the supply/demand of aromatics in West Europe will be greatly affected by the trend in the U. S. A., it is expected that the present shortage situation will persist until relaxation is achieved in the supply/demand situation in the U. S. A.

Table V-12 Benzene Supply and Demand Balance in West Europe

(10^3 ton)

		1972	1973	1974	1975
Supply	Flowsheet Capacity	-	4,740	5,120	-
	Production	-	3,780	4,260	-
Demand	Styrene	1,535	1,885	2,245	2,670
	Cumene/Phenol	785	840	890	960
	Cyclohexane	700	780	860	950
	Aniline	185	225	250	285
	Maleic Anhydride	150	160	170	190
	Alkylbenzene	190	195	200	210
	Others	145	150	160	170
	Total	3,690	4,235	4,775	5,435
Balance		-	-455	-515	-

3-3 The Supply/Demand Situation in Japan

The shortage of aromatics supply in Japan derives from causes different from those existing in the U. S. A. and West Europe.

3-3-1 The Supply/Demand Situation of Benzene in Japan

Table V-13 shows the records of production, export and import of benzene in Japan. The supply sources of benzene reveals that petroleums took over coals in 1966 and by 1972 the petroleum sources comprized approximately 85% of the total. As far as the production is concerned, an acute increment was achieved during the decade of 1060s with an average annual growth rate of 20 to 40%,

Table V-13 Benzene Production and Export/Import in Japan

(ton)

	Production				Export	Import
	Petroleum	Coal	Total	Growth Rate(%)		
1953	-	32,611	32,611	-	-	-
54	-	33,212	33,212	1.8	-	-
55	-	40,556	40,556	22.1	-	-
56	-	56,648	56,648	39.7	-	-
57	-	59,759	59,759	5.5	-	-
58	4,913	59,578	64,491	7.9	-	-
59	10,906	81,483	92,389	43.3	-	-
60	14,835	118,721	133,556	44.6	-	-
61	27,327	136,670	163,997	22.8	-	-
62	55,925	141,491	197,416	20.4	3,097	-
63	83,588	167,754	251,342	27.3	436	12,221
64	98,775	209,008	307,783	22.5	10,488	36,476
65	143,013	238,184	381,197	23.9	25,417	21,765
66	279,074	250,161	529,235	38.8	38,973	537
67	370,995	281,552	652,517	23.3	24,721	-
68	541,034	321,121	862,155	32.1	22,786	19,579
69	883,699	337,715	1,221,414	41.7	48,881	17,764
70	1,212,938	371,751	1,584,689	29.7	102,523	1,532
71	1,370,571	318,454	1,689,025	6.6	145,308	5,726
72	1,576,923	274,637	1,851,560	9.6	224,342	14,893
73	1,739,132	256,169	1,995,301	7.8	129,654	24,739

Source: Kagaku Kogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)

however, from 1971 onward, the average annual growth rate stayed within the range of 10%. In spite of this situation, no stagnation in export has been present. Figure V-8 shows the actual consumption records. As is evident from this table, the styrene consumption takes up more than 40% of the share, followed by cyclohexane and phenol both of which are large outlets for consumption. It must be noted here that the supply/demand structure of benzene in Japan has the following features.

(1) The main sources of supply are pyrolysis gasoline:

Table V-14 shows the supply sources of benzene during the year 1973 in Japan and U. S. A. Compared with the case of the U. S. A. where 55% of the sources are of the reformate gasolines, 53% of the Japanese sources of supply is comprized by the benzene included in the aromatics obtained by the pyrolysis gasoline which is by-produced at the time of producing ethylene through naphtha cracking. Both in the case of Japan and U. S. A., 1/4 of the total supply sources is comprized by the benzene by means of dealkylation. The benzene obtained from reformate gasolines in Japan takes up merely 7% of the total supply sources.

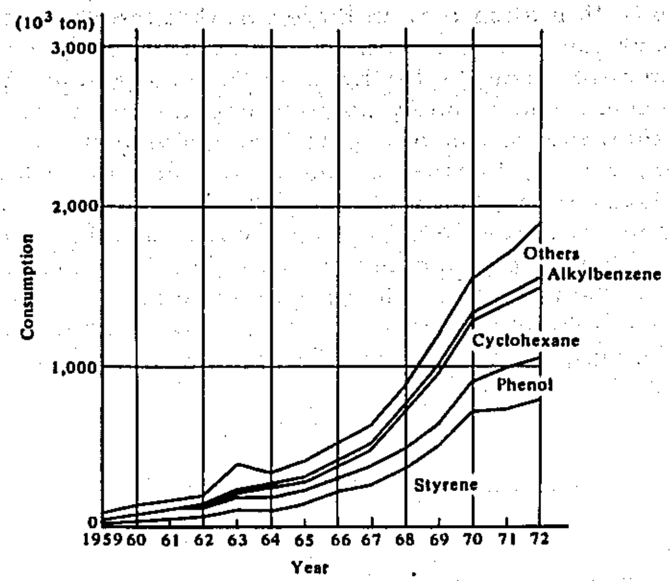


Figure V-8 Benzene Consumption in Japan

Table V-14 Source of Benzene Production in Japan and USA (1973)

(%)

	Japan	USA
Pyrolysis Gasoline	53	11
Reformate	7	55
Dealkylation	25	27
Caol Tar	15	7
Total	100 (1,950)[1]	100 (4,700)[1]

Note: 1) ( ) shows total production amount in 10^3 ton.

(2) The adjustment of supply/demand balance has been made by exportation:

As is evident from the above-mentioned supply source situation, the benzene production in Japan is affected vitally by the production of ethylene, and therefore the benzene production operation itself is not directly geared to the demand situation. Due to the fact that so far, the ethylene production has been increased with a considerably high pace, the general picture of the benzene market in Japan has been displaying an oversupply position. Because of this fact, and in order to prevent the deterioration of the economic viability in the aromatic production operation, the manufacturers took a policy of positively concluding export contracts during the current year for the expected surplus portion, which is the difference between the forecast production and forecast domestic demand for the forthcoming year. By this method, the supply/demand balance has been artificially maintained. Due to this situation, in the event that the domestic demand turned out to be above the forecast level or when the production is below the estimated level towards the forthcoming year, there has been cases in which the benzene short supply position became inevitable inside Japan while a considerable extent of export is being undertaken at the same time. During the year 1973, because of the plant accidents in Idemitsu Petrochemical, Osaka Petrochemical, etc. at their ethylene plant, the production was behind the estimated level so that a considerable demand has been suppressed. The supply/demand forecast for the period from 1974 to 1975 is as shown in Table V-15. When the already contracted export is included, the supply and demand will almost balance with each other, so that in view of the equilibrium, it is expected that no export surplus capacity will be newly obtainable.

Table V-15 Benzene Supply and Demand Balance in Japan

(10^3 ton)

		1972	1973	1974	1975
Supply	Pyrolysis Gasoline	930	1,030	1,130	1,230
	Reformate	100	130	240	250
	Dealkylation	520	490	530	650
	Coal Tar	300	300	330	330
	Sub-Total (Production)	1,850	1,950	2,230	2,460
	Import	18	30	-	-
	Total	1,868	1,980	2,230	2,460
Demand	Styrene	793	-	-	-
	Cyclohexane	434	-	-	-
	Cumene/Phenol	260	-	-	-
	Alkylbenzene	64	-	-	-
	Maleic Anhydride	32	-	-	-
	Others	83	-	-	-
	Sub-Total (Domestic)	1,666	1,910	2,150	2,430
	Export	230	75	56 ~ 66	-
	Total	1,896	1,985	2,206~2,216	2,430
Balance		-28	-5	24-14	30

3-3-2 The Supply/Demand Situation of Toluene in Japan

The actual records of production, export and import of toluene are as shown in Table V-16. For the most part, toluene is supplied regardless of the level of actual demand, from the reformer as well as from naphtha thermal cracking facilities. On the other hand, as far as the demand is concerned, as is evident from Table V-17, the major destinations are for use as solvent and for use in dealkylation, however, because of the fact that in Japan, the dealkylation hydrogen is suffering from shortage, the consumption for dealkylation is not so much as in U.S.A. Therefore, the supply/demand balance is being maintained by positively promoting exportation. Although it is expected that the demand in the future for toluene for use in gasoline blending will increase, a comparatively relaxed supply/demand position will be available as far as toluene is concerned, for some time to come, when compared with benzene and xylene.

Table V-16 Toluene Production and Export/Import in Japan

(ton)

	Production				Export	Import
	Petroleum	Coal	Total	Growth Rate (%)		
1953	-	6,717	6,717	-	-	-
54	-	6,685	6,685	-0.5	-	-
55	-	7,738	7,738	15.8	-	-
56	-	9,465	9,465	22.3	-	-
57	-	10,387	10,387	9.7	-	-
58	8,975	12,564	21,539	107.4	-	-
59	27,779	17,162	44,941	108.6	-	-
60	34,563	26,494	61,057	35.9	-	-
61	55,919	32,132	88,051	44.2	-	-
62	74,382	34,756	109,138	23.9	179	1,990
63	96,024	37,596	133,620	22.4	432	8,383
64	112,066	44,751	156,817	17.4	2,924	28,599
65	138,738	47,778	186,516	18.9	3,127	25,882
66	200,322	52,499	252,821	35.5	2,972	29,978
67	253,757	55,269	309,026	22.2	2,633	10,083
68	300,938	59,197	360,135	16.5	7,131	7,443
69	535,959	54,456	590,415	63.9	53,715	573
70	719,147	55,866	775,013	31.3	108,267	3,033
71	739,539	50,985	790,524	2.0	141,769	-
72	791,469	41,478	832,947	5.4	167,697	13,000
73	890,689	27,777	918,466	2.7	127,012	21

Source: Kagaku Koogyo Tookei Nenpoo
(Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)

Table V-17 Toluene Consumption in Japan

(ton)

	Domestic					Export	Total
	Solvent	Dealkylation	TPA	Others	Sub-Total		
1970	301,500	214,700	24,500	134,000	674,700	108,400	783,100
71	316,200	179,100	25,800	123,800	644,900	142,400	787,300
72	338,000	171,800	24,800	142,300	676,900	167,700	844,600
73	365,000	253,700	25,600	157,500	801,800	78,000	879,800
74	387,100	254,000	25,600	165,100	831,800	100,000	931,800
75	410,800	254,000	25,600	188,500	878,900	100,000	978,900
76	436,100	254,000	25,600	196,600	912,300	100,000	1,012,300
77	463,200	254,000	25,600	204,500	947,300	100,000	1,047,300

Source: Sekkakyo (The Association of Petrochemical Industry in Japan)
(June, 1973)

3-3-3 The Supply/Demand Situation of Mixed Xylene in Japan

The actual records of production, export and import are shown in Table V-18. During the period from 1969 to 1972, the balance between supply and demand has been maintained by means of undertaking exports. Table V-19 illustrates the details of the supply and demand situation.

Table V-18 Mixed Xylene Production and Export/Import in Japan

(ton)

	Production				Export	Import
	Petroleum	Coal	Total	Growth Rate (%)		
1953	-	1,295	1,295	-	-	-
54	-	1,223	1,223	-5.6	-	-
55	-	1,234	1,234	0.9	-	-
56	-	1,656	1,656	34.2	-	-
57	-	1,765	1,765	6.6	-	-
58	7,128	2,343	9,471	436.6	-	-
59	16,338	3,457	19,795	109.0	-	-
60	26,136	5,754	31,890	61.1	-	-
61	42,344	6,320	48,664	52.6	-	-
62	53,184	7,515	60,663	24.7	434	6,123
63	63,069	8,161	71,230	17.4	2,567	5,877
64	73,188	10,575	83,763	17.6	4,262	14,598
65	91,133	9,780	100,913	20.5	9,114	6,621
66	137,579	11,585	149,164	47.8	14,496	8,185
67	183,760	11,049	194,809	30.6	7,911	13,500
68	278,572	11,257	289,829	48.8	3,119	10,404
69	531,820	10,238	542,067	87.0	33,912	8,111
70	752,447	7,457	759,904	40.2	94,215	1
71	849,948	5,663	855,611	12.6	90,671	1,280
72	925,205	4,087	929,292	8.6	79,332	9,137
73	1,057,083	1,015	1,058,098	13.9	73,479	23,579

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)

Table V-19 Mixed Xylene Supply and Demand Balance in Japan

(10^3 ton)

		1972	1973	1974	1975
Supply	Reformate	620	730	935	1,060
	Pyrolysis Gasoline	330	350	370	390
	Coal Tar	30	40	40	40
	Sub-Total (Production)	980	1,120	1,345	1,490
	Import	16	40	40	40
	Total	996	1,160	1,385	1,530
Demand	Isomerization	787	978	1,195	1,361
	Solvent & Others	161	166	176	188
	Sub-Total (Domestic)	948	1,144	1,371	1,549
	Export	47	14	-	-
	Total	995	1,158	1,371	1,549
Balance		1	2	14	-19

(1) Supply sources of mixed xylene:

During the year 1973, the reformate-type mixed xylene comprized 65% of the supply, while 31% by pyrolysis gasoline and 4% by coal coking. Also, the mixed xylene obtained from pyrolysis gasolines and coal coking respectively have inherent characteristics of being by-products from ethylene plant and from coal coking, whereas only the xylene from the reformate are being produced for the purpose of turning out aromatics including the mixed xylene.

(2) Types of mixed xylene:

Mixed xylene comes in different compositions depending upon the respective supply sources. Table V-20 illustrates the typical example of the mixed xylene composition. As is evident from this table, the ethylbenzene content is as high as 53% only in the case of the pyrolysis gasoline source, whereas other types contain approximately 20%. As is obvious from the relative structural formula, m-xylene and o-xylene can be easily isomerized to p-xylene, however, the isomerization of ethylbenzene to p-xylene is comparatively difficult. Therefore, in order to enhance the production efficiency of p-xylene the manufacturers prefer the utilization of the reformate-type mixed xylene which has a low content of ethylbenzene. On the other hand, concerning the mixed xylene for solvent use, there is no particular limitation as to the composition thereof. Therefore, for the production of this type, the mixed xylene from pyrolysis gasoline is being utilized.

Table V-20 Typical Xylene Isomer Breakdown by Source of Mixed Xylene

(%)

	Catalytic Reformate	Pyrolysis Gasoline	Disproportionation	Coke Oven
Ethylbenzene	17 - 20	53	Nil	15 - 23
p-Xylene	16 - 20	10	26	15 - 17
m-Xylene	35 - 40	25	50	42 - 44
o-Xylene	19 - 26	12	24	14 - 20

Source: Hydrocarbon Processing (July, 1971, p. 113)

(3) Demand for mixed xylene:

For the year 1973, the mixed xylene for isomerization (which is destined to the p-xylene manufacturers to be used for the production of p-xylene, o-xylene and ethylbenzene) comprizes 85% of the total domestic demand and the remaining portion is, for the most part, destined to solvent use. For the future also, along with the enhancement of p-xylene production, the demand for isomerization use mixed xylene is forecast to grow.

(4) Prospect on the supply/demand balance of mixed xylene:

As is evident from Table V-19, it is forecast that the supply and demand will be balanced as far as mixed xylene is concerned, by undertaking

40,000 tons of importation for each year of 1974 and 1975. Therefore, there would be no export surplus capacity. However, when observed in accordance with the types of the commodity, the shortage seems inevitable for the reformate type mixed xylene for isomerization use, whereas the pyrolysis gasoline type mixed xylene for solvent use will show a surplus. This being the circumstance, the p-xylene manufacturers will be forced to employ unwillingly the pyrolysis gasoline type mixed xylene which they do not actually prefer.

4. Raw Materials for Polyester

4-1 General

It is expected that polyester will show the greatest extent of growth of all the various types of synthetic fibers. Therefore, projects for the expansion of production facilities for the raw materials for polyester such as p-xylene, p-TPA/DMT are being laid out, however, the supply/demand forecast towards the future is not quite bright. In this chapter, discussions will be conducted on the subject of two methods for polyester production, i.e., the p-TPA method and the DMT method, together with the observation of the trend concering these methods. Also, in the following paragraphs, the supply/demand forecast for both p-TPA and DMT will be conducted.

According to the result of the p-TPA observation, it will be revealed that the future shortage of p-TPA is quite conspicuous and it will also be concluded that because of the possibility of the loss of future demand sources for DMT, it would be a highly risky project to newly install DMT plants during the period from 1976 onward especially in the Southeast Asian areas.

On the other hand, the shortage anticipated for the ethylene glycol which is another monomer for polyester is also serious. Both ethylene oxide and ethylene glycol are derivatives of ethylene and these materials have a great outlet for application traditionally in such areas as anti-freeze in addition to the application for polyester production. Therefore, the capacity increment for ethylene oxide and ethylene glycol so far has been undertaken not exactly on the pure basis of the polyester production capacity expansion. The ethylene shortage which became apparent in the recent years therefore constituted a major reason for encouraging the delay in the expansion projects on the side of the ethylene oxide/ethylene glycol manufacturers regardless of the forecast upon the future growth of polyester.

4-2 p-TPA/DMT

4-2-1 The Past Supply/Demand Trend of p-TPA/DMT

Tables V-21 through V-25 show the data concerning the past records in this respect. In the case of the U.S.A. and West Germany, they have been assuming the position of exporting countries of DMT. In Japan, exportation of DMT were not conducted up until 1970; however, since 1971, Japan began to assume the position of a DMT exporting country. Japan exported 60,000 tons in 1971 and 120,000 tons in 1972 mostly to Southeast Asian markets. These have been exported to the Southeast Asian countries and to the syntheric fiber joint-venture enterprises of

Japan. The export amount in the year 1972 corresponds to 19% of the total production of Japan. However, under the circumstance of raw material shortage which took place since 1972, it is highly questionable as to whether or not Japan will be able to continue to export such a large quantity of DMT for a long period of time in the future.

Table V-21 c-TPA Production in USA

(ton)

	Production	Growth Rate (%)
1965	-	-
66	233,091	-
67	314,790	35.1
68	420,304	33.5
69	-	-
70	602,813	-
71	717,577	19.0
72	874,933	21.9

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-22 DMT Production and Export in USA

(ton)

	Production	Growth Rate (%)	Export
1962	-	-	-
63	150,108	-	-
64	161,294	7.8	-
65	247,020	53.1	-
66	361,732	46.4	-
67	424,639	17.4	-
68	593,811	39.8	-
69	-	-	-
70	656,331	-	58,356
71	788,647	20.2	72,229
72	983,080	24.7	52,493
73			76,095

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-23 DMT Export and Import in West Germany

(ton)

	Export	Import
1966	-	-
67	26,244	4,279
68	30,976	9,825
69	27,347	8,314
70	25,777	11,800
71	-	-
72	-	-

Source: Trade Statistics of West Germany

Table V-24 c-TPA Production and Consumption in Japan

(ton)

	Production	Growth Rate (%)	Consumption 1)	Export	Import
1957	-	-	-	-	-
58	1,726	-	1,677	-	-
59	11,489	565.6	11,066	-	-
60	25,156	119.0	23,832	-	-
61	37,636	49.6	36,310	-	-
62	46,724	24.1	46,235	-	-
63	55,592	19.0	58,552	-	-
64	69,693	25.4	68,977	-	-
65	77,795	11.6	78,440	-	6
66	110,352	41.8	110,451	-	6
67	129,560	17.4	130,223	-	115
68	166,282	28.3	163,154	-	-
69	194,247	16.8	194,175	-	48
70	257,762	32.7	263,552	168	977
71	353,763	37.2	347,352	238	186
72	428,073	21.0	450,601	606	251
73	525,858	22.8	560,552	6,067	1

Note: 1) Including export

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

Table V-25 DMT Production and Consumption in Japan

(ton)

	Production	Growth Rate (%)	Consumption 1)	Export	Import
1961	-	-	-	-	-
62	-	-	-	-	72
63	-	-	-	-	2,972
64	-	-	-	-	6,605
65	-	-	-	-	481
66	-	-	-	-	2
67	149,408	-	150,434	-	8,881
68	219,321	46.8	213,935	-	350
69	290,459	32.4	291,594	-	5,213
70	401,719	38.3	409,492	5,187	34,319
71	551,326	37.2	593,639	59,694	1,497
72	647,797	17.5	669,784	124,346	-
73	720,299	11.2	772,373	108,989	998

Note: 1) Including export

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

As far as c-TPA is concerned, the all production is consumed domestically and no import or export is being conducted. Figure V-9 shows the actual records of the production capacities and consumptions of p-TPA and DMT in the world. As is evident from the facilities operational rates stipulated in the table, the market position was balanced or on a slightly oversupply side for the period from 1967 to 1972, however, in the year 1973, the consumption level of p-TPA/DMT superseded the facility capacity, thereby bringing the market situation into a tight position. It seems that the situation was barely overcomed by allocating the inventory stock in order to cope with the tight position of the market.

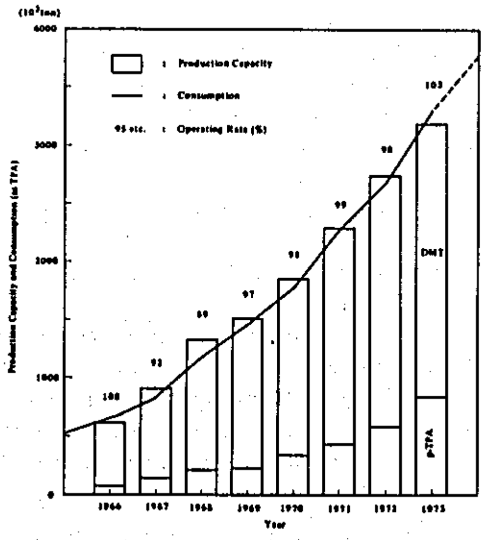


Figure V-9 World Supply/Demand Balance of p-TPA, DMT

4-2-2 Behavior of Manufacturers Concerning the p-TPA Process and the DMT Process

As is well known, there are two processes available for the production of polyester as shown in Figure V-10. Compared with the DMT process, the p-TPA process is a newer process, however, the share comprised by this process has been rapidly increasing over the recent years. Here, explanations will be made regarding the behaviour and the trends shown by raw materials manufacturers and fiber manufacturers concerning the employment of the processes.

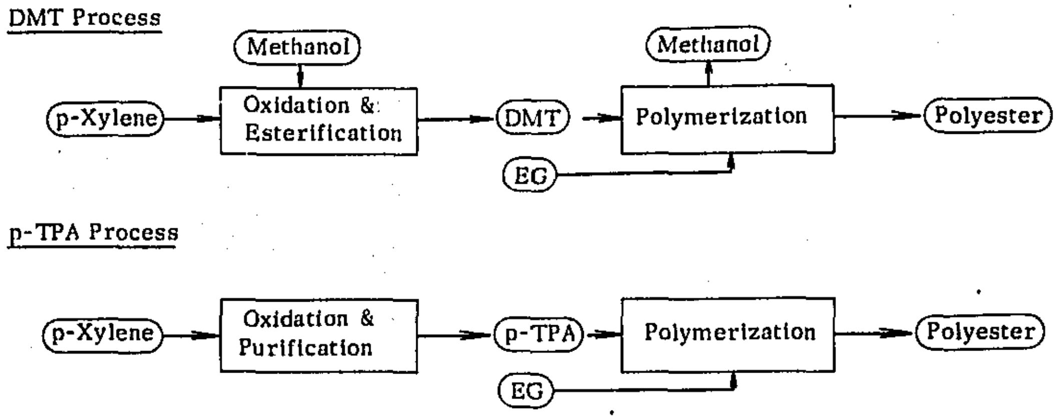


Figure V-10 Manufacturing Processes for Polyester

(1) Behaviour of Raw Material Manufacturers

Table V-26 shows the new installation or expansion projects of the p-TPA facilities now scheduled by various manufacturers. The production capacity of 870,000 tons as of the end of 1973 will be increased up to 1.86 million tons by the end of 1976, thereby achieving a multiple of 2.1.

The point which is worthy of attention here is the fact that Hercules who is the largest manufacturer employing the Witten-DMT process was compelled to commence the production of p-TPA at last because of strong requests voiced by the users. This event has generally been conceived as a symbolic instance indicating the future fall of DMT. It is also reported that ICI is planning to replace all the existing DMT facilities with p-TPA equipment. Also, in addition to the stipulations made in Table V-26, Du Pont and Hoechst seem to be projecting new installation of p-TPA facilities.

The comparison between p-TPA and DMT production facility capacities for the years 1974 and 1977, the results are revealed as shown in Table V-27. The increment in the production capacity from 1974 to 1977 shows 800,000 tons for p-TPA, whereas, concerning DMT the increment is only 480,000 tons, thereby clearly indicating the general trend of the raw material manufacturers shifting towards the employment of more p-TPA. As a result, by 1977, the share comprised by p-TPA will increase up to 36% from the present 27% level.

Table V-26 **Flowsheet Capacity of p-TPA Plant**

(10^3 ton)

		Capacity at the end of 1973	Increase 1974 - 1976	Total Capacity at the end of 1976
Amoco	(USA)	341	+ 495	836
Hercules	(USA)	116		116
ICI	(UK)	155		155
Amoco	(Belgium)	68		68
Rhône-Poulenc	(France)	0	+ 50	50
Montedison	(Italy)	44	+ 80	124
CEPSA	(Spain)	0	+ 50	50
Toray	(Japan)	25	+ 77	102
Mitsubishi Chemical	(Japan)	18 1)	+ 150	150
Mitsui Petrochemical	(Japan)	0	+ 80	80
Mizushima Aroma	(Japan)	36		36
Matsuyama Petrochemical	(Japan)	25	+ 25	50
East Germany		45		45
Total		873	+ 1,007	1,862

Note: 1) This plant is scheduled to be scrapped.

Table V-27 **Expansion Plan of p-TPA and DMT**

	Flowsheet Capacity(10^3 ton as TPA)				Share (%)	
	1974	Increase	1977	1977/1974	1974	1977
p-TPA	1,064	+798	1,862	1.75	27	36
DMT	2,862	+483	3,345	1.17	73	64
Total	3,926	+1,281	5,207	1.33	100	100

(2) Behaviour of Synthetic Fiber Manufacturers

Table V-28 indicates a summary of the movements shown so far by leading polyester fiber manufacturers on the basis of information became available. Following are the enumeration of the manufacturers who are expected to positively employ p-TPA process:

Table V-28 Major Polyester Fiber Makers and Their Choice of Monomers

Group	Company		Reported Capacity in 1973 (t/d)	Comment
p-TPA Group	Celanese	(USA)	870	Producing both FY and SF by p-TPA process
	ICI	(UK)	318	Producing almost all FY and SF by p-TPA process since early 1973
	Toray	(Japan)	330	Producing SF by p-TPA process these ten years and planning also FY production
	Monsanto	(USA)	149	Producing all FY by p-TPA process
	Rhône-Poulenc	(France)	336	Constructing p-TPA plant of 50,000 t/y
	Montedison	(Italy)	128	Planning to expand existing p-TPA plant of 44,000 t/y to 124,000 t/y
	Toyobo	(Japan)	170	Producing SF by p-TPA process and planning also FY production
DMT Group	Eastman	(USA)	479	Producing DMT by Eastman process
	Hoechst	(W. Germany)	318	Producing DMT by Witten process
	Teijin	(Japan)	330	Producing DMT by Witten process
	Hoechst	(USA)	236	Producing DMT by Witten process
	AKZO	(W. Germany)	179	-
Unknown Group	Du Pont	(USA)	1,081	Considering to adopt p-TPA process in future

Celanese (U. S. A.), Rhone-Poulenc (France), Toray (Japan), ICI (U. K.), Toyobo (Japan), Monsanto (U. S. A.), Montedison (Italy), etc. ICI in particular is definitely endeavoring to shift to the employment of p-TPA process in both aspects of raw material production and fiber production.

On the other hand, the following are the groups which assume a passive attitude towards the employment of the direct polymerization process utilizing p-TPA as the raw material: Eastman (U. S. A.), Teijin (Japan), Hoechst (West Germany, U. S. A.), AKZO (West Germany).

Except of AKZO, all the others now possess DMT plants. Particularly in the case of Teijin and Hoechst, they employ the Witten process so that even if they desire to shift to the employment of the p-TPA process, they are not possible to do so. Nevertheless, it seems that all these manufacturers are seriously scrutinizing the feasibility of the p-TPA process facilities installation.

