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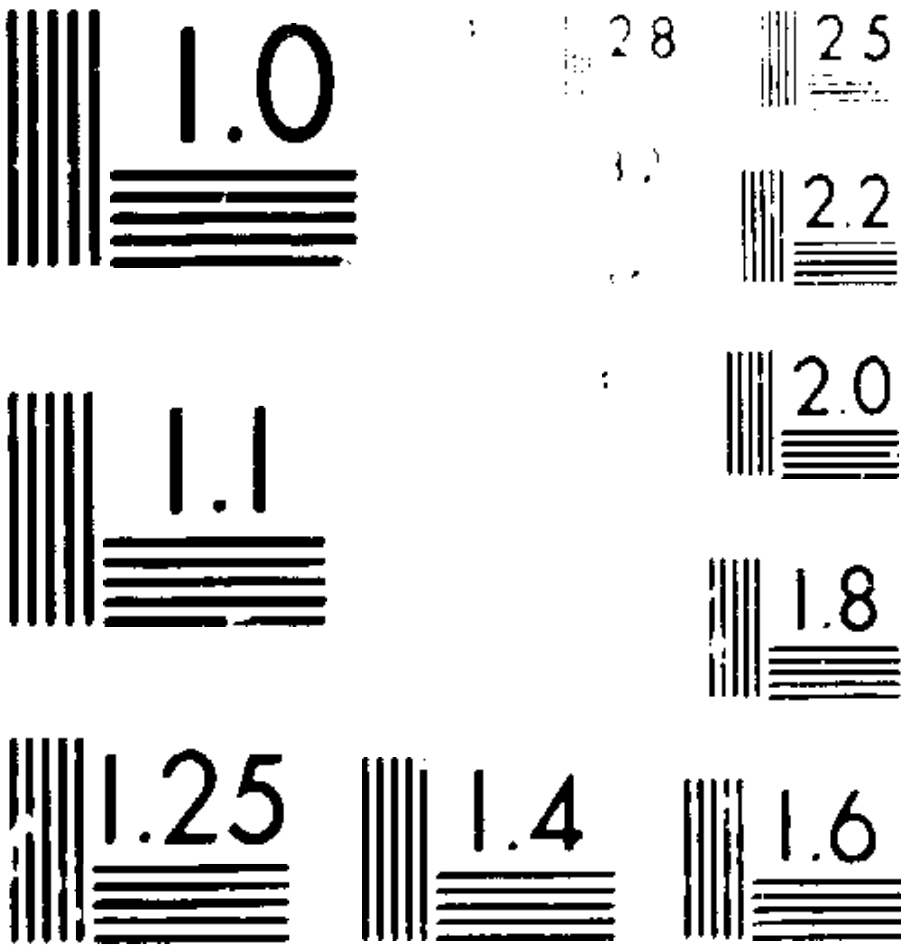
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org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THE DEVELOPMENT OF THE PETROCHEMICAL INDUSTRY IN TURKEY*

prepared by H. Gürsey
UNIDO Consultant

In co-operation with the
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PREFACE

The Second Consultation on the Petrochemical Industry was held in Istanbul from the 22nd to 26th of June, 1981. According to the Conclusions and Recommendations obtained, UNIDO should prepare several studies mentioned in their report. One of the subjects of the study is: "In co-operation with the parties concerned, to develop a programme of co-operation among Developing Countries, with or without petrochemical feedstocks to promote the development of the Petrochemical Industry in those Countries."

This subject has been chosen as a case study of a developing country which has previous experience in the Petrochemical Industry. Turkish petrochemical industry is taken as the subject of this study. There are large differences among developing countries with respect to various aspects of technical and economic development e.g. the structure of market, the nature of feedstock and structure of capital formation. Such differences cause them to make close co-operation and benefit from each other as much as possible in order to avoid the same mistakes and thus to improve the economy of the petrochemical industry in developing countries and make it more competitive.

Within the framework of this study we will attempt to design an area of co-operation and emphasize the role of each one can play.

The Chemical Industry after 1950 has been based on cheap and abundant petroleum products and consequently petrochemical industry became prominent in the second half of this century. Between 1950 and 1970 most of the petrochemical plants were put on stream in the developed countries. After 1973 when oil emerged as a single factor which could deeply affect the economies of most countries, some of the developing countries had already decided to establish their own petrochemical industries. Since this industry needs intensive capital and technology, oil producing developing countries have established petrochemical industry by importing license and technology from

industrialized countries and the others who did not have enough foreign capital had to import both capital and technology.

Turkey established its petrochemical industry during 1965-1970 onwards. The first petrochemical complex was realized at Yarimca, near Istanbul between 1965-1975. The second petrochemical complex which is under construction will be on stream towards the end of 1983.

During the establishment of Turkish petrochemical industry, some financial, technical and marketing difficulties have been encountered. Furthermore, to meet foreign components of the investment requirements Turkey had to receive financial loans from industrial countries. Therefore the development of the Turkish petrochemical industry will be analysed as a case study. Areas of difficulty met during different stages of implementation will be summarized and overcoming these will be discussed in some detail. Other developing countries can benefit from the Turkish experience in the petrochemical industry so that co-operation can be established among the developing countries. Areas of co-operation will also be outlined in the last part of this study. Also because it is generally accepted that the Turkish petrochemical industry has been established with skill and well-used strategy and wise policies, the ways the Turkish petrochemical industries were carried out should be of vital interest to all countries entering this process regarding all arrangements made.

1.0 SUMMARY AND CONCLUSIONS

Turkey started to build its petrochemical industry in 1965. The first petrochemical complex was designed for the production of ethylene-based plastic raw materials in this year. The purpose of the petrochemical industry was to develop the Turkish industry by producing goods necessary for the national economy and to reserve foreign exchange. The Turkish Authorities fully supported the development of the petrochemical industry and therefore PETKIM Petrochemical Co. was established in 1965. At the beginning because of the lack of experience and insufficient foreign currency, almost all technology, engineering, materials and financing of the Complex had to come from abroad. Turkey was not self-sufficient in financing industrial projects, hence loans from Government to Government were accepted from Western Europe and Japan during realization of petrochemical industries.

At this point it should be mentioned that the years of 1965-1970 became a real learning and gaining experience of the petrochemical industry for Turkey. But in the year of 1975 and onwards the experiences obtained in the previous complex have been used in the second complex. For example, Turkish engineering companies and construction companies have been engaged to a greater extent. The ability to use national engineering and construction companies has resulted in substantial savings of foreign currency. This in turn has accelerated the development of the Turkish petrochemical industry leading to healthy capital structure and capital development among the companies operating in the field.

In detail

The State run Petkim Petrochemical Co. hired an engineering consulting firm before starting the project in 1965. They advised Petkim on the selection of technology such as licences and know-how as well as the selection of supply contractors. Based on experience it is recommended that an experienced consulting firm must be engaged by the companies which will start for the first time in the petrochemical industry.

During the selection of technology, engineering and supply constructors, no difficulty has been encountered. The most complicated unit of a complex is the ethylene plant. At the stage of operation of the ethylene plant in 1968, the major problem encountered was with the mechanical equipment, especially some high pressure pumps failed to perform the duty for which they were designed. These pumps had to be replaced with the suitable ones later.

The other problem was the power shortage faced during operation. In order to eliminate this problem emergency power generators were installed. Another important point is spare parts and equipment i.e. a reasonable amount of flexibility in the spare equipment must be provided to have continuous operation. Moreover, a fully equipped maintenance workshop was also established at the beginning. These facilities have been found very useful to eliminate mechanical problems at the site, without losing time to send equipment away from the site to be repaired and later bring them back.

