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DEVELOPMENT OF THE PETROCHEMICAL INDUSTRY IN PAKISTAN[1/]

by

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Pakistan

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INTRODUCTION

Petrochemicals are a sector where Pakistan has only made a beginning. The existing capacity is limited to one small PVC plant based on imported calcium carbide, one polyethylene plant based on indigenous molasses and two urea formaldehyde plants based on indigenous urea and imported formaldehyde.

One of the chief raw materials i.e. natural gas is available in abundance in both wings of the country. In East Pakistan, there are seven known gas fields with a proven reserve of about 10^{12} cubic feet. In West Pakistan the two major fields also contain about [illegible] ^{12} cubic feet of gas. So far, in East Pakistan only three gas fields have been tapped and this exclusively for use as fuel for power generation and as raw materials for nitrogenous fertilizer. In West Pakistan also, the natural gas is used only as a fuel and as a raw material for nitrogenous fertilizer. There are three oil refineries, two in West Pakistan and one in East Pakistan based on imported crude oil. A scheme is at present under the consideration of the Government for establishing a petrochemical plant in West Pakistan which will use naphtha from the refineries as a raw material. It envisages establishing a naphtha cracker to produce 20,000 tons of ethylene in the first phase. The main end products will be polyethylene = 10,000 tons, PVC = 15,000 tons, polypropylene = 5,000 tons, DDB = 5,000 tons, vinyl monomer 16,500 tons, etc. A scheme for setting up a petrochemical complex using natural gas from one of the big gas fields at Titas about 40 miles east of Dacca is currently under the consideration of the Government.

PAST DIFFICULTIES IN DEVELOPMENT

Despite the availability of raw materials, the petrochemical industry in Pakistan could not be launched earlier owing to limited development of end-use industries like plastic industry, heavy investment needed, and controversies over the selection of products to be produced. The high landed cost of imported petrochemicals in turn has stifled the growth of the end-use industry. In fixing priorities conversion of gas to fertilizer and power was favoured in preference to making petrochemicals.

But time has now come to process the raw materials available i.e. natural gas and naphtha to petrochemicals which are highly priced, which will be able to replace some imported construction materials and consumer goods when converted into finished plastic products and also earn foreign exchange by export. A petrochemical complex would also serve as a nucleus for future development of sophisticated technology.

RAW MATERIALS

The two main raw materials, naphtha and natural gas, for going into petrochemical manufacturing, are available in Pakistan. In East Pakistan, we have got only one refinery which is estimated to produce approximately [illegible] tons of naphtha annually. This in turn could give us ethylene, somewhere around 18,000 tons a year. This is rather a small unit to be really economical. The other streams namely propylene and butylene are still smaller and are hardly worth exploiting. On the other hand, West Pakistan, having two existing refineries has a better possibility to go for a petrochemical project based on naphtha. Such a project is already at the planning stage. The other raw material, natural gas, as a basis for petrochemicals manufacturing could be tapped in East Pakistan. The methane content of natural gas of East Pakistan origin varies between 94 and [illegible] per cent. It has therefore been our intention to manufacture PVC and synthetic fibres starting with acetylene. Such a project is being planned and the planning is already advanced to a considerable extent.

As mentioned earlier in this paper, the end processing industries of petrochemicals cannot be developed to the desired extent because of non-availability of domestic supply of raw materials. If the capacities of a proposed petrochemical project are based on the existing domestic consumption only, they will be much too small to be economical. On the other hand, if we go for larger units build ahead of demands, the products have to be competitive in the world market and have to be sold for the time being in markets other than the domestic one. The demands of petrochemicals would grow fast once domestic production is undertaken and therefore it would really be prudent to build capacities ahead of demand. We think, we have to be careful that the cost of producing the materials is competitive compared with that in existing manufacturing areas.

The price of natural gas which is only 0.[illegible] Rupee per thousand cubic feet at well head would be to our advantage. The analyses and the extent of deposit of natural gas in East Pakistan are as follwos, besides the one now discovered and estimated to be of 3.7^{12} cubic feet reserve: (1US$ = Rupees 4.[illegible])

Table I

Reserves

(figures in cubic feet x 10^9)

Reserves	Rashidpur	Kailastial	Titas	Habiganj	Haripur	Chattack
proven	470	380	950	1,000	280	20
probable	180	150	900	190	-	-
possible	90	70	400	90	-	-
total	740	600	2,250	1,280	280	20

grand total : 5.2^{12} cubic feet

Table II

Composition

%

Components	Rashidpur	Kailastial	Titas	Habiganj	Haripur	Chattack
methane	98.2	95.7	97.2	97.8	95.4	99.95
ethane	1.2	2.6	1.8	1.5	2.67	0.25
propane	0.2	0.9	0.5	-	0.3	-
butane and higher	0.1	0.4	0.2	-	0.78	-
nitrogen	0.3	0.2	0.3	0.7	0.37	0.67
carbon-di-oxide	-	0.2	-	-	0.48	0.04
hydrogen sulphide	-	-	-	-	-	-
calorific value (BTU's/cubic foot)	1014	1050	1039	1020	1052	1007