Although it has been reported that Du Pont is studying the employment of the p-TPA process at present, it seems that they have not as yet arrived at the final conclusion as to whether they actually employ the process or not.

On the basis of the following prerequisites, the estimated facility capacities of polyester manufacturers of the world in the year 1981 will be classified into the p-TPA process group and the DMT process group.

Prerequisite conditions:

(a) It is assumed that the p-TPA group companies and their affiliates shown in Table V-28, as well as those who are considering the employment of the p-TPA process will be deemed to have been shifted toward the employment of p-TPA process concerning their entire facilities by 1981.

(b) The DMT group companies and their affiliates shown in Table V-28 will not employ the p-TPA process until 1981.

(c) The Unknown group in Table V-28 and those who do not fall under the category of the above (a) and (b) will, by 1981, carry out their operation by employing the p-TPA process for 1/2 of their facilities, the remaining 1/2 being the DMT process.

The result of the classification is shown in Table V-29. The rate of the p-TPA process employment will be 58% regarding the whole world.

Table V-29 Estimated Capacity of Polyester Fiber Production by Process in 1981

Area	Estimated Capacity in 1981 (t/d of fiber)			Share (%)	
	p-TPA Process	DMT Process	Total	p-TPA Process	DMT Process
East and West Europe 1)	4,406	3,756	8,162	54	46
South and North America	6,111	4,710	10,821	56	44
Asia, Africa, Oceania 2)	4,125	1,966	6,091	68	32
Total	14,642	10,432	25,074	58	42

Notes: 1) Including U.S.S.R.
2) Including Japan

4-2-3 Macro-Situation Concerning the p-TPA Process and the DMT Process

In the foregoing paragraphs, the behavior displayed by various manufacturers, concerning the direct polymerization process employment has been described. In the following paragraphs, the present situation and the future status will be observed concerning the direct polymerization situation from macro-point of view.

Although it is not possible to confirm the extent of the actual employment of the p-TPA in the present day world, when the comparative studies are viewed in the production capacities, the following can be revealed. As shown in Table V-30, the share of p-TPA which was 12% in 1966 is estimated to be increased up to 27% by 1973 and further the rate will attain 36% in 1977. Therefore, the average annual growth rate of the share comprised by the p-TPA process over the period from 1966 to 1977 will be 10.5%/y.

According to information obtained from Amoco Chemical Company, the actual record of the production of p-TPA and DMT and the estimates thereof in the United States are as shown in Table V-31 and Figure V-11 in which it is shown that the p-TPA share in 1970 was 26% and will attain 50% by 1976 and 57% by 1980. In this respect, the average annual growth of p-TPA over the period from 1966 to 1980 will be 14%/y. An observation will be made here concerning the rise and fall of various processes in the case of producing a certain chemical product when a plural number of different processes have come to conflict with one another. Of the raw materials for synthetic fiber, ethylene oxide and acrylonitrile can be enumerated as the examples which fall under this instance.

Table V-30 Share of p-TPA and DMT Production Capacity in the World

(% as TPA)

	p-TPA	DMT
1966	12 (-)[1]	88
67	16 (33)	84
68	16 (0)	84
69	15 (-6)	85
70	18 (20)	82
71	19 (6)	81
72	21 (10)	79
73	27 (29)	73
74	27 (0)	73
75	32 (18)	68
76	34 (6)	66
77	36 (6)	64

Note: 1) ( ) shows annual growth rate of the share of p-TPA process in %.
Average value from 1966 to 1977 is 10.5%.

Table V-31 p-TPA and DMT Production in USA

	Production (ton as TPA)			Share (%)	
	p-TPA	DMT	Total	p-TPA	DMT
1960	-	47,180 (54,886)[1]	47,180	-	-
62	-	67,100 (78,019)	67,100	-	-
64	454	138,870 (161,482)	139,324	0.3	99.7
65	2,722	-	-	-	-
66	30,391	311,300 (361,973)	341,691	9 (-)[2]	91
67	62,597	-	-	-	-
68	124,286	510,640 (593,762)	634,926	19 (45)	81
69	170,100	599,580 (697,183)	769,680	22 (13)	78
70	190,512	526,630 (612,360)	717,142	26 (20)	74
72	317,520	688,520 (800,604)	1,006,040	31 (9)	69
74	567,000	780,190 (907,200)	1,347,190	42 (16)	58
76	884,520	877,720 (1,020,600)	1,762,240	50 (9)	50
78	1,179,360	936,230 (1,088,640)	2,115,590	55 (6)	45
80	1,315,440	975,240 (1,134,000)	2,290,680	57 (1)	43

Source: H.A. Leipold and G.C. Brooks, (Amoco Chemical Co.) Outlook for Synthetic Fibers - Polyester Fiber Feedstocks in the 1970's - Terephthalic Acid and Its Dimethyl Ester

Notes: 1) ( ) shows actual amount of DMT
2) ( ) shows annual growth rate of the share of p-TPA process in %.
Average value from 1966 to 1980 is 14%.

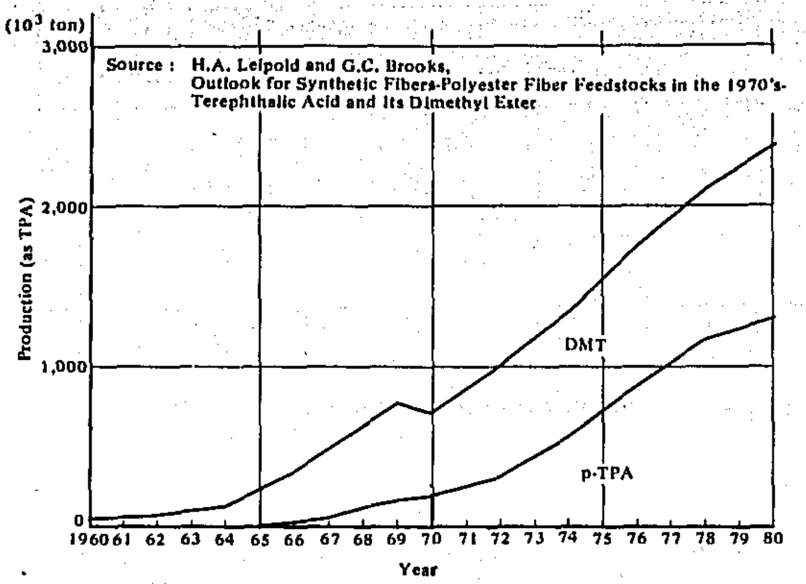
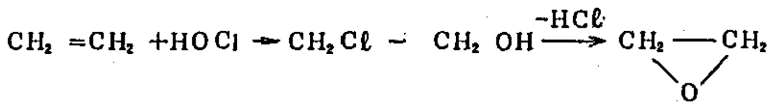


Figure V-11 Production of p-TPA, DMT in the U.S.A.

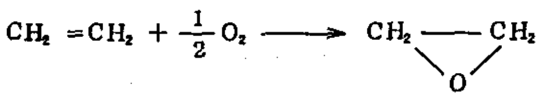
(1) Ethylene Oxide

Among the ethylene oxide producing processes, there are two processes, i.e., the Chlorohydrine process and the Direct Oxidation process.

Chlorohydrine Process



Direct Oxidation Process



The process-wise production amount of ethylene oxide and the share taken up by the various processes in the U.S.A. are shown in Table V-42. Figure V-12 can be obtained by plotting on a semi-logarithmic chart paper the annual change in the share comprised by the Direct Oxidation process.

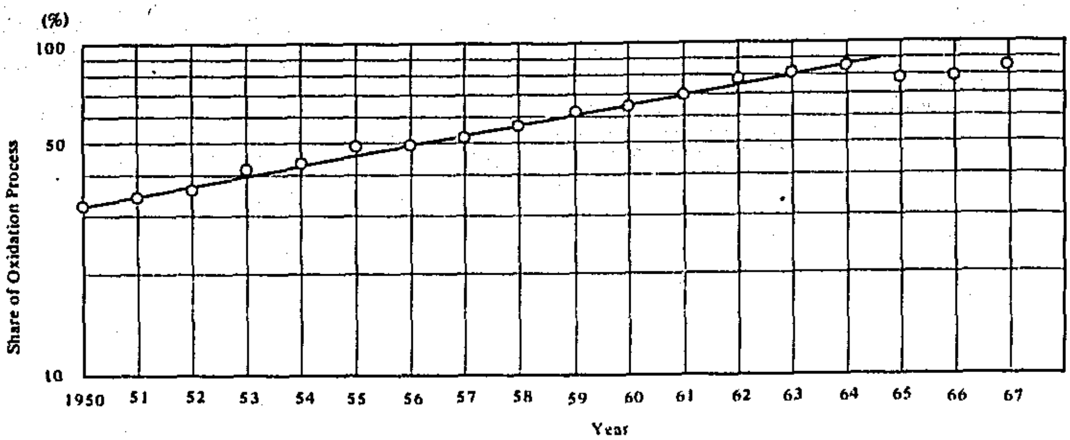


Figure V-12 Share of Oxidation Process in EO Production in the U.S.A.

(2) Acrylonitrile

For the production of acrylonitrile, there are three processes, i.e., the Acethylene process, Ethylene Oxide process and the Propylene process.

Acethylene Process

$$CH{\equiv}CH + HCN \longrightarrow CH_2{=}CHCN$$

Ethylene Oxide Process

$$\underset{\diagdown\ O\ \diagup}{CH_2 - CH_2} + HCN \longrightarrow CH_2(OH)CH_2CN \xrightarrow{-H_2O} CH_2{=}CHCN$$

Propylene Process

$$CH_2{=}CHCH_3 + NH_3 \xrightarrow{O_2} CH_2{=}CHCN$$

The process-wise acrylonitrile production amount and the share taken up by the various processes above-mentioned in the U.S. are as shown in Table V-65. Figure V-13 can be obtained by plotting on a semi-logarithmic chart paper the annual change in the share taken up by the propylene process.

As is evident from Figures V-12 and V-13, an exponential functional increment has been achieved by the share of economically superior process until the share ratio exceeds 80% in both cases of ethylene oxide and acrylonitrile. In other words, when two different processes come into conflict with each other for the same purpose of producing the same product, the economically superior process will increase its share year after year with an approximately constant growth rate until it expels almost completely the competing process.

The average annual growth rate of the share can be deemed as relating to the comparative superiority of each one of the processes. The direct oxidation process for the production of ethylene oxide shown in Figure V-12 displays an annual growth rate of 8%/y, whereas the Propylene process for the production of acrylonitrile shown in Figure V-13 has been displaying a growth rate of 40% per year.

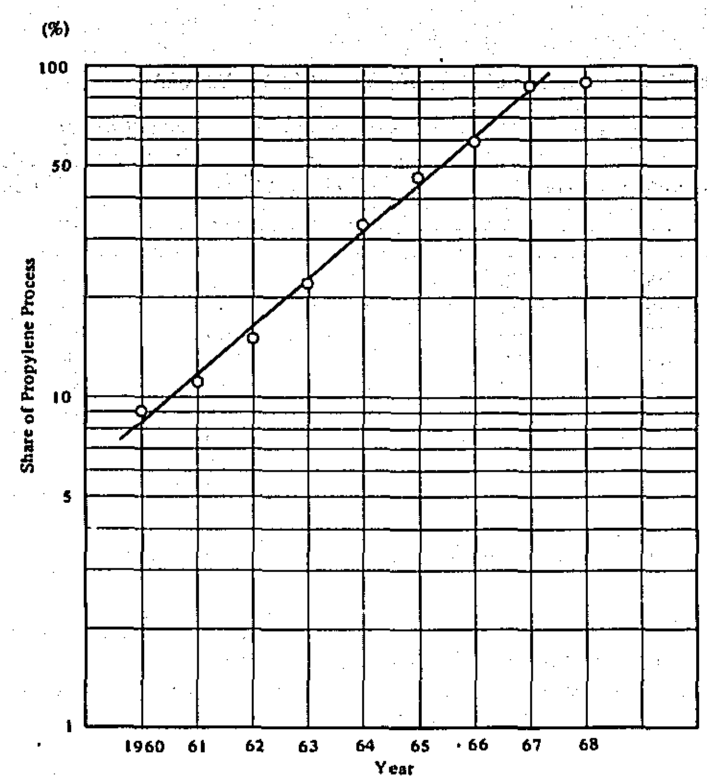


Figure V-13 Share of Propylene Process in AN Production in the U.S.A.

Assumption is made here that the above-mentioned empirical rule of superiority can be applied also to the case of the competition between the p-TPA process and the DMT process in the polyester production. On the basis of such an assumption, a forecast is made here concerning the future extent of share ratio of these two processes concerning areas of Southeast Asia including Japan and also concerning the rest of the areas of the world.

As the basic figures for forecasting the share which will be taken up by these two methods, the estimated share of p-TPA process for the year from 1974 until 1976 is 25%, 35% and 40% for each year, concerning the Southeast Asian areas including Japan. For the forecast for the year 1974 concerning the rest of the areas of the world, the p-TPA/DMT production capacity ratio (28% for p-TPA process) will be employed as the basic figure for the forecast. Regarding the average annual growth rate of the share to be taken up by the p-TPA process from the year 1974 onward, a conservatively estimated rate of 10%/y, will be employed here by referring to the 14% figure shown in Table V-31 (U.S.A.) as well as to the 10.5% figure stipulated in Table V-30 (World). The obtained results are shown in Table V-32.

According to these results, it can be forecast that in the area of Southeast Asia including Japan, the share taken up by the p-TPA process at a rate of 25% in 1974 will exceed a 50% level by 1979 and further, by 1981, the rate will attain a level of 64%. Also, regarding the rest of the area the 28% level in 1974 will attain 55% by 1981. As far as the whole world is concerned, the 27% level in 1974 will exceed the 50% in 1980 and by 1981, the rate will attain a level of 57%. This

Table V-32 Forecast of Share of p-TPA and DMT Demand

(% as TPA)

	Southeast Asia 1)		Rest of the World		Total 2)	
	p-TPA	DMT	p-TPA	DMT	p-TPA	DMT
1974	25	75	28	72	27	73
75	35	65	31	69	32	68
76	40	60	34	66	35	65
77	44	56	37	63	39	61
78	48	52	41	59	43	57
79	53	47	45	55	47	53
80	58	42	50	50	52	48
81	64	36	55	45	57	43

Notes: 1) Including Japan
2) Weighted Average of Southeast Asia and Rest of the World

conclusion approximately coincides with the rate figure of 58% estimated for the total share to be taken up by the p-TPA process in the whole world in 1981 which is shown in Table V-29 and was estimated on the basis of the behavior by various synthetic fiber manufacturers of the world.

4-2-4 Comparison between the p-TPA Process and the DMT Process

The question remains here as to why the p-TPA process will assume the main current of the future polyester fiber production process. Operations will be made in the following paragraphs in order to clarify reason for such a conclusion by comparing the p-TPA and the DMT processes.

(1) Concerning the product quality, no serious problems exist in both process.

At a certain time in the past, there was an opinion which maintained that the p-TPA process is not capable of producing FY. However, such a problem has completely been solved at present. As has already been stipulated in Table V-28, as such manufacturers as Celanese (U.S.A.), I.C.I. (U.K.), Toray (Japan), Monsanto (U.S.A.), Toyobo (Japan), ANIC (Italy), etc. either are actually producing or planning for the production of not only SF but also FY. Therefore, regarding the production and the quality of the product SF and the product FY it can be concluded that no problem exists in either the p-TPA process or the DMT process.

(2) Production cost of polyester chip from p-TPA is lower than that from DMT.

The following paragraphs will carry out a comparative study in the production of polyester chip produced by the p-TPA process and the DMT process. A preliminary calculation on the basis of an assumption that the per kg price of p-TPA and DMT is identical on the polyester chip production scale of 36,500 t/y, the following will be revealed as the cost after interest as shown in Tables V-33 and V-34.

p-TPA Process: US¢130.2/kg-chip
DMT Process: US¢138.2/kg-chip

Table V-33 Estimated Production Cost of Polyester Chip (p-TPA Process)

(36,500 t/y)

	Unit Consumption (kg/kg)	Price (US¢/kg)	Unit Cost (US¢/kg)
Variable Costs			
Raw Materials			
p-TPA	0.86	75.7	65.10
EG	0.35	60.69	21.24
Catalysts & Chemicals			2.00
Total Raw Material Costs			88.34
Utilities			
Fuel (kg)	0.06	8.3	0.50
Electricity (KWH)	0.5	2	1.00
Cooling Water (m^3)	0.05	3.2	0.16
Steam (kg)	1.6	6	9.60
Total Utility Costs			11.26
Total Variable Costs			99.60
Wages			0.50
Depreciation			
Battery Limits			7.18
Off-Site			2.66
Building			0.26
Royalty, Eng. Fee			0.55
Pre-Operating Expenses			1.00
Int. During Construction			1.67
Total Depreciation			13.33
Repairs and Insurance			4.79
Taxes			0.00
Plant Overhead Costs			0.50
Total Fixed Costs			19.12
Running Royalty			0.00
Factory Costs			118.72
Selling Expenses			0.00
General Administrative Exp.			3.56
Total Product. Cost Before Int.			122.28
Interest			
Int. on Total Inv. Costs			3.21
Int. on Working Capital			4.75
Total Interest			7.96
Total Product. Cost Including Int.			130.24

Working Capital (10^3 US$) 14,443

Total Investment Cost *(10^3 US$) 63,993

* Including Land Price & Working Capital

Table V-34 Estimated Production Cost of Polyester Chip (DMT Process)

(36,500 t/y)

	Unit Consumption (kg/kg)	Price (US¢/kg)	Unit Cost (US¢/kg)
Variable Costs			
Raw Materials			
DMT	1.0	75.7	75.70
EG	0.35	60.69	21.24
Catalysts & Chemicals			2.00
Rec. Methanol	0.33	-16.425	-5.42
Total Raw Material Costs			93.52
Utilities			
Fuel (kg)	0.08	8.3	0.66
Electricity (KWH)	0.5	2	1.00
Cooling Water (m^3)	0.05	3.2	0.16
Steam (kg)	1.8	6	10.80
Total Utility Costs			12.62
Total Variable Costs			106.15
Wages			0.52
Depreciation			
Battery Limits			6.99
Off-Site			3.19
Building			0.26
Royalty, Eng. Fee			0.55
Pre-Operating Expenses			1.06
Int. During Construction			1.75
Total Depreciation			13.81
Repairs and Insurance			5.02
Taxes			0.00
Plant Overhead Costs			0.52
Total Fixed Costs			19.87
Running Royalty			0.00
Factory Costs			126.02
Selling Expenses			0.00
General Aministrative Exp.			3.78
Total Product. Cost Before Int.			129.80
Interest			
Int. on Total Inv. Costs			3.37
Int. on Working Capital			5.04
Total Interest			8.41
Total Product. Cost Including Int.			138.21

Working Capital (10^3 US$) 15,332

Total Investment Cost *(10^3 US$) 67,321

* Including Land Price & Working Capital

Therefore, the p-TPA process involves an obviously lower production cost.

As has been discussed in Chapter IX, the production cost after interest for p-TPA/DMT from p-xylene are:

US¢62.2/kg for p-TPA in the case of a production scale of 70,000 t/y and US¢70.9/kg for Witten DMT in the case of a production scale of 77,000 t/y, thereby showing the lower extent of production cost for p-TPA.

In view of the above finding, it can be concluded that the economy of p-TPA for the production of polyester chip will be higher than that of the DMT process.

(3) p-TPA involves a smaller amount of material transportation:

Figure V-14 shows the material balance of polyester chips of 36,500 t/y (100 t/d). When observed in view of the raw materials, the importation amount of p-TPA is 31,400 tons per year whereas in the case of the DMT, the amount is 36,500 tons, so that the p-TPA process involves lower amount of the raw material importation by 5,100 tons per year. In the case of ethylene glycol, there is no difference between these processes.

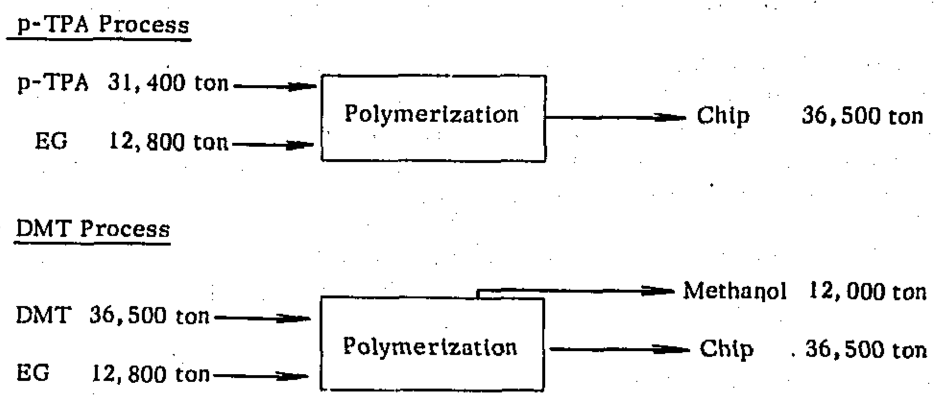


Figure V-14 Material Balance for Polymerization of p-TPA and DMT (Chip Production 100t/d or 36,500 t/y)

As for the by-products are concerned, the p-TPA by-produces water so that the disposal thereof can be simply undertaken on site of the plant. On the other hand, in the case of the DMT process, 12,000 tons methanol will be by-produced per year. This by-produced methanol must either be returned to the DMT plant or consumed in some outlet.

Therefore, in order to employ the DMT process, it becomes a necessary condition that the DMT plant should be built adjacent to the polymerization plant. If there is a certain geographic distance between the raw material plant and the polymerization plant, the advantage of the p-TPA process employment is quite obvious. A rough calculation of the transportation cost in the case of Indonesia as an example will be shown in Table V-35.

Table V-35 Transportation Cost of Polyester Chip by Process

	Transportation Cost[1] (US¢/kg)	p-TPA Process (t/y)	p-TPA Process (US$/y)	DMT Process (t/y)	DMT Process (US$/y)
p-TPA	2.7	31,400	847,800		
DMT	2.7			36,500	985,500
EG	2.6	12,800	332,800	12,800	332,800
Methanol	2.6			12,000	312,000
Total			1,180,600		1,630,300

Note: 1) Palembang to Jakarta

In case that the raw material plant is built in Palembang and the polymerization plant in the suburbs of Jakarta, the transportation cost in DMT process is 1.4 times as high as p-TPA process, and it can be concluded that the economy of DMT process will be lower than that of p-TPA process.

(4) In the case of the DMT process, there is a possibility of causing pollution:

In the case of the p-TPA process, no handling of methanol would be undertaken, however, in the DMT process, the generation of 12,000 tons per year of methanol will be made within the framework of the production line. Therefore it becomes inevitable that the discharge of methanol from ejectors, etc. into the waste water.

Methanol is a poisonous substance of the 64.6°C boiling point and miscible into water. Even the slightest extent of methanol is added into water, BOD of the water will be extremely increased. If for instance, in Indonesia, the utilization of river water to everyday use is highly frequent, the damage to be inflicted upon the human being, animals and fish, etc. will be considerably serious if the discharge of plant waste water containing methanol is undertaken. Therefore, the plants in which the employment of the DMT process is made, a high amount of pollution control investment is made to undertake the waste water treatment.

Also, it is obvious that independently from the above-mentioned polymerization plant, there is a possibility of pollution problems being caused by methanol also in the case of the DMT monomer producing plants. If the DMT process is employed, it will therefore become necessary to constantly pay attention to the prevention of pollution in both the monomer plant and the polymerization plant.

(5) The p-TPA process has a future potential:

The DMT technology is an old technology, therefore, there is very little allowance for technological innovation within the framework of this process. Therefore, the presently prevailing production cost is the minimum possible level and there is little prospect for further reduction in the cost as far as this process is employed. On the other hand, concerning the p-TPA process, the actual employment was started in 1964 and, therefore, the actual operation record is approximately 10 years. In spite of this history, it is deemed that the p-TPA process will still have a possibility of reducing production cost by means of technical innovation.

The technical innovation possible to be made in this process is the improvement in the refining step of the p-TPA production. By means of such an improvement, a lower cost p-TPA can be produced and in turn to materialize the cost reduction in the polyester chip production. The actual studies in this direction have already been started by leading polyester manufacturers. For instance, Maruzen Petrochemical's (Japan) HTA process is now being studied for employment by Du Pont (U.S.A.). (Oil, Paint, and Drug Reporter, January 14, 1974).

In order to quickly cope with such a trend, and to constantly maintain the polyester production activities on a profitable level, it seems necessary to prepare the employment of the p-TPA process for the polyester plants to be constructed in the future. Because of the fact that the polymerization equipment is different between two processes, the employment of the above-mentioned new p-TPA process is extremely difficult if the DMT process is employed.

(6) The p-TPA process is a resource-saving type process:

The comparison of the utilities from p-xylene up to polyester reveals as follows:

p-TPA process:	9,500kcal/kg-chip
DMT process:	19,200kcal/kg-chip

As shown in the above, the DMT process is approximately double as much as the p-TPA process. This mainly due to the fact that there is a difference in the utility consumption because of the necessity in the case of the DMT production plant for the recovery of methanol which is by-produced within the plant.

The oil or natural gas which are the primary energy sources have limitation in the extent of the reserves and therefore, wasteful consumption of such resources must be avoided. From this point of view, the p-TPA process can be deemed as one of the superior processes in this field.

On the basis of various reasons explained in the above paragraphs, it is definitely clear that the p-TPA process will assume the main current of the future polyester production processes.

4-2-5 Supply/Demand Forecast on p-TPA/DMT

In the following paragraphs, forecast will be made concerning the supply/demand balance of p-TPA and DMT in the future concerning the Southeast Asian areas including Japan and the rest of the areas of the world. Following are the pre-requisite conditions to be assumed for conducting the said forecast.

Pre-requisite conditions:

(1) Concerning the production amount of FY and SF, the figures stipulated in Table IV-7, 8 will be employed.

(2) The demand shall be defined as the domestic demand including that for film production.

(3) The break-down of the p-TPA and DMT as far as the demand is concerned will be based on the figures stipulated in Table V-32.

(4) Regarding the supply, estimates shall be made on the basis of the Flow-sheet Capacity stipulated in Table V-36.

The results of the forecast are shown in Table V-37. It must be noted here that the supply amount shown in this Table has been compiled on temporary assumption that there is no project for a new installation or expansion of the production facilities except for those projects stipulated in Table V-36. Therefore, the supply/demand balance figures can be understood as the figures which indicate the scope of the market for the new manufacturers including Indonesia.

The sources of supply in the Southeast Asian areas are Japan and Taiwan. The maximum suppliable amount confirmed as of the present stage including the facility expansion projects are estimated to be 397,000 tons of p-TPA and 660,000 tons of DMT. On the other hand, the demand of p-TPA/DMT as TPA is estimated to be 23,000 tons in 1974 and 182,000 tons in 1981. Regarding the other areas, 844,000 tons for 1974 and 1.816 million tons for the year 1981. The extent of demand in Indonesia for p-TPA/DMT will attain 80,000 tons by 1977 and it is estimated that the production of p-TPA/DMT will attain the level of economic scale.

The breakdown of p-TPA and DMT demand for the whole area of Southeast Asia is 217,000 tons of p-TPA in 1974, 1.279 million tons for the year 1981, whereas DMT is 650,000 tons in 1974 and 719,000 tons in 1981. The point which must be noted here is the change in the DMT demand trend. In other words, the DMT demand level of 650,000 tons in 1974 will attain a level of 785,000 tons in 1977 through 1980. However, the demand will attain a peak at this point and by 1981, the demand becomes 719,000 tons which is a reduction to the level of 1976. This is the resultant phenomenon of the shifting from the DMT polymerization facilities to p-TPA process which has already been manifesting itself in Japan, etc.

As far as the balance is concerned, the shortage in p-TPA supply will be intensified year after year so that by 1981, the supply will be 882,000 tons. On the contrary, DMT supply/demand position will be relaxed after showing a shortage by 124,000 tons in 1979. In view of this fact, although there would be no problem at all in the future construction of p-TPA plants in the Southeast Asian areas, the construction of DMT plant will involve an extremely high degree of risk in view of demand aspect. In other words, the DMT plant which will be constructed newly during the period of 1976 onward will be able to allocate the outlet until 1980, for four years, by the support of the increment in the demand.