The operation time of the different units of a complex should not be the same, for this reason an alternative design criteria was considered in the second petrochemical complex as such; the design of intermediate units were based on 6000 hrs/per year and product units 7200 hrs/per year as on stream time. But during normal operation 8000 hrs/per year shall be maintained. With this over-capacity production losses in case of any mechanical failure will be revamped easily.

The petrochemical industry in Turkey has naphtha as its basic feedstock with the other important consumer being ISGAS (Istanbul Fertilizer Industries Co.) which produces ammonia and urea. After the completion of Aliaga Petrochemical Complex in 1983, Turkey's naphtha requirements will increase by five to six times the present level. According to the projection on the domestic refining capacity made by the Turkish Petroleum Company, most of the naphtha requirements will be met locally, it should be borne in mind that Turkey is not an oil-producing country and imported crude oil is required for the industry. Hence long-term arrangements on supply of raw materials will be a good basis of co-operation.

Quality-wise imports of sub-standard petrochemical products, which were abundant on the Turkish market before start-up Petkim production units, have been partially prevented to impact the Turkish market.

Following the appearances of Petkim's products, the manufacture of good quality consumer goods started and with the resultant encouragement of the processing industry to produce durable end-products, some expert potential was created.

Another problem is the realization period of investments. Both in the public and private sectors, investments tend to be longer to complete in Turkey. This was mainly due to:

(a) financing difficulties
(b) shortages of foreign exchange
(c) lengthy official formalities
(d) inadequacy of management in controlling all phases of projects.

Despite the fact that the last two items have been partially overcome over the last few years, the first and the second still remain.

The Turkish Petroleum Industry has increased in line with the development in the capacity of the downstream industries, therefore the demand of Turkish home market is enough to absorb domestic production.

Today, in some areas the finished plastic product manufacturing industry is well advanced with greater capacity (in polypropylene, polyethylene and polyvinylchloride applications) in Turkey and raw materials have to be imported, manufactured and re-exported to the country of origin.

2.0 THE EXPERIENCE OF TURKEY IN DEVELOPING THE PETROCHEMICAL INDUSTRY AND LESSONS THAT CAN BE DRAWN FOR OTHER DEVELOPING COUNTRIES

2.1 Selection of Production Plants

The fast development exhibited by the petrochemical industry throughout the world in the fifties that continued during the following years made this industry one of the main industrial sectors. In view of this and utilization of naphtha obtained in the domestic refineries a pre-project report for Turkey's first petrochemical complex was submitted to the State Planning Organization in 1963. After approval of pre-project Petkim Petrochemical Co. was found in April 1965 with the aim of establishing and developing the petrochemical industry in Turkey. The first five units of Yarimca Petrochemical Complex, namely: ethylene, polyethylene, chlor-alkali, VCM and PVC came into operation in 1970. A dodecyl-benzene unit was brought into operation in 1972, Carbon Black unit in 1975, styrene, polystyrene and caprolactam plants in 1975. A selection of the above-mentioned product list as shown in the plastic processing industry in Turkey was at the developing stage between 1960-70. After 1970 application areas increased. Consequently demand for plastic has not been met by local production. Therefore Turkey has decided to construct the second petrochemical complex in Aliaga. The second complex will encompass thirteen production units at internationally competitive capacities, as shown in Table 2. The complex is planned to come on stream in 1983 and to reach full capacity by 1985.

Estimated total investment cost of the second complex based on the expenditures already incurred plus the planned expenditures up to 1985 including an adequate contingency factor for the year 1983, will be around 1.5 billion dollars.

2.2 Selection of Process Licensors

Following criteria were used during selection of technology:

- the technology to be transferred should bring new processes to Turkey;
- the technology should be successfully operated at least in two plants;

Table 1: MAJOR PETROCHEMICAL PLANTS IN TURKEY (Yarimca Petrochemical Complex)

Petrochemical Plant	Produced by	Design capacity (1000 t/y)	Licensor	Engineering and Supply Contractor	Year of operation
Ethylene	PETKIM PETKIM total	30 25 55		Stone Webster Eng. Ltd.	1970 1973
VCM	PETKIM PETKIM total	27 27 54	ICI-Solvay Solvic Solvic	Humphreys + Glasgow PETKIM	1970 1976
PVC	PETKIM PETKIM total	26 26 52	Solvic Solvic Solvic	CTIP CTIP	1970 1975
LDPE	PETKIM PETKIM total	12 15 27	ICI ICI	Sim-Chem Sim-Chem	1970 1973
Chlor Alkali	PETKIM PETKIM total	18 18 36	Olim Methieson Chem Co. "	Pintsch-Bamag AG Bamag-Verfahrens Tech. GmbH	1970 1975
Styrene	PETKIM	25	UOP	Litwin S.A.	1975
Polystyrene	PETKIM	15	Cosden Tech. Inc.	Litwin S.A.	1975
DDB	PETKIM	10 10	CONOCO-UOP	Foster Wheeler Snamprogetti	1972 1982
Carbon Black	PETKIM	15	Phillips Petr.	Euro-Technics SpA	1974
Caprolactam	PETKIM	25	Investa Erms	Nissho-Iwai Co.	1976
SBR	PETKIM	32	Polysar	Heurtey	1975
CBR	PETKIM	13	Polysar	Heurtey	1975
Butadiene extraction	PETKIM	33	Polysar	Heurtey	1975
Carbon Black (expansion)	PETKIM	15	Phillips Petr.	Snamprogetti	1981
DMT	SASA	60	Witten Procers		1977
Polyester Fibres	SASA MIS	27			1968

Table 2: ALIAGA PETROCHEMICAL COMPLEX CAPACITY

PROJECTS	capacity	
1. Chlor Alkali	75.000	Catalytic Int., Oronzio de Nora, Permelec Spa.
2. Vinylchloride monomer	105.000	Solvay - ICI
3. Polyvinyl chloride	100.000	Solvay - ICI
4. High Density Polyethylene	40.000	Mitsui Petrochemical
5. Low Density Polyethylene	150.000	ICI
6. Polypropylene	60.000	Mitsubishi Petrochemical
7. Ethylene Oxide/Ethylene Glycol	68.000	Shell Research Ltd.
8. Phtalic Anhydride	30.000	Rhone Poulenc
9. Acrylonitrile	70.000	Sohio (Vistron)
10. Naphtha Cracking	300.000	Institute Francaise Ptr (IFP)(x)
11. Aromatics	124.000	UOP
12. Pure terephytalic Acid	70.000	Standard Oil Co.(Amoco)

(x) For the Hydrogenation unit

Table 3: LIST OF CONTRACTORS FOR ALIAGA PETROCHEMICAL COMPLEX

	PROJECTS	Engineering and Supply Contractors	Construction and Erection Contractors
1.	Chlor Alkali	Catalytic Int.Oronzio de Nora, Permelec SpA	Entes A.S.
2.	Vinylchloride Monomer	CTIP,SpA	Alarko A.S.
3.	Polyvinyl Chloride	CTIP,SpA	Alarko A.S.
4.	High Density Polyethylene	Mitsui and Co.	Koray A.S.
5.	Low Density Polyethylene	Sim-Chem Ltd.	Kutlutaş Ltd.Sti
6.	Polypropylene	Mitsubishi Co.	AEA Koll.Sti.
7.	Ethylene Oxide/Ethylene Glycol	Mitsui and Co.	AEA Koll. Sti
8.	Phthalic Anhydride	Krebs	Atilla Dogan Ltd.St
9.	Acrylonitrile	Badger Engineering Ltd.	Entes A.S.
10.	Naphtha Cracking	Stone and Webster Engineering Ltd.	Tekfen A.S.
11.	Aromatics	Japan Gasoline Co. (JCC)	Enka A.S.
12.	Pure Terephthalic Acid	Technipetrol SpA	Alarko A.S.