FEASIBILITY STUDIES

Since 1963, a number of feasibility studies on the petrochemical industry have been carried out, the three latest were from Sumitomo of Japan, M/s E.B.S. Management Consultants of U.S.A., and Austrian Petrochemical Consultants of Austria. They recommended different product distribution and plant sizes:

Table III

SUMITOMO (Japan)

Product	Capacity metric tons/year
PVC resin	16,500
PVA fibre	7,800
methanol	12,690
caustic soda	11,530
formalin	[illegible],860
acetic acid	590
off gas	burning

Capital cost : Rupees 622 million with foreign exchange component of Rupees 407 million.

Table IV

E.B.S. (USA)

Product	Capacity metric tons/year
PVC resin	20,700
polyvinyl alcohol chips	2,140
soda ash	15,100
sodium sulphate	2,400
acetylene	215
bleaching powder	33
off gas	burning

Capital cost - Rupees 304 million with foreign exchange component of Rupees 144 million.

Table V

A.P.C. (Austria)

Product	Capacity metric tons/year	Estimated cost of production per metric tons Rupees
acetylene	3,000	566.00
bleaching powder	1,000	2,402.00
caustic soda	42,000	264.00
PVC resin	50,000	945.00
PACN fibre (polyacronitrile)	12,000	3,923.00
PACN tows	4,000	3,923.00
polymethylmethacrylate	4,000	3,324.00
methanol	37,000	152.00
ammonium sulphate	28,000	-
urea	320,000	144.00

Off gas should be used to make urea and methanol.

Capital cost = [illegible] million Rupees with foreign exchange component of [illegible] million Rupees.

The plant capacity based on the Austrian Petrochemical Consultants'(APC) specification has been accepted in the scheme that has been submitted to the Government for a petrochemical complex in East Pakistan. The following considerations influenced the acceptance of the recommendations of the Austrian Petrochemical Consultants:

1. Large plant capacity was necessary to lower production cost. This was possible despite the present low domestic demand as possibilities for exporting [illegible] tons of PVC resin, [illegible] tons of PACN fibre, [illegible],000 tons of methanol and 200,000 tons of urea and [illegible] tons of caustic soda existed, [illegible] competitive world market.
2. PACN is a [illegible] synthetic fibre. It is also lighter than other fibres [illegible] the know-how can be obtained from several developed countries, resulting in lower fees. It will also be cheaper than other comparable fibres like PVA.

3. Off gas would be utilized to make urea and methanol.

4. Surplus HCN would be used for making synthetic glass.

5. Valuable by-products like ammonium sulphate and caustic soda will be obtained.

The individual costs of production as estimated by the consultants in the first year of 100 per cent operation are as follows in U.S. dollar per ton.

Table VI

Product	World price	Sumitomo	E.B.S.	A.P.C.
PVC resin	265	300	236	164
methanol	85	102	-	762
caustic soda	-	230	-	56
acetylene	140	366	306	110
bleaching powder	120	-	470	36

However, as can be seen, all the three cases do not have similar product distribution. In case of Sumitomo, formalin and acetic acid manufacture was undertaken in order to meet the requirement of these materials from within the complex. These materials are required for PVA fibre manufacturing. The E.B.S. report has considered the manufacture of only PVA chips and not PVA fibre. As such the cost of production of PVA chips can not be compared with that of fibre.

The report has also considered conversion of available caustic soda into soda ash. The costs of acetylene is particularly important as this is the starting material for PVC and synthetic fibres.

In order to be able to see the difference between the merits of these three cases, the following analysis has been attempted. The gross revenue in three different cases has been calculated on the basis of the proposed selling prices in the present scheme for the products, the revenue for the rest of the materials has been calculated at selling prices proposed by the individual consultants. The selling prices for the materials not common to this scheme and proposed by the individual consultants are:

PVC chips	Rs.	3,150	per ton
soda ash	Rs.	263	per ton
sodium sulphate	Rs.	291	per ton
PVA fibre	Rs.	12,900	per ton
formalin	Rs.	600	per ton
acetic acid	Rs.	1,890	per ton