Table V-36 Flowsheet Capacity of p-TPA and DMT in the World

(10^3 t/y)

Nation	Company	Site	Process	Products	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
U.S.A.	Amoco Chemical	Joliet, Ill.	Amoco (p-Xylene)	DMT/p-TPA	68			
		Decatur, Ala.		p-TPA	315	540	1958	Expansion to 540,000 t/y is scheduled by the end of 1974.
				DMT	90		1958	
	Du Pont	Old Hickory, Tenn.	Du Pont	DMT	112			
		Gibbstown, N.J.		DMT	112			
		Wilmington, N.C.		DMT	-	136		136,000 t/y Plant is due on stream by the end of 1973.
	Hercules	Burlington, N.J.	Hercules/Witten (p-Xylene)	DMT	45	68	1955	The expansion Plant is due on stream in early 1974.
		Wilmington, N.C.	"	DMT	270	400	1966	
				p-TPA	-	90		90,000 t/y Plant is scheduled for completion by the end of 1973.
	Hystron (Hoechst)	Spartanburg, S.C.	Hercules/Witten (p-Xylene)	p-TPA	45			
	Mobil Chemical	Beaumont, Tex.	Mobil	p-TPA	68			
	Eastman	Kingsport, Tenn.	Eastman	DMT	135			Eastman Process is developed in 1971.
France	Rhône-Poulenc	St-Fons	Witten	DMT	75			
		Chalampé	Rhône-Poulenc (p-Xylene)	DMT	-	50		Scheduled for completion by the end of 1973.
			Amoco (p-Xylene)	p-TPA	-	100		
Germany, Fed., Rep. of	BASF	Ludwigshafen	BASF	DMT	45			
	Huels	Marl	(p-Xylene)	DMT	24		1968	
	Dynamit Nobel	Lulsdorf	Witten (p-Xylene)	DMT	90	190	1968	Expansion to 190,000 t/y is scheduled by the end of 1973.
		Witten	" "	DMT				
	Hoechst	Gersthofen		DMT	200			
		Offenbach		DMT				
Italy	Montedison	Ferrara	Amoco (p-Xylene)	DMT	32			
		Porto Marghera		p-TPA	45	65	1968	Scheduled for completion by the end of 1974.
				DMT	22			
	SIR	Porto Torres	(p-Xylene)	DMT	12		1968	
	Fibra del Tirso	Ottana		p-TPA	-	80		80,000 t/y Plant is scheduled for completion by the end of 1975.
United Kingdom	ICI	Wilton	Amoco	p-TPA	100			
				DMT	100			
Netherlands	Petrochimie (Amoco)	Delfzjl	Amoco (p-Xylene)	DMT	25			
				p-TPA	30			
	Hercules	Middlesburg	Witten (p-Xylene)	DMT	70	80	1968	Expansion to 80,000 t/y is scheduled by the end of 1973.
	Hoechst Holland	Flushing	" "	DMT	50	68		Expansion to 68,000 t/y is scheduled by the end of 1975.
Spain	Rio-Mit	Tarragona	Mitsui-Toatsu	DMT	-	50		Scheduled for completion by the end of 1975.
				p-TPA	-	40		
	International Qimica		Amoco	DMT/p-TPA	-	90		Scheduled for completion by the end of 1974.
Portugal	Amoniaco Portugues	Estarreja		p-TPA	-	50		Scheduled for completion by the end of 1976.
				DMT	-	30		

Table V-36-2

(10^3 t/y)

Nation	Company	Site	Process	Products	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
Turkey	Pekim Petrokimya	Aliaga-Izmit	(p-Xylene)	DMT	-	40		Plan
Belgium	Amoco Chemical Belgium	Geel	Amoco (p-Xylene)	p-TPA	50			
				DMT	50		1969	
India	Gujarat Aromatics Project	Koyali	Witten (p-Xylene)	DMT	24		1972	
		Assam	(p-Xylene)	DMT	-	33		Scheduled for completion by the end of 1975.
	Indian Petro-chemical	Baroda	Witten	DMT	-	24		24,000 t/y plant is scheduled for completion by the end of 1974.
Taiwan	Chinese Petroleum	Kaohsiung	Amoco	DMT	26		1973	
Thailand			(p-Xylene)	DMT	-	20		Plan
U.S.S.R.	State Complex	Novomoskovsk	Witten	DMT	7		1969	
	"	Yerevan		DMT	60		1969	
	"	Mogilev	Witten	DMT	120	174	1970	Expansion to 174,000 t/y is scheduled in middle 1975.
Czecho-slovakia	Slovanft	Bratislava		DMT	12		1971	
	V.C.H.Z.Synthesia	Pardubice		DMT	-	12		Scheduled for completion by the end of 1973.
German Democratic	Erdölverarbeitungs-werke	Schwedt	Amoco	DMT	22			
				p-TPA	20		1971	
				p-TPA	-	45		Scheduled to start production by the end of 1973.
Rumania	State Complex	Ploesti	Witten (p-Xylene)	DMT	14	64	1969	Expansion to 64,000 t/y is scheduled by the end of 1975.
Poland	Polimex	Eleha	Witten (p-Xylene)	DMT	15	63		Expansion to 63,000 t/y is scheduled by the end of 1973.
		Blachownia Slaska		DMT	30			
		Plock		DMT	-	40		Under construction
Bulgaria	Dimetos Dimow Combine	Jambol	Witten	DMT	14			
Iran	National Petrochemical	Bander Sharpur		DMT	-	30		Scheduled for completion by the end of 1976.
Argentina	Petroquimica Sudamericana	La Plata	Witten (p-Xylene)	DMT	14	25	1972	Expansion to 25,000 t/y is planned.
Brazil	Rhodiaco	Campinas	Amoco (p-Xylene)	DMT/p-TPA	-	45		45,000 t/y Plant is scheduled for completion in 1973.
		Bahia		DMT	-	30		Plan
Chile				DMT/p-TPA	-	15		Plan
Colombia				DMT	-	25		Plan
Mexico	Petrocel	Tampico		DMT	-	91		Scheduled for completion by the end of 1974.
Japan	Teijin-Hercules	Matsuyama	Hercules(p-Xylene)	DMT	36			
		Tokuyama	" "	DMT	50			
		Ehime	" "	DMT	100			
	Mitsui Petrochemical	Iwakuni	Amoco (p-Xylene)	DMT	102			
		"	" "	p-TPA	-	80		
	Matsuyama Petrochemicals	Matsuyama	Amoco (p-Xylene)	DMT	90			
		"	Maruzen(p-Xylene)	p-TPA		50		

Table V-36-3

(10^3 t/y)

Nation	Company	Site	Process	Products	Flowsheet Capacity		Start of Operation	Comment
					Present	Future		
Japan	Kuraray Yuka	Yokkaichi	Amoco (p-Xylene)	DMT	95			
	Toray	Tokai	Toray (p-Xylene)	p-TPA	20	100		
		Mishima	Toray	DMT	120			
	Mizushima Aroma	Mizushima	Amoco (p-Xylene)	p-TPA	36			
	Mitsubishi Chemical	Kurosaki	Henkel II (Toluene)	p-TPA	18			
			Amoco (p-Xylene)	DMT	108			
			Mitsubishi (p-Xylene)	p-TPA		150		

Source: Kasen Handbook, 1974 (Man-made Fibers Handbook)
(Japan Chemical Fibers Association)

Table V-37 Forecast of p-TPA and DMT Supply/Demand Balance in the World (10^3 ton as TPA)

				1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	Supply	Japan	p-TPA	211	274	397	397	397	397	397	397
			DMT	632	639	639	639	639	639	639	639
		Taiwan	DMT	21	21	21	21	21	21	21	21
		Total		864	934	1057	1057	1057	1057	1057	1057
		(p-TPA)		(211)	(274)	(397)	(397)	(397)	(397	(397)	(397)
		(DMT)		(653)	(660)	(660)	(660)	(660)	(660)	(660)	(660)
	Demand	Indonesia		23	33	54	80	110	140	170	182
		Others [1]		844	976	1113	1223	1342	1529	1699	1816
		Total		867	1009	1167	1303	1452	1669	1869	1998
		(p-TPA)		(217)	(353)	(467)	(573)	(697)	(885)	(1084)	(1279)
		(DMT)		(650)	(656)	(700)	(730)	(755)	(784)	(785)	(719)
	Balance			-3	-75	-110	-246	-395	-612	-812	-941
		(p-TPA)		(-6)	(-79)	(-70)	(-176)	(-300)	(-488)	(-687)	(-882)
		(DMT)		(3)	(4)	(-40)	(-70)	(-95)	(-124)	(-125)	(- 59)
Rest of the World	Supply			2866	3437	3783	3890	3890	3890	3890	3890
		(p-TPA)		(800)	(1107)	(1266)	(1373)	(1373)	(1373)	(1373)	(1373)
		(DMT)		(2066)	(2330)	(2517)	(2517)	(2517)	(2517)	(2517)	(2517)
	Demand			2918	3325	3801	4242	4960	5711	6348	6875
		(p-TPA)		(817)	(1031)	(1292)	(1570)	(2034)	(2570)	(3174)	(3781)
		(DMT)		(2101)	(2294)	(2509)	(2672)	(2926)	(3141)	(3174)	(3094)
	Balance			-52	112	-18	-352	-1070	-1821	-2458	-2985
		(p-TPA)		(-17)	(76)	(-26)	(-197)	(-661)	(-1197)	(-1801)	(-2408)
		(DMT)		(-35)	(36)	(8)	(-155)	(-409)	(-624)	(-657)	(-577)
Total	Supply			3730	4371	4840	4947	4947	4947	4947	4947
		(p-TPA)		(1011)	(1381)	(1663)	(1770)	(1770)	(1770)	(1770)	(1770)
		(DMT)		(2719)	(2990)	(3177)	(3177)	(3177)	(3177)	(3177)	(3177)
	Demand			3785	4334	4968	5545	6412	7380	8217	8873
		(p-TPA)		(1034)	(1384)	(1759)	(2143)	(2731)	(3455)	(4258)	(5060)
		(DMT)		(2751)	(2950)	(3209)	(3402)	(3681)	(3925)	(3959)	(3813)
	Balance			-55	37	-128	-598	-1465	-2433	-3270	-3926
		(p-TPA)		(-23)	(-3)	(-96)	(-373)	(-961)	(-1685)	(-2488)	(-3290)
		(DMT)		(-32)	(40)	(-32)	(-225)	(-504)	(-748)	(-782)	(-636)

Note: 1) Including Japan

However, from 1980 onward, demand will decrease year after year with a danger of complete loss of the outlet. In order to avoid such a danger, it is *necessary* to export DMT to areas other than Southeast Asian areas or to reconstruct the facilities into a p-TPA production plant or to take over the demand from DMT plant to be scrupped. Although the above enumerated are the alternatives which exists, each one of these alternatives will be extremely difficult to undertake in the actual practice.

Therefore, wise DMT manufacturers will naturally refrain from the future new installation or expansion of their facilities. And, as a result, it is possible that the shift was direct polymerization of the Southeast Asian areas will be advanced by much faster speed than is estimated in Table V-36. Similar phenomena also take manifest themselves in the rest areas.

In view of the balance, p-TPA will display shortage year after year so that by 1981 the supply shortage will attain a level of 2.4 million tons. However, in the case of DMT, the supply/demand balance will be relaxed because of the fall in the demand after showing the shortage peak of 657,000 tons in 1980.

In any case, it can be concluded that the DMT production project involves a high extent of instability and risk not only in terms of the Southeast Asian areas but for the whole areas of the world.

4-3 p-Xylene

The actual records of production, exportation and importation amounts are shown in Tables V-38 through V-40 concerning p-xylene. The U.S.A. has traditionally been a p-xylene exporting country. This position has been supported and buttressed by the ample domestic procurement capacity of mixed xylene of the reformate type.

Table V-38 p-Xylene Production and Export in USA

(ton as p-Xylene)

	Production	Growth Rate (%)	Consumption		
			TPA	Export	Total
1956	-	-	-	-	-
57	39,162	-	-	-	-
58	48,237	23.2	-	-	-
59	71,653	48.5	-	-	-
60	95,455	33.2	43,000	56,000	99,000
61	112,454	17.8	51,000	48,000	99,000
62	116,343	3.5	64,000	59,000	123,000
63	119,083	2.4	98,000	20,000	118,000
64	134,143	12.6	105,000	46,000	151,000
65	179,777	34.0	163,000	32,000	195,000
66	235,328	30.9	254,000	11,000	265,000
67	343,533	46.0	320,000	30,000	350,000
68	596,778	73.7	500,000	97,000	597,000
69		-	580,000	162,394	742,394
70	721,319	-	584,000	150,482	734,482
71	753,785	4.5	-	105,794	-
72	1,001,325	32.8	-	93,898	-
73				72,144	

Sources: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission).
U. S. Foreign Trade Exports Commodity by Country (Bureau of the Census)

Table V-39 p-Xylene Export and Import in West Germany

(ton)

	Export	Import
1966	-	-
67	2,804	35,718
68	2,000	69,496
69	2,489	89,373
70	2,008	98,657
71	9,170	120,804
72	27,352	60,055
73	13,769	91,837

Source: Trade Statistics of West Germany

Table V-40 p-Xylene Production and Consumption in Japan

(ton)

	Production	Growth Rate (%)	Consumption	Export	Import
1961	-	-	-	-	-
62	-	-	-	-	7,717
63	-	-	-	-	7,245
64	-	-	-	-	24,036
65	-	-	-	-	15,497
66	-	-	-	-	24,387
67	-	-	-	-	25,673
68	90,900	-	113,596	-	37,321
69	171,659	88.8	191,417	-	32,298
70	255,450	48.8	256,437	-	25,469
71	298,652	16.9	341,399	-	47,124
72	339,203	13.6	380,403	-	96,070
73	421,239	24.2	451,099		87,133

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyoo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

West Germany is importing p-xylene and is exporting DMT as shown in Table V-23. In the same manner as West Germany, Japan is also an importing country of p-xylene. As shown in Table V-25, DMT importation was carried out up to 1970; however, from 1971 onward, the DMT exportation began to be undertaken by Japan in the same manner as West Germany. Along with this change, the import of p-xylene into Japan has drastically increased since 1971. In continuing the export of DMT to the Southeast Asian areas in the future, the most serious problem will be the procurement of p-xylene.

Table V-41 shows the prospect of p-xylene supply/demand trend in the Southeast Asian areas including Japan as well as in other areas of the world. Concerning the demand, shown in the table are the figures of the amount of p-xylene necessary to be employed by the existing and newly constructed or expanded facilities for the production of TPA/DMT together with the amount of p-xylene corresponds to polyester demand shown in Table V-37. According to Table V-41, it would not be possible for Southeast Asia to fully operate the p-TPA/DMT production facilities unless the importation of p-xylene be continued until 1976.

Table V-41 **Forecast of p-Xylene Supply and Demand Balance in the World**

(10^3 ton as p-Xylene)

			1973	1974	1975	1976	1977
Southeast Asia	Supply	Japan	411	549	632	730	777
		Taiwan	7	13	19	19	19
		Total	418	562	651	749	796
	Demand	(TPA/DMT) 1)	510	622	672	761	761
	"	(Polyester) 2)	–	624	726	840	937
	Balance	(TPA/DMT) 1)	-92	-60	-21	-12	35
	"	(Polyester) 2)	–	-62	-75	-91	-141
Rest of the World	Supply		1964	2225	2548	3004	3133
	Demand	(TPA/DMT) 1)	1788	2063	2475	2724	2801
	"	(Polyester) 2)	–	2101	2394	2737	3054
	Balance	(TPA/DMT) 1)	176	162	73	280	332
	"	(Polyester) 2)	--	124	154	267	79
Total	Supply		2382	2787	3199	3753	3929
	Demand	(TPA/DMT) 1)	2298	2685	3147	3485	3562
	"	(Polyester) 2)	–	2725	3120	3577	3992
	Balance	(TPA/DMT) 1)	84	102	52	268	367
	"	(Polyester) 2)	–	62	79	176	-63

Notes: 1) Demand (TPA/DMT) = Capacity of p-TPA/DMT as TPA x 0.72
2) Demand (Polyester) = Demand of p-TPA/DMT as TPA x 0.72

Naturally, the p-xylene to be allocated for the new construction or expansion of p-TPA/DMT production facilities other than the stipulated must separately be considered.

In the rest of the areas of the world, it seems that a surplus of p-xylene will take place as far as the new installation and the expansion in the TPA/DMT production facilities is concerned. However, because of the delay in the expansion projects due to the crude oil shortage caused by the crude oil production control by the OAPEC, the surplus of p-xylene will likely be reduced from the figures shown in Table V-41. Further, in terms of the p-xylene amount corresponding to the polyester demand extent, the shortage is evident in Southeast Asian areas as shown in Table V-41.

4-4 Ethylene Oxide and Ethylene Glycol

There are a number of problems pertaining to ethylene glycol which is another monomer of polyester. Normally, the production capacity for ethylene glycol is determined commensurate with the ethylene oxide production capacity. Further, there would be no case in which ethylene glycol shortage should take place while ethylene oxide supply is ample. In this writing, observations will, therefore, be made mainly concerning the supply/demand of ethylene oxide.

Tables V-42 through V-45 show the actual records of production of ethylene oxide and ethylene glycol in the U.S.A. and Japan. In spite of the fact that the polyester production of the U.S.A. is merely twice as high as that of Japan, the American ethylene glycol production is as high as 4.6 times the Japanese level. This is due to the fact that the ethylene glycol demand for anti-freeze in the U.S.A. is greatly higher than Japan.

Table V-42 EO Production in USA

	Production (10^3 ton)				Share (%)	
	Chlorohydrin Process	Oxidation Process	Total	Growth Rate (%)	Chlorohydrin Process	Oxidation Process
1950	141	65	206	-	68	32
1951	158	82	240	16.5	66	34
1952	201	111	312	30.0	64	36
1953	161	111	272	-12.8	59	41
1954	161	122	283	4.0	57	43
1955	203	194	397	40.3	51	49
1956	240	229	469	18.1	51	49
1957	259	277	536	14.3	48	52
1958	232	293	525	- 2.1	44	56
1959	223	364	587	11.8	38	62
1960	226	400	626	6.6	36	64
1961	182	421	603	- 3.7	30	70
1962	159	564	723	19.9	22	78
1963	163	694	857	18.5	19	81
1964	148	833	981	14.5	15	85
1965	218	775	993	1.2	22	78
1966	223	833	1,056	6.3	21	79
1967	162	885	1,047	- 0.9	15	85
1968	-	-	1,191	13.8	-	-
1969	-	-	1,546	29.8	-	-
1970	-	-	1,753	13.4	-	-
1971	-	-	1,638	- 6.6	-	-
1972	-	-	1,852	13.1	-	-

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-43 EG Production in USA

(ton)

	Production	Growth Rate (%)
1955	402,879	-
56	462,970	14.9
57	544,286	17.6
58	519,597	-4.5
59	550,920	6.0
60	588,456	6.8
61	536,730	-8.8
62	650,407	21.2
63	752,801	15.7
64	823,103	9.3
65	815,543	-0.9
66	944,012	15.8
67	902,106	-4.4
68	926,635	2.7
69	1,166,182	25.9
70	1,377,810	18.1
71	1,392,524	1.1
72	1,706,017	22.5

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-44 **EO Production and Consumption in Japan**

(ton)

	Production	Growth Rate (%)	Consumption
1952	-	-	-
53	450	-	-
54	661	46.9	-
55	1,014	53.4	-
56	1,348	32.9	-
57	1,712	27.0	-
58	3,709	116.6	3,648
59	8,650	133.2	8,608
60	16,228	87.6	15,945
61	22,668	39.7	22,521
62	27,480	21.2	27,475
63	31,932	16.2	32,009
64	54,277	70.0	53,692
65	76,072	40.2	75,735
66	105,540	38.7	108,182
67	159,327	51.0	162,662
68	176,908	11.0	175,974
69	215,933	22.1	216,556
70	304,347	40.9	304,349
71	333,837	9.7	337,191
72	360,728	8.1	364,588
73	402,553	11.6	406,321

Source: Kagaku Koogyo Tookei Nenpoo
(Year Book of Chemical Industries Statistics)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

Table V-45 **EG Production and Consumption in Japan**

(ton)

	Production	Growth Rate (%)	Consumption: Domestic Polyester Fiber (A)	A/B (%)	Others	Total (B)
1957	-	-	-	-	-	-
58	2,100	-	-	-	-	-
59	7,490	256.7	-	-	-	9,011
60	13,981	86.7	-	-	-	14,691
61	20,395	45.9	-	-	-	20,861
62	23,051	13.0	16,387	64.5	9,019	25,406
63	27,098	17.6	21,803	71.0	8,904	30,707
64	41,167	51.9	29,949	61.6	18,630	48,579
65	64,797	57.4	34,088	51.7	31,883	65,971
66	93,858	44.8	42,263	38.8	66,781	109,044
67	147,983	57.7	53,187	36.4	92,855	146,042
68	154,285	4.3	63,507	38.7	100,687	164,194
69	191,086	23.9	78,200	39.5	119,864	198,064
70	300,501	57.3	108,108	34.2	207,754	315,862
71	325,483	8.3	140,083	35.8	251,656	391,739
72	346,467	6.4	136,168	35.0	252,841	389,009
73	377,613	9.0				

Source: Kagaku Koogyo Tookei Nenpoo
(Year Book of Chemical Industries Statistics)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

4-4-1 Supply/Demand Prospect on Ethylene Oxide in the U.S.A.

Table V-46 shows the ethylene oxide supply/demand prospect in the U.S.A. At present in the U.S.A., the shortage of ethylene oxide/ethylene glycol is prevailing and the demand is not fulfilled. The major applications of ethylene oxide, i.e., for use as anti-freeze for automobiles and for use in the production of polyester are both suffering from supply shortage, thereby making it difficult to ensure stable procurement.

Table V-46 Forecast of EO Supply and Demand Balance in USA

(10^3 ton as EO)

			1973	1974	1975	1976	1977
Supply	Flowsheet Capacity		2162	2162	2162	2334	2334
	Production		1800	1950	1950	2100	2100
Demand	EO		830	900	970	1040	1110
	EG	Anti-Freeze	570	590	610	630	650
		Polyester	340	390	440	500	560
		Others	230	230	230	230	230
		Sub-Total	1140	1210	1280	1360	1440
	Total		1970	2110	2250	2400	2550
Balance			-170	-160	-300	-300	-450

In the ethylene glycol industrial sphere in the U.S.A. in 1973, successive accidents resulted in reduction in production capacity and such a situation further accelerated the shortage of ethylene glycol supply. In other words, because of electrical power shortage in Puerto Rico, both UCC and PPG were compelled to reduce production and on the Gulf Coast areas, Jefferson Chemical and Shell suffered from operation trouble.

Because of these circumstances, the supply of ethylene glycol to synthetic fiber manufacturers has since been cut down, thereby driving the American polyester manufacturers into ethylene glycol crisis. Traditionally in the U.S.A., the recycle use of ethylene glycol recovered from polymerization process has hardly been undertaken in the polyester production. The recovered ethylene glycol has so far been sold to the anti-freeze market. However, at present, due to the above-mentioned circumstances the recycle utilization of the recovered ethylene glycol to the polymerization process became apparent in some parts of the industry. Even under such a case, it seems difficult to expect a large quantity allocation of ethylene glycol to the synthetic fiber manufacturers from the anti-freeze market. Such a forecast is based on the following facts:

(1) The shortage of anti-freeze itself is also apparent and the automobile manufacturers are suffering from difficulties in securing the steady supply of the solution to be applied for the newly produced automobiles.

(2) Unilateral supply reduction to the anti-freeze industry which is a traditional and large-quantity customer of ethylene glycol is extremely difficult to undertake.

(3) For the part of the ethylene glycol manufacturers, a higher profit is available by selling the products to the anti-freeze market than to the synthetic fiber industry. The future prospect of supply/demand in this respect is as shown in Table V-46. It can be seen from the illustration, the ethylene oxide shortage will not be solved for sometime to come. The facility operational rate of ethylene oxide in the year 1973 was estimated as having been 83% due to the above-mentioned problems and troubles. However, even if an assumption is made that no problem will take place in the future, the maximum operational rate attainable will be approximately 90%. This will be caused by the shortage of ethylene due to the delay in the expansion in the ethylene production facilities. The reasons for the delay in the ethylene production facility construction are as follows:

(a) There was a delay in the construction of refineries, i.e., the supply sources of oil refining off-gas and naphtha both of which are the raw materials for ethylene.

(b) Because of the administrative policies taken by the government, the above-mentioned ethylene raw materials were allocated for motor gasoline and household heating fuel with a higher priority so that there was a suppression in the allocation of the raw materials to be used as the raw material for chemical industry.

The reasons for the delay in the oil refinery construction has already been discussed. At present, the relaxation of crude oil importation is progressing and the promotion of the oil refineries and naphtha crackers are being positively undertaken. However, plant construction works normally take at least three years until completion so that the participation of the production by these new plants will be commenced during the period of 1976 to 1977. This being the circumstance, the production increment in ethylene glycol will not be accomplished until such period. The capacity expansion projects in ethylene oxide facilities on the other hand show no active prospect till 1976 in line with the ethylene shortage situation which is deemed to persist until then. The only announcement made in this respect was by UCC who is projecting a capacity expansion of 345,000 tons of ethylene oxide with a target on-stream set for 1976.

As shown in Table V-46, the demand will grow with an average annual growth rate of approximately 7% centering around the ethylene glycol for anti-freeze and for polyester production. This being the circumstance, the ethylene oxide shortage will not be relaxed even in 1977. On the contrary, it is expected that the shortage will become more serious as the years go by.

4-4-2 Prospect of Supply/Demand of Ethylene Oxide in West Europe

Table V-47 shows the supply/demand balance of ethylene oxide in West Europe. Although a production capacity increase by 454,000 tons is expected over the period from 1973 to 1976, the question still remains as to whether or not the expansion project will be completed as scheduled. The facility operational rate was estimated as being 85%; however, it seems that this figure is the upper limit in view of the ethylene shortage caused by the difficulties in procuring crude oil in West Europe. The difference between the supply and demand reveals that approximately 200,000 tons of ethylene oxide surplus will be yielded over the period from 1974 to 1976.

Table V-47 Forecast of EO Supply and Demand Balance in West Europe

(10^3 ton as EO)

		1973	1974	1975	1976	1977
Supply	Flowsheet Capacity	1486	1637	1824	1940	1940
	Production	1250	1390	1550	1650	1650
Demand		1150	1200	1320	1450	1590
Balance		100	190	230	200	60

4-4-3 Prospect of Supply/Demand of Ethylene Oxide in Southeast Asia

The ethylene oxide supply/demand prospect in the Southeast Asian areas including Japan is as shown in Table V-48. The demand consists mainly of ethylene oxide for polyester production and it is forecast that an annual growth rate of 15% will be achieved over the period from 1973 to 1977. On the other hand, as far as the production is concerned, the figures were calculated on an assumption that the plant expansion projects in Japan targeted for completion in 1975 and the construction of 50,000 ton plant in Taiwan will be put on-stream as planned. Even so, the ethylene oxide shortage will inevitably manifest itself in the Southeast Asian areas from 1974 onward. A preliminary calculation will be made in the following paragraphs concerning the supply/demand balance of ethylene glycol for polyester production use in the Southeast Asian areas independently from the overall supply/demand balance of the ethylene oxide. The supply of ethylene oxide for polyester use is assumed here to be allocated on the basis of the share taken up by the polyester use ethylene glycol stipulated in the total demand for ethylene oxide shown in Table V-48. The demand for ethylene glycol for polyester production corresponds to the TPA demand shown in Table V-37. The obtained results are shown in Table V-49. In the event that no importation of ethylene glycol is possible in the Southeast Asian areas, the extent of shortage of ethylene glycol for polyester use in the Southeast Asian areas will be, in terms of conversion into textile, 120,000 tons in 1974, 40,000 tons in 1975, 90,000 tons in 1976 and 170,000 tons in 1977.