- the degree of foreign dependance such as on materials and equipment should be minimized;
- contribution to the national economy should be maximized.

Furthermore, licensors or know-how owners are required to provide the following in their proposals:

- technical information about the process
- consumption of raw materials
- consumption of utilities
- capital cost of estimation for battery limit plant
- terms of payment of license (royalty) fee
- type of license; paid-up royalty or running royalty
- right to export products
- right of exclusive license or transferable license.

The above-mentioned points are the basic information necessary for selecting a license. We do not intend to give full details because of the type of agreement, which may vary according to the different plants. However, the foregoings will be useful for the licensees:

- licensor should register his license or know-how in the related office of the licensee's country. Additionally licensee must be held harmless for any patent infringements;
- licensor should indicate the list of engineering contractors whom he would disclose his license to;
- licensor should have export permit from his country;
- licensor should indicate secrecy period of his license;
- licensor should accept training of licensee's operating and maintenance personnel in a plant similar to the proposed one;
- the technology to be transferred to the country should have energy saving systems and prevent environmental pollution;
- licensor should guarantee quality and quantity of the product as well as consumption of raw materials and utilities.

2.3 Selection of Supply Contractor

Generally the supply contractor is an engineering company. They design the plant according to the basic design data obtained from the licensor. Before appointment of a supply contractor, the client should look for his experience whether he has engineered and completed a similar plant at the same capacity or not before.

It is important that a plant which was designed previously by the contractor should meet all guarantees related to the quality, quantity and utility consumptions. Licensor also should accept the contractor. In doing so he can disclose his license to the contractor. Another point is that the contractor should have a well-established technical and financial organization to perform design and procurement obligation of the plant. As far as we know we have not experienced serious defaults in plant design so far.

2.4 Terms and Conditions of Contract

During construction of Plants separate contracts had been signed with licensor and supply contractor. License was based on fully paid-up royalty system. Concluded contracts were based on Guaranteed Maximum Price with Supply Contractors. In this case the amount of money saved from the ceiling price was shared between Petkim and the Contractor.

Generally license agreements are based on paid-up royalty system. According to this system client buys a license up to a certain production capacity. In case at a production which passes the agreed capacity client pays additional fee. This is calculated by multiplying excess amount of production with the unit price of product.

Guaranteed maximum price (G.M.P.) system is the most common contract type for the engineering and supply contractors. In this system engineering fee is fixed. But contractors offer a G.M. Price for the supply of equipment necessary for the Plant. In order to encourage contractor to buy equipment at a lower price, a cost-sharing concept is provided in the contract as explained below. If

actual total price of the plant equipment is under G.M.P., the difference saved shall be shared by 50% between the contractor and client. In this case the contractor shall be entitled for an additional payment. If actual total plant cost is over G.M.P. nothing shall be payed to the contractor.

2.5 Selection of Site Contractor

Appointment of a foreign site contractor for construction and erection was a favourite model for Turkish Industry until 1970. First complex in Yarimca was constructed by Foster Wheeler Ltd of London. But after 1971 expansion of plants has been realized by Petkim. Furthermore, the entire construction and erection of second petrochemical complex in Aliaga are continuing under the responsibility of Turkish contractors and Petkim.

During selection of site contractor following criteria were used:

- the contractor should be experienced in the construction of similar sized projects;
- the contractor should have enough technical personnel and construction equipments;
- the contractor should have financial capabilities to manage such a big project. On the other hand at the site project owner also forms a construction and erection control group. In addition to Petkim group construction and erection experts of licensors exist at the site. Both parties have to control the construction and erection whether they are progressing according to the projects or not. The Turkish site contractors are shown in Table 3.

2.6 Selection of Plant Site

The site chosen for both Yarimca and Aliaga complexes are at the coast and next to the refineries. Yarimca complex is some 80 km from Istanbul by road. A high proportion of the downstream consumer industries are situated in the area of Istanbul.

Aliaga complex is about 60 km from Izmir by road. Izmir area is the second potential market for plastic application after Istanbul. The roads connecting the plants to the cities are well surfaced and carry a good deal of commercial traffic.

Rail access is available in the Yarimca complex, but the nearest rail head for Aliaga is 25 km away. It should be stated that the rail access to Aliaga will be realized in the near future.

According to the present consideration, transport and distribution in bulk will be done by sea for Aliaga petrochemical complex.

It is possible to have a product distribution terminal on the coast of the Istanbul area, a similar centre on the southern cost of Turkey, both of which would be responsible for the further distribution of products to customers. Both Aliaga and Yarimca Petrochemical Complexes are provided with the harbour facilities for handling both solid and liquid products in bulk.

Petrochemical plants are generally located near to a refinery and close to the market. Additionally the following studies should be done before site selection:

- water and electricity supply conditions;
- supply of source of raw materials, such as naphtha in our case, at optimum cost;
- environmental protection against pollution;
- resistance of soil;
- availability of easy transportation of products at minimum cost;
- weather conditions;

In the rough lay-out of plant site American safety standards should be reviewed at first.

2.7 Operation Stage

Pre-commissioning and start-up activities took place in 1969 for Yarimca Petrochemical Complex. The manpower required for operation e.g. plant operators, foremen, engineers and technicians were not available in full at that time. Therefore the Company applied an intensive training programme in the country and in the licensor's similar plants outside Turkey.

Contractors and licensors supplied one or more start-up engineers or operators to guide and advise the owner's operating staff. The expatriate supervisers stayed in Yarimca until company's operating personnel acquired adequate experience in operation. The foremen and operators required for process units are not easily available respectively with remaining required for off-sites and general facilities. For off-sites and general facilities the problems of acquiring adequate operating staff may not be too severe since these areas do not generally involve a high degree of sophisticated technology and personnel can be drawn from many sectors of industry. During start-up of first complex of Turkey in Yarimca, Company supplied necessary operating personnel from refineries and other chemical companies. For the second Petrochemical Complex in Aliaga which will be in operation in 1983, Company will establish good estimate of the manpower that can be made available from the Yarimca Complex with experience of the particular process involved at Aliaga. From a timing point of view it is very important that the start-up staff are assembled and trained well before the completion of construction of the plants. They can then follow the final stages of construction in readiness for pre-commissioning and make necessary lists for omitting items in the piping and equipments as well as small changes and improvements needed locally.

There was not any serious problem at the stage of start-up activities of Yarimca Complex. But during test-run of one unit production capacity could not meet the guaranteed amount. In this event engineering company performed remedial design action and then a new column was replaced at their own cost according to the contract.

Training of operators and maintenance technicians are one of the most important phases of the project A separate group of personnel formed from operators and maintenance technicians should be sent to the licensor's plant at least for a 4 or 6 week period before 2-12 months of start-up and test-runs of the plant.

2.8 Marketing

The first complex established by Petkim Petrochemical Co. in Yarimca in 1970 had the idea to provide Turkish home market demand. But because of the growth of the market in Turkey the domestic production was not able to meet the demand. Therefore import of petrochemicals has started in 1972 and will continue until the production of Aliaga goods in 1983. The imports of petrochemicals in Turkey are shown in Table 4. The estimated demand and production programme for the year 1983 is given in Table 6.