Table VII

	Sumitomo	E.B.S.	A.P.C.
Capital investment	Rs. 6,211.77lacs	Rs. 3,042.79lacs	Rs. 10,141.82lacs
Gross revenue	Rs. 1,571.21lacs	Rs. 689.73lacs	Rs. 4,435.74lacs
less cost of production	Rs. 1,149.58lacs	Rs. 572.29lacs	Rs. 2,271.36lacs
Gross profit	Rs. 421.63lacs	Rs. 117.44lacs	Rs. 2,164.38lacs
Revenue/investment ratio	Rs. 1:3.95	Rs. 1:4.41	Rs. 1:2.29
Profit/investment ratio	Rs. 1:14.73	Rs. 1:25.91	Rs. 1:4.69
Natural gas consumed million cubic feet/year	6,642.70	4,110.00	24,215.80
Annual recurring F.E. liability (Rs. in lacs)	645.40	304.18	1,071.63
Profit per million cubic feet gas consumed	Rs. 63,473	Rs. 28,574	Rs. 89,379
F.E. liability per million cubic feet gas consumed	Rs. 9,717	Rs. 7,401	Rs. 4,425

Note: 10 lacs = 1 million

It may be observed that the PVA fibre will be a too costly material in view of the sales prices estimate by consultants and the PVA chips could not be processed into fibre as there is no existing facility to do so apart from the fact that installtion of such facility is quite costly.

The comparative merits of the AFC recommendations may be attributed partly to the product distribution, scale of capacity and also complete utilization of off-gases. Sumitomo proposal envisages utilization of only 9.26 per cent of generated off-gas in the manufacture of methanol and E.B.S. report has not considered any utilization of off-gas as feedstock, except burning the entire quantity as fuel. Off-gases as a fuel has a limited return, its heating value being only one-third of the natural gas.

PROCESS AND ROUTES

The processes and the routes followed in manufacturing the different products have largely been dictated by the basic starting raw material, natural gas and the products to be manufactured.

BASF process has been recommended for acetylene production. Both the BASF and the SBA processes are based on partial oxidation of natural gas. The SBA method requires stainless steel, lined furnaces requiring higher capital investment. The BASF process would use refractory material as the furnace wall. The acetylene produced would be required to be absorbed in a solvent. NMP has been recommended as the solvent because of its low partial pressure and the high selectivity.

Since PVC is proposed to be manufactured from natural gas, acetylene has to be the starting material and thus the acetylene process is to be followed. For polymerization of PVC, suspension process, the latest widely accepted modern process has been recommended. PVC manufacturing by suspension process needs a smaller amount of plasticizers added when manufacturing the end products, thus reducing the import of plasticizing chemicals.

Hydrocyanic acid (HCN) production is based on ammonoxidation as ammonia, natural gas and air are available as the feedstock. Manufacturing of HCN needs care. The ANDRUSSOW process has been recommended. The safety precautions in this process are fully automated. In the manufacturing of PAN production, wet spinning process has been recommended. Fibres manufactured in this process are more suitable for mixing with cotton (cotton type) than that manufactured from the dry spinning process.

It is recommended that ammonia be manufactured with a capacity of 600 tons per day in one stream as this has now become the minimum economic capacity. For manufacturing urea, the two most economic processes are the total recycle process and the stripping process. The stripping process is comparable with the total recycle process investment-wise and consumption-wise. The consultants have recommended the stripping process for its advantage both from operating point of view and from the reduced corrosion [illegible].

The consultants have based their recommendation on widely used and upto date and proven processes. The exact specification of the machinery supplied by different manufacturers may vary to some extent due to design conditions. However, the relative advantages can be known only at the time of evaluation of the tender offers.

The end products chosen in this complex are widely manufactured throughout the world and as such know-how and licences may not be difficult to obtain, unlike the PVA fibre manufacturing.

MATERIALS REQUIRED

Besides the natural gas itself, the following materials would be required in the three different cases of schemes as outlined by Sumitomo, E.B.S and A.P.C.:

	Sumitomo	E.B.S.	A.P.C.
Salt	20,955 tons (West Pakistan)	[illegible],600 tons (West Pakistan)	70,000 tons (West Pakistan)
Acetone	not required	not required	5,700 tons (import)
Auxiliary chemicals and catalyst	Rs. 104.1[illegible] lacs (local & imported)	Rs. 3[illegible].20 lacs (local & imported)	Rs. 179.19 lacs (local and imported)
Sulphuric acid	5,870 tons (assumed local availability)	3,500 tons (assumed local availability)	(based on sulphur)
Methanol	(produced in complex)	435 tons (imported)	(produced in complex)
Acetic acid	(produced in complex)	765 tons (imported)	not required

Market study and projection of demand for petrochemicals

Market studies so far undertaken to ascertain the demand for petrochemical products, fibres and by-products have shown wide variations. The import figures and whatever quantity of production or consumption is available, do not show a definite trend of demand for plastic products or synthetic fibres. The reason for wide fluctuations are attributed to the conditions of restricted imports, licensing controls and bonus vouchers. Neither the import figures nor the consumption figures should, therefore, be taken to represent either the requirements or the demand for these products.