Table V-48 Forecast of EO Supply and Demand Balance in Southeast Asia [1)]

(10^3 ton as EO)

		1973	1974	1975	1976	1977
Supply	Japan	392	412	520	535	535
	Taiwan	0	0	0	24	47
	Total	392	412	520	559	582
Demand	EO	110	130	144	158	174
	EG Polyester Indonesia	4	6	9	15	23
	Others	182	239	276	314	344
	Total	186	245	285	329	367
	Anti-Freeze	39	42	44	47	50
	Others	55	61	67	73	79
	Sub-Total	280	348	396	449	496
	Total	390	478	540	607	670
Balance		2	-66	-20	-48	-88

Note: 1) Including Japan

Table V-49 Forecast of EG Supply and Demand Balance for Polyester in Southeast Asia 1)

(10^3 ton as EG)

	1974	1975	1976	1977
Supply for Polyester	262	340	376	396
Demand for Polyester	304	354	408	456
Balance	-42	-14	-32	-60
	(-120) 2)	(-40)	(-93)	(-171)

Notes: 1. EO : EG = 1 : 1.24
2. Fiber : EG = 1 : 0.35

1) Including Japan
2) ( ) shows polyester fiber equivalent

4-4-4 Prospect of Supply/Demand of Ethylene Oxide in the World

The above-mentioned data can be summarized as shown in Table V-50. No clear confirmation can be made regarding the supply/demand situation of ethylene oxide in East Europe and in the U.S.S.R., however, the ethylene oxide shortage will persist for some time to come throughout the Southeast Asian areas, the U.S.A. and West Europe. The large extent of shortage prevailing in the U.S.A. will not be remedied even by the surplus available from West Europe and at the same time, the ethylene oxide shortage suffered by the Southeast Asian countries will not be relaxed in the foreseeable future.

Table V-50 Forecast of EO Supply and Demand Balance in the World

(10^3 ton as EO)

			1973	1974	1975	1976	1977
Southeast Asia	Supply	Japan	392	412	520	535	535
		Taiwan	0	0	0	24	47
		Total	392	412	520	559	582
	Demand	Indonesia	4	6	9	15	23
		Others	386	472	531	592	647
		Total	390	478	540	607	670
	Balance		+2	-66	-20	-48	-88
U.S.A.	Supply		1800	1950	1950	2100	2100
	Demand		1970	2110	2250	2400	2550
	Balance		-170	-160	-300	-300	-450
West Europe	Supply		1250	1390	1550	1650	1650
	Demand		1150	1200	1320	1450	1590
	Balance		+100	+190	+230	+200	+60
Total	Supply		3442	3752	4020	4309	4332
	Demand		3510	3788	4110	4457	4810
	Balance		-68	-36	-90	-148	-478

5. Raw Materials for Nylon

5-1 General

The intermediates of caprolactam which is the raw material for nylon 6 consist almost totally of cyclohexane and phenol which are the derivatives of benzene, except in the case of the SNIA process which employs toluene as the raw material. Also, the AH-Salt which is the raw material for nylon 66 almost totally consist of adipic acid which is made from cyclohexane. Therefore, the supply/demand trend of raw materials for nylon will be largely affected by the supply/demand balance of benzene. However, as has already been discussed in Cahpter V-3, benzene is now suffering from global supply shortage. The production facility expansion projects for caprolactam which is the raw material for nylon 6 are generally slow at present and global supply shortage of caprolactam is threatening to persist for a long period of time.

5-2 Nylon 66 and Nylon 6

Nylon consists of nylon 6 which employs caprolactam as raw material and nylon 66 which is made from AH-Salt. The ratio of nylon 6 versus nylon 66 has been changing in the world as shown in Figure V-15. In 1959, 70% of the share was taken up by nylon 66. However, the predominant position has been undermined year after year by nylon 6 until at present, the nylon 66 share lowered to approximately 40%. It seems that such a phenomenon has been due to the high price level of nylon 66 for the most part. It is forecast in this respect that in the future, the nylon 66 versus nylon 6 ratio will settle at 40 : 60 as a stable share ratio after finding the appropriate application fields, in which the respective advantages will be displayed in terms of physical properties of these two nylon materials. Unlike other synthetic fiber products, nylon 66 production displays an extreme case of

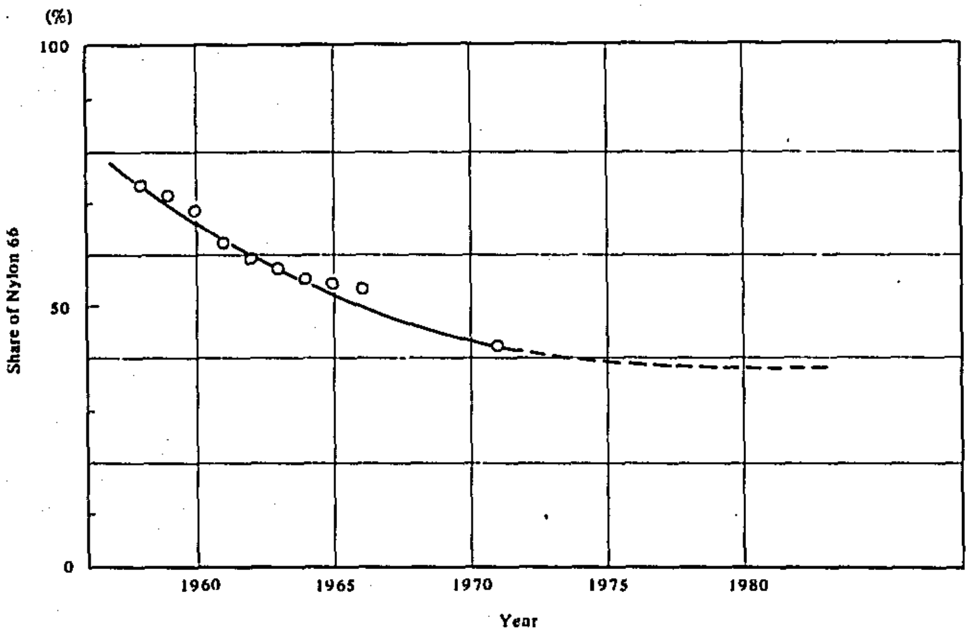


Figure V-15 Share of Nylon 66 in World Nylon Production monopoly by few leading manufacturers. This has been mainly due to the patent policy adopted by Du Pont who first developed nylon 66. Du Pont has been granting the patent right of nylon 66 production to one specific manufacturer for one country as shown below.

U.K.:	ICI
France:	Rhodiaceta (Rhone-Poulenc Group)
Italy:	Rhodiaceta (Rhone-Poulenc Group)
Germany:	I. G.
Netherlands:	AKU

In the above enumerated countries, the industrialization of nylon 66 production has been progressed under the protection of the patents so that even to this day, the share of nylon 66 in these countries is considerably high. The nylon 66 industry of the world today is monopolized up to approximately 90% of the total production by the above-mentioned Du Pont, ICI, Rhone-Poulenc Group and by America's Monsanto who made its entry in 1950s. Table V-51 shows the product-ion capacity of nylon 66 of the above-mentioned four monopoly groups. Although affiliated companies of these leading manufacturers are allocated in various overseas countries, no such manufacturer is yet located in the Southeast Asian areas.

Table V-51 Nylon 66 Production Capacity of Largest Four Groups

(10^3 ton)

	Capacity	Subsidiary Companies' Capacity	Total Capacity	Site of Subsidiary Companies
Du Pont	380	62	444	Canada, Argentina, West Germany
I C I	226	96	322	U.S.A., West Germany, Australia, New Zealand, South Africa
Rhône-Poulenc	228	108	336	Italy, West Germany, Spain, Switzerland, Brazil, U.S.A.
Monsanto	166	32	198	U.K., Luxemburg, Colombia, Uruguay
Total	1,000	298	1,298	

Source: Kasen Geppo, (p. 54, October 1971)
(Japan Chemical Fibers Monthly)

These groups are undertaking a thorough production system also concerning the raw material AH-Salt and according to the system of the groups, the raw materials thus produced will be supplied to the affiliated companies from the home country as a principle. This being the circumstance, the supply/demand of AH-Salt is basically balanced and the distribution of the "floating commodity" is highly seldom. In this respect, the AH-Salt supply/demand situation is basically and virtually different from that of caprolactam. In Japan, Toray and Asahi Chemical are producing AH-Salt and nylon 66, however, the rate comprised by these two producers in the total production of the world is extremely small.

As has been discussed in the above, the nylon 66 and the raw material industries thereof has been and will be developing centering around the four major groups. Therefore, it is difficult to clearly confirm the actual status of supply and demand balance. Also, in the Southeast Asian areas except Japan, no production of nylon 66 is being undertaken. Therefore, in this report, the cyclohexane which is the raw material for caprolactam and caprolactam will be treated as far as the raw materials for nylon are concerned.

5-3 Caprolactam

5-3-1 Supply/Demand Situation of Caprolactam in the Past

Tables V-52 and V-53 show the actual records of production, exportation of caprolactam carried out in the U.S.A. and Japan. Because of the fact that in the case of Japan, most of the nylon is nylon 6, the caprolactam production is as high as 1.5 times that of the U.S.A. Since 1969, Japan has been assuming a position

Table V-52 Caprolactam Production and Export in USA (ton)

	Production	Growth Rate (%)	Export
1962	74,300	-	-
63	85,100	14.5	-
64	111,400	30.9	-
65	131,000	17.6	-
66	145,000	10.7	8,435
67	149,000	2.8	7,020
68	181,000	21.5	8,282
69	218,000	20.4	17,950
70	230,000	5.5	22,944
71	-	-	17,753
72	-	-	9,114
73	-	-	8,619

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-53 Caprolactam Production and Consumption in Japan (ton)

	Production	Growth Rate (%)	Consumption				Export	Import
			Nylon Domestic (A)	A/B (%)	Others [1]	Total (B)		
1953	2,563	-	-	-	-	-	-	-
54	5,334	108.1	-	-	-	6,027	-	-
55	9,480	77.7	-	-	-	9,352	-	-
56	18,236	92.4	-	-	-	17,974	-	-
57	26,837	47.2	-	-	-	27,316	-	-
58	25,461	-5.1	-	-	-	25,412	-	-
59	34,549	35.7	-	-	-	34,656	-	-
60	45,821	32.6	-	-	-	45,866	-	-
61	55,373	20.8	-	-	-	55,595	-	-
62	65,535	18.4	63,159	97.5	1,625	64,784	-	-
63	87,398	33.4	84,265	97.2	2,457	86,722	-	-
64	124,258	42.2	116,614	94.4	6,873	123,487	-	10,574
65	167,158	34.5	127,435	80.2	31,554	158,989	-	2,392
66	199,905	19.6	157,706	79.9	39,721	197,427	-	39
67	229,643	14.9	202,729	85.9	33,276	236,005	15,021	2,142
68	269,002	17.1	231,776	88.2	31,117	262,893	12,586	12,639
69	318,427	18.4	272,621	85.3	47,136	319,757	30,062	1,896
70	349,407	9.7	327,389	95.5	15,330	342,719	23,418	6,228
71	376,199	7.7	334,324	87.9	46,160	380,484	39,501	2,819
72	401,962	6.8	323,123	78.5	88,316	411,442	61,710	35
73	459,341	14.3					56,107	3,268

Note: 1) Including export

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

of caprolactam exporting country, thereby undertaking the caprolactam export of 60,000 tons in 1972 to the Southeast Asian area. Figure V-16 shows the past situation of the caprolactam production capacity and consumption covering the whole world. Up to 1972, the over-production capacity situation persisted; however, in 1973, the production capacity turned to display shortage so that the supply/demand balance suddenly became tight. Such a phenomenon has been caused by the following reasons:

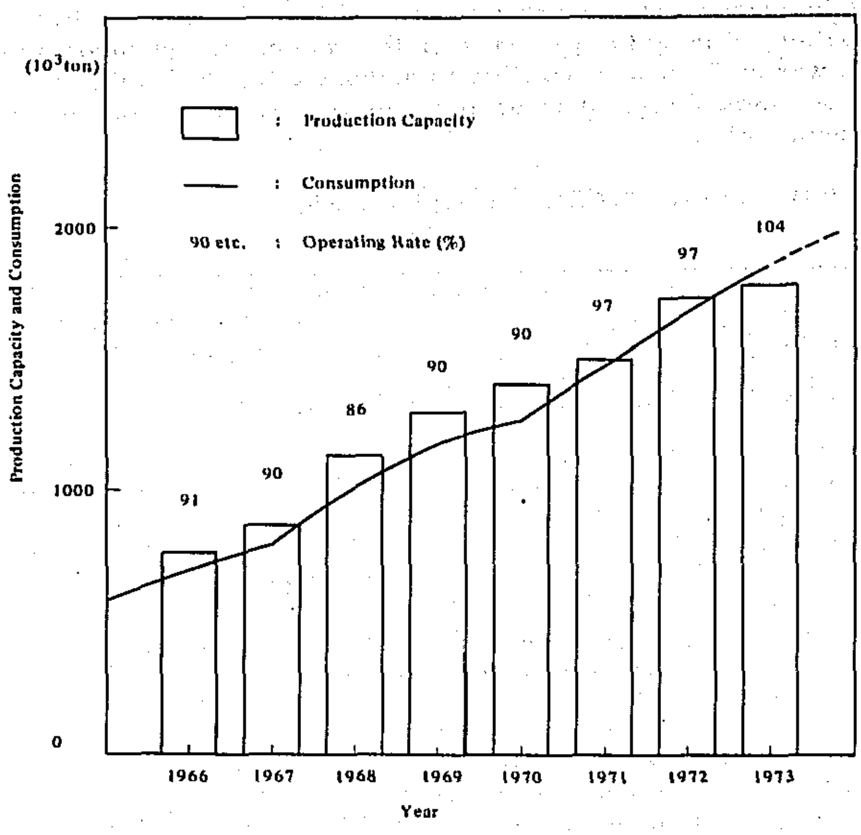


Figure V-16 World Supply/Demand Balance of Caprolactam

(1) As has already been shown in Figure V-2, the caprolactam price showed yearly decrease until 1972 so that the profit of caprolactam manufacturers decreased considerably. Because of this fact, the caprolactam manufacturers in the developed countries refrained from expanding the production capacity.

(2) Almost all the project for constructing caprolactam production facilities in the developing countries displayed a delay.

(3) Supply/demand of ammonium sulfate of the world became oversupply so that the caprolactam manufacturers were affected severely by disposal problem of the by-produced ammonium sulfate. This also worked as one of the major factors to let the caprolactam manufacturers refrain from the new construction or expansion of the production facility.

The process-wise production rates of ammonium sulfate in Japan are shown in Table V-54. In 1964, 60% of the total ammonium sulfate production was taken up by synthesis ammonium sulfate, 29% by the recovered ammonium sulfate from chemicals production process such as caprolactam and 11% by the by-produced ammonium sulfate from coke production. However, in 1972, 77% of the total production has been comprised by a recovered ammonium sulfate, whereas 21% was taken up by by-produced ammonium sulfate, and only 2% by the synthesis ammonium sulfate. Most of the recovered ammonium sulfate came from caprolactam producing plants. This recovered ammonium sulfate and by-produced ammonium sulfate cannot be placed under production control in accordance with the trend of the market. During the period when the rate of the synthesis ammonium sulfate was high, it was possible to dispose of the recovered and by-produced ammonium sulfate by undermining the outlets for the synthesis ammonium sulfate.

Table V-54 Ammonium Sulfate Production by Process in Japan

(%)

	1964	1965	1966	1967	1968	1969	1970	1971	1972
Synthesized 1)	59.7	55.6	51.6	43.3	37.2	26.0	10.2	2.1	2.1
Recovered 2)	29.1	33.2	36.7	43.6	48.2	56.1	69.0	76.1	76.5
By-produced 3)	11.2	11.2	11.7	13.1	14.6	17.9	20.8	21.8	21.4

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)

Notes: 1) Synthesized from ammonium and sulfuric acid
2) Recovered from the production plants of caprolactam, methyl methacrylate, acrylonitrile, titanium oxide and so on
3) By-produced in the production plant of cokes

However, since 1970, the synthesis ammonium sulfate could not afford to be a buffer of the ammonium sulfate market. Therefore, the recovered and by-produced ammonium sulfate which by then has come to be over-produced had to be disposed of by promoting exportation or even by storage. Such a situation persisted in all the developed countries including Japan. Therefore, caprolactam manufacturers started the development of processes in which the extent of ammonium sulfate by-production is low.

However; because of the global fertilizer shortage which have taken place since 1973, the demand for ammonium sulfate suddenly increased. It must be noted that the demand for ammonium sulfate cannot be determined by the demand for ammonium sulfate itself but is largely affected by the supply/demand balance of urea. Thus, if the production increment is achieved in urea, the demand for ammonium sulfate will rapidly decrease and the price thereof will deteriorate. The manufacturers who are intending to newly produce caprolactam in the future will definitely select processes in which the amount of by-produced ammonium sulfate is low in view of the bitter experiences of the other manufacturers in the past.

(4) Because of the global benzene shortage, the lack of feedstock for caprolactam production became apparent. The process-wise share of caprolactam production facilities is shown in Table V-55, in which it is revealed that 66% is comprised by the cyclohexane process, and 21% by

Table V-55 Caprolactam Production Capacity by Process in the World (1973)

	(%)
Cyclohexane	66.2
Phenol	20.7
Toluene	5.1
Unknown	8.0
Total	100.0

Source: Table V-56

the phenol process, while the toluene process takes up only 5%. Including the unconfirmed portions, as high as 95% of the total caprolactam production and processes are employing benzene as the basic raw material. Therefore, the global benzene shortage will directly result in the caprolactam supply shortage.

(5) In 1973, operational problems frequently took place in newly constructed caprolactam plants. Particularly in the case of Columbia Nypro (U.S.A.) of 50,000 tons capacity, Nypro U.K. (U.K.) of 50,000 tons and Ube Industries (Japan) of 40,000 tons plant of the new DSM process as well as Dauna (Italy) with 40,000 tons plant of the SNIA process all suffered from operation problem and consiquently accelerated the caprolactam shortage.

It can therefore be stated that the caprolactam shortage in the year 1973 was mainly attributable to the above stated causes.

5-3-2 Supply/Demand Forecast of Caprolactam

In the following paragraphs, a forecast will be made for the Southeast Asian areas including Japan and for the rest of the areas of the world concerning the future supply/demand balance of caprolactam. In formulating such a forecast, the following prerequisite conditions were taken into consideration.

Prerequisite Conditions:

(1) The production of FY and SF shall be as per the stipulation made in Table IV-6.

(2) The demand shall be limited to the domestic demand including the outlet for resin production.

(3) The supply shall be estimated on the basis of the Flowsheet Capacity stipulated in Table V-56.

Table V-56 Flowsheet Capacity of Caprolactam in the World

(10^3 t/y)

Nation	Company	Site	Process	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
U.S.A.	Allied Chemical	Hopewell, Va.	Allied (Phenol)	135		1954	
	Dow Badische	Freeport, Tex.	BASF (Cyclohexane)	105	160	1962	Expansion to 160,000 t/y is scheduled by the end of 1976.
	Nypro Columbia	Augusta, Ga.	DSM (Cyclohexane)	45	70		
	Union Carbide	Taft, La.	UCC	25		1970	Plant is not in operation due to technical problems.
Germany, Fed, Rep. of	BASF	Ludwigshafen	BASF (Cyclohexane)	120	180		Expansion to 180,000 t/y is scheduled by the end of 1973.
	Bayer	Uerdingen	Bayer (Cyclohexane)	50			
United Kingdom	Nypro U. K.	Flixborough	DSM (Cyclohexane)	75	125	1965	
Ireland	SNIA	Sligo	SNIA	-	7		Scheduled for completion by the end of 1973.
Italy	SNIA Viscosa	Torviscosa	SNIA (Toluene)	18		1962	
	Chimica Dauna	Manfredonia	" "	80		1972	
	Montedison	Porto-Marghera	Montedison (Phenol)	75			
	SIR	Porto-Torres					
Netherlands	DSM	Geleen	DSM (Phenol) (Cyclohexane)	160		1952 (Phenol) 1964 (Cyclohexane)	100,000 t/y is produced from Phenol.
Belgium	Bayer	Antwerp	Bayer (Cyclohexane)	90	160	1971	70,000 t/y plant is under construction.
	BASF	Antwerp	BASF (Cyclohexane)	90	120	1969	Expansion to 120,000 t/y is scheduled by the end of 1974.
Spain	Esso Productos	Castellon	Inventa (Phenol)	20		1969	
	Paular	Puertollano	Montedison	-	45		45,000 t/y Plant is scheduled for completion by the end of 1973.
U.S.S.R.	State Complex	Kemorovo	DSM (Cyclohexane)	50	100		Scheduled for completion by the end of 1973.
	"	Grondno	" "	50	100		
German Democratic	Leuna	Leuna		40	64		Expansion to 64,000 t/y is scheduled by the end of 1973.
Czechoslovak	Spolana	Neratovice	Zimmer	32			
Rumania	State Complex	Savinesti	Zimmer(Phenol)	65	70	1969	Scheduled for completion in early 1973.
Bulgaria	State Complex	Stara Zagora		15			
Hungary	State Complex			20	30	1966	Expansion to 30,000 t/y is scheduled by the end of 1973.
Poland	Polimex	Tarnow	Inventa	25	50	1971	Expansion to 50,000 t/y is scheduled by the end of 1974.
	Zaklady Azotowe	Palawy	Inventa	-	50		50,000 t/y Plant is scheduled for completion in 1975.

Table V-56-2

(10³ t/y)

Nation	Company	Site	Process	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
Mexico	Univex	Salamanca	DSM (Cyclohexane)	44		1972	
Colombia	Monomeros de Colombo	Barranquilla	DSM (Cyclohexane)	18		1971	
	Ecopetrol	Barrancabermeja		20		1972	
Argentina	Cordonsed Argentina	San Lorenzo	DSM	-	35		35,000 t/y Plant is scheduled for completion by the end of 1973.
India	Gujarat State Fertilizers	Baroda	Inventa	-	20		20,000 t/y Plant is scheduled for completion in middle 1974.
Taiwan	State Complex			-	33		33,000 t/y Plant is scheduled for completion by the end of 1974.
Korea Rep.	Hankuk Caprolactam	Ulsan	DSM	-	33		33,000 t/y Plant is scheduled for completion by Feb., 1974.
Turkey	Petkim Petrokimya	Yarimca Izmit	Inventa	-	25		25,000 t/y Plant is scheduled for completion in 1974.
Japan	Toray	Nagoya	PNC (Cyclohexane)	100			
		Tokai	" "	50			
	Ube Ind.	Ube	Inventa (Cyclohexane)	96			
		Sakai	" "	30			
			DSM (Cyclohexane)	50			
	Mitsubishi Chemical	Kurosaki	Inventa(Cyclohexane)	78			
	Nihon Lactam	Niihama	BASF (Cyclohexane)	65	95		

Source: Kasen Handbook 1974 (Man-made Fibers Handbook)

The obtained results are shown in Table V-57. In the Southeast Asian areas including Japan, the caprolactam shortage will continue to manifest itself even if the on-schedule completion of the plants projected in Korea, Rep. of, and Taiwan were accomplished. If there is no new construction or expansion of the production facilities for the period after 1976, the caprolactam shortage will grow year after year. The domestic demand in Indonesia in 1977 will attain a level of 26,000 tons and, if the exportation is also taken into consideration, the demand level of Indonesia will attain the economic scale of caprolactam production.

Table V-57 Forecast of Caprolactam Supply and Demand Balance in the World

(10^3 ton)

			1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia 1)	Supply	Japan	458	491	491	491	491	491	491	491
		Korea	15	31	31	31	31	31	31	31
		Taiwan	0	27	52	52	52	52	52	52
		Total	473	549	574	574	574	574	574	574
	Demand	Indonesia	15	18	23	26	33	41	49	51
		Others 1)	510	571	647	714	760	796	837	873
		Total	525	589	670	740	793	837	886	924
	Balance		-52	-40	-96	-166	-219	-263	-312	-350
Rest of the World	Supply		1485	1621	1645	1645	1645	1645	1645	1645
	Demand		1479	1589	1702	1789	1872	1946	2057	2128
	Balance		6	32	-57	-144	-227	-301	-412	-483
Total	Supply		1958	2170	2219	2219	2219	2219	2219	2219
	Demand		2004	2178	2372	2529	2665	2783	2943	3052
	Balance		-46	-8	-153	-310	-446	-564	-724	-833

Note: 1) Including Japan

The supply/demand situation in the areas other than the Southeast Asia will display a balance for the period from 1974 to 1975, thereby yielding no supply surplus to other areas. If no new construction or expansion other than the projects revealed at the present stage were to be undertaken from 1967 onward, the caprolactam shortage will evidently manifest itself also in these areas. Therefore, it must be anticipated that from 1974 onward, no supply surplus will available from these areas to the Southeast Asian areas.

5-4 Cyclohexane

5-4-1 The Demand Structure of Cyclohexane

Cyclohexane has the outlets for the production of adipic acid and solvents in addition to the application for caprolactam production so that the confirmation of the supply/demand trend is not as easy as in the case of p-xylene. Figure V-17 shows the demand structure of cyclohexane in the world in the year 1973.

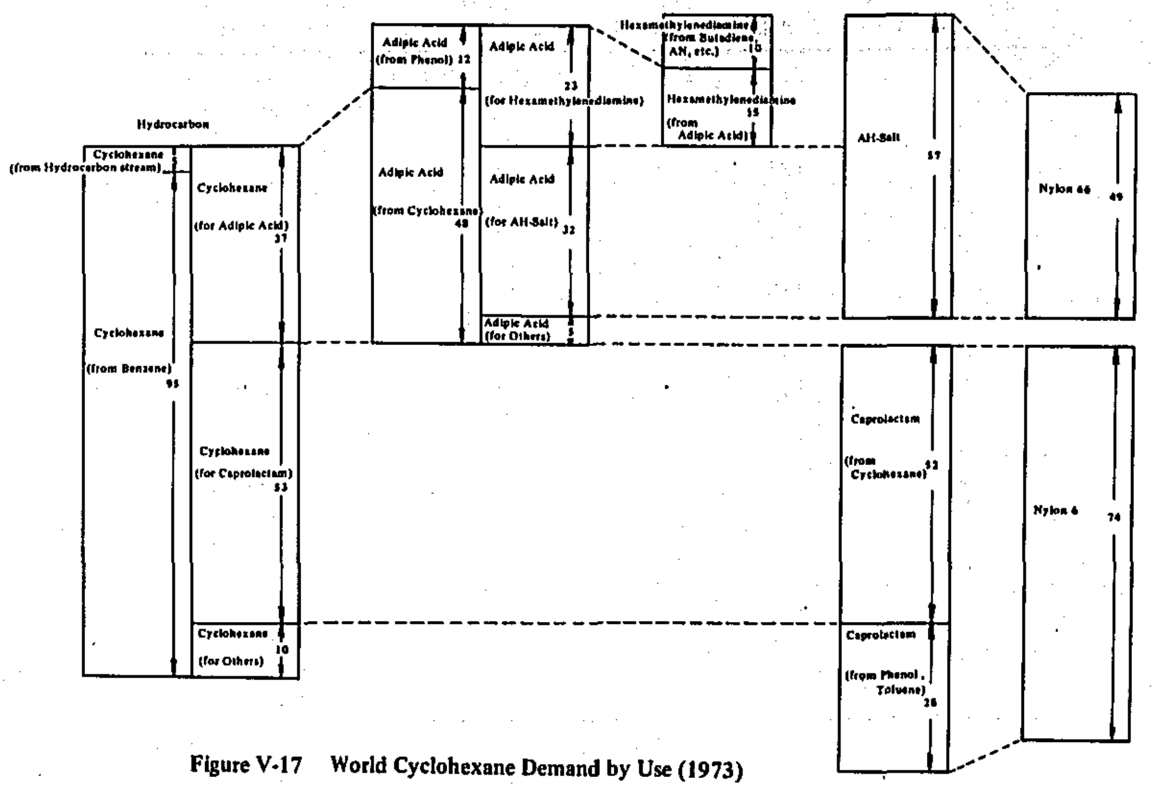


Figure V-17 World Cyclohexane Demand by Use (1973)

(1) 95% of cyclohexane are produced by hydrogenation of benzene and only 5% is produced by the extraction from the hydrocarbon stream by the Phillips Petroleum (U.S.A.).