In the non-plastic products, the major units of the Second Petrochemical Complex in Aliaga, are acrylonitrile, ethylene oxide/glycol, phthalic anhydride and PTA (for polyesters). Both PTA and acryonitride consumption are dominated by the synthetic fibres industry.

For ethylene glycol, besides polyesters, the main market is in vehicle coolant systems. Growth in Turkey can be expected in line with the growth in vehicle usage.

Phthalic anhydride has a variety of uses in Turkey. Plasticisers made from phthalic anhydride provide a good market for PA.

All domestic market forecast for above-mentioned non-plastic products appears reasonable.

For plastics, there are mainly four products. Polypropylene is likely to maintain its position as the fastest growing of the major plastics, partly because of the natural growth of the market and partly by taking over at least a part of the market share at present held by high density polyethylene. For many applications, there is considerable overlap in the technical suitability of PP and HDPE. Both PVC and LDPE are little affected by competition from other plastics. Their market arises mainly from substitution of the markets of natural materials or production of bulk low cost products. The impact of higher ethylene prices on the final product may produce temporary consumer resistance, but there are few, if any, cheaper substitute materials available. Thus after a short period of readjustment, growth is likely to continue.

Table 4: IMPORTS OF PETROCHEMICALS IN TURKEY (in 100 tons)

PETROCHEMICALS	'68	'72	'74	'75	'76	'77	'78	'80
Benzene	55	*	34	20	165	300	180	144
Toluene	31	81	60	119	139	177	94	81
Xylene	16	33	96	140	129	280	214	338
Tri/per chlor ethylene	20	24	14	28	38	30	24	15
Polyvinyl chloride	183	159	209	233	233	377	239	141
Polyethylene	190	245	259	264	329	325	317	306
Polystyrene	59	133	73	156	51	104	45	22
Polypropylene	4	72	57	145	210	173	118	193
Polyvinyl acetate	-	-	-	-	-	-	-	-
SBR	137	137	148	133	46	28	77	20
CBR	8	291	2	1	2	*	3	3
Phthalic anhydride	24	34	29	6	12	22	38	13
Carbon black	93	156	169	7	83	74	43	3
Ethylene oxide	*	1	1	1	2	2	3	3
Ethylene glycol	8	58	104	113	137	357	329	205
Caprolactam	28	105	53	85	83	12	*	-
Acrylonitrile	*	31	98	145	223	283	263	297
Dimethyl terephthalate	1	108	208	230	473	269	4	3
Dodecylbenzene	46	110	10	27	69	117	41	92
Acrylic fiber	49	65	123	33	158	73	3	
Polyamid fiber	13	1	9	6	3	4	4	
Polyester fiber	55	-	30	42	6	*	-	
Polyamide yarn	24	8	10	14	57	62	46	
Polyesteryarn	12	4	10	11	3	2	2	

* less than 100 tons

The establishment and development of the petrochemical industry is an essential part of the growth and evaluation of a modern industrial economy. Therefore development of this industry must be closely matched to the overall format of the economy of the country, bearing in mind that the petrochemical industry should not be regarded as a self-contained entity on its own. Its main reason for existence is to support major areas of the economy by providing raw materials for further and ongoing production processes. The complexes must be planned in a manner which is responsive to the needs of the economy. There also needs to be an overall strategic plan for petrochemical development over a fairly long period, say twenty years, which reflects likely trends in the economy and consequently the development of product pattern. According to the previous experience, the Turkish feasibility study prepared for the first and second petrochemical complexes were based on a sound market forecast. The home market had a prime importance in the feasibility studies. Production capacities selected in 1965 for Yarimca complex were suitable at that time. But because of the fast development of the domestic market indicated capacities became insufficient. Therefore more realistic and economic capacities projected in the second complex in Aliaga. After a large study on the raw materials of the ethylene plant naphtha is considered as a major feedstock for the Turkish petrochemical industry. Naphtha, however, is a highly desirable product, not only within the refinery, but also for the fertilizer industry. Because of unexpected and very substantial cost escalation, there is a reluctancy to use naphtha in the industry and as an alternative cheaper feedstocks in the petrochemical industry like gas oil or LNG should be considered in the future. However, it should be pointed out that the above-mentioned alternative feedstocks do not exist in Turkey. They have to be imported as well. As a result Yarimca and Aliaga complexes have been designed for the use of naphtha as the sole carbon-bearing raw material. Improvement of the plastic market depends greatly on the development of processing industry. Hence marketing experts of the Company periodically visit the plastic industry and make market forecasts for the next years. Because of an increase in the cost of raw materials and energy, the market will not be improved fast and the demand curve tends to be parallel. Long-term supply of cheap raw material such as naphtha and the export of finished products would be a solution to the market problems. As an indication of domestic sales for the major petrochemicals are shown in Table 5.

Table 5: DOMESTIC SALES FOR THE MAJOR PETROCHEMICALS BETWEEN 1982-1991 (ton/year)

YEARS PRODUCTS	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
LD POLYETHYLENE	65 000	73 000	80 000	90 000	100 000	110 000	120 000	133 000	147 000	160 000
H D POLYETHYLENE	13 000	14 000	15 000	16 000	20 000	22 000	24 000	27 000	30 000	33 000
POLYVINYL CHLORIDE	61 000	67 000	73 000	81 000	89 000	97 000	107 000	119 000	133 000	147 000
POLYSTRYRENE	17 000	18 000	20 000	22 000	24 000	27 000	29 000	32 000	35 000	38 000
POLYPROPYLENE	24 000	28 000	33 000	39 000	46 000	50 000	55 000	61 000	68 000	75 000
DODECYLBENZENE	21 000	23 000	26 000	28 000	31 000	35 000	38 000	42 000	46 000	50 000
CAPROLACTAM	18 000	19 000	21 000	23 000	24 000	25 000	27 000	29 000	31 000	33 000
CARBON BLACK	18 000	20 000	21 000	24 000	26 000	29 000	32 000	35 000	38 000	41 000
SBR	21 000	23 000	25 000	28 000	31 000	34 000	37 000	41 000	45 000	50 000
CBR	8 000	9 000	10 000	11 000	12 000	13 000	14 000	15 000	16 000	17 000
PHTHALIC ANYDRIDE	24 000	25 000	27 000	29 000	30 000	32 000	34 000	36 000	38 000	40 000
ETHYLENE GLYCOL	32 000	34 000	36 000	38 000	40 000	43 000	45 000	48 000	51 000	55 000
ACRYLONITRILE	60 000	63 000	67 000	72 000	76 000	81 000	86 000	91 000	97 000	104 000
PURE TEREPHTHALIC ACID	30 000	32 000	34 000	36 000	38 000	40 000	43 000	45 000	48 000	50 000
O XYLENE	20 000	33 000	40 000	47 000	47 000	47 000	47 000	47 000	47 000	47 000
P XYLENE	45 000	80 000	92 000	150 000	150 000	150 000	150 000	150 000	150 000	150 000
BENZENE	71 000	79 000	84 000	90 000	95 000	101 000	107 000	113 000	119 000	125 000
CAUSTIC SODA (100%)	128 000	141 000	155 000	171 000	188 000	207 000	226 000	250 000	273 000	295 000
FORMALDEHYDE	41 000	44 000	47 000	51 000	54 000	58 000	62 000	66 000	71 000	76 000
DI-METHYLTEREPHTHALATE	59 500	72 000	75 000	85 000	85 000	85 000	85 000	85 000	85 000	85 000

2.9 Onstream Factors

The onstream factors, in terms of operating hours to reach required annual production was 8000 hours per year for Yarimca petrochemical complex. During operation, these operating hours have never been met continuously, because of the needs of frequent maintenance shut down and power shortages.