The projection of demand which is being made is based on information obtained from different agencies and studies so far made. Although various methods were followed for making the projections of different items, attempts were made to rationalize the projected demand for a particular item with its end-uses.

The potential demand for petrochemical products will depend upon both the growth rates of demand for its own products as well as the share that it can capture from other substitutes. It is expected that the growth in demand for petrochemicals would be faster when these will be available from indigenous sources at favourable prices.

Table VIII

Demand for PVC resin in East Pakistan

End use	1969/1970	1974/1975
Footwear	4,000 tons	6,450 tons
Wires and cables	1,000 tons	2,500 tons
Coated textiles	1[illegible]0 tons	250 tons
Flexible sheet	430 tons	1,070 tons
Conduits, fitting etc	350 tons	705 tons
Municipal irrigation and water pipes	585 tons	1,050 tons
Pipes	4,000 tons	7,500 tons
Telephone and miscellaneous	500 tons	1,240 tons
	11,045 tons	21,095 tons

There is a substantial demand for polyethylene (PE) in East Pakistan. Taking the import figures computed by Central Statistical Office consumption estimates of PE, consumption for 1965/66 and 1966/67 were [illegible] tons and 3,800 tons respectively. It is estimated that the demand for PE will go up to [illegible] tons in 1969/70. This estimate has been arrived at after considering the present consumption of PE. The total demand for PE in East Pakistan upto 1984-1985 has been estimated to be as under:

1969/1970	1974/1975	1979/1980	1984/1985
[illegible] tons	[illegible] tons	26,[illegible] tons	[illegible],200 tons

It has been suggested by various agencies that with improved technology and with the availability of PVC, [illegible] can be met by PVC. Thus an additional demand for PVC as shown below will arise.

In case of West Pakistan the estimates of imports and consumption for PVC and PE are as given under in tons:

Table IX

		[illegible]	1966/1967	1967/1968
PVC	Imports	[illegible]	[illegible],734	3,700
	Consumption	[illegible]	3,[illegible]	3,710
PE	Imports	[illegible]	[illegible]	4,201
	Consumption	[illegible]	[illegible]	3,[illegible]
Total thermoplastics		[illegible]	6,[illegible]	11,400

The projected demand for PVC in West Pakistan is given below:

Table X

1967/1970	11,400 tons
1974/1975	20,000 tons
1979/1980	[illegible],200 tons
1984/1985	[illegible],500 tons

The total demand for PVC (resin) upto 1984/1985 comes to as follows:

Table XI

	East Pakistan	West Pakistan	Total
1969/1970	12,950 tons	11,400 tons	24,350 tons
1974/1975	26,400 tons	20,000 tons	46,400 tons
1979/1980	51,300 tons	40,400 tons	91,700 tons
1984/1985	109,600 tons	92,500 tons	202,100 tons

These estimates are quite realistic considering the versatility of PVC plastic which can be used as substitutes for innumerable items for day to day use.

The biggest use of PVC is bound to come in the field of pipes and corrugated sheet production. PVC is being used at present to only a limited extent for pipe production both in East and West Pakistan. With the availability of PVC in the country, the pipes produced will serve to replace cast iron pipes, C.I. pipes, asbestos cement, and all other pipes.

Fields of application of PVC pipes

1. Water supply
2. Natural gas supply
3. Brine, chemicals or oil supply
4. Irrigation channels
5. Ventilation and drains
6. Sanitation systems
7. Tubewells and strainers
8. Borings, and
9. Conduit work.

The project earmarked an amount of 20,000 tons of PVC for export. Although no information on growth of world demand is available, the growth of world production, reflects some indication about the growing demand for PVC. Information on exports for U.S.A., Japan and OECD countries show that about 364,000 tons of products of polymerisation were exported in 1967. The export of products of polycondensation in 1967 from U.S.A. and OECD amounted to [illegible] tons. The export as proposed by the project turns out to be about [illegible] per cent of the export products of polymerization from U.S.A., Japan and [illegible] countries and about [illegible] per cent if the exports of products of polycondensation from [illegible] are also included. Keeping in mind, that the world demand and exports are growing [illegible] Canada, another big exporting country is included the share of export as proposed in the projected scheme will be almost down to [illegible] per cent of total world export. Potential markets for export are the South and South East Asian countries. According to available information, the demand for PVC resin in 1974/1975 is likely to be between [illegible] and [illegible] thousand tons in this area alone.