(2) 37% of cyclohexane are being utilized for adipic acid production, most part of which will finally be converted into nylon 66.

(3) 53% of cyclohexane are being used for caprolactam production which will eventually be turned into nylon 6.

(4) 10% of cyclohexane are being utilized as solvents, etc.

(5) 90% of cyclohexane will for the most part be converted eventually into nylon 66 and nylon 6 so that, should there be any fluctuation in the cyclohexane supply/demand balance, the effects will immediately be exerted on the supply/demand balance of nylon as far as the demand structure is concerned.

(6) Butadiene and acrylonitrile for hexamethylene diamine are the only ones which belong to the olefins of all the basic raw materials for nylon and all the rest belongs to the aromatics. This implies that, as long as the aromatics are available, the nylon manufacturing operation can be completely undertaken. Tables V-58 through V-60 show the actual records of production, exportation and importation of cyclohexane in the U.S.A., West Germany and Japan. As can be seen from the tables, the U.S.A. is a cyclohexane exporting country, whereas West Germany is an importing country. As far as Japan is concerned, the importation of cyclohexane has been undertaken up to the 1970s. Since then, the self-supply of cyclohexane in Japan became possible.

Table V-58 Cyclohexane Production and Export in USA (ton)

	Production	Growth Rate (%)	Export
1955	-	-	-
56	121,296	-	-
57	210,147	73.3	-
58	150,120	-28.6	-
59	175,859	17.1	-
60	255,738	45.4	-
61	317,960	24.3	-
62	391,677	23.2	-
63	489,297	24.9	-
64	620,136	26.7	-
65	771,231	24.4	326,370
66	862,199	11.8	335,027
67	805,875	-6.5	382,450
68	924,868	14.8	373,134
69	-	-	344,292
70	835,101	-	246,716
71	792,822	-5.1	170,963
72	1,042,529	31.5	235,243
73			234,422

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
U.S. Foreign Trade Exports Commodity by Country (Bureau of the Census)

Table V-59 Cyclohexane Export and Import in West Germany (ton)

	Export	Import
1965	-	-
66	261	159,959
67	324	220,262
68	166	284,819
69	30	251,370
70	1,369	252,070
71	2,331	217,460
72	2,634	238,018
73	4,773	235,481

Source: Trade Statistics of West Germany

Table V-60 Cyclohexane Production and Consumption in Japan

(ton)

	Production	Growth Rate (%)	Consumption	Export	Import
1961	-	-	-	-	-
62	-	-	-	-	17,677
63	-	-	-	-	24,588
64	-	-	-	-	43,227
65	-	-	-	-	103,316
66	68,931	-	141,511	-	125,941
67	113,454	64.6	192,530	-	133,241
68	238,908	110.6	314,784	-	50,948
69	334,843	40.2	406,444	-	35,883
70	408,390	22.0	491,492	-	846
71	428,872	5.0	514,674	-	288
72	464,695	8.4	553,232	-	-
73	535,093	15.1	658,977	-	3,093

Source: Kagaku Koogyo Tookei Nenpoo
(Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

5-4-2 Prospect of Supply/Demand of Cyclohexane in the U.S.A.

Table V-61 shows the prospect of cyclohexane supply/demand position in the United States. The operational rate of the facilities is estimated 80% for the year 1973 due to the benzene shortage. For the period from 1974 onward, an assumption is made temporarily that the operational rate will be maintained on a level of 85%. No expansion project of the production facility is planned at present. Therefore, the supply/demand position will become tighter year after year along with the increment in the domestic demand so that from 1975 onward, the fulfillment of domestic demand would not be possible unless cyclohexane importation be undertaken to the U.S.A.

Table V-61 Forecast of Cyclohexane Supply and Demand Balance in USA

(10^3 ton)

		1968	1973	1974	1975	1976	1977
Supply	Flowsheet Capacity	-	1123	1123	1123	1123	1123
	Production	835	900	950	950	950	950
Demand	Nylon 66	332	-	-	-	-	-
	Caprolactam	125	-	-	-	-	-
	Others	100	-	-	-	-	-
	Total	557	890	930	980	1030	1080
	Export	275	-	-	-	-	-
Balance		-	10	20	-30	-80	-130

5-4-3 Prospect of Supply/Demand of Cyclohexane in West Europe

A summary of the situation is shown in Table V-62. Even if the presently announced construction projects were smoothly completed and, even if the facility operational rate would increase to 90% from 1974 onward, from 85% estimated for 1973, the shortage extent of cyclohexane in West Europe would not be less than 250,000 tons in spite of such an optimistic assumption. So far, the supply/demand balance has been maintained by means of carrying out importation from the U.S.A. However, as has been discussed earlier, the export surplus capacity will become unavailable from the United States in the future. This being the circumstance, it is expected that the cyclohexane shortage situation in West Europe will present a considerably serious status in the future.

Table V-62 Forecast of Cyclohexane Supply and Demand Balance in West Europe

(10^3 ton)

		1968	1973	1974	1975	1976	1977
Supply	Flowsheet Capacity	-	906	936	936	936	936
	Production	435	770	840	840	840	,840
Demand	Fiber	660	-	-	-	-	-
	Nylon 6	152	-	-	-	-	-
	Others	90	-	-	-	-	-
	Total	750	1050	1100	1150	1200	1260
Balance		-315	-280	-260	-310	-360	-420

5-4-4 Prospect of Cyclohexane Supply/Demand in Southeast Asia

The supply/demand prospect regarding the Southeast Asian areas including Japan is shown in Table V-63. If the construction project in Korea, Rep. of, and Taiwan were completed as scheduled, it is expected that cyclohexane supply will be made available corresponding to the capacity of caprolactam production facilities now existing and projected for future construction and expansion. However, as has been mentioned in the foregoing, there is a high possibility of shortage becoming prevalent in the supply of raw material benzene. Therefore, there are some opinions that it is questionable as to whether or not the sufficient supply would be possible from Japan as stipulated in the relative tables.

Table V-63 Forecast of Cyclohexane Supply and Demand Balance in Southeast Asia 1)

(10^3 ton)

		1973	1974	1975	1976	1977
Supply	Japan	517	557	614	614	614
	Korea	-	-	17	34	34
	Taiwan	-	-	-	28	57
	Total	517	557	631	676	705
Demand	Caprolactam	450	480	560	585	585
	Others	60	70	80	90	100
	Total	510	550	640	675	685
Balance		7	7	-9	1	20

Note: 1) Including Japan

5-4-5 Prospect of Cyclohexane Supply/Demand in the World

The above data can be summarized in Table V-64. It can be seen from this summary that the cyclohexane shortage which will take place in West Europe is the most conspicuous. Although a temporary balance is expected to be maintained in the Southeast Asian areas, it seems impossible to import from the rest of the areas, should any higher demand than the forecast level be achieved. Therefore, for the cyclohexane which is to be fed to the caprolactam production facilities which are to be newly projected in the future, it is necessary to secure some other independent means of securing supply.

Table V-64 Forecast of Cyclohexane Supply and Demand Balance in the World

(10^3 ton)

			1973	1974	1975	1976	1977
Southeast Asia	Demand		510	550	640	675	685
	Supply	Japan	517	557	614	614	614
		Korea	-	-	17	34	34
		Taiwan	-	-	-	28	57
		Total	517	557	631	676	705
	Balance		7	7	-9	1	20
U.S.A.	Demand		890	930	980	1030	1080
	Supply		900	950	950	950	950
	Balance		10	20	-30	-80	-130
West Europe	Demand		1050	1100	1150	1200	1260
	Supply		770	840	840	840	840
	Balance		-280	-260	-310	-360	-420
Total	Demand		2450	2580	2770	2905	3025
	Supply		2180	2347	2421	2466	2495
	Balance		-263	-233	-349	-439	-530

6. Raw Materials for Acrylic Fiber

Unlike other raw materials for synthetic fiber such as p-TPA/DMT, caprolactam and AH-Salt can be produced from aromatics, acrylonitrile which is the raw material for acrylic fibers must be produced from olefin. In the whole world, 65% of acrylonitrile production is destined for use in the production of fibers and the remaining 35% is allocated for turning out synthetic rubber, synthetic resin, etc.

6-1. Supply/Demand Situation of Acrylonitrile in the Past

Tables V-65 through V-67 show the actual records of production, exportation and importation of acrylonitrile in the U.S.A., West Germany and Japan. As far as acrylonitrile is concerned, West Germany is an importing country and Japan is an exporter. The past production capacity and consumption records of the world are as shown in Figure V-18. As is evident from these tables and figure, the supply/demand position has become tight since 1973, although acrylonitrile has so far been one of the petrochemical products the supply of which was on a comparatively oversupply side. The major reasons for such a turn of the situation are as follows, as has already been mentioned.

Table V-65 AN Production in USA

	Production (10^3 ton)					Share (%)		
	Acetylene Process	EO Process	Propylene Process	Total	Growth Rate(%)	Acetylene Process	EO Process	Propylene Process
1955	29.5	24	-	53.5	-	55	45	-
56	35.5	28	-	63.8	19.3	56	44	-
57	59	19.5	-	78.8	23.6	75	25	-
58	63.5	18	-	81.5	3.5	78	22	-
59	78	27	-	105.4	29.2	74	26	-
60	69.5	25	9.5	104.0	-1.3	67	24	9
61	78	22	13	113.2	8.8	69	20	11
62	111	27	25	163	44.3	68	17	15
63	129	32	45	206	26.4	63	15	22
64	150	32	88	270	30.5	55	12	33
65	148	42	160	350	29.9	42	12	46
66	132	-	193	325	-7.2	41	-	59
67	42	-	262	304	-6.3	14	-	86
68	52	-	412	463	52.2	11	-	89
69	-	-	-	525	13.3	-	-	-
70	-	-	-	471	-10.3	-	-	-
71	-	-	-	444	-6.4	-	-	-
72	-	-	-	506	14.7	-	-	-

Source: U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)

Table V-66 AN Export and Import in West Germany

(ton)

	Export	Import
1965	-	-
66	15	27,118
67	6	33,245
68	654	26,702
69	7,945	30,547
70	423	37,701
71	1,597	63,007
72	9,205	61,208
73	35,812	12,973

Source: Trade Statistics of West Germany

Table V-67 AN Production and Consumption in Japan

(ton)

	Production	Growth Rate (%)	Consumption: Acrylic Domestic (A)	A/B (%)	Others 1)	Total (B)	Export	Import
1957	-	-	-	-	-	-	-	-
58	670	-	-	-	-	569	-	-
59	12,534	1870.7	-	-	-	11,413	-	-
60	22,267	77.7	-	-	-	20,976	-	-
61	21,300	-4.3	-	-	-	21,945	-	-
62	29,021	36.2	27,392	96.0	1,133	28,525	-	537
63	37,947	30.8	36,015	93.5	2,519	38,534	-	5,056
64	78,056	105.7	61,624	85.9	10,136	71,760	-	11,519
65	153,268	96.4	84,070	55.6	67,201	151,271	44,443	-
66	167,668	9.4	99,441	60.9	63,933	163,374	40,073	-
67	190,276	13.5	125,772	65.8	65,386	191,158	17,163	-
68	231,467	21.6	159,530	66.6	79,847	239,377	19,493	1,042
69	326,310	41.0	189,491	58.2	136,007	325,498	35,107	2,861
70	423,785	29.9	262,872	63.4	151,486	414,358	54,762	462
71	525,787	24.1	295,920	55.9	233,505	529,425	104,157	-
72	537,232	2.2	277,349	50.6	270,537	547,886	89,697	-
73	595,234	10.8					72,226	-

Note: 1) Including export

Source: Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
Nihon Booeki Geppyo (Japan Exports & Imports)
Kasen Handbook, 1974 (Man-made Fibers Handbook)

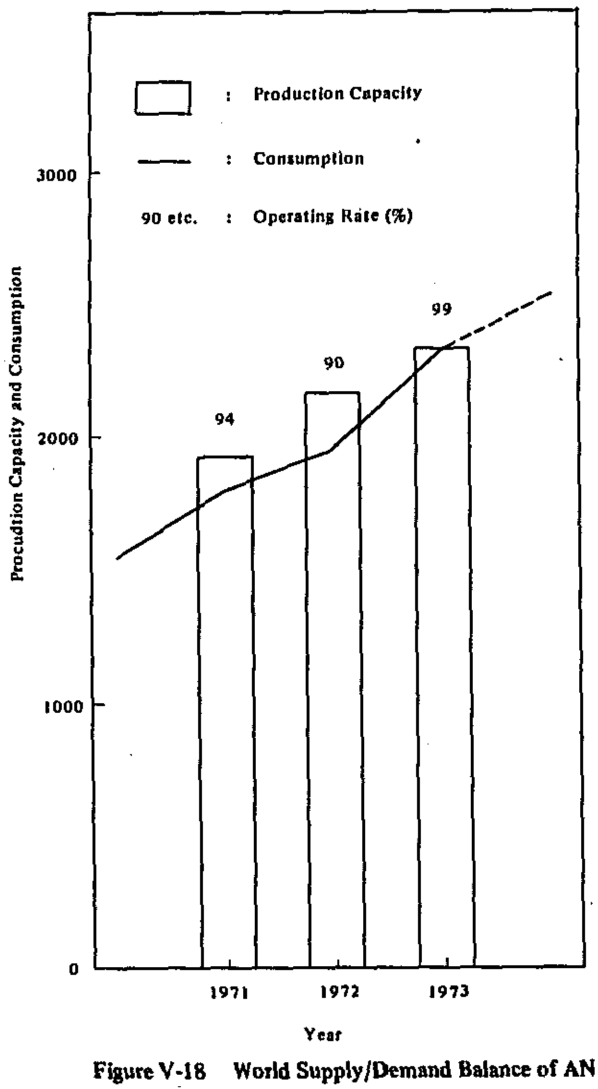


Figure V-18 World Supply/Demand Balance of AN

Table V-68 Flowsheet Capacity of AN in the World

(10^3 t/y)

Nation	Company	Site	Process	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
U.S.A.	American Cyanamid	Fortier, La.	Sohio	80		1954	
	Du Pont	Memphis, Tenn.	"	82		1966	
		Beaumont, Tex.	"	91		1972	
	Monsanto	Alvin, Tex.	"	170			
	Vistron	Lima, Ohio	"	277		1961	
Germany, Fed. Rep. of	Erdölchemie (Bayer/BP)	Dormagen	Sohio	240		1965	
	Kalkstickstoff Werke (Hoechst)	Trostberg	"	-	90		90,000 t/y Plant is scheduled for completion by the end of 1973.
	Knapsack(Hoechst)	Knapsack	(Acetylene-HCN*)	20			Production will be discontinued by the completion of Trostberg Plant.
United Kingdom	Border Chemicals	Grangemouth	Distillers-Ugine	70	90	1966	Expansion to 90,000 t/y is scheduled.
	Monsanto	Seal Sands	Sohio	68	91	1969	Expansion to 91,000 t/y is scheduled by the end of 1973.
Italy	Montedison	Porto Marghera	Montedison	30	60		Expansion to 60,000 t/y is due on stream by the end of 1974.
	Sincat	Priolo	Montedison	65		1969	
	Acrilsarda (Rumienca)	Cagliari	Sohio	25	48		Expansion to 48,000 t/y is scheduled by the end of 1973.
Italy	ANIC	Gela	Snam Progetti	30	80	1968	Expansion to 80,000 t/y is scheduled by the end of 1975. (Total capacity will be changed to Sohio process.)
France	Ugilor	St-Avold	Distillers-Ugine	68	95	1957	Expansion to 95,000 t/y is scheduled by the end of 1973.
		Yvours	"	45	70	1968	Expansion to 70,000 t/y is Planned.
	Total Chimie	Gonfreville		-	90		90,000 t/y Plant is due on stream in 1973.
Spain	Paular	Puertollano	Montedison	40	60	1972	Expansion to 60,000 t/y is scheduled by the end of 1973.
	Iberacryl	Tarragone	Distillers-Ugine	-	40		40,000 t/y Plant is due on stream by the end of 1973.
Finland	Sateri Oy	Porvoo		25		1972	
U.S.S.R.	State Complex	Kalinin	BP-Ugine	130			
		Polotsk	Sohio				
German Democratic		Schwedt	Sohio	20		1969	
		Merseburg	Own Process	15			
Rumania	State Complex	Savinesti	Sohio	25		1962	
		Pitesti	"	20	40	1970	Expansion to 40,000 t/y is scheduled by the end of 1973.
Poland	State Complex	Tarnow	Distillers-Ugine	10		1965	

Note: * Hydrocyanic acid

Table V-68-2

(10^3 t/y)

Nation	Company	Site	Process	Flowsheet Capacity Present	Flowsheet Capacity Future	Start of Operation	Comment
Bulgaria	State Complex	Burgas	Sohio	22		1969	
	"	Pleven	"	50		1971	
Hungary	State Complex		OSW	-	10		Plan
China			Sohio	-	50		Due on stream in early 1976.
Pakistan			Sohio	-	3		Plan
Mexico	Pemex	Cosoleacaque	Distillers-Ugine	24	40	1972	Expansion to 40,000 t/y is planned.
Canada	Imperial Oil	Sarnia, Ont.	Sohio	14		1970	
Brazil	Fisiba Petroquimica	Salvador	Sohio	-	24		24,000 t/y Plant is due on stream by the end of 1973.
Argentina	Hisisa Argentina	Baradero		-	7.2		Scheduled to start production by the end of 1973 at 7,200 t/y and to expand to 20,000 t/y in 1975.
Yugoslavia	State Complex	Ljubljana		-	10	1974	
	"	Skopje	OSW				
India	State Complex	Koyali-Gujarat	Sohio	-	24		24,000 t/y Plant is due on stream by the end of 1975.
Korea Rep.	Tong Suh Petrochemical	Ulsan	Sohio	27	54	1972	Expansion to 54,000 t/y is scheduled by the end of 1974.
Taiwan	Chinese Petroleum	Kaohsiung	Sohio	-	65		Scheduled for completion by the end of 1975.
Japan	Asahi Kasei	Kawasaki	Sohio	53.3			
		Mizushima	"	133.3			
	Sumitomo Chemical	Niihama	"	60			
		Chiba	"	80			
	Mitsubishi Chemical	Mizushima	"	96.8			
	Toyo Chemics	Osaka	"	43.8			
	Nitto Chemical	Yokohama	"	88.2			
		Otake	"	54.2			
	Showa Denko	Kawasaki	"	56.8			

Source: Kasen Handbook, 1974 (Man-made Fibers Handbook)

(1) Naphtha shortage due to crude oil production control;

(2) Stagnation in ethylene production expansion projects;

(3) Accidents which have taken place in petrochemical plants.

Because of the above reasons, the shortage for olefin became apparent, thereby causing the tightening of supply/demand balance of acrylonitrile.

6-2 Prospect of Demand/Supply of Acrylonitrile in the World

In the following paragraphs, a forecast will be made regarding the supply/demand balance of acrylonitrile in the future concerning the Southeast Asian areas including Japan, as well as regarding the other areas of the world. Following are the prerequisite conditions for formulating the forecast.

Prerequisite Conditions:

(1) The production amounts of FY and SF shall be in accordance with the figures stipulated in Table IV-9;

(2) The demand shall include that for synthetic rubber production and synthetic resin production. However, no import and export shall be included;

(3) The supply shall be estimated on the basis of the Flowsheet Capacity figures stipulated in Table V-68.

The obtained results are shown in Table V-69.

In the Southeast Asian areas including Japan an oversupply position will be maintained for the period from 1974 to 1975. However, concerning the period from 1976 onward, the acrylonitrile shortage will become apparent even if the plant projects of Taiwan were put on-stream as scheduled. In the rest of the areas of the world, it is forecast that the acrylonitrile supply will show a shortage from 1975 onward, thereby making it impossible to carry out exportation to the Southeast Asian areas.

Table V-69 Forecast of AN Supply and Demand Balance in the World

(10^3 ton)

			1974	1975	1976	1977	1978	1979	1980	1981
Southeast Asia	Supply	Japan	634	680	680	680	680	680	680	680
		Korea	26	26	26	26	26	26	26	26
		Taiwan	0	0	30	62	62	62	62	62
		Total	660	706	736	768	768	768	768	768
	Demand	Indonesia	2	3	4	5	6	8	10	12
		Others[1]	585	665	743	800	895	982	1075	1138
		Total	587	668	747	805	901	990	1085	1150
	Balance		73	38	-11	-37	-133	-222	-317	-382
Rest of the World	Supply		1955	2057	2139	2174	2174	2174	2174	2174
	Demand		1951	2172	2393	2610	2844	3010	3190	3400
	Balance		4	-115	-254	-436	-670	-836	-1016	-1226
Total	Supply		2615	2763	2875	2942	2942	2942	2942	2942
	Demand		2538	2840	3140	3415	3745	4000	4275	4550
	Balance		77	-77	-265	-473	-803	-1058	-1333	-1608

Note: 1) Including Japan

VI. Price Trend and Price Forecast

1. Price Trend

In the past, the prices of petrochemical industrial products including raw materials for synthetic fiber have been declining year after year. The past trend of the raw materials for synthetic fiber prices in Japan and the U. S. A. are shown in Figure VI-1 and Figure VI-2. The prices for the basic raw materials such as

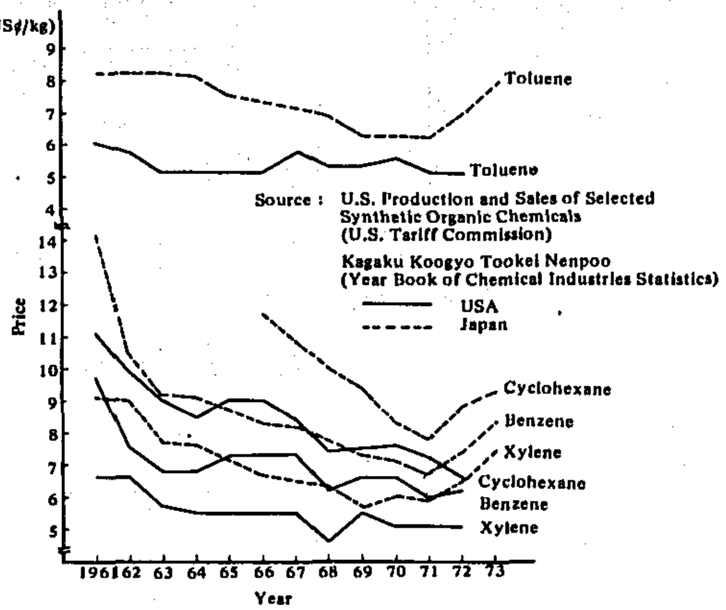


Figure VI-1 Price Trend of BTX and Cyclohexane

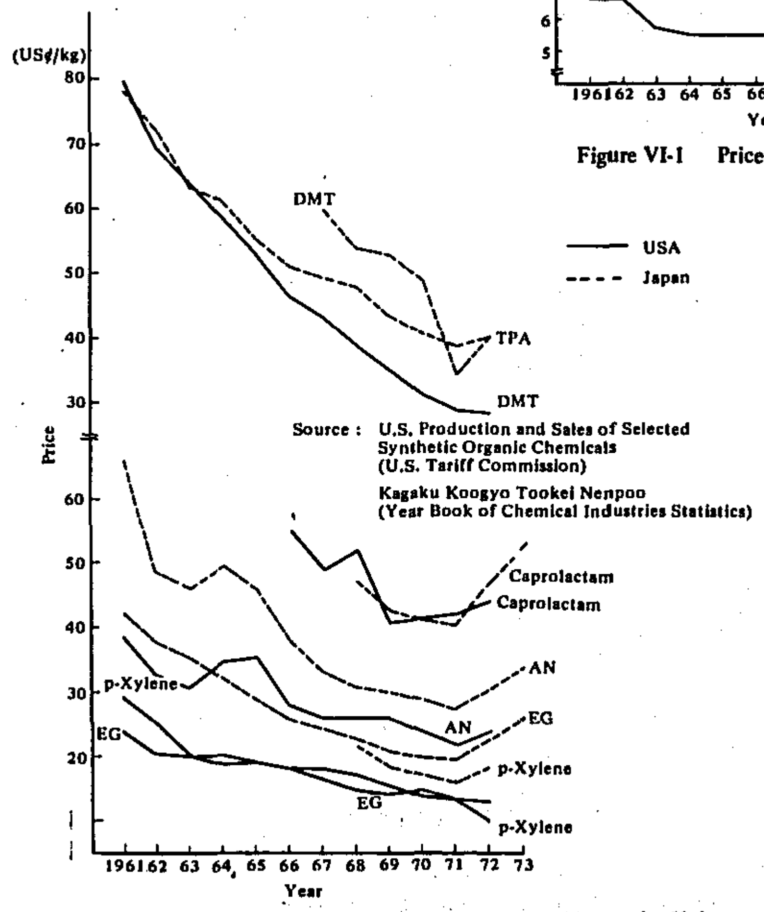


Figure VI-2 Price Trend of Monomers for Synthetic Fiber and p-Xylene benzene, toluene, xylene, etc. has been showing a comparatively steady trend specially in the U. S. A.; however, the price decrease is particularly conspicuous in the highly processed items such as cyclohexane, p-xylene and further DMT. The declining trend is particularly remarkable in the case of DMT. The 1961 was US¢80/kg became US¢30/kg in 1971, representing the decrease ratio of 1/2.7.

The relationship between the above-mentioned price decrease trend and the trend of production can be illustrated as shown in Figures VI-3 and VI-4. As is

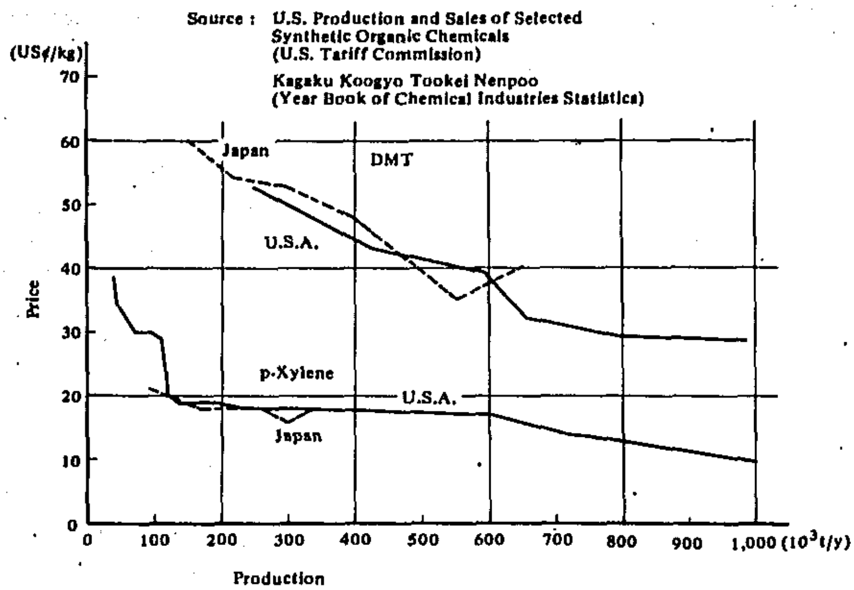


Figure VI-3 Production and Price of p-Xylene and DMT

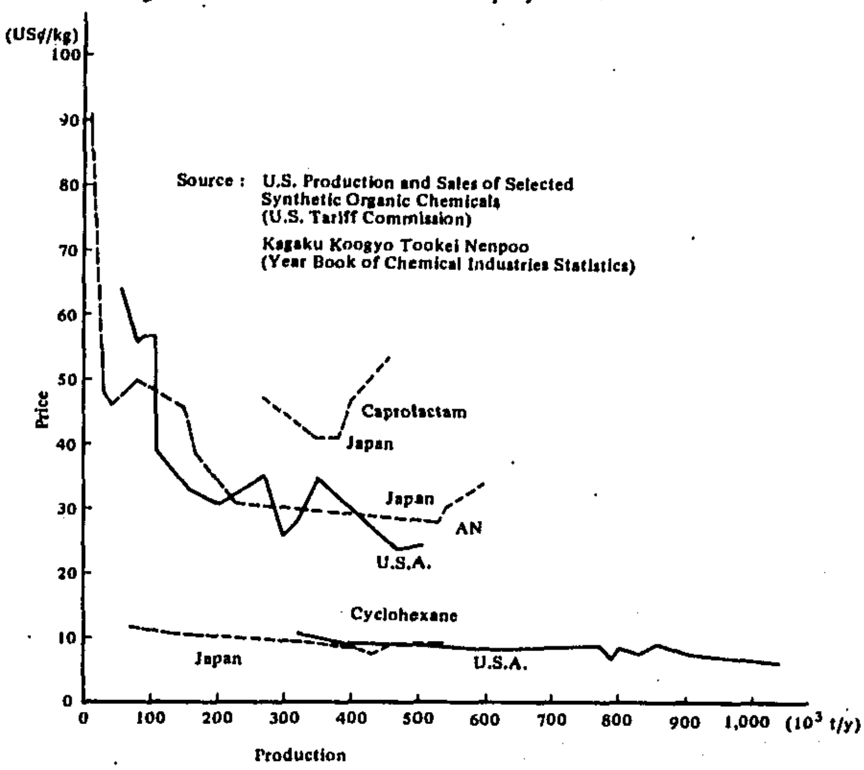


Figure VI-4 Production and Price of Cyclohexane, Caprolactam and AN shown in the figures, the price reduction took place suddenly during the period in which the production is low. When the production attains a certain level and exceeds it, the price decrease trend then becomes extremely slow. However, in the case of DMT, the price continues to decrease even during the period when the production attained a considerable extent of increase. On the other hand, Figures VI-5, VI-6 and VI-7 show the price decrease trend in terms of processing cost. The processing cost signifies here the result obtained by subtracting from the product price the cost of the main raw materials, i.e., the multiple of the main raw material price and the unit consumption. For instance, the processing cost for DMT can be obtained by subtracting from the DMT price the value obtained by 0.62 times the p-xylene price.