Consequently, Aliaga Petrochemical Complex has been designed according to the following operating hours:

UNIT	OPERATING HOURS PER YEAR
Naphtha cracker	6000
Cat Reformer/Aromatics	8000
VCM	6600
PVC	7200
HDPE	7200
LDPE	7200
Polypropylene	7200
EO/EG	7200
ACN	7200
Chlorine	6000

In practice, the above-mentioned figures are well established norms for the plant operations in developing countries. However, at the stage of operation 8000 hours per year as operating time shall be maintained. In case there is a loss of production for any reason this shall be rewamped in a short period with the above-mentioned overcapacities.

2.10 Financing

In the inquiry documents for both Yarimca and Aliaga Complexes, contractors were requested to provide outside finance for their own portion of the project. The Turkish company directly financed all Turkish Liras expenditure inside Turkey. For foreign financing

Government loans were used either on a direct government-to-government basis, or as loans raised from commercial sources and insured through official governments (ECGD, COFACE etc.). In some cases, like carbon black expansion, DDB expansion, the project was financed through an international agency, the IBRD.

Synthetic rubber plants were financed by the European Investment Bank. Certainly, financing of projects became the main difficulty in the development of the Turkish petrochemical industry. In the financing agreements the period of grace for loans is five years and then payment of interest and principals starts. Generally construction and erection of plants cannot be completed within five years, therefore repayment of loans falls in the construction period instead of the production and profit making period, in the developing countries. To overcome this problem, repayment of loans should start after commercial operation of plants. In some cases, domestic financing of projects also creates problems. Consequently, at the beginning of the project activities domestic and foreign financing of plant costs must be secured by the companies.

2.11 Project Management

The second difficulty concerns the administration of the project. In the period before 1965, the Turkish industry had obtained construction and erection works on a turn-key basis. Foster Wheeler Ltd. was the general site contractor for the first petrochemical complex in 1968, as well as the supply contractors. In the case of the second petrochemical complex, however, a different path was followed. There were a number of alternatives for organizing this complex. One of them was the appointment of a foreign managing contractor to handle the day-to-day activities directly involved, in getting the plant engineered, purchased and built. But the owner Petkim Petrochemical Co. had applied a different system in this project as such: feasibility studies carried out by Petkim, to define plant capacities. Additionally the following activities were undertaken by Petkim Petrochemical Co.:

- planning of the investment programme
- arranging finance and financial control
- approval of Turkish engineering portion

- review all engineering documents submitted for client approval
- control of overall project costs
- purchasing of all Turkish equipment
- bidding of construction and erection jobs within Turkish contractor
- co-ordinating of contractors' activities
- training of operators and maintenance personnel
- pre-commission and commission of the complex.

As can be seen from the above list, there is no managing contractor and Petkim Petrochemical Co. itself co-ordinates all activities.

2.12 Operation Experience

Start-up activity has to be planned very carefully. During operation of the first Petrochemical Complex in Yarimca, a large number of operators and maintenance personnel have been provided by the owner, locally.

Outside companies such as contractors and licensors have assisted the owner by providing adequately trained and experienced personnel. After successful start-up and normal operation expatriate operating personnel left the complex. Another significant event during the operation is the power shortage. In the year of 1970, Petkim Petrochemical Co. had to face many problems arising from power shortage. Therefore emergency power generators had been put into operation in the first petrochemical complex. It is suggested that as a minimum, at least two-thirds of the power requirement of the plant should be established and generated within the petrochemical complex. The rest will come from the national grid system. This target has been achieved in he second petrochemical complex. The number of spare parts required for equipments is very important also at the beginning. After certain years of operation, spare parts necessary for two years operation of the plants should be made available in the warehouse at the beginning. After certain years of operation this amount may not be necessary at this level. Plants should be adequately provided with spare equipment. For example naphtha cracking unit is the most complex and important part of a petrochemical complex. Ethylene and propylene etc. produced from this

unit are intermediates for other units of the complex. If this unit stops, the complex will suffer from this event. Therefore special attention should be given to the naphtha cracking unit. Spare cracking furnaces have to be established in addition to the necessary amount of operation. Cracking compressors must be double train. In the first petrochemical complex in 1968 the Company put a single train cracking compressor according to the advice of the supply contractor. But due to the mechanical failures, many shut-downs have been faced during operation. As a resolution another cracking furnace has been put in Yarimca as a spare. Taking this experience into account in the second petrochemical complex, the naphtha cracking unit has been provided with double train cracking compressors.

As a result of this clause, it should be kept in mind that an experienced and trained operation team is one of the main factors for successful start-up. Start-up is a joint action of the Company and contractor's operation personnel. Contractor and licensor had to send their qualified engineers and operators to the field. Company operators carried out commissioning of the plant under witness of the above-mentioned expatriate personnel. Process engineers were advising the team in case any problem arose because of the design of the plant.

Moreover, there are problems in the field of maintenance, such as mechanical failure of equipments. When this happens the plant has to be repaired. In developed countries this is very easy, just a call to the maintenance companies would be sufficient. They come and repair in a short time. But in developing countries such maintenance companies do not exist. Therefore a strong group of maintenance with well-equipped workshops must be established before start-up and test-runs.

2.13 Market forecasting

In all developed countries of the world, over the past twenty years, the rate of growth of the chemical industry has run significantly ahead of the rate of growth of the economy as a whole. The petrochemical sector has itself set the pace for the chemical industry.

This growth has been based upon the substitution of traditional natural materials by synthetic products, substantially on price grounds, as well as on the development of new markets and applications for new products.

Parallel to the developed countries, the petrochemical industry has been taking place at an increasing pace since 1973, in some locations of developing countries, such as the Middle East, especially the Gulf countries in the far-east region.

In the Middle East, Turkey has a special place in the development of her petrochemical industry by making long range market forecasts since 1964.

The demand and production programme for the year 1983, indicated in the Fourth Five Year Development Plan, is given in table 6 below.

Domestic market forecast generally has been done in two ways. First, marketing experts visit periodically plastic processors before finalizing yearly production programmes and they get their demands and future expansion plans. Second, forecast is the general trend of demand in the industry. Results of both activities consist of the domestic market of the country. The other area, export market forecast is creating a real difficulty to Turkey.

TABLE 6

PETROCHEMICALS	DEMAND (Ton) 1983	PRODUCTION (Ton) 1983
Benzene	110.000	152.700
Toluene	23.000	4.300
Xylene	120.000	175.000
Tri/Per Chloro Ethylene	7.500	7.500
PVC	136.000	127.000
Polyethylene	174.000	160.000
Polystyrene	40.000	15.000
Polypropylene	28.000	45.000
Polyvinyl Acetate	30.000	30.000
SBR	42.000	32.000
CBR	6.800	13.500
Phthalic Anhydride	30.000	40.000
Carbon Black	46.000	30.000
Ethylene Oxide	30.000	40.500
Ethylene Glycol	51.000	51.000
Caprolactam	24.100	25.000
Acrylonitrile	70.000	52.500
Dimethyl Terephthalate	53.000	60.000
Dodecylbenzene	36.000	24.000
Acrylic Fibre	62.000	70.000
Polyamide Fibre	7.000	14.000
Polyester Fibre	37.000	57.000
Polyamide Yarn	25.000	18.000
Polyester Yarn	28.000	30.000

But, the only thing which is available, is to follow publications on the petrochemical market and to get information from world marketing forecast companies. For general information, a list of supply and demand of petrochemical products in Turkey prepared for UNIDO is submitted here in Table 7.