On the basis of the projection the detailed fibre requirement in East Pakistan is expected to be as follows:

Table XII

All fibre requirement

Year	East Pakistan		West Pakistan	
	total tons	per capita lbs.	total tons	per capita lbs.
1964/1965	[illegible]	2.15	104,000	4.07
[illegible]	[illegible]	3.01	147,500	5.17
1974/1975	17[illegible]	4.47	215,300	6.59
[illegible]	335,400	6.74	312,300	8.42
1984/1985	5[illegible]	10.70	44[illegible],200	10.83

Under these assumptions the demand for man-made fibres and its break-up in tons is given in the table below:

Table XIII

Man-made fibres

Year	East Pakistan			West Pakistan		
	total	rayon	synthetics	total	rayon	synthetics
1964/1965	6,700	5,000	1,700	15,600	9,400	6,200
1969/1970	8,500	5,700	2,800	22,200	13,300	8,900
1974/1975	16,200	9,700	6,500	32,300	16,100	16,200
1979/1980	28,400	14,200	14,700	46,900	23,400	23,500
1984/1985	50,100	25,000	25,100	67,200	33,600	33,600

The demand for synthetic as estimated above is considered to be very much on the conservative side in view of the elasticity of demand. A short-fall in total fibre demand, as well as a short-fall considered for man-made fibres due to climatic conditions has been taken into account. The proportion of man-made fibres (10 per cent) is a very low one when we see in advanced countries 30 to 40 per cent of synthetics are mixed with cotton fibres to attain better quality as well as cheaper price.

Polymethyl methacrylate

This will be first product of its kind in Pakistan and will be replacing sheet and plate glass. It is unbreakable and lighter in weight than plastics as well as cheaper in comparison with plate and sheet glass now being produced in Pakistan.

The total production capacity of glass in Pakistan (1966/1967) was 84,000 tons of which 69,500 tons was located in West Pakistan and 15,000 tons in East Pakistan. There are only three units - two in West Pakistan and one in East Pakistan producing sheet and plate glass. The production of sheet and plate glass comprise only a small fraction of total production of glass. For example, the production of plate and sheet glass in West Pakistan in 1966/1967 was 100 tons and 2,000 tons respectively out of a total production of 50,000 tons. Cost of ordinary plate and polished plate glass is estimated to be 2.4 Rupees per square foot and 4.4 Rupees per square foot respectively according to the present market price. Cost of production of polymethyl methacrylate is estimated to be around 1.4 Rupees per square foot. The C.I.F. price of polymethyl methacrylate is approximately Rs. 5,702.40 ($1,180) per ton and landed cost including taxes comes out to be Rs.11,404.00 ($2,400) per ton. The present production capacity is much below the demand for sheet and plate glass. Further, because of the cheaper price and superior quality of artificial glass than even polished plate and sheet glass, it is expected that it will not be at all difficult to find a domestic market for 4,000 tons of artificial glass envisaged to be produced in the petrochemical project. The characteristics of polymethyl methacrylate glass will be indicated from the following:

Table XIV

Item	Thickness	Specific gravity	Weight per sq.ft.	Cost per sq.ft.
Ordinary plate glass	4 mm	2.47	2.1 lb	Rs. 2.4
Polished plate	4 mm	2.47	2.1 lb	Rs. 4.4
Synthetic	4 mm	1.18	1.0 lb	Rs. 1.4

Urea and ammonium sulphate

The requirement of nitrogenous fertilizers in East Pakistan by 1974/1975 has been estimated to be around 1.5 million tons. This estimate does not include the additional demand that arose due to introduction of Irri rice. It only includes full coverage for the minor agriculture crops. By 1969/1970 the production capacity for nitrogenous fertilizer in East Pakistan will be 458,000 tons (Natural Gas Fertilizer Factory Fenchuganj 106,000 tons, Ghorasal Fertilizer Factory 340,000 tons, Ammonium Sulphate Plant, Fenchuganj 12,000 tons). It is expected that by 1974/1975 the production capacity of nitrogenous fertilizers will increase to 1,138,000 tons with the addition of two more urea fertilizer factories at Ghorasal, one in the private and the other in public sector. This will still leave a large gap to be filled up in order to make up the requirements for nitrogenous fertilizers in East Pakistan.

Ammonium sulphate is at present consumed by the tea gardens. The capacity by 1969/1970 for ammonium sulphate will be 12,000 tons and the planning commission estimates that another 10,000 tons will be required to meet the demand for ammonium sulphate by 1974/1975. This will leave an amount of [illegible] tons of ammonium sulphate to be produced by petrochemical projects, either to be consumed domestically or to be exported. [illegible] that the surplus ammonium sulphate may be exported to [illegible]. However, after [illegible] the expansion of the tea plantations most of the surplus ammonium sulphate will be consumed locally in East Pakistan.

In case of urea, it is found that the requirements of East Pakistan are much higher than the anticipated production of urea in East Pakistan [illegible] production in the proposed projects. There will therefore be no difficulty [illegible] selling the quantity of urea fixed for domestic market. The [illegible] prices of ammonium sulphate and urea are Rs. [illegible] and Rs. [illegible] per ton respectively compared with the present market price of Rs. [illegible] per ton of ammonium sulphate and Rs. [illegible] per ton of urea. The proposed ex-factory sales prices for these two items are respectively Rs. [illegible] and Rs. [illegible] per ton.