Source : U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)

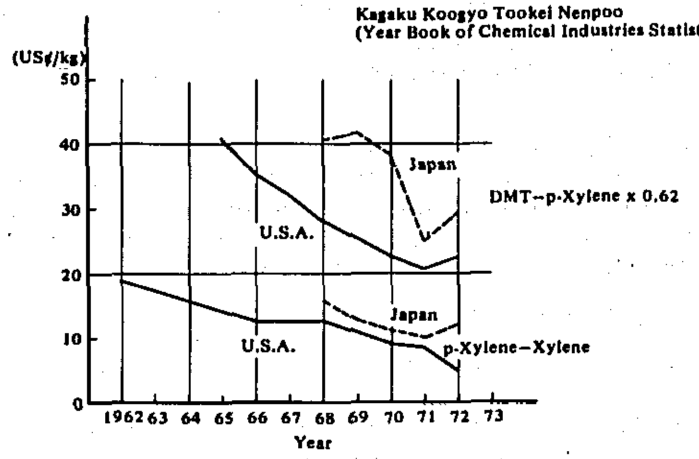


Figure VI-5 Processing Cost of DMT and p-Xylene

Source : U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)

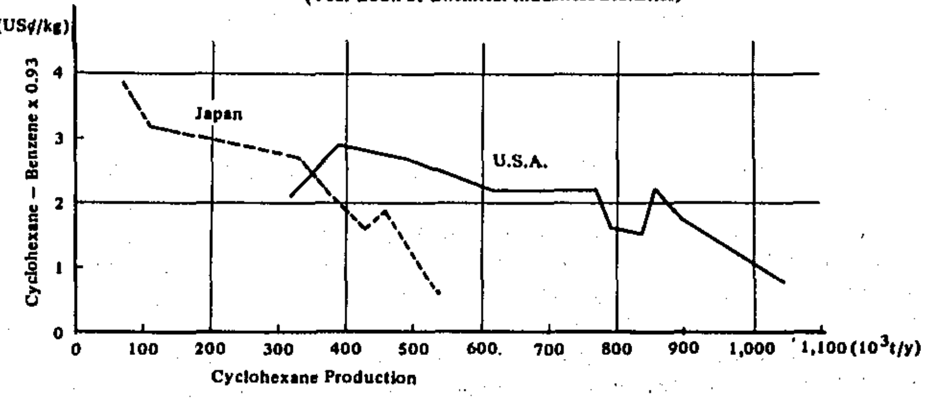


Figure VI-6 Production and Processing Cost of Cyclohexane

Source : U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
Kogaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)

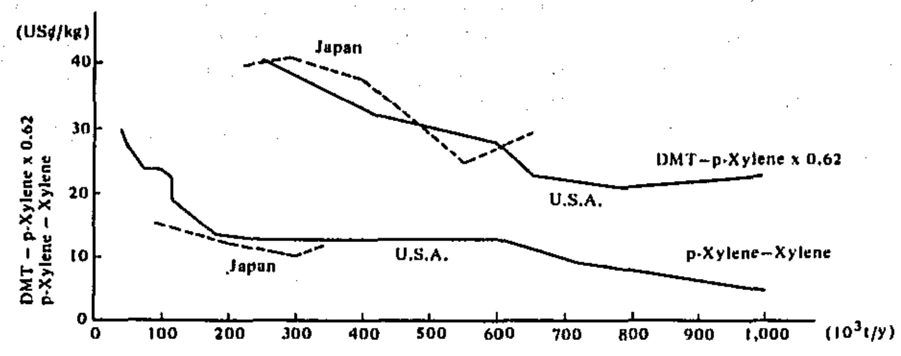


Figure VI-7 Production and Processing Cost of p-Xylene and DMT

As is shown in Figure VI-5 the processing cost has also been showing yearly decrease, thereby, displaying an analogous trend to that of prices. Also, as shown by Figures VI-6 and VI-7, the relationship between the production and the processing costs again showed the trend analogous to the prices so that the rate of decrease became less when the production increase is achieved.

On the basis of the above-mentioned results, it can be judged that the major reason for the price decrease in the past were the expansion in the raw material plant scale along with the development of synthetic fiber industry and the development and improvements made in the production processes which were undertaken simultaneously with the above-mentioned scale expansion. However, now that the plant scale has attained a vast extent of increase, a drastically vast extent of plant scale expansion is no longer feasible and also no significant improvement is likely to be made in the production process.

On the other hand, the price of crude oil which is the basic raw material for the production of raw materials for synthetic fiber has also been showing yearly decrease up until 1971. However, the extent of such decrease in the prices was rather slight so that the maximum price fall during the period from 1961 to 1971 was approximately 20%. This signifies that the contribution exerted by the crude oil price to the price decrease of the raw materials for synthetic fiber has been insignificant.

The above-mentioned price trend will be analyzed in the following paragraphs in view of the raw material exportation operations. Figures VI-8 and VI-9 display the relationship between the production and export in Japan regarding caprolactam and DMT. Up to 1972, the export showed growth along with the increment in the production so that by 1972, caprolactam export attained 62,000 t/y while DMT attained a level of 120,000 t/y. However, in 1973, this uptrend was completely suspended and a slight extent of decrease was displayed. This signifies that up to 1972 in Japan, the raw materials were under the over-supply condition. The export ratio at the time of 1972 was 15% for caprolactam and 18% for DMT.

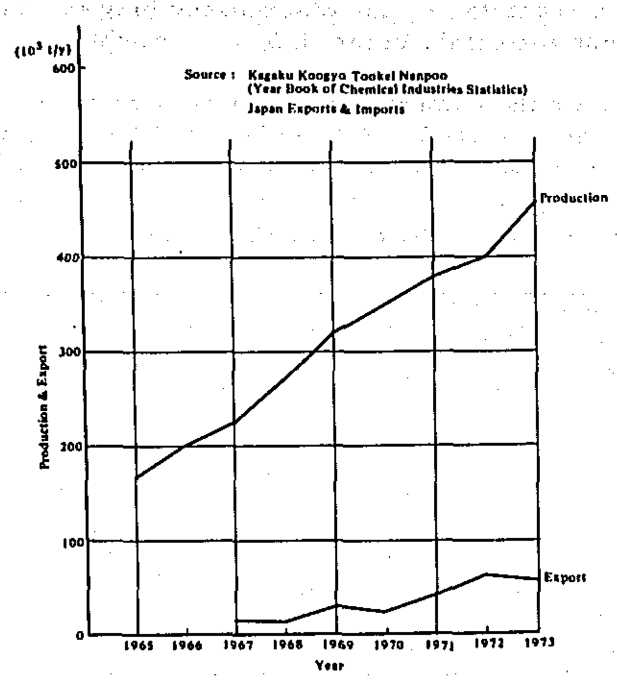


Figure VI-8 Production and Export of Caprolactam in Japan

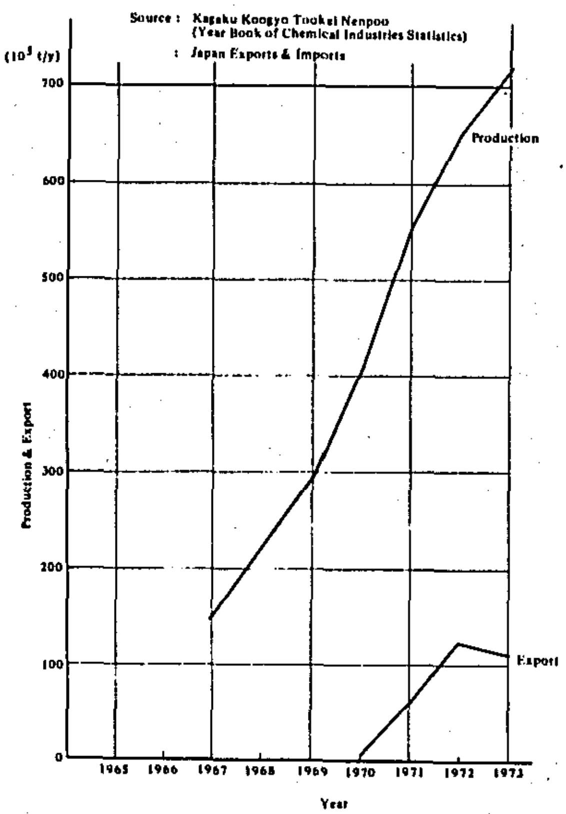


Figure VI-9 Production and Export of DMT in Japan

In the U. S. A., the exportation of raw materials for synthetic fiber has been small so that by 1972, the caprolactam exportation was made for 9,000 tons while DMT for 52,000 tons, both of which are much lower than the Japanese level. Partly due to such a circumstance, the discrepancy between the export price and domestic price of these materials in the U. S. A. is slight.

Table VI-1 shows the comparison of the export prices and domestic prices in Japan for caprolactam and DMT. As can be noted from the table, the export price has been on a lower level than the domestic price level by 10% to 20%.

Table VI-1 Prices of Raw Materials for Synthetic Fiber in Japan

(US¢/kg)

	Caprolactam			DMT			AN		
	Domestic (A)	Export (B)	(A) - (B)	Domestic (A)	Export (B)	(A) - (B)	Domestic (A)	Export (B)	(A) - (B)
1965	-	-	-	-	-	-	45.6	44.9	0.7
1966	-	-	-	-	-	-	37.8	30.1	7.7
1967	-	40.5	-	59.7	-	-	33.1	28.0	5.1
1968	47.2	41.4	5.8	53.9	-	-	30.8	31.2	-0.4
1969	42.8	37.8	5.0	52.8	-	-	30.0	34.1	-4.1
1970	41.4	42.9	-1.5	48.9	38.1	10.8	28.9	27.0	1.9
1971	40.6	37.2	3.4	34.7	31.7	3.0	27.5	20.9	6.6
1972	46.8	42.0	4.8	40.6	32.6	8.0	30.5	20.6	9.9
1973 1)	54.1	46.8	7.3	46.3	35.2	11.1	33.7	19.1	14.6

Note: 1) From January to June

Source: *Japan Exports & Imports*
Kagaku Koogyo Tookei Nenpoo
(Year Book of Chemical Industries Statistics)

The exportation of the raw materials for synthetic fiber have thus been carried out in the past with a background of over-supply conditions in the domestic market. This having been the circumstance, profitability of the raw material manufacturers continued to deteriorate because of the price decrease. In addition to this fact, owning to the depression in synthetic fiber industry, raw material producers refrained from new construction or expansion of the production facilities.

However, whilst the manufacturers refrain from the expansion or new construction, the demand for synthetic fiber kept increasing. Therefore, when the depression in the synthetic fiber industry was clarified, the raw material shortage situation all of a sudden took place. In addition to this, the crude oil price jumped by approximately four-fold during one year, the prices of the raw materials for synthetic fiber were severely affected until finally in 1974, the age of price control and price confusion manifested itself.

2. Price Forecast

Explanations has already been made on the price forecast method in the chapter entitled, "Survey Method". The results of the forecast made in accordance with the method are as follows:

2-1 Crude Oil Price

Crude oil price in Japan in 1971 was CIF ¥4,800/kl and import duty at ¥640/kl totaling ¥5,440/kl (US$2.40/bbl).

The increase in the crude oil price as announced by the six Persian Gulf countries of the OPEC on the 23rd of December 1973 was as follows:

Royalty and Tax	- US$ 7.00/bbl
Production cost	- US$ 0.12/bbl
Posted price	- US$11.65/bbl

All the oil exporting countries decided to increase the oil price in a large extent after the above announcement was made. Although the market price level is unknown from the above announcement, the conventional calculation formula, i.e., 1/1.4 of the posted price, was applied so that a price of US$8.32/bbl was obtained. Then, the transportation charges and insurance premium, totaling US$0.70/bbl and import duty (of Japan) at US$0.34/bbl (¥640/kl) were added to make a total of US$9.36/bbl as the oil price following the crude oil price increase. Thus, the crude oil price is now 3.9 times the price prevailing in 1971.

The price of crude oil indigenous to the U.S.A. has been understood to be high. The crude oil price in the U.S.A. was US$3.00/bbl during 1970. The U.S.A. depends much on the domestic crude oil unlike Japan, yet, the domestic crude oil price has increased considerably after the vast extent of price increase decided by the countries of OPEC. Also, Venezuela which exports crude oil to the U.S.A. has raised the crude oil price in a vast extent to US$14.08/bbl.

When the crude oil price in the U.S.A. after the above-mentioned price increase is assumed to be the same as that in Japan, the price would be US$9.36/bbl which is 3.1 times the former price.

2-2 Price of Naphtha

The price of naphtha in Japan in 1971 was ¥5,800/kl (US$2.25/bbl) when the return tax at ¥513/kl (US$2.25/bbl, US¢2.21/kg) is deducted. The price including return tax was ¥6,313/kl (US$2.79/bbl, US¢2.40/kg). Therefore, the naphtha price after the increase in the crude oil price was forecast to be US¢9.37/kg by multiplying the naphtha price including return tax with the price increase rate of crude oil.

On the other hand, naphtha price in the U.S.A. in 1971 is understood to have been between US¢1.3/lb and US¢1.5/lb. The average value obtained from the above prices is US¢2.96/kg. If this average value is multiplied by the increase rate of the crude oil price, the naphtha price after the crude oil price increase will be US¢9.25/kg.

2-3 B T X

It is assumed that the following compositions will be valid regarding the reformate, on the basis of the actual records obtained in Japan, when naphtha is processed by a reformer.

Benzene	(B)	5.6%
Toluene	(T)	15.0%
Xylene	(X)	16.9%
Raffinate	(R)	42.4%

The price wise relationship among each of the above component can be described in the following formula.

$$B \times 0.056 + T \times 0.15 + X \times 0.169 + R \times 0.424 = N + A$$

Where, N and A are the price of naphtha and the processing cost, respectively. The raw materials price in Japan and in the U. S. A. in 1971 shown in Table VI-2 and the naphtha price after the crude oil price increase are put into the above formula.

Table VI-2 BTX Prices in Japan and in The U.S.A.

(US¢/kg)

		Japan	U.S.A.
Naphtha	(1971)	2.21	2.96
Benzene	(")	6.7	6.0
Toluene	(")	6.2	5.1
Xylene	(")	5.9	5.1
Naphtha	(1974)	9.37	9.25

Further, following conditions are took into consideration i. e., toluene and xylene being the same price, the price of benzene being 1.3 times the price of toluene, raffinate and naphtha being the same in price, and the processing costs before and after the increase of crude oil price are unchanged.

Under these conditions, the price of benzene, toluene and xylene after the crude oil price increase are calculated by employing the above formula. These prices are shown in Table VI-3.

Table VI-3 Forecast on BTX Prices in Japan and The U.S.A. after Crude Oil Price Increase

(US¢/kg)

	Japan	U.S.A.	Average
Benzene	21.3	18.5	19.9
Toluene	16.4	14.2	15.3
Xylene	16.4	14.2	15.3

The past price trends of toluene and xylene has been almost identical as shown in Figure VI-10 whereas the price trends of benzene and toluene indicate that the benzene price has been approximately 1. 3 times the price of toluene as shown in Figure VI-11. The trend approximately coincides with the unit consumption figure of 1. 2 for dealkylation of toluene.

Source : U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
o--- Japan
x--- U.S.A.

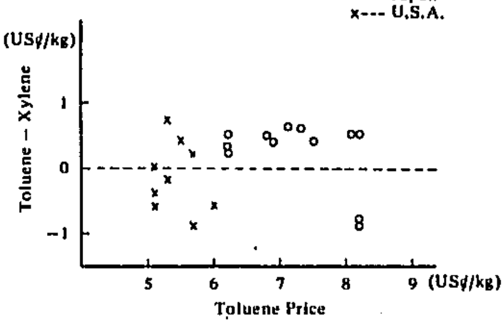


Figure VI-10 Price of Toluene and Xylene

Source : U.S. Production and Sales of Selected Synthetic Organic Chemicals (U.S. Tariff Commission)
Kagaku Koogyo Tookei Nenpoo (Year Book of Chemical Industries Statistics)
o --- Japan
x --- U.S.A.

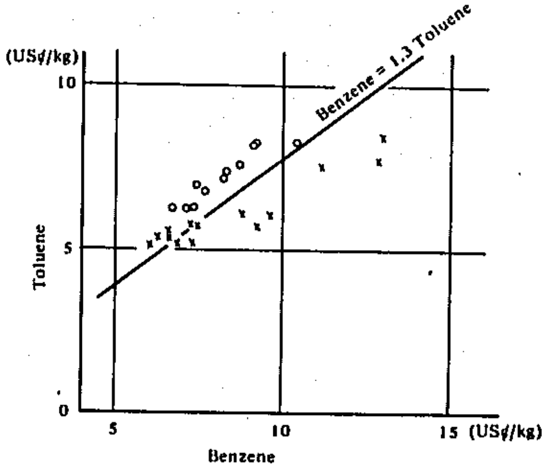


Figure VI-11 Price of Benzene and Toluene

2-4 Cyclohexane and p-Xylene

The following formula will be obtained when the price,processing costs and the unit consumptions of benzene and xylene, respectively, are substituted into the formula which was explained in the Survey Method. Table VI-4 shows all the data based on the average values obtained from the figures both of Japan and the U. S. A.

Table VI-4 List of Unit Consumption and Processing Cost for the Production of Raw Materials for Synthetic Fiber (1971)

(US¢)

	Unit Consumption(kg/kg)	Japan	U. S. A.	Average
Benzene ——→ Cyclohexane	0. 93	1.6	1.6	1.6
Xylene ——→ p-Xylene	1.0	10.6	8.3	9.5
Cyclohexane → Caprolactam	1.14	31.7	-	31.7
p-Xylene ——→ DMT	0.62	25.3	20.7	23.0

Cyclohexane = 19. 9 (Benzene price) x 0. 93 (Unit consumption) x α_1
+ 1. 6 (Processing cost) x α_2

p-Xylene = 15. 3 (Xylene price) x 1. 0 (Unit consumption) x α_1
+ 9. 5 (Processing cost) x α_2

For obtaining the 1977 prices of cyclohexane and p-xylene, the following values should represent α_1 and α_2.

$$\alpha_1 = 1.07^3 = 1.225$$

$$\alpha_2 = 1.2 \times 1.07^6 = 1.801$$

The prices of cyclohexane and p-xylene in 1977 obtained by the above-mentioned formula are, as mentioned in Table VI-5 US¢25.6/kg and US¢35.8/kg, respectively.

Table VI-5 Forecast on Prices of Raw Materials for Synthetic Fiber (1977)

	(US¢/kg)
Benzene	24.4
Toluene	18.7
Xylene	18.7
Cyclohexane	25.6
p-Xylene	35.8
Caprolactam	86.2
p-TPA/DMT	63.6
Ammonia	15.0
Ammonium Sulfate	8.3 1)
Sulfuric Acid	4.5

Note: 1) Excluding bagging cost: 7.3 US¢/kg

2-5 Caprolactam

The cyclohexane unit consumption figure of 1.14 was used in the computation. This figure is on a slightly higher side at present; however, owing to the low oxidation yield of cyclohexane, it seems that the unit consumption had actually been on this level. When the cyclohexane price at US¢7.8/kg (in Japan) and the processing cost at US¢31.7/kg are used for forecasting the caprolactam price in 1977, the figure is US¢86.2/kg as mentioned in Table VI-5..

2-6 p-TPA and DMT

The statistical data on the price of DMT are available, however, no data are available on the p-TPA price. As the price of p-TPA is understood to be almost the same as that of DMT, an assumption is made in this forecast that prices are identical.

The unit consumption for the production of polyester is 0.86 for p-TPA and 1.0 for DMT so that DMT is higher by 16%. Therefore, the price of DMT should be lower than that of p-TPA. The forecast DMT price for the year 1977 is US¢63.6 /kg when the estimate is made on the basis of p-xylene unit consumption figure of 0.62 for DMT production, US¢23/kg processing cost for the year 1971 and the already calculated p-xylene price after the crude oil price increase.

2-7 Ammonia

The price of urea is determined by the price of ammonia and is understood to be approximately 10% higher (including the bagging cost, etc.) than the price of ammonia. Further, the price of ammonium sulfate is closely associated with the urea price. For this reason, price forecast on urea will be undertaken at first in order to obtain therefrom the forecast on ammonia and ammonium sulfate.

For producing urea (ammonia), naphtha, natural gas, heavy oil, etc. are used as the raw materials. Price forecast was undertaken on the basis of future price of naphtha, which is the highest price raw material.

On the basis of such factors as 1.0 unit consumption of naphtha required in producing urea, the already calculated naphtha price based on the increased crude oil price and the processing cost (in Japan) at US¢2.79/kg in 1971, the forecasted urea price in 1977 is estimated to be US¢16.5/kg. Consequently, the forecast price of ammonia is US¢15.0/kg.

2-8 Ammonium Sulfate

The past trend of the prices and the price ratio of urea and ammonium sulfate are shown in Figures VI-12 and VI-13. The prices of these fertilizers have increased suddenly since mid-1972. However, the price of ammonium sulfate has been maintained at approximately one-half of the price level of urea, reflecting the nitrogen content difference between the two. Therefore, the ammonium sulfate price in the future is forecast to be one-half the price of urea, so that US¢8.3/kg will be the price for 1977. When the bagging cost is deducted, the net price will be US¢7.3/kg.

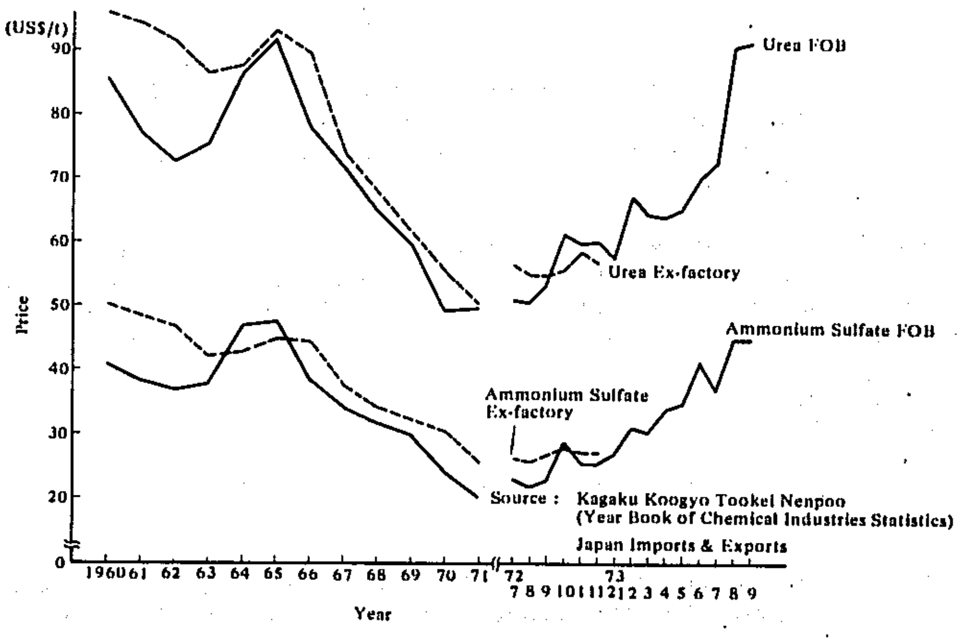


Figure VI-12 Trend of FOB Price and Domestic Price of Urea and Ammonium Sulfate (Japan)

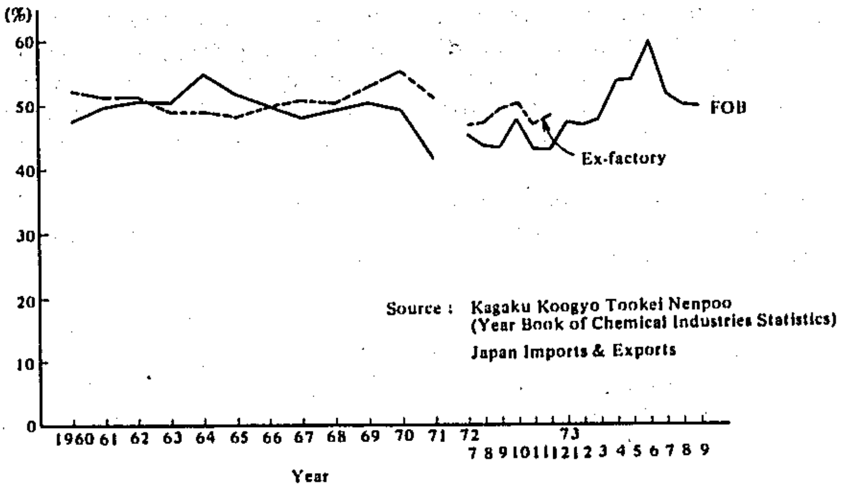


Figure VI-13 Trend of Urea/Ammonium Sulfate Price Ratio (Japan)

2-9 Sulfuric Acid

The import price for sulfur in Indonesia as of the end of 1973 was US$62.00 /t. As the price of sulfur is expected to increase in the future, an annual increase of 7% is incorporated to forecast the 1977 price to be US$81.00/t.

The unit consumption of sulfur required for the production of sulfuric acid is 0.334. Therefore, the forecast price of sulfuric acid in 1977 is US¢4.5/kg when the processing cost including profit is taken as US$18.00/t.

2-10 Acetic Acid

Acetic acid is produced via ethylene and acetaldehyde. The unit consumption of naphtha required for the production of ethylene is estimated at 6.1kl/t ethylene = 4.3kg/kg ethylene then, as mentioned in the foregoing, the increase of naphtha price is, estimated to be US¢7.2/kg.

When the rate of ethylene, propylene and C_4 in olefin produced by cracking of naphtha is estimated at 0.46, 0.33 and 0.21, respectively, and also when the prices of these products are estimated at ¥30/kg, ¥21/kg and ¥16/kg, respectively, the equivalent value of these items are 57%, 29% and 14%, respectively.

Consequently, the increase in the ethylene price can be computed from the above figures as follows:

$$4.3 \times 7.2 \times 0.57 = \text{US¢}\ 17.6\ /\text{kg}$$

If the ethylene price prior to the crude oil price increase was taken as ¥30/ kg (US¢10/kg), the price after the crude oil price increase is US¢27.6/kg.