Table 7: COUNTRY INFORMATION ON SUPPLY OF AND DEMAND FOR 32 PETROCHEMICAL PRODUCTS FOR TURKEY

	Capacity at 1 January			Supply (Production)			Demand		
	Actual 1980	Forecast 1985	Forecast 1990	Actual 1980	Forecast 1985	Forecast 1990	Actual 1980	Forecast 1985	Forecast 1990
			----		metric tons	----			
Basic Petrochemicals									
Ethylene	[illegible]	367000	367000	41600	292000	367000	41600	292000	367000
Propylene	39[illegible]	198990	198990	31941	159100	198990	16300	139000	177000
Butadiene	323[illegible]0	32360	32360	5900	32360	32360	16800	35950	35950
Benzene	23700	154400	28640	20800	154400	286400	48300	79400	88800
Toluene	4000	4000	4000	4000	4000	4000	3110	4050	4500
Ortho-xylene	-	65000	65000	-	48750	65000	4620	32400	39300
Para-xylene	-	132000	132000	-	99000	132000	43700	142600	156500
Methanol	-	-	-	-	-	-	26200	68000	68000
Ammonia*	-	-	-	-		-	22800	63800	78850
Acetylene				5800	6750	7600	5800	6750	7600
Intermediates									
Styrene	19450	19450	19450	13090	19450	19450	16200	23600	25800
Vinyl Chloride Monomer (VCM)	48600	153600	153600	31200	127350	153600	31000	1[illegible]0100	156400
Acrylonitrile	-	70000	70000	-	52500	70000	50700	144220	144220
Caprolactam	25000	25000	25000	14900	25000	25000	12300	18900	22500
Dimethylterephthalate (DMT)	60000	145000	145000	60000	145000	145000	50000	85000	85000
Terephthalic Acid (TPA)	-	70000	70000	-	52500	70000	70000	11300	37500
Ethylene Oxide	-	54000	54000	-	40500	54000	-	45300	46600
Ethylene Glycol	-	68000	68000	-	51000	68000	30900	57000	58700
Formaldehyde	70000	89000	89000	39000	87800	87800	36700	53800	74700
Phenol	500	500	500	500	500	500	9500	17200	27900
Final Products									
L-D Polyethylene	24300	174300	174300	16270	136800	174300	39500	92400	149900
H-D Polyethylene	-	40000	40000	-	30000	40000	9450	18000	30000
Polypropylene	-	60000	60000	-	45000	60000	19700	39400	68400
PVC	46800	146800	146800	27600	121800	146800	47100	84800	136800
Polystyrene	13500	13500	13500	11000	13500	13500	13200	22100	35100
Polyester fibres 8 yarn	65500	107960	109360	58000	107960	109360			
Polyamide fibres 2 yarn	21100	21100	21100	10500	17180	21000			
Acrylic fibres	42630	147200	147200	42630	147200	147200			
SBR	32150	37800	37800	17800	37800	37800	19700	28000	45000
Polybutadiene (CBR)	13500	13500	13500	3050	13500	13500	8000	11500	16500
Polyisoprene									
Butyl Rubber									

* For Petrochemical consumption

1/ This includes 25 products, as recommended by the First UNIDO Consultation on the Petrochemical Industry, plus polybutadiene, polyisoprene, butyl rubber, phenol, formaldehyde, ethylene oxide and ethylene glycol.

2.14 Research and Development

The Research and Development Centre of Petkim Petrochemical Co. has been established since 1969 mainly:

- to find solutions to the problems arising in the works;
- to upgrade and establish better and more economical areas of usage for the by-products;
- to find better, more economical and preferably locally produced substitutes and alternatives to the chemicals and other materials used in the Company;
- to make developments on the present production processes to improve them and;
- to develop new processes.

Some of the works done are:

- investigating the reasons for flooding of HCl distillation column in the VCM plant and checking its design calculations:
- modification of brine purification process of the chlor-alkali plant;
- hypochlorite production from waste chlorine;
- study of the cracking parameters of naphtha cracking plant, to improve the properties of the pyrolysis gasoline;
- market development for the by-products of VCM, DDB and styrene plants and execution of laboratory research for this purpose;
- development of a new feedstock from local resources for the carbon black plant in order to replace the imported aromatic oil;
- development of a polymerization inhibitor system to be used in the compressors of the ethylene plant;
- alternatives to some catalysts used in the caprolactam plant;
- replacement of some chemicals used in polymerization recipes by locally produced ones;
- development of a recipe for production of expandable polystyrene suitable for manufacturing isolation blocks;
- development of a polymerization recipe for production of PVC type suitable for battery separator production;
- full process development for production of tri- and perchloro-ethylene from the chlorinated wastes of the VCM plant.

The R and D Centre consists of offices, laboratories and pilot plant buildings with a total area of 4697 m^2. The present office building

has three stories and can be expanded by the addition of two more. This section has been designed to accommodate process design and engineering units consisting of offices for engineers, technical drawing rooms, a documentation room, a meeting room, a seminar room and a library with a useful area of approximately 900 m^2.

General chemistry, instrumental analysis and polymerization and polymer testing laboratories are one storey units which are designed to be expanded easily both towards the south and west. They all have the necessary facilities like demineralized water, pressurized air, air-conditioning, aeration, etc. General chemistry laboratory is used to carry out general analytical tests and analysis and laboratory and bench scale work of R and D project. Instrumental analysis related to the above work is carried out in the instrumental analysis laboratory where the major instruments are accommodated in separate air-conditioned units. These two laboratories have a 1000 m^2 useful area of which 500 m^2 belongs to the general chemistry laboratory, 500 m^2 to the instrumental analysis laboratory.

Polymerization and polymer testing laboratories have two main sections. In the first section, polymerization in both suspension and emulsion is carried out in reactors from 2 to 20 lt. by simulating the conditions in the polymerization plants except that of polyethylene. In the second section, characterization tests rather than the quality control tests are carried out. These laboratories have a useful area of 400 m^2.

Office and laboratory buildings have a total of 1800 m^2 useful basement area to accommodate central heating, air-conditioning, aeration, etc. equipments of the laboratory and building facilities and store rooms for the laboratories and pilot plants. A small work shop for the R and D Centre only is also located in the basement.

At present, the R and D Centre has a 96 m^2 pilot plant facility but is being extended to 250 m^2. This is a high roofed (10 m high) covered area with hot oil heating system, steam, instrument air and nitrogen utility facilities to accommodate at least three full size pilot plants two of which are waiting to be erected after the completion of the extension.

As part of the Sales Department, Petkim has technical service facilities to introduce new products - mainly the polymeric ones - to the market, to determine the best processing conditions of them and to deal with the customer complaints to find solutions to their problems.

Another unit which has to be mentioned is the Technological Control Unit which is part of the Technical Control Department. The purpose of this Unit is to do process design and make developments on the present processes and to solve their problems.

In overall manpower terms, the staffing level of the R and D Centre is as such: under a manager who is a Dr. in Chemical Engineering, there are 21 researh engineers and technicians, 5 general helpers and 4 workers.