The cost of production as well as the proposed [illegible] sales price are particularly favourable for [illegible] indigenous production. The production cost is estimated to be $30 per ton compared with $[illegible] at the Natural Gas Fertilizer Factory, Fenchuganj. From the [illegible] price of $[illegible] per ton and the present world price of $[illegible] per ton, it seems there will be no difficulty in exporting [illegible] tons of urea in the world market, since there is great dearth of urea fertilizer especially in all the developing countries.

Methanol

Methanol is used in the manufacture of urea, phenol and melamine formaldehyde resins. Formaldehyde is used as a binding material in making boards out of wastes like jute sticks and is needed in the production of the melamine type of crockery, as well as in other various items of daily use. [illegible] information is available about the import and demand of methanol in East and West Pakistan. However, almost all of the local demand is met by imports. The Eastern [illegible] Industries of Chittagong alone requires about [illegible] tons of methanol. It is estimated by Austrian Petrochemicals, that the present domestic demand is about 10,000 tons and it is increasing.

It is proposed that about 2[illegible],000 tons of methanol be exported in the world market. Methanol has been in short supply since 1965. This shortage is due [illegible] demand for formaldehyde. This situation is likely to continue for some time. Any [illegible] quantity of methanol can be exported since there is acute short supply [illegible] market. [illegible] production as well as FOB sales price are estimated to be [illegible] the world market price. There is good export [illegible] in the [illegible] Asian countries [illegible] in the European market, although supply and prices in the world market were affected by occasional deliveries from the East European countries. [illegible] of methanol by East European countries is [illegible] likely to affect the proposed export since the proposed FOB price is expected to be lower than the average world price.

Detailed information [illegible] below:

[illegible]

Year	CIF price [illegible]	World price (December 1968)	
1965	Rs. [illegible] per ton (approx.)	U.K.	$ 76 per ton
1966	Rs. [illegible] per ton (approx.)	[illegible]	$ [illegible] per ton
1967	Rs. [illegible] per ton (approx.)	Belgium	$ [illegible] per ton
1968	Rs. [illegible] per ton (approx.)	France	$ [illegible]4 per ton
1969	Rs. [illegible] per ton (approx.)	Italy	$ [illegible] per ton

Table XVI

Present market price	Rs. [illegible] per ton (approx.)
Sales price	Rs. [illegible] per ton (approx.)
Proposed export price	$ [illegible] per ton (approx.)
Present world market price	$ [illegible].00 per ton (approx.)

Acetylene

There are facilities for the production of acetylene in East Pakistan. These facilities are, however, based on the calcium carbide process and the required amount of calcium carbide is met from imports. Information on consumption and requirements [illegible] East Pakistan are almost non-existent. The [illegible] management [illegible] consultants estimate that the demand [illegible], which was about 3 million cubic feet in 1968, [illegible] will grow to about [illegible] million cubic feet in 1969/1970 and to [illegible] to [illegible] million cubic feet ([illegible] tons) in 1972/1973.

The demand in 1974/1975 is estimated to be still higher.

Detailed information on prices is given below:

Table XVII

	C.I.F.*
1967 import price	Rs. [illegible] per ton (EEC arrangement)
Present import price	Rs. [illegible] per ton
Present market price	Rs. [illegible] per ton
Proposed ex-factory sales price	Rs. [illegible] per ton

Note: *) prices in [illegible] lbs cylinders. Prices excluding freight or cylinder.

Table [illegible]

SUMMARY TABLE SHOWING PRODUCTION, [illegible] EXPORT POTENTIALITY OF [illegible] (in tons)

ITEMS	Production: for domestic consumption	Production: for export	Demand [illegible]: East Pakistan	West Pakistan	Demand [illegible]: East Pakistan	West Pakistan	Demand [illegible]: East Pakistan	West Pakistan	Demand [illegible]: East Pakistan	West Pakistan	Export potentiality in 1[illegible]
PVC	[illegible]0,000	[illegible],000	12,[illegible]	11,[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	over [illegible]0,000
PACN fibre	[illegible]0,000	6,000	7,[illegible]	1[illegible],[illegible]	1[illegible],[illegible]00	[illegible]	[illegible],7[illegible]	[illegible],7[illegible]	[illegible],200	[illegible]	over 6,000
PACN tows	2,000	2,000	-	-	-	-	-	-	-	-	-
Caustic soda	30,000	12,000	19,650	29,500	[illegible]9,800	41,100	37,100	48,500	45,500	5[illegible],[illegible]00	over 12,000
Polymethyl-Methacrylate	4,000	-	4,000	-	over 4,000	-	-	-	-	-	over 2,000
Urea	120,000	200,000	over 120,000	-	over 120,000	-	-	-	-	-	over 200,000
Ammonium sulphate	2[illegible],000	-	10,000	over 18,000	over 10,000	over 1[illegible],000	-	-	-	-	over 22,000
Methanol	15,000	[illegible]2,000	10,000*	-	-	-	-	-	-	-	-
Acetylene	3,000	-	-	-	-	-	-	-	-	-	-
Bleaching powder	1,000	over 1,500	over 3,000	-	-	-	-	-	-	-	-

Note: *) includes demand for West Pakistan also.