The unit consumption of ethylene required for the production of acetaldehyde is 0.67. The price of acetaldehyde in 1971 was US¢11.9/kg (in Japan) and the ethylene price was US¢7.5/kg (in Japan). Therefore, the processing cost in 1971 was US¢6.9/kg. Thus, the price of acetaldehyde in 1977 is forecast to be US¢35/kg.

The unit consumption of acetaldehyde required for the production of acetic acid is 0.77. The price of acetic acid in 1971 was US¢14.2/kg so that the processing cost in 1971 was US¢5.0/kg. Therefore, the price of acetic acid in 1977 is forecast to be US¢36.0/kg.

2-11 Methanol

The unit consumption of naphtha required for the production of methanol is 0.79. The methanol price in 1971 was US¢6.4/kg (in Japan) so that the processing cost thereof in 1971 was US¢4.6/kg. When the foregoing price of naphtha is used, the price of methanol in 1977 is forecast to be US¢17.5/kg.

2-12 Ethylene Glycol

The unit consumption of ethylene required for the production of ethylene oxide is 0.95. The prices of ethylene oxide and ethylene in 1971 were US¢22.2/kg and US¢7.5/kg respectively. Therefore, the processing cost in 1971 was US¢15.1/kg. On the basis of these figures and of the ethylene price after the increase of crude oil price, the price of ethylene oxide in 1977 is forecast to be US¢59.3/kg.

The unit consumption of ethylene oxide required for the production of ethylene glycol is 0.83. The prices of ethylene glycol and ethylene were US¢19.4/kg and US¢7.5/kg respectively. Therefore, the processing cost in 1971 was US¢1.0/kg. On the basis of these figures and of the above-mentioned price of ethylene oxide, the price of ethylene glycol in 1977 is forecast to be US¢51.0/kg.

Tables VI-6 and VI-7 show the summary of the above results the forecast prices covering the period from 1977 and 1986 obtained by incorporating the average annual increase rate of 7% and 5%, respectively. Economic evaluation is mainly conducted on the basis of price increase rate at 7% per year.

Table VI-6 Forecast on International Prices of Raw Materials for Synthetic Fiber (Annual Rate of Increase 7%)

(US¢/kg)

	Cyclohexane	p-Xylene	EO	EG	Acetic Acid	Methanol	Caprolactam	p-TPA/DMT	Ammonia	Sulfuric Acid	Ammonium Sulfate
1977	25.6	35.8	59.3	51.0	36.0	17.5	86.2	63.6	15.0	4.5	7.3 1)
1978	27.3	38.3	63.4	54.5	38.5	18.7	92.2	68.0	16.1	4.8	7.8
1979	29.3	40.9	67.8	58.4	41.2	20.0	98.7	72.8	17.2	5.2	8.4
1980	31.3	43.8	72.6	62.5	44.1	21.4	105.6	77.9	18.4	5.5	8.9
1981	33.5	46.9	77.7	66.8	47.2	22.9	113.0	83.3	19.7	5.9	9.6
1982	35.8	50.1	83.1	71.5	50.5	24.5	120.9	89.2	21.1	6.3	10.2
1983	38.3	53.7	88.9	76.5	54.0	26.2	129.4	95.4	22.5	6.8	11.0
1984	41.0	57.4	95.1	81.9	57.8	28.0	138.4	102.1	24.1	7.2	11.7
1985	43.9	61.4	101.8	87.6	61.8	30.0	148.1	109.3	25.8	7.7	12.5
1986	47.0	65.7	108.9	93.7	66.1	32.1	158.5	116.9	27.6	8.3	13.4
1987	50.3	70.3	116.6	100.3	70.8	34.3	169.6	125.1	29.5	8.9	14.4

Note: 1) Excluding bagging cost

Table VI-7 Forecast on International Prices of Raw Materials for Synthetic Fiber (Annual Rate of Increase 5%)

(US¢/kg)

	Cyclohexane	p-Xylene	EO	EG	Acetic Acid	Methanol	Caprolactam	p-TPA/DMT	Ammonia	Sulfuric Acid	Ammonium Sulfate
1977	24.0	32.9	54.5	46.9	33.0	16.1	78.3	57.4	14.0	4.3	6.7 [1)]
1978	25.2	34.6	57.2	49.3	34.7	16.9	82.2	60.3	14.6	4.5	7.0
1979	26.5	36.3	60.1	51.7	36.4	17.7	86.4	63.3	15.4	4.7	7.4
1980	27.8	38.1	63.1	54.3	38.2	18.6	90.7	66.4	16.1	5.0	7.8
1981	29.2	40.0	66.2	57.0	40.2	19.5	95.2	69.8	17.0	5.2	8.1
1982	30.6	42.0	69.5	59.9	42.2	20.5	100.0	73.2	17.8	5.5	8.6
1983	32.2	44.1	73.0	62.9	44.3	21.5	105.0	76.9	18.7	5.8	9.0
1984	33.8	46.3	76.7	66.0	46.5	22.6	110.2	80.8	19.6	6.1	9.4
1985	35.5	48.6	80.5	69.3	48.8	23.7	115.7	84.8	20.6	6.4	9.9
1986	37.2	51.0	84.5	72.8	51.2	24.9	121.5	89.0	21.6	6.7	10.4
1987	39.1	53.6	88.7	76.4	53.8	26.1	127.6	93.5	22.7	7.0	10.9

Note: 1) Excluding bagging cost

The prices obtained in the above are the international prices (CIF Jakarta). On the basis of these prices and in accordance with the methods described in the "Survey Method", the domestic and export prices have been obtained as indicated in Tables VI-8 through VI-11. Further, the purchasing prices of the raw materials which are required for the production of caprolactam, etc. are shown in Tables VI-12 and VI-13.

Table VI-8 Prices of Raw Materials for Synthetic Fiber for Domestic Market (Annual Increase Rate 7%)

(US¢/kg)

	Cyclohexane	p-Xylene	Caprolactam [1)]	p-TPA/DMT [1)]
1977	30.5	42.6	100.1	73.2
1978	32.6	45.6	107.1	78.3
1979	34.9	48.8	114.6	83.8
1980	37.3	52.2	122.6	89.7
1981	39.9	55.8	131.2	96.0
1982	42.7	59.8	140.4	102.7
1983	45.7	63.9	150.2	109.9
1984	48.9	68.4	160.7	117.5
1985	52.3	73.2	172.0	125.8
1986	56.0	78.3	184.0	134.6
1987	59.9	83.8	196.9	144.0

Note: 1) Excluding Transportation Cost to Jakarta

Table VI-9 Prices of Raw Materials for Synthetic Fiber for Domestic Market (Annual Increase Rate 5%)

(US¢/kg)

	Cyclohexane	p-Xylene	Caprolactam 1)	p-TPA/DMT 1)
1977	28.6	39.2	90.7	65.8
1978	30.0	41.1	95.2	69.1
1979	31.5	43.2	100.0	72.5
1980	33.1	45.3	105.0	76.2
1981	34.7	47.6	110.2	80.0
1982	36.5	50.0	115.8	84.0
1983	38.3	52.5	121.5	88.2
1984	40.2	55.1	127.6	92.6
1985	42.2	57.8	134.0	97.2
1986	44.3	60.7	140.7	102.1
1987	46.5	63.8	147.7	107.2

Note: 1) Excluding Transportation Cost to Jakarta

Table VI-10 Export Prices of Raw Materials for Synthetic Fiber (Annual Increase Rate 7%)

(US¢/kg)

	Cyclohexane	p-Xylene	Caprolactam	p-TPA/DMT
1977	18.2	28.3	74.6	52.2
1978	19.5	30.3	79.8	55.8
1979	20.8	32.4	85.4	59.7
1980	22.3	34.6	91.3	63.9
1981	23.8	37.1	97.7	68.4
1982	25.5	39.7	104.6	73.2
1983	27.3	42.4	111.9	78.3
1984	29.2	45.4	119.7	83.8
1985	31.2	48.6	128.1	89.6
1986	33.4	52.0	137.1	95.9
1987	35.8	55.6	146.7	102.6

Table VI-11 Export Prices of Raw Materials for Synthetic Fiber (Annual Increase Rate 5%)

(US¢/kg)

	Cyclohexane	p-Xylene	Caprolactam	p-TPA/DMT
1977	17.0	25.9	67.4	46.6
1978	17.9	27.1	70.7	49.0
1979	18.8	28.5	74.3	51.4
1980	19.7	29.9	78.0	54.0
1981	20.7	31.4	81.9	56.7
1982	21.7	33.0	86.0	59.5
1983	22.8	34.6	90.3	62.5
1984	24.0	36.4	94.8	65.6
1985	25.2	38.2	99.5	68.9
1986	26.4	40.1	104.5	72.3
1987	27.7	42.1	109.7	76.0

Table VI-12 Raw Materials Purchasing Prices (Annual Increase Rate 7%)

(US¢/kg)

	Cyclohexane	p-Xylene	Acetic Acid	Methanol	EG	Ammonia	Sulfuric Acid	Ammonium Sulfate 1)
1977	30.5	42.6	42.8	20.8	60.7	15.0	4.5	8.3
1978	32.6	45.6	45.8	22.3	64.9	16.1	4.8	8.8
1979	34.9	48.8	49.0	23.8	69.5	17.2	5.2	9.5
1980	37.3	52.2	52.5	25.5	74.3	18.4	5.5	10.1
1981	39.9	55.8	56.2	27.3	79.6	19.7	5.9	10.8
1982	42.7	59.8	60.1	29.2	85.1	21.1	6.3	11.6
1983	45.7	63.9	64.3	31.3	91.1	22.5	6.8	12.4
1984	48.9	68.4	68.8	33.4	97.5	24.1	7.2	13.3
1985	52.3	73.2	73.6	35.8	104.3	25.8	7.7	14.2
1986	56.0	78.3	78.8	38.3	111.6	27.6	8.3	15.2
1987	59.9	83.8	84.3	41.0	119.4	29.5	8.9	16.2

Note: 1) Selling price excluding bagging cost

Table VI-13 Raw Materials Purchasing Prices (Annual Increase Rate 5%)

(US¢/kg)

	Cyclohexane	p-Xylene	Acetic Acid	Methanol	EG	Ammonia	Sulfuric Acid	Ammonium Sulfate[1]
1977	28.6	39.2	39.3	19.2	55.8	14.0	4.3	7.7
1978	30.0	41.1	41.2	20.1	58.6	14.6	4.5	8.1
1979	31.5	43.2	43.3	21.1	61.5	15.4	4.7	8.5
1980	33.1	45.3	45.5	22.2	64.6	16.1	5.0	8.9
1981	34.7	47.6	47.7	23.3	67.8	17.0	5.2	9.3
1982	36.5	50.0	50.1	24.5	71.2	17.8	5.5	9.8
1983	38.3	52.5	52.6	25.7	74.8	18.7	5.8	10.3
1984	40.2	55.1	55.3	27.0	78.5	19.6	6.1	10.8
1985	42.2	57.8	58.0	28.3	82.5	20.6	6.4	11.3
1986	44.3	60.7	60.9	29.7	86.6	21.6	6.7	11.9
1987	46.5	63.8	64.0	31.2	90.9	22.7	7.0	12.5

Note: 1) Selling price excluding bagging cost

VII. Site Survey

1. Various Factors for a Chemical Plant Site

Various points which are necessary to be taken into consideration in general at the time of selecting a chemical plant site are as follows.

(1) The main and sub-raw material procurement must be carried out without difficulties.

(2) The product distribution for domestic and overseas markets can be carried out without difficulties.

(3) The utilities procurement can be carried out without difficulties.

(4) The waste disposal can be carried out without difficulties.

(5) The site must not be in a highly populated area.

(6) The labor force recruitment can be carried out without difficulties.

(7) The usage of medical, cultural facilities or the facilities of related industries are feasible.

(8) The climate conditions such as the extent of rainfall or wind velocity must be favorable.

(9) The ground of the site should be flat and possess a suitable bearing layer and would not stand on a rock.

2. Plant Layout in Raw Material Industry for Synthetic Fibers

Figure VII-1 shows the most typical form of the main raw material production industry in view of a special emphasis on polyester and nylon. Of the plants shown in Figure VII-1, industry up to caprolactam, TPA and DMT production are typical synthesis industry carrying out a mass-production of limited number of product items.

On the contrary, the polymerization and spinning stage is characterized by small-quantity production of numerous product items and therefore is comparatively labor-intensive textile industry. Regarding the basic raw material production industries such as oil refining and petrochemical industry through synthetic fiber production, the manufacturing processes up to the production of caprolactam, TPA/DMT fall under the category of chemical industry and the subsequent processes can be classified as belonging to fiber industry. This being the case, the suitability of the plant site conditions differ for these two categories of the industry. Therefore, it is possible to select separate sites for the two categories of the industry.

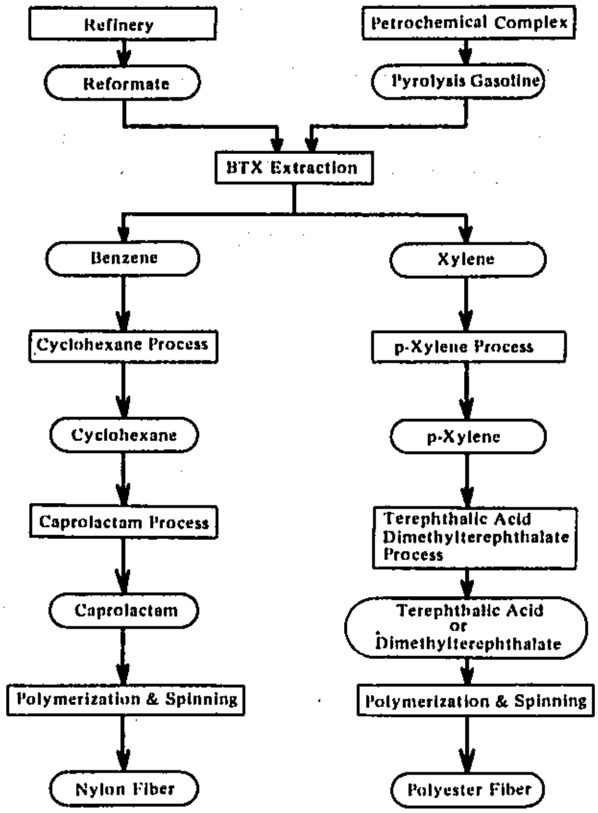


Figure VII-1 Production Process of Nylon and Polyester

In view of the material flow between the two industries, however, the establishment of two separate sites for each one of the industries is not necessarily advantageous, as methanol is consumed in the monomer production plant, while in the polymer plant methanol is generated.

3. Special Conditions for Plant Sites for Aromatics Extraction and the Production of Cyclohexane and p-Xylene

As to BTX, cyclohexane and p-xylene, the extent of the added value of the products is low. Therefore, long-distance transportation of the products will result in high ratio of transportation cost in the production cost. This being the case, this type of plants are usually located in the vicinity of an oil refining plant or a petrochemical plant. In this case, advantages could be gained, as the sub-raw materials, such as hydrogen, or the utilities such as steam employed could be shared in common for the oil refining plant and the petrochemical plant.

Recently the economic scale of aromatics industry has largely expanded so that the economic size of reformer has become of the capacity of approximately 10,000 to 15,000 BPSD of naphtha. In the case of using reformate from an oil refinery, in order to supply such an amount of raw materials, a refinery must have a capacity of more than 100,000 BPSD. If pyrolysis gasoline from a petrochemical plant is to be employed, even in the case of cracked naphtha in which the pyrolysis gasoline amount is comparatively large, an ethylene plant with a capacity of more than 400,000 t/y would be necessary.

In Indonesia at present, there is no ethylene plant with such an extent of capacity. Further, in Indonesia, natural gas is likely to be used as a raw material for ethylene plant, so that it is not feasible to acquire from ethylene plant raw material supply for BTX. This being the circumstance, the plant sites for BTX, cyclohexane, and p-xylene are limited to a site adjacent to an oil refining plant of the capacity about 100,000 BPSD.

4. Special Conditions for Sites for TPA and/or DMT Plants

The raw materials for TPA and DMT are p-xylene and a slight extent of acetic acid or methanol. As all of the raw materials are liquid substances, the transportation is comparatively easy. Therefore, it is not necessary to emphasize the raw material procurement aspect in selecting the site.

The products in all cases are in powder form, so that the transportation cost is high and the handling is troublesome. The products must be supplied to number of domestic and overseas users. Further, as high quality is the requirement in textile raw materials, sufficient care must be exercised in the transportation and storage. Therefore, it is necessary to place a special emphasis on the stabilization and cost reduction of the product transportation to the market.

In the case of textile industry in which polymerization and spinning operations are undertaken, it is generally true that the production scale is on a small size of several tons to several hundreds tons per day approximately, so that in the case of expanding the production facilities, it is possible to gradually undertake the expansion by carrying out additional investments. However, the raw material industry for synthetic fiber is one of the typical facilities-intensive industries in whitch the effect of production scale on the production cost is extremely significant. Therefore, in general cases, a plant in this field possesses several hundreds of tons per day capacity. This being the circumstance, gradual and small-scale series of production facilities expansion is extremely difficult.

Thus, the construction of raw material producing plants is usually undertaken by integrating into one large-scale production facilities at one site by incorporating the production increase allowance in order to meet the future increment in the demand. The products turned out in the raw material plants are not only supplied to textile plants, but are also allocated for exportation as far as the surplus portion of the production is concerned, during the period when the domestic demand is smaller than domestic production.

Therefore, as to a desirable site for a TPA/DMT plant, an area in the vicinity of a sea shore near a port of export is highly advantageous.

The site selection conditions described in the foregoing paragraphs also apply exactly to the case of the site selection for a p-TPA production plant. Therefore, the site selection for a p-TPA plant can well be undertaken on the basis of the above-mentioned requirements.

However, in the case of a DMT production plant, some additional site selection conditions will be called for, i. e., the relationship with the fiber plant. In the case of selecting a site for a DMT plant, it is favorable to construct the facilities in the vicinity of the fiber plant, otherwise, a disadvantage of inability in recycling utilization of methanol generated by the polymerization process for the production of DMT can be obtained.

If the DMT plant is constructed in the vicinity of a fiber plant, an advantage in addition to the recycling use of methanol will be obtained, i. e., the facilitation of the transportation of DMT in liquid state. However, even if the liquid transportation of DMT is possible, such an advantage will be applicable only to the case of domestic consumption. This being the case, although it is desirable that a DMT plant be constructed near a fiber plant, it is by no means imperative in view of the procurement of raw materials and the undertaking of exportation.

5. Special Conditions Concerning the Site for a Caprolactam Plant

In the production of caprolactam, a large amount of ammonia and sulfuric acid are necessary as the sub-raw materials, in addition to the main-raw material cyclohexane. Due to the fact that the transportation of these sub-raw materials entails a certain extent of difficulties, it is desirable that the caprolactam plant site be selected in an area adjacent to a fertilizer plant in which the production of ammonia and sulfuric acid is undertaken in view of the raw material supply.

Particularly concerning ammonia, it is economically difficult to construct an ammonia plant only for the purpose of supplying the products to the caprolactam plant. Although it is possible to carry out the transportation of liquid ammonia, however, it is still more desirable to select the site in the vicinity of an ammonia plant.

Also, in view of the fact that a large amount of ammonium sulfate as much as at least 1. 7 times the amount of the product caprolactam will be by-produced through the caprolactam production operation, it is also necessary to select the site in the vicinity of a fertilizer plant.

Also, in the case of caprolactam production, it is difficult in view of cost considerations to possess own auxiliary facilities such as the maintenance facilities and the also to undertake the substantiation of the living environment for the plant personnel in view of the fact that the production capacity of caprolactam will be small in comparison with the production of TPA/DMT because of the fact that the level of demand for nylon is lower than that of polyester. In view of this fact, it is necessary to commonly own the above-mentioned auxiliary facilities by constructing the caprolactam plant in the vicinity of an existing fertilizer plant.

If a caprolactam plant is constructed near a fiber plant, there would be an advantage in the transportation of caprolactam in liquid state, however, in view of the importance of the raw material procurement problems, it is far more important that the site be selected in the vicinity of a fertilizer plant.

6. Conditions Specific to Indonesia

The conditions specific to Indonesia in view of the chemical plant site selection are as follows.

(1) The climate is the so-called stable oceanic climate covering all the areas, presenting a slight extent of temperature fluctuation throughout a year. Also, the areas are not within the typhoon route so that the cases of damage by rainstorm is seldom.

Comparatively large rivers exist in the major candidate sites. Therefore, the securing of water will not cause any problem. The water treatment facilities must be reinforced both in quality and quantity, considering the factors regarding the irrigation water usage and the bathing habits of the people, as a 15 to 20 km long-distance water intake will have to be carried out.

(2) The major candidate sites are suitable geologically for coastal chemical industrial zone, as plain clay soil is present in these areas. The land preparation for the plant sites must be carried out by filling and levelling the earth to 1 - 2 meters with sand soiled or sea sand in each area due to the fact that the underground water level is high. It is necessary to effect boring to investigate into the nature of the soil and the bearing layer. According to the data on each site collected through the present survey, it was discovered that the pile length was less than 30 meters. The data are similar to those obtained in Japan in the coastal alluvial soil areas.

Earthquakes are infrequent the instance so which is one-half to a quarter of that of Japan. Therefore, it will cause no problems in installing heavy weight machinery and equipment for chemical plants except in the case of especially swampy areas.

(3) Chemical industries in general, a highly sophisticates sectors such as synthetic fiber industry in particular, have much closer connection with the related industries than in the case of such other industries as oil drilling, oil refining or mining industries. In the case of chemical plants, the living environments for the workers who are highly educated are desired to be culturally well developed. It is also necessary to have sufficient transportation facilities and communication network in order to contact the users of the products.

It is also desirable that a machine shop exist in the vicinity of the area manned by skilled workers in order to ensure the maintenance servicing to the plant. In view of the presence of the existing plants and the extent of the local development, only Java Island and South Sumatra satisfy the above conditions to a certain extent. Other areas are not yet suitable at the present stage as they have shortcomings in the requirements and therefore it is likely that cost increase will be cause thereby.

(4) In Indonesia, industrial development has the nature of local development. In carrying out industrial development, it is necessary to take into account not only the construction of the relative plants, but also the substantiation of transportation and communication systems and networks must be carried out in addition to the simultaneous fostering of the related industries, substantiation of the living environments, etc. This being the circumstance, it is imperative that the plant sites be selected on a long-term and integrated point of view along with the materialization of efficient developments on the basis of the available capital.

In establishing a plant, it is necessary to also invest into the substantiation of the auxiliary facilities required due to the fact that it is not possible to expect to utilize off-site facilities. These facilities are the utility facilities including the water intake facilities and the power station, the maintenance facilities and equipment including various construction machines, warehouses for raw materials, products and hardware materials as well as cargo handling facilities and the welfare facilities including medical and educational institutions.

7. Comparison of Sites in Indonesia

7-1 South Sumatra (Palembang)

Naphtha obtained from crude oil produced in the Palembang area has a total of approximately 60% contents of naphthene and aromatics. This content rate is extremely high and therefore it is highly suitable for aromatic production. Natual gas is also available in this area. At present, large oil refineries and fertilizer plants are being operated by using these raw materials. In view of obtaining raw materials for TPA/DMT and caprolactam production, it is possible to secure cyclohexane and ammonia except for sulfuric acid as the raw materials.

This signifies that all the required conditions are present. This seems to afford a high economic advantage, as the natural gas is to be employed as the raw material for ammonia production. In Indonesia, other oil refineries are located in Central Sumatra and Kalimantan, however, the aromatic contents rate in naphtha is inferior to that of Palembang. Also, as the major market for synthetic fiber is Jakarta and surrounding areas thereof, Palembang is located closest to the market when compared with the other oil refinery locations.

Further, in view of the utilization of the existing facilities, various facilities which belong to the above-mentioned large oil refineries and fertilizer plants may be shared.

In view of the above points, Palembang can be nominated as having the most favourable conditions. However, there are several problems in Palembang as follows.

(1) New sites, such as Cilacap and Batam Island are beginning to be considered with priority for future oil refinery construction sites, due to the fact that crude oil production in South Sumatra has been decreasing by approximately 10% to 15% every year.

(2) The maximum size of a tanker which can travel on the Musi River is approximately 10,000 tons so that an extreme disadvantage would be present if it is necessary to transport crude oil from other areas.

(3) A considerable length of time has passed already since the construction of the oil refinery.

Of the above problems, it is possible to transport from other areas the necessary crude oil or naphtha into Palembang areas in order to cover the shortage portion of the raw materials and therefore, no serious problem will be caused in this respect. Regarding the transportation problems, all the raw materials and the products are in the state of either liquid or solid so that the storage is comparatively simple and also it is not necess: ·y to transport a large amount by one trip. This being the case, the transportation will not present any serious problem.

7-2 East Java (Suburbs of Surabaya)

Surabaya is the second largest city in Indonesia in which fertilizer, soda and cement plants are now operating. Surabaya therefore is the center of chemical industrial operation of Indonesia.

In P.N. Petrokimia in Gresik, the production operations are now being undertaken at present for 200 t/d of ammonia 390 t/d of sulfuric acid, 500 t/d of ammonium sulfate and 136 to 185 t/d of urea. In addition to these operations, a new project for the production of sulfuric acid and TSP fertilizers is being contemplated.

Therefore, if it is possible to receive supply of sulfuric acid and ammonia from P.N. Petrokimia, it can be considered that Surabaya is a suitable site for caprolactam production.

However, due to the fact that the ammonia produced in Surabaya is employing heavy oil as the raw material, the economic disadvantage is greater when compared with the natural gas employment undertaken in Palembang.

It must be noted here that Surabaya is not suitable as a site for constructing a plant for the production of aromatics and TPA/DMT because of the fact that there is no source of supply of raw materials. Also, in view of the fact that the transportation of the products to Jakarta which is the consumption area for raw materials for synthetic fiber, it is not convenient to travel across the Java Island for the transportation of the products.

7-3 Central Java (Cilacap)

No chemical plant is operating at the present stage in Central Java area and therefore, the area is not suitable as the site for constructing raw material production plants for synthetic fiber.

However, in Cilacap, the construction of 100,000 BPSD new oil refinery is now being undertaken and if this refinery is to be expanded in the future up to 200,000 BPSD, the conditions will become highly favourable not only in view of the available auxiliary facility sharing, but also in the raw material procurement aspect for the construction of BTX plants.

The crude oil to be refined in this refinery will be the Middle East Crude and the Java Off-shore Crude. The latter is rich in aromatics and therefore is suitable for BTX production.

However, it must be noted that in these areas, the port facilities, road network, railway network and other infrastructures are largely under-developed and the substantiation in this respect will be necessary.

The Cilacap area is geographically away from large cities and the substantiation of the living environments including the medical and other cultural institutions as well as the transportation systems is required. However, in order to disperse the population which is now concentrated in the West Java area, it would be the most effective means to develop Central Java in general, the areas in the vicinity of Cilacap in particular.

In view of this consideration, the construction of chemical plant into this area is the most effective and favourable undertakings in view of the future development of Indonesia.

This being the case, the construction of BTX and TPA/DMT plants in this area is feasible with the prospect of future development. Further, as to the site for the caprolactam plant, this area is not suitable in view of the fact that there is no possibility of constructing an ammonia plant in Central Java.

7-4 West Java

In West Java, a number of synthetic fiber plants are now being operated. Therefore, a considerable extent of advantage can be gained for raw materials for synthetic fiber plants in view of product transportation.

Also, because of high concentration of population, the recruitment of labor force will be easy. Further, West Java is the most developed area in the whole Indonesia, so that there are numerous advantages in constructing plants in this area.

However, in view of the procurement of raw materials, West Java is in an extreme disadvantage when compared with the other candidate site areas. The sites which can be considered as being suitable in West Java will be Cirebon and Jatibarang areas on the Java Sea coast and Cilegon and Merak areas as well as the Jakarta area.

Of these three locations, Jakarta has a high density of population so that no chemical plant construction should be undertaken in view of the safety and pollution prevention. This being the circumstance, Jakarta will be excluded from the scope of scrutinization.

The Cirebon area may be nominated as the candidate site for the caprolactam plant construction as a fertilizer plant employing natural gas is to be built, however, for the time being, there is no implementation plan is announced therefore, the Cirebon area shall also be excluded from the scope of scrutinization.