2.15 Turkish Experience in the Technology of the Petrochemical Industry

2.15.1 In the period before 1965, the Turkish industry had obtained license, engineering, equipment supply, construction and erection works on a turn-key basis. But Petkim ceased to obtain agreement on such a basis and initiated the policy of making agreements for license, equipment supply and other services separately. The most recent technologies throughout the world were studied and examined abroad by Petkim personnel and bids were obtained from as many bidders as possible. After evaluation of the said bids, agreements were made on the basis of paid-up or running royalty, fixed fee, guaranteed maximum price and at cost systems and maximizing the Turkish supply parts. The entire construction , erection and in some cases (as for VCM expansion) even detailed engineering and equipment supply services were carried out by Petkim itself. Recently, Petkim's policy has tended to tempt the foreign contractors to have partial or overall local partnerships in doing their services.

As mentioned above, the technologies in the Petrochemical Industry were studied from all over the world as such; a general

questionnaire for the licensor and engineering companies has been prepared at the beginning. Then a team of process engineers visited the proposed licensor's plants and that questionnaire was filled in at the joint meeting with the licensors. After returning from the study trip and observation tour, results of questionnaires have been evaluated by the engineering department of the Company. In doing so, the Company obtained information about license and engineering companies. The same type of study can be applied to the foreign contractors. Today besides license and process engineering, all detailed engineering construction and erection works are carried out by the Turkish companies.

2.15.2 Equipments and Services supplied from Turkey

Equipment and materials with the following specifications can be included in the Turkish supply:

- carbon steel field tanks, spherical and torispherical head pressure vessels, columns, medium pressure heat exchangers;
- cold water pumps, fans, totally enclosed fan cooled motors, transformers (up to 25.000 KWA), motor control centre;
- carbon steel pipes and fittings, plates, valves, flanges;
- electrical cables, instrument cables;
- instruments, single core copper tubes;
- carbon steel bolts and nuts, insulation materials, belt conveyors etc.

Equipment and materials other than those stated above such as reactors, high-pressure drums, compressors, ex-proof electric motors and pumps, stainless steel pipes and fittings etc. are imported.

100% of the work related to civil engineering, construction, piping engineering and electrical engineering can be performed in Turkey. Also, 30-40% of the instrumental works can be carried out locally.

There are many Turksih firms which have worked with Petkim and are experienced in the petrochemical field.

2.15.3 Manpower Utilization

Since Petkim put the First Petrochemical Complex into successful operation and carried out most of the engineering and equipment supply works locally during expansion of the original plants, Petkim presumes that most of the manpower required to realize the Second Petrochemical Complex is available within Turkey. After realization of the Second Complex, Petkim can be considered to be one of the experienced firms in the petrochemical industry.

More detailed information cannot be given within the scope of this paper. However, any developing country which wants to get the benefit of the above-mentioned experience can apply to Petkim.

2.15.4 Construction and Erection

Petkim has made contracts with Turkish firms for the construction and erection of Aliaga Complex.

The Turkish contractors have experienced erectors, pipe fitters and welders who work according to API standards. The construction equipments are imported and used at the site. Construction and erection organization of the Turkish firms are similar to the developed countries and in international standards.

The progress of construction and erection of the Complex are controlled according to the critical path methods. Any bottleneck points are extracted from that CPM diagnosis and correction activities start quickly. At this stage there is not any serious delay for the completion of Aliaga Complex.

3.0 POTENTIAL AREAS OF CO-OPERATION BETWEEN DEVELOPING COUNTRIES IN THE PETROCHEMICAL INDUSTRY AND HOW THEY MIGHT BE IMPLEMENTED

The present international economic order is well-dominated by industrialized market economies as most characteristically observed in the existing world trade picture. Despite their relatively small populations, their collective share of world trade stays around 80%. As a matter of fact the developed countries import more than three-quarters of the raw materials exported by the developing countries. On the other hand, the Third World with its limited industrialization and under-developed technology imports from industrialized countries. Furthermore, it is observed that the already economically powerful developed world continues to derive the benefits of almost complete integration reflected in active substantial trade relations and close economic ties with one another.

An additional indication of the above-mentioned dominance is well reflected in the fact that the national currencies of the developed countries serve as the major convertible currencies in the world trade with wide-ranging implications on the operation and control of the world monetary system. Finally, it should be observed that the world capital markets and the majority of the powerful multi-nations are integral parts of these economies.

On the other hand the Second General Conference of the United Nations Industrial Development Organization (UNIDO) held at Lima, Peru, in March 1975, recommended that UNIDO should include among its activities a system of continuing consultations between developed and developing countries with the object of raising the developing countries' share in the world industrial output through increased international co-operation. In order to reach this aim the developing countries should act together to the extent possible and through economic and technical co-operation and integration schemes among themselves to face the industrialized world in unity.

The Petrochemical Industry in the developing countries has expanded rapidly between 1970-1980. After the 1980's exports will start

from new petrochemical plants built in the Arab countries. As a result of this development, surplus petrochemical products will exist in the oil-producing countries. In this aspect long-term arrangements between industrial developing and developed countries will gain importance. The following actions would be recommended:

- an information exchange system between developing countries on the technical and statistical basis should be established and directed from a centre;
- in order to provide uniformity, raw materials and end-products have to be standardized;
- oil-producing and non oil-producing countries have to come together and review their needs in financing, technical and marketing aspects;
- additionally, countries should encourage and facilitate the participation of consulting engineering and constructing services in the development projects of each other, including building of infrastructure facilities;
- take all the necessary steps to ensure the continuous and rapid flow of the goods by the other country's transit transport over their own territories;
- encourage the development of technical co-operation between themselves.

The above-mentioned activities may lead in the future to the establishment of a common market of the developing countries as a whole or regional.

3.1 Technical Co-operation

The development of the petrochemical industry is generally realized in three main developed regions: Japan, the United States and Western Europe. Consequently, licences are becoming available from the developed countries belonging to the above-mentioned areas. Some of the developing countries such as Turkey, India, Egypt and some of the Gulf countries have technical experiences accumulated from their applications. The technical data and information stored in these countries would be retrieved and provided for the other developing countries. During the preparation of pre-feasibility studies the developing countries can transfer the aforesaid technical information from one to another. For this purpose the developing countries should act together and maintain co-operation as stated in the following abbreviated version:

- development and expansion of the information systems concerning technical co-operation in the field of petrochemicals;
- identification and improvement of the potentials of national institutions for technical co-operation aimed at strengthening their capabilities through joint efforts and sharing of experiences;
- expansion of bilateral and multilateral arrangements for promoting technical co-operation and development of a legal and administrative framework covering the entry, employment obligations and privileges of experts, consultants, fellowships, use of contractors and other specialist services including the entry of equipment and supplies;
- provision and support of personnel, data and information to the training activities of the petroleum or petrochemical institutions with mandates to meet the immediate needs of technical manpower;
- development and expansion of the technical Date Base System of the developing countries. This system can be developed within the activities of the Statistical, Economic and Social Research and Training Centre for Islamic Countries, Ankara, Turkey.

Petkim Petrochemical Company has an engineering and study department with qualified engineers in the field of petrochemicals. They are carrying out all feasibility studies to be prepared by the company and necessary for the country.

In addition to Petkim's engineering and study department a number of engineering companies also exist to make feasibility studies. These are mainly listed below:

- Tumas Engineering and Contracting Co.
- Tustas Engineering Co.
- Bimas Engineering Co.
- Boral Engineering Co.

During the pre-feasibility study or feasibility study and license selection all necessary technical information can be provided by the above-mentioned companies.