PLANT SIZE AND PRODUCT-MIX

We have been working to fix the plants sizes and the product distribution that would give the optimum benefit. In adopting the acetylene route from natural gas, the conversion usually obtained is only about 15 per cent and the rest, the major fraction, is the off-gas comprising hydrogen, carbon monoxide, carbon dioxide, methane and nitrogen. In many cases, consultants advised us to burn this as fuel in power plants. But the off-gas has a lower heating value, only approximately one-third of natural gas. On the other hand, this could be a good feedstock for manufacturing methanol and ammonia. There has been no domestic production of methanol as yet and in East Pakistan, which is basically an agricultural country, the ammonia can very well be used for chemical fertilizer production. The off-gases generated in the acetylene plant as a major fraction needs to be utilized for the over-all improved viability of such a project.

The kind of product distribution and the plant sizes which we have now been thinking of are as follows:

Table XIX

PVC resin	50,000 tons per year
PACN fibres	12,000 tons per year
PACN tows	4,000 tons per year
Methanol	40,000 tons per year
Urea	320,000 tons per year
Polymethyl methacrylate	4,000 tons per year

The by-product caustic soda and ammonium sulphate on this basis would amount to 42,000 tons and 28,000 tons per year respectively.

PACN fibre has been selected contrary to the previous report on the same subject recommending PVA fibre because a PACN plant requires less capital investment and its cost of production is lower than that of PVA fibre. The cost of production of PACN fibre has been estimated at US$738 per ton as against US$1,900 for PVA fibre, according to Sumitomo. Since its cost of production is lower than the prevailing world prices of US$2,000 per ton, PACN may be exported.

For the manufacture of PACN fibre, HCN is required. In order to have a minimum economic capacity HCN plant, some surplus HCN will be obtained after meeting the demand for PACN fibre. This surplus HCN is proposed to be utilized for manufacturing methylmethacrylate and polymethylmethacrylate (synthetic glass). Ammonium sulphate will be obtained as a by-product in the process.

The capacity for methanol in the APC report is 20,000 tons per year. The minimum economic capacity, working on low pressure technique which gives a lower cost of production, is 30,000 to 40,000 tons per year. (It was, therefore, decided that the final report will recommend a plant for 40,000 tons which could operate at 30,000 tons per year). 3,000 tons of methanol will be consumed in the plant and 27,000 tons will be sold partly to industrial units and the balance can be exported to Western and other countries. Methanol could be transformed into formaldehyde and we could manufacture urea-formaldehyde which is a glue for the manufacture of chip board. This could transform a very large quantity of jute stick (waste material) into board for housing. One formaldehyde plant has already been set up by Eastern Chemical Industries in East Pakistan, but another plant can be set up at a subsequent stage without disturbing the present complex.

Production of PVC has been indicated at 50,000 tons per year. This has been retained in view of the increasing trend of the demand for PVC. It was decided that the consultants should indicate factors of investment and cost of production for a 25,000 tons PVC plant with a view to comparing it with a 50,000 tons plant. The comparison will show the risks and losses for operating a 25,000 tons PVC plant as against operating the 50,000 tons plant at partial capacities. This exercise will be indicated separately from the report. It has been the experience that domestic production of PVC enlarges the home consumption very substantially. This could take place in this country at the same time increasing the overall size of the domestic market, particularly in the use of corrugated PVC pipes and sanitary fittings. PVC could also be a supplement and substitute for packaging in East Pakistan, particularly for its climatic conditions. (Packaging of cement, fertilizer, salt, sugar, tea, etc.)