A project is being studied for the construction of an iron and steel plant in the Cilegon area by utilizing the natural gas available from the Java Sea. In view of this project, it is expected that the development of this area will be considerably progressed in the future. Although there is no project related to the raw material production for synthetic fiber such as oil refinery, fertilizer plant, etc., the area is geographically close to Jakarta. There is a project for road system expansion between the Cilegon area and Jakarta and the geographic proximity to Palembang is also another advantage.

DMT production will be the most feasible as the raw material production for synthetic fiber to be undertaken in the Cilegon area. c-TPA or p-xylene can be transported from Palembang and the DMT production can be undertaken in Cilegon which will then be transported to Jakarta from where the recovered methanol from the polymerization of the synthetic fiber plants in Jakarta can be transported to Cilegon. Further, p-TPA production can be undertaken in Cilegon by transporting p-xylene from Palembang.

7-5 North Sumatra (Suburbs of Medan and Aceh)

A project for constructing a petrochemical complex by utilizing natural gas as the raw material is being studied for this area so that as a part of such a project it is highly advantageous in view of the fact that the common utilization of the auxiliary facilities would be made possible if the raw material production industry for synthetic fiber is included within the scope of the complex.

The existing industry in the North Sumatra area is a small-scale oil refinery in Pangkalanberandan. Therefore, this area is not suitable in view of the basic raw material procurement and demand of the products of raw material industry for synthetic fiber. Also in view of the product transportation, the inland transportation system up to Belawan (Medan Port) is made highly complicated so that full utilization of the port facilities will be difficult.

As a conclusion, this area cannot be nominated as a suitable site for the construction of raw materials plant for synthetic fiber in view of the difficulties and problems in raw material procurement even if petrochemical plants were constructed in the future.

8. Conclusion Concerning the Site Selection Problems

The foregoing discussions can be summarized as follows.

8-1 Plant Sites for BTX, p-Xylene and Cyclohexane Production

Palembang will be the most suitable candidate site in view of the procurement of crude oil and naphtha suitable for the production of BTX and also in view of the existence of an oil refinery at the present stage.

However, taking into consideration the prospect of future development, Cilacap will be another candidate site besides Palembang. A large-scaled oil refinery of 100,000 to 200,000 BPSD capacity will be constructed in Cilacap in the future so that the procurement of raw materials will be made easy.

8-2 Plant Site for TPA/DMT Production

The best suited site at the present stage will be Palembang for the same reason as stated for the BTX plant site selection. Also, considering the future development prospect, Cilacap will be another site besides Palembang for the same reason as that stated for the BTX plant.

However, if the DMT production alone is considered on the basis of transporting c-TPA and by taking into consideration the prospect of the future development, the Cilegon area is also a potential site.

8-3 Plant Site for Caprolactam Production

Gresik and Palembang can be nominated as the candidate sites in view of the procurement of the main-raw materials and sub-raw materials.

In Gresik, the procurement of ammonia and sulfuric acid can be carried out, however, as far as cyclohexane is concerned, it is necessary to transport the material from some other areas such as Palembang for example. Also, in Gresik, the production of ammonia is now being undertaken by employing heavy oil as the raw material and this operation is suffering from apparent economic disadvantage when compared with the natural gas raw materials available in Palembang.

Although cyclohexane and ammonia can be obtained in Palembang, a sulfuric acid plant must be constructed newly for the purpose of supplying the products to the production of caprolactam. However, the ammonia being produced in Palembang is employing natural gas as the raw material, the economic advantage is evident.

In view of the foregoing discussion, Gresik and Palembang are two candidate sites which can be nominated as the plant sites for caprolactam plant construction.

VIII. Production of BTX, p-Xylene and Cyclohexane

1. Introduction

Concerning the subject, detailed surveys are being conducted by the Indonesian Petrochemical Industrialization Survey also conducted by OTCA. Therefore, it is requested that reference be made to the petrochemical industry survey regarding the details of the subject. However, in order to facilitate the visualization of the overall status of the raw material industry for synthetic fiber in Indonesia, this report will also touch upon the subject briefly regarding the process up to the production of the raw materials for monomer.

The scale of monomer plants which fulfill the domestic demand, as described in the foregoing chapters, and which attain the internationally competitive level and the required amount of the raw materials therefor can be stated as follows:

p-TPA	100,000 t/y	p-Xylene required	69,000 t/y
DMT	110,000 t/y	p-Xylene required	66,000 t/y
		Total	135,000 t/y
		(As Xylene	156,000 t/y)
Caprolactam	60,000 t/y	Benzene required	56,000 t/y
		(Cyclohexane	60,000 t/y)

These basic raw materials mentioned above are assumed to be domestically produced in order to achieve the stabilization of supply, saving in foreign currency as well as the effective utilization of domestically available crude oil. The following paragraphs will treat briefly the production process of these raw materials.

As has been discussed in Chapter V, two raw materials will be employed for the production of aromatics, i.e., the naphtha reformate supplied from oil refining industry and the cracked gasoline supplied from petrochemical industry. However, in the case of petrochemical industry, the amount of xylene is less than 10% of the amount of ethylene even in the case of comparatively high yield of pyrolysis gasoline in naphtha cracking. Even the xylene production from toluene is taken into consideration, the available amount of xylene is approximately 17%.

In the case of an ethylene plant which employs the natural gas as raw material as being projected in Indonesia, the amount of a pyrolysis gasoline will be further reduced, thereby making it almost impossible to carry out aromatics production on the basis of supply from petrochemical industry. Also, another shortcoming in this respect is that the petrochemical industrialization will have to be achieved after the completion of the establishment of raw material industry for synthetic fiber.

This being the case, it is inevitable to rely entirely upon the reformate gasoline as far as raw material for aromatics production are concerned. Therefore, the studies will be made in this chapter concerning the processes to produce the required amount of benzene and p-xylene by employing reformate gasoline as the raw material in Indonesia.

2. Production of BTX

The most popularly employed process for the production of BTX from reformate gasoline consists of the extraction of aromatics by solvents and the separation of benzene, toluene and xylene by means of distillation. The actually industrialized process other than this solvent extraction process for the production of BTX is the one in which the p-xylene production is undertaken by extracting C_8 fraction by distillating reformate gasoline.

When the production of benzene is simultaneously required, the C_6 and C_7 fractions are extracted and then the mixture of these two fractions can be immediately treated through the dealkylation reaction in order to produce benzene. In the distillation process, the yield of BTX from raw material naphtha is low when compared with the case of the solvent-extraction process. Further, the extent of xylene in the case of the distillation process will be low while the amount of benzene becomes high therefore, this process does not meet the demand structure of Indonesia.

The distillation process is suitable as the means to obtain p-xylene comparatively simply when the procurement of naphtha is possible. However, when it is desired to obtain xylene and benzene as much as possible by effectively utilizing naphtha, the employment of the solvent-extraction process will be more advantageous.

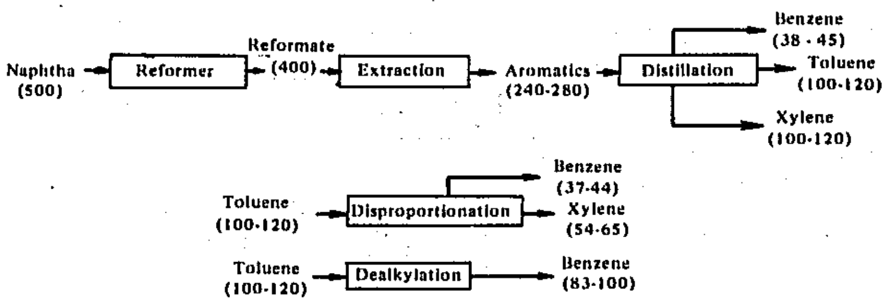
The amount and composition of BTX available at the time of producing the BTX from naphtha via reformate gasoline will be greatly affected by the type of the BTX production process and also by whether or not a disproportionation process of toluene into benzene and xylene is employed. Therefore, on the basis of the under-mentioned assumption, rough calculations will be carried out concerning the solvent-extraction process in order to obtain the available BTX amount in Indonesia.

The naphtha to be employed shall be available from the South Sumatra crude oil. This naphtha has a high extent of aromatics and naphthene, therefore, this naphtha is highly suitable for producing aromatics by means of a reformer. This is the reason why the above-mentioned assumption for the employment of the South Sumatra crude oil has been made. Another assumption is made that 500,000 t/y (12,600 BPSD) will be available in Indonesia as far as the naphtha for BTX production is concerned. The yield of reformate gasoline from this naphtha is assumed to be 80% and the contents of BTX in the reformate gasoline is at 60 to 70 wt%. The rate comprised by BTX in this case shall be assumed as being 16% of benzene, 42% of toluene and 42% of xylene.

When the production of BTX is calculated on the basis of the above-mentioned conditions, the results will be as shown in Figure VIII-1.

The demand of p-xylene and benzene are, 135,000 t/y (156,000 t/y as xylene) and 56,000 t/y respectively. When the BTX separation is simply undertaken, both benzene (38,000 to 45,000 t/y) and xylene (100,000 to 120,000 t/y) will become short. When toluene is dealkylated, benzene will be produced for 121,000 to 145,000 t/y, while xylene shortage will become apparent by 100,000 to 120,000 t/y production.

When the above-mentioned disproportionation is combined, the amount of benzene would be 75,000 to 89,000 t/y and that of xylene would be 154,000 to 185,000 t/y, thereby both satisfying the demand. Therefore, of the processes illustrated in Figure VIII-1, the most suitable processes are those in which the combination of the toluene disproportionation is incorporated.



(10^3 t/y)

Process	Benzene	Toluene	Xylene	Total
Distillation	38 ~ 45	100 ~ 120	100 ~ 120	238 ~ 285
Distillation + Disproportionation	75 ~ 89	0	154 ~ 185	229 ~ 274
Distillation + Dealkylation	121 ~ 145	0	100 ~ 120	221 ~ 265

Figure VIII-1 Typical Flow Scheme of Aromatics Industry

3. Production of p-Xylene

The produced xylene is a mixture of p-xylene, m-xylene and o-xylene so that even if the p-xylene alone is separated, the demand for m-xylene and o-xylene in general, m-xylene in particular, will have little demand and, therefore, the prices are low. Therefore, these substances will be isomerized into p-xylene and then will be separated. The separation of p-xylene is undertaken by two processes, i.e., the crystallization process and the adsorption process.

The crystallization process is most popularly employed in the world at present, however, in this process, it seems economically disadvantageous to carry out the separation of p-xylene alone from the mixed xylene in combination with the isomerization process due to the fact that the p-xylene concentration in the mother liquor after the separation process still shows a rate of 9% to 10%. In this process, as the yield of p-xylene in the crystallization process is poor so that it is necessary to pass through the processes of isomerization, crystallization and separation repeatedly, thereby making the scale of facilities for these processes comparatively large and also causing economical disadvantage because of the increment in the utility cost. Due to this fact, there are a number of cases in which the operation conditions are so provided in the crystallization process that o-xylene in addition to p-xylene recovery can be undertaken.

On the other hand, in the adsorption process, the adsorbent is used for selective adsorption of p-xylene alone, the p-xylene concentration in the raffinate after adsorption will be 1% to 2%. This being the case, the recovery of p-xylene from the mixed xylene is possible so that the yield of p-xylene as against the raw material xylene will be extremely high.

The case in which the above-mentioned disproportionation, i.e., the case of 154,000 to 185,000 t/y mixed xylene is illustrated in terms of the flowsheet in Figure VIII-2 in which the two p-xylene production processes are adopted.

When the adsorption process is employed, 130,000 to 160,000 t/y of p-xylene will be obtained, a quantity which can satisfy the required amount of p-xylene in Indonesia.

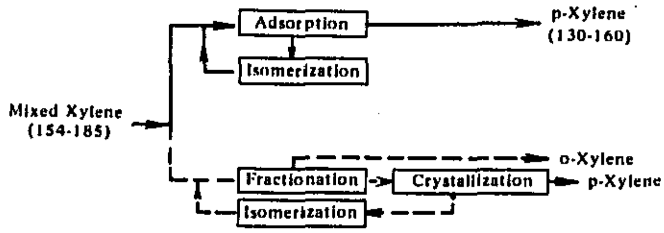


Figure VIII-2 Production of p-Xylene (10^3 t/y)

For reference, Table VIII-1 shows an example of new construction and expansion cost projects for p-xylene and benzene production in the recent years in the world. The production plant for p-xylene to cover the required amount within Indonesia can be considered as being on an economic scale of the international standard.

Table VIII-1 New Installation and Expansion Projects for p-Xylene and Benzene Production

Company	Location	Product	Capacity (t/y)	Process	Start Up Date
Indian Petrochemical Crop.	India	o-Xylene p-Xylene	21,000 17,000	Engelhardt	1973
Teijin	Japan	o-Xylene p-Xylene	30,000 100,000		1974
Toray	Japan	p-Xylene	200,000 1)	Toray	1973
State Authorithy	Poland	p-Xylene	48,000	Krupp	
State Authorithy	U.S.S.R.	p-Xylene	60,000	Arco	1974
Exxon Chemical	U.S.A.	p-Xylene	180,000 1)		1975
Hercor Chemical	Puerto Rico	p-Xylene	215,000 1)		
CDF Chimie	France	Benzene	90,000		
ATD Chimie	France	Benzene	150,000	Lurgi	1975

Note: 1) Expansion

Source: European Chemical News, Jan. 5 - Oct. 19 (1973)

4. Production of Cyclohexane

Cyclohexane can be simply produced by means of hydrogenation of benzene. The reactions proceed almost quantitatively. Approximately 80,000 to 95,000 t/y of cyclohexane can be obtained from 75,000 to 89,000 t/y of benzene, thereby making it possible to satisfy the Indonesian demand. For reference, Table VIII-2 shows the scale of cyclohexane plants to be constructed in the future. The number of examples in this table is not numerous and the internationally competitive plant scale for cyclohexane production cannot be pinpointed clearly; however, it can be understood that such a level should be more than approximately 60,000 t/y. The extent of demand in Indonesia can be amply covered within this range.

Table VIII-2 New Installation and Expansion Projects for the Production of Cyclohexane

Company	Location	Capacity (t/y)	Process & Feedstock	Main & Sub-Contractors	Start Up Date
State Authority	Savinesti, Rumania	25,000		U.S.S.R.	Early 1974
State Authority	China	45,000	IFP	Technip/Spechim	1976 - 1978
Chinese Petroleum	Taipei, Taiwan	60,000	IFP		1975

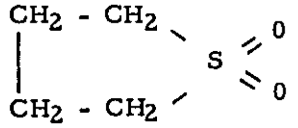
Source: European Chemical News

As has been explained in the above, the scale of plant to produce the quantity to cover the p-xylene and cyclohexane for demand will be on an internationally competitive production scale.

5. Explanation of the Processes

5-1 Solvent-extraction of BTX

There are a number of processes in the solvent-extraction methods for aromatics depending upon the type of the solvent employed. The typical example of the processes is the sulforane process. This process has been popularly employed in the world in view of the low extent of construction cost and the variable cost. Figure VIII-3 shows the flowsheet of this process. The raw material reformate gasoline will come in contact with the sulfolane (tetramethylene sulfon)



which is the extraction solvent in counter-flow within the extraction tower, thereby dissolving into the solvent the contained aromatics substances. The raffinate will be taken out of the reaction process after the accompanying solvent is extracted by washing with water, and then will be used as a gasoline-blend, etc.

The solvent containing aromatics will be treated by a stripper in which the non-aromatic substances are eliminated and then separated into aromatics and solvent in a recovery tower. For the most part, the separated solvent will be returned to the extraction tower, however, a certain portion of the solvent will be

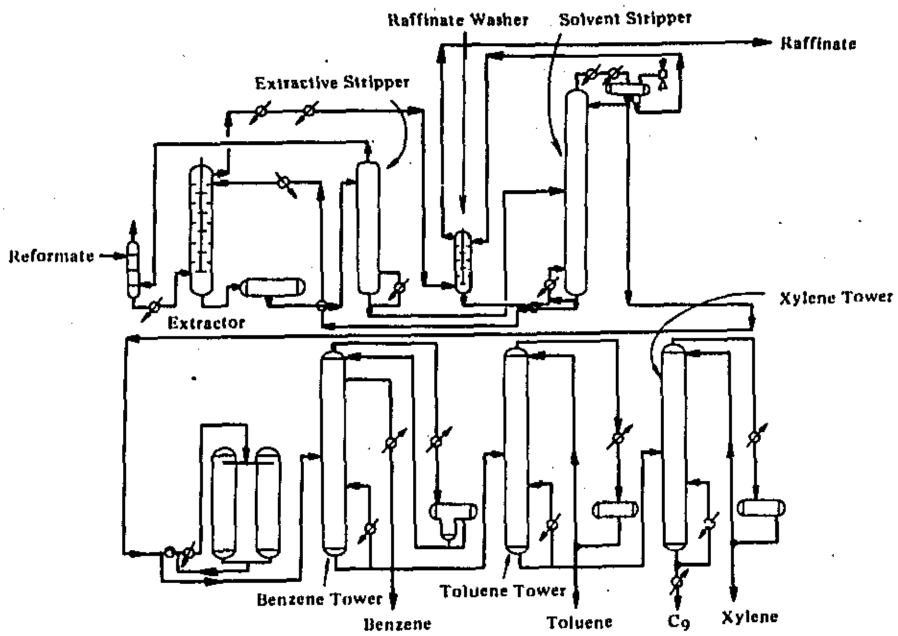


Figure VIII-3 Sulfolane Process

fed to the solvent regeneration tower in which the elimination of heavy impurities, etc. is undertaken.

The aromatics separated in the recovery tower will be fed to the clay tower in which the elimination of a slight amount of unsaturated compounds is undertaken. Thereafter, benzene, toluene and xylene will be separated in respective evaporators. The C9 aromatics coming out from the bottom of the xylene tower will be mostly used as a gasoline blend, etc., except for a limited amount thereof which is utilized in the disproportionation reactions explained later.

The features of this process are as follows:

(1) Sulfolane solvent has a higher dissolving power and selectivity to absorb aromatics hydrocarbons. Also, this solvent possesses high specific gravity (1.26), low specific heat (0.4), high boiling point (287°C), thermal stability and low corrosiveness, etc.

(2) In addition to the above-mentioned features, a high extent of extraction efficiency can be obtained by means of employing an extraction tower of rotating disk type.

(3) The extent of utilities cost will be low due to the low ratio of solvent employed. It is understood that the product yield are 99.9% for benzene, 99% for toluene and more than 95% for xylene.

5-2 Disproportionation of Toluene

There are three types of disproportionation process of toluene.

Tatoray Process (Toray)

Xylene plus Process (Atlantic Richfield)

LTD Process (Mobil Research Development)

The first two processes possess approximately the same features, both employing the gas-phase reaction and having the records of industrialization. The third process is still new and, therefore, contains unconfirmed factors in view of the actual application. In this writing, the Tatoray Process will be taken up as a typical example.

The flowsheet of this process is shown in Figure VIII-4.

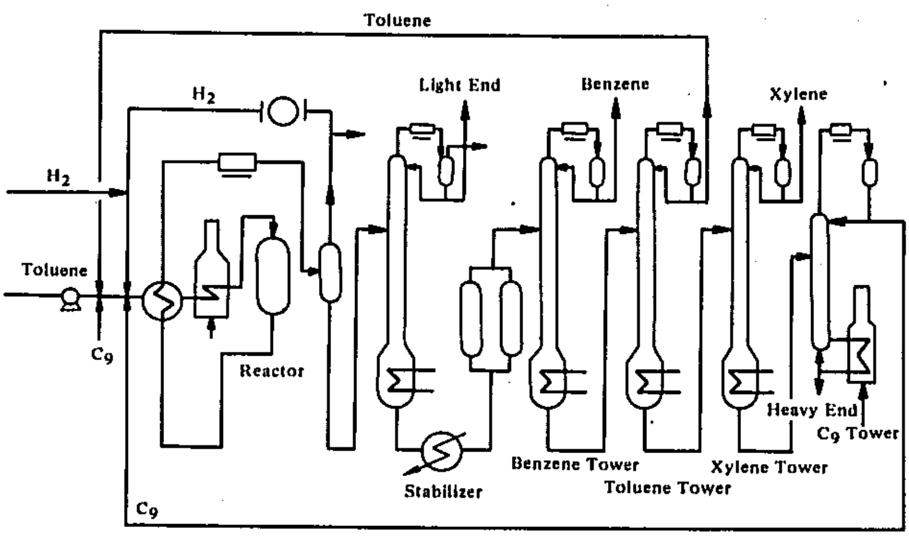


Figure VIII-4 Flow Diagram of Tatoray Process

The raw material toluene is mixed with hydrogen and then pre-heated up to the reaction temperature in a heating furnace before being fed to the reactor. The reaction conditions are: 10 to 50 atm, and 350°C to 530°C. When it is desired to obtain a large amount of xylene as the product, wide range adjustment will be possible by adding C_9 aromatics to raw materials. The hydrogen gas will be separated from the reacted compound and further light hydrocarbons will be eliminated in a stabilizer. Thereafter, the separation into benzene, toluene and xylene will be conducted by means of distillation. The toluene and C_9 aromatics are again recycled to the disproportionation reaction cycle.

The Tatoray Process has the advantage of employing high stability catalysts of high activity. Because of this advantage, the adoption of single fixed layer reactor of the simplest design is made possible, in addition to the long catalyst life and an extremely low extent of catalyst regeneration. When compared with the other processes, the feature of this process is the employment of hydrogen; however, the consumption of hydrogen is yet extremely low. The yield is on a high level of 414 kg of benzene and 561 kg of xylene as against one ton of toluene.

Also, the amount of ethylbenzene contained in xylene is 0.5% to 2% which is less than 1/10 of the 18% to 20% rate of ethylbenzene content in the xylene obtained from reformate gasoline. Therefore, this process is extremely suitable for the production of p-xylene.

5-3 Separation and Isomerization of p-Xylene

The separation of p-xylene can be classified into the following two main categories:

Crystallization Process (ICI Process, Octafining Process, etc.)

Adsorption Process (Aromax Process, Parex Process)

In view of the extent of investment cost and variable cost, the adsorption process is popularly employed in the recent years. This process will be mainly considered in this writing and as the typical example, the Aromax process will be taken here for explanation. Figure VIII-5 shows the flowsheet of this process.

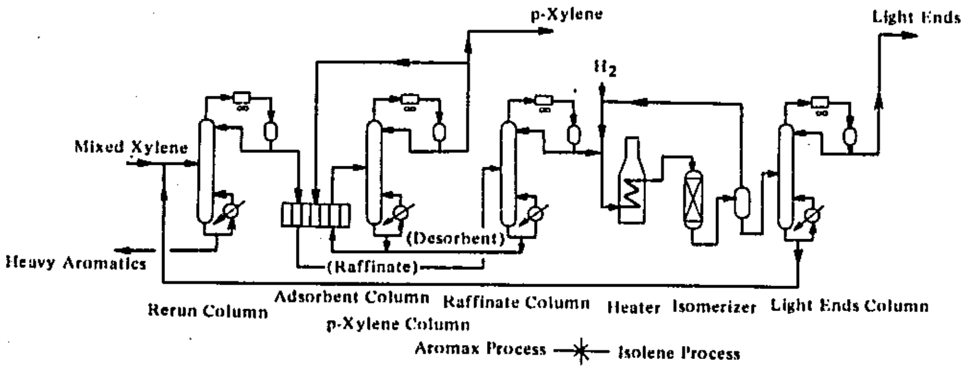


Figure VIII-5 Flow Diagram of Aromax-Isolene Process

The mixed xylene is supplied to the adsorption tower where more than 90% of p-xylene will be selectively adsorped to the adsorbent. The adsorbed p-xylene will be desorbed by desorbent. The product p-xylene will then be obtained by separating desorbent by means of distillation. The p-xylene in the raffinate which has not been adsorbed will be reduced to 1% to 2%. After the desorbent in the raffinate is separated, the raffinate is fed to the isomerization process in which the o-xylene and m-xylene will be isomerized into p-xylene. For the isomerization process, methods are available, i.e., the one in which high-cost platinum catalyst and the troublesome handling of hydrogen are involved, and another in which a low-cost silica-alumina is employed. If the platinum catalyst is employed, it is possible to isomerize the ethylbenzene contained in xylene into p-xylene so that the yield of p-xylene will be enhanced.

However, when the low cost silica-alumina catalyst is used, it is not possible to carry out the isomerization of ethylbenzene. The contents of ethylbenzene in xylene made from reformate gasoline is generally on a level of 18% to 20%. Due to this low contents, the economics of p-xylene production will not be improved even if the separation of ethylbenzene is carried out. Therefore, it is desirable that the isomerization of ethylbenzene be carried out by utilizing the platinum catalyst. The raffinate will be mixed with hydrogen and then heated up to 400°C to 600°C before being fed to the isomerization reactor. In the isomerization reactor, slightly less than 20% of the C_8 aromatics will be isomerized into p-xylene. Hydrogen will be separated from the reacted compound and also the light ends and heavy ends will be removed and then will be fed again to the p-xylene separation process.

The features of the adsorption process when compared with the crystallization process are as follows:

(1) Because of the operation conditions, which can be carried out in a uniform liquid layer, the complexity of the mechanical structure is less when compared with the crystallization process in which the handling of slurry is involved. Therefore, the adsorption process will cause less extent of mechanical problems.

(2) Because of the operation conditions of pressure level closer to the normal pressure and at temperature less than 200°C, no special material is called for to form the equipment thereby, reducing the investment cost.

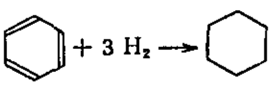
(3) Because of the high one-pass yield, the extent of feed amount is low to yield a unit amount of product so that both the investment cost and utility cost are low.

(4) Because of the low extent of the p-xylene content in raffinate, the recycle amount to the isomerization process is low so that the size of the isomerization process can be made small.

5-4 Hydrogenation of Benzene

For the most part, cyclohexane is produced by hydrogenation of benzene. In some cases, the cyclohexane production is carried out by means of distillation of petroleum fraction; however, the share of this process is small.

The hydrogenation reaction of benzene is a strong exothermic reaction and the reaction process will proceed to the cyclohexane side for almost 100% on an equilibrium in accordance with the following formula under the existence of the catalyst.



$-\Delta H = 48.6\,Kcal/mol\,(150\,°C)$

If the high extent of reaction that is not satisfactorily removed, thermal distribution will take place in the catalyst layer, thereby causing the deterioration of the catalyst activity and also the by-production of impurities due to the decomposition and isomerization process take place.

Therefore, in an industrialized process, improvements are made by each manufacturer in the way of the effective removal of reaction heat, the satisfactory temperature control of the reaction equipment and the even distribution of the temperature. The method for eliminating the reaction heat is normally to circulate inside the reactors a portion of the generated cyclohexane or un-reacted hydrogen gas. Various improvements are made in the design of the heat-exchanging method in the reactor itself. As one of the means for the reaction heat elimination, the hydrogenation is sometimes undertaken in the liquid phase and to carry out cooling by the forced circulation of the reaction mixture through heat exchanger (IFP Method).

As to the processes in this field, the available ones are the Hydrocarbon Research Institute Process, UOP Process, IFP Process, Houdry Process, Lummus Process, Toray Process, Ube Process, etc.

Figure VIII-6 shows a typical flow of the gas-layer reaction. The required extent of benzene for the production of one ton of cyclohexane is 930 kg.

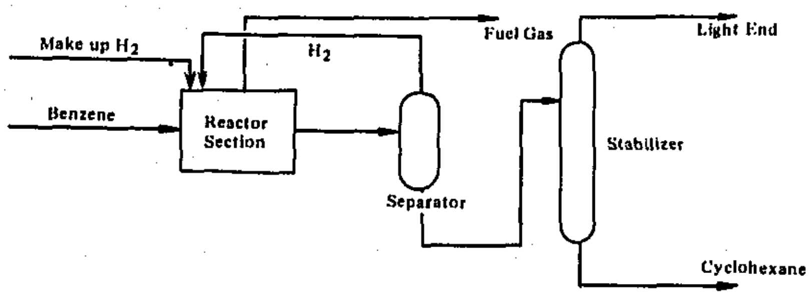


Figure VIII-6 Production Process of Cyclohexane