The process of technical co-operation, besides being part of the above-noted activities, requires independent action in certain specific

areas in order to generate and proliferate its effects in a multifarious manner towards the evaluation of various plans of co-operation and collaboration aimed at achieving the main purpose of development and progress with this in mind, action has to be started in the following specific areas of technical co-operation:

- Training and Research;
- Exchange of Engineers and Technicians;
- Education and Fellowship;
- Inventory of Consultancy Firms and Roster of Experts.

3.1.1 Training and Research

In view of the importance of training technical personnel such as process operators and maintenance people, the developing countries with less experience in the field of operation and maintenance should be able to send their personnel to the other developing countries which have experience in the same field. For example, Turkey can accept applications from the developing countries on this matter. There are a variety of plants of production on the petrochemical and non-petrochemical products in Turkey belonging to the governmental or private sector. If necessary, training at site would also be provided in case of a request by sending experts to the developing countries from the above-mentioned plants.

Petkim Petrochemical Co. has a Research and Development Centre in Yarimca. The description of this technical Centre was summarized in Section 2.14. Petkim's Research and Development Centre will be developed to a petrochemical research institute within the coming years. There is a joint project with UNIDO Ankara on this subject. The Petkim Research and Development Centre, thought to be necessary for expanding their existing activities, is ready to co-operate with their counterparts in the developing countries.

3.1.2 Exchange of Engineer and Technicians

Another important area of technical co-operation [illegible]

that the petrochemical industry requires highly specialized engineers, operators and maintenance technicians. During start-up and normal operation adequately experienced personnel should be provided. In highly industrialized countries, even very large operating companies have difficulty in finding such personnel. Therefore exchange of skilled manpower among developing countries is becoming more important. In order to reach this aim, technical manpower agreements with regard to the requirements and availability of personnel should be established and encouraged.

3.1.3 Education and Fellowship

Another area of technical co-operation is to identify the institutions of higher education in the developing countries and to establish co-operation and co-ordination among them through various means including the development and launching of fellowship and scholarship programmes for the exchange of technical students and teachers.

3.1.4 Consultancy Firms and Roster of Experts

The information with regard to firms working in the area of consultancy and feasibility studies in the developing countries has also been very poor. An attempt has to be made to collect information in this area. Various library sources and other international organizations can also be tapped to obtain information on the subject so that a comprehensive director listing all such concerns along with the addresses will be ready for the benefit of developing countries.

3.2 Joint Ventures

The aim of joint ventures is to formulate a workable concept among developing countries. There are a number of joint venture projects between Arab countries and Turkish companies such as:

1. Kirkuk (Iraq), Iskenderun (Turkey) pipeline project. $550 m. and 981 kms. Kirkuk-Iskenderun pipeline project is a major product of good neighbourly relations and fruitful co-operation between Turkey and Iraq. It was finalized late 1973. After the responsibility

for the development and operation of the Turkish section, the project was assigned to Boru Hatları ile Petrol Taşıma A.Ş. (BOTAŞ) 99.9% owned by the state-run National Oil Company (TPAO).

Construction works were completed by Consortium Groups namely Mannesman of Germany, Ballast of Holland, CMP of France and Tefken of Turkey at the end of 1976.

2. The Arab-Turkish Bank. Agreement between Turkey and Libya has been reached and ratified by the Turkish Government on July 18, 1976 to create a joint venture, a bank, to promote and strengthen the economic and financial ties and assist in the increasing volume of foreign trade and other activities between the two countries.

3. Akdeniz Gubre A.S. (AKGUBRE). Akgubre is another joint venture project between Turkish Fertilizer Co. and the Petrochemical Industry of Kuwait. There are several areas of joint venture on the subject as listed below:

   (i) A joint venture company on engineering and study; to help countries participate in a pre-feasibility study and detailed engineering of projects in the petrochemical industry.

   (ii) A joint company in the field of operation and maintenance. This company will be very helpful especially for the Gulf Countries which are very close to each other. Joint venture companies may, however, establish branches in or outside the Gulf countries.

To discuss the results of joint venture activities is not within the scope of work of this paper because of this nature of business being commercial and confidential. Another important point is that joint venture areas and possibilities depend on financial, economical status and customs formalities of each country. Moreover, Governments also should not encourage such multilateral activities. In the study we cannot give more details on this subject since it is somewhat political.

3.3 Marketing

As is commonly known the rationale of situation energy-intensive industries near the sources of fuel and feedstocks is not any longer subject to discussion. Since the primary energy costs now outweigh the

sum total of costs for labour, plant construction, transportation to market and furthermore, since in the petrochemical industry energy accounts for rather more than 50% of the costs of production, one would think that the supreme logic of placing petrochemicals in a oil producing country is established beyond any doubt. Therefore major petrochemical plants will be taking place in the Middle East soon. Supply of petrochemicals in developing countries is growing by about 15% per year. By 1987, 27 developing countries will have established plants to manufacture ethylene, compared to 13 countries with plants in existence in 1979; 16 of these countries will also produce propylene and 11 will produce butadiene. The biggest increase in capacity to produce basic petrochemicals will come after 1984, e.g. ethylene capacity will be 7.9 million tons at the end of 1984 and an estimated 14.5 million tons at the end of 1987. Demand for the final products based on basic petrochemicals is less than production capacities. Therefore there will be a surplus of petrochemicals in 1990. What are we going to do with this surplus? Long-term arrangements between developing countries and developed countries on the marketing may be a good answer to the above question.

Turkey can enter into such a long-term marketing arrangement especially with oil-producing countries. The Turkish petrochemical industry is based on naphtha as a feedstock. Ammonia is used in the fertilizer industry. Crude oil for naphtha and ammonia are imported from outside the country. In order to secure the supply of oil-based raw materials, multilateral arrangements will be appreciated. Production of non-plastic petrochemicals is well advanced in comparison to the other developing countries. Turkey may supply these products to the other developing countries rather than producing them again in those countries.

As a result of efforst between the regional countries, Turkey has exported SBR, carbon black to Iran, DDB to Iraq and some finished products of PVC and PE to the Gulf countries.

3.4 Relations of Turkey and Developing Countries

There is already good co-operation between Turkey and developing countries especially the Islamic countries. Many joint venture projects

have been accomplished in the past and many of them are under consideration. These areas of co-operation may be summarized within the following section:

- A credit foreign payment has been opened by the United Arab Emirates to Petkim Petrochemical Co. to help them with the initial financing of their second Petrochemical Complex:
- Petkim Petrochemical Co. has offered to send qualified engineers and operators to Pakistan to support operation activities of their carbon black plant. This was requested by Pakistan Authorities as a result of the Second Consultation held in Istanbul, 22-26 June 1981;
- Petkim Petrochemical Co. has offered the same type of start-up services for an ethylene plant to Libya and to other Gulf countries;
- On the marketing aspect, joint actions exist between private sectors of Gulf countries and Turkey in the downstream processing industries;
- The Turkish constructors can also take an important role in the construction and erection of petrochemical plants.

As a result, Turkey follows the principle of establishing fruitful co-operation with a large number of developing countries in the petrochemical field.

3.5 Conclusion

The above resumé of activities should be co-ordinated from a centre which has to be established by the developing countries. The same type of activities in a larger area have been co-ordinated by "Statistical, Economical and Social Research Centre for Islamic Countries (SESRTCIC) in Ankara" for Islamic Countries. The scope of the work of SESRTCIC is not sufficient to cover economic and technical co-operation among developing countries. But this Centre may play a bigger role for the subject studied in this paper if required.