The production of PACN has been indicated at 10,000 tons per annum. The consultants felt that this fibre could be produced at a very low cost in East Pakistan compared with world prices. PACN has properties similar to wool. The consultants indicated that this fibre could also be made in a cotton-like quality. According to their contention the quality of the major fibre in a fabric dominates the properties. Thus if a percentage of 40 or below is mixed with cotton one would not expect to get the properties of PACN. On the other hand, PACN is a lighter fibre and can give more surface per unit weight. It was, therefore, decided that the consultants, in order to establish their contention would make available samples of PACN blends with cotton in different proportions and also data for the comparative properties of the samples against pure cotton on an evaluation basis. The consultants indicated that the Ministry of Defence had already accepted PACN fibre for the Armed Forces uniforms. It could also be used for the carpet industry now using jute and wool. The water absorption properties were considered and it was felt that a mixture with cotton in a lower ratio would retain the property of cotton. However, data pertaining to the samples will throw more light in this respect. In this respect the data for relative humidities above 65 per cent is more important for East Pakistan. In regard to processing difficulties in the existing textile mills, the consultant felt that this would not be a factor when PACN was used in a lower ratio. However, they agreed to investigate this matter in plants making PACN - cotton mixed fabrics and make available further details to [illegible].

It was therefore decided that the consultant should give figures for properties of fabrics in different proportions of PACN and cotton and send samples as well as sufficient quantities of PACN fibre for testing in the textile units both for cotton textile as well as carpet industries. The consultants will also indicate in the final report, the field of PACN wherePACN could be used in Pakistan under the existing condition.

The HCN plant will have a capacity of 15,000 tons per year. It was proposed that 2,500 tons be consumed in the manufacture of alkali cyanide. In the absence of possible markets the proposal for manufacturing alkali cyanide could be dropped for the present. The plant could be operated at a lower capacity. The HCN can be utilized for production of nylon-66 at a later stage. This should not disturb the present project. It was also agreed that the tender documents will include capacity for 10,000 tons for production of fibre, and as an alternative 15,000 tons of methylmethacrylate. The profitability of the project will be evaluated for both capacities and products, this will decide the capacity of the HCN plant as well as the possibility of manufacture of synthetic glass.

A comparison will be drawn between the proposed sales prices of polymethylmethacrylate and the present sales price of sheet glass locally manufactured. The comparison will be based on the surface area taking into account the specific gravity of the materials.

The eight thousand tons acetylene reactor is the largest approved reactor so far. This project would require five such reactors. The consultants should indicate this aspect in the tender document to get best possible selection of the equipment and operating cost under various processes for the highest economy of the plant.

SALES AND FINANCIAL JUSTIFICATION OF THE PROJECT

The consultants envisaged the following distribution of products for domestic sales and export.

Table XX

Product	Domestic sales (in tons)	Export (in tons)
Acetylene	3,000	
Bleaching powder	1,000	-
Caustic soda	30,000	-
PVC	50,000	12,000
PACN fibre	6,000	20,000
PACN tows	2,000	6,000
Polymethylmethacrylate	4,000	2,000
Methanol	15,000	-
Ammonium sulphate	25,000	22,000
Urea	120,000	-
		200,000

The cash flow statement of the draft report shows a return of 14.28 per cent on the investment in the first year of operation assuming operation at 75 per cent capacity; this would increase to 24.34 per cent in the fifth year.

The project is estimated to save net foreign exchange to the extent of Rs 1[illegible] crores in the first year increasing to about Rs [illegible]0 crores in the fifth year of operation.

1 crore = 10 million

STAFFING

The East Pakistan Industrial Development Corporation has now established the major factories in East Pakistan namely the natural gas fertiliser factory Fenchganj and the urea fertilizer factory [at] Ghorasal both based on natural gas. There are also a number of refineries in operation in both parts of the country. They have served as a training ground for the development of technical skill in the field of [illegible] similar nature and capacity in Pakistan. It is therefore [illegible] internal sources. Wage scales similar to those in oil companies' refineries are being worked out. Provision has also been made for training about [illegible] persons abroad for an average period of six months [illegible] training in the existing gas based chemical industries for about five hundred people at the operation level for a period of about one year has also been assumed in the plan.

MANAGEMENT

In general it is felt that the public sector administration and management is subject to rules, procedures and unable to be competitive with private industry. A sophisticated industry of this kind has not been managed before in this country. The project needs maximum management efficiency in order to compete in the international market. Provision has been allowed for appointing foreign management consultants in this line at an initial fee of 1 per cent on the net profit for the initial period of five years. Fees have been based on profits as a check on the efficiency of the consultants. The primary purpose of appointing foreign consultants is to assist in introducing modern techniques of industrial management in the complex and secondly to infuse such techniques into the general activities of the industrial management of the Corporation. It has been assumed at this preliminary stage that foreign management consultants will be wholly responsible to the Board of Directors for running the complex.

But it is not only in petrochemicals that the technology and expertise have not yet been developed to a sufficient degree in Pakistan. UNIDO can therefore assist us in increasing our knowledge by technical help and training courses. Since it might be necessary to build a plant of considerable capacity [illegible] requirements would also be large. The international finance [illegible] possibly assist us in this respect by providing loans and credits. [illegible] would also be [illegible].

[illegible] starts there would be a [illegible] the industries in the country. [illegible] in establishing [illegible] units and [illegible].

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