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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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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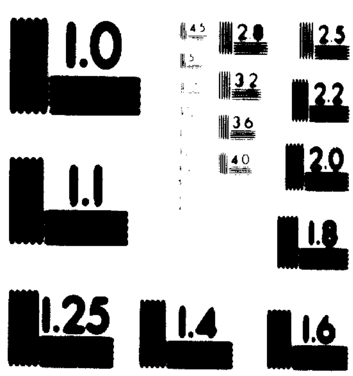


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UNIDO
PROJECT PAK-28

# UNITED NATIONS DEVELOPMENT PROGRAMME/SPECIAL FUND

"PRE-INVEFTMENT STUDIES FOR THE PROMOTION OF FERTILIZER AND PETROCHEMICAL INDUSTRIES IN PAKISTAN"

Pakistan

## PROJECT "B"

## FEASIBILITY STUDY FOR THE PROMOTION OF "MONOMER COMPLEX" IN CHITTAGONG (CAPROLACTAM, TA/DMT AND PHTHALIC ANHYDRIDE)

PREPARED FOR THE GOVERNMENT

*BY*

T. V. Janakievski, D. Ch. E.

UNIDO-EXPERT

ISLAMABAD-PAKISTAN

MAY, 1971

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PAK-26 PROJECT

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T.V. JANAKIEVSKI, D.CH.E.
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"This report is presented to the Government Project Representative without prior approval of either the United Nations or the United Nations Development Programme and therefore does not necessarily represent the views of either organisation".

## ABSTRACT

In this Volume a techno-financial evaluation of the Monomer Complex has been made. The Monomer Complex (Project B) is continuation of BTX-aromatic plant (Project A) Monomer Complex Industry consists of three separate production units:-

| | |
|---|---|
| - Caprolactam unit with capacity | 16,000 T/A |
| - Terephthalic acid/DMT-unit | 18,000 T/A |
| - Phthalic anhydride unit | 8,000 t/y |

Financial evaluation of these three units together in one complex proves that the production of these three monomers as joint project with Aromatics is economically feasible in East Pakistan. Condensed figures are given in the summary of this Volume.

PROJECT "B"

FEASIBILITY STUDY FOR THE PROMOTION OF "MONOMER COMPLEX" IN CHITTAGONG (CAPROLACTAM, TA/DMT AND PHTHALIC ANHYDRIDE)

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# SECTION 1.

## 1. SUMMARY

### 1.1. History, Background and Conclusion

This Feasibility study for the promotion of "Monomer Complex" to say :-

| | | |
|---|---|---|
| - Caprolactam monomer | 16,000 | T/A |
| - Terephthalic acid/DMT | 18,000 | T/A |
| - Phthalic anhydride | 8,000 | T/A |

is a continuation of the Project "A" BTX-aromatics. As we have mentioned BTX-aromatics (Project "A") would be an integral part of Refinery production.

We would suggest that this Project should be physically separate from the Project "A" but it being located on the same site, very close to the Project "A" BTX-aromatics/Refinery.

The implementation of the Project "A" and "B" should be carried out as joint venture (as A+B Joint Project) at the same time.

Out of these (A+B) Projects feasibility studies for the promotion of :-

- Polyester fibers production units in West and East Pakistan and
- Di-octylphthalate (DOP) in West Pakistan will be prepared.

These three units would be consumers of DMT-production and phthalic anhydride from the "Monomer Complex". Caprolactam unit production would be consumed by the existing Nylon plants units in both Wings and the new promoted one.

1.2. General Conclusion.

Analysing the all components of Pakistan we come to the conclusion that the "Monomer Complex" with the following units :-

| | | |
|---|---|---|
| - Caprolactam | 16,000 | T/A |
| - Terephthalic acid/DMT | 18,000 | T/A |
| - Phthalic anhydride | 8,000 | T/A |
| Total | 42,000 | T/A |

should be located in adjacency of the BTX-Aromatics/Refinery-Chittagong as the most economical solution. The basic raw material for these three units will be supplied by Refinery from the Project "A" (BTX-Aromatics plant). Nearly all other materials as Ammonia, Caustic Soda, Sulphuric Acid would be supplied from the other existing or new coming units.

- Ammonia for the production of caprolactam will be coming from Gorosal about 130 miles from Chittagong by Railway.
- Caustic soda from the PVC plant which most probably will be located in Gorosal.
- Sulphuric acid would be provided from extended plant for sulphuric acid in TSP-plant-Chittagong very near to the Eastern Refinery's site.

1.3 Marketing.

Based on the growing market potential and taking into consideration the overall economic objectives and needs of Pakistan.

The planned quantities of production anticipated from the proposed complex are shown under item 1.2. in the previous page.

In the next Chapter the market forecast is given in detail for a period of 1975-80. This means the implementation of this conception should start by 1975 and start-up to come sometime to the end of 1977 and full production during the 1980.

## 1.4 Principal Products.

a) Caprolactam will be consumed by the four existing plants, some of these will be extended and the new coming plants with higher capacity.

b) Terephthalic acid/DMT will be consumed by projected two new manufacturers of polyester fibers :-

| | | |
|---|---|---|
| - One plant in East Pakistan | 6,000 | t/y |
| - One plant in West Pakistan | 12,000 | t/y |
| Total: | 18,000 | t/y |

c) Phthalic anhydride will be consumed by new coming DOP-plant in the scope of PVC-production in East Pakistan and producers of Alkyd Resin in both Wings.

### 1.4.1 Proposed Selling Price.

The proposed ex-factory selling price are estimated on base of CIF and landing existing price.

We would like to make the two alternatives of ex-factory selling price.

**Table 1**

Proposed selling Price

1 US $ = Rs. 4.76

| | Total quantity T/A | Alternative No.1 | | | Alternative No.2 | | |
|---|---|---|---|---|---|---|---|
| | | Price $/t | Price Rs/t | Total value Rs(000) | Price $/t | Price Rs/t | Total value Rs(000) |
| Caprolactam | 16000.0 | 630.0 | 3000.0 | 48000.0 | 588.0 | 2800.0 | 44800.0 |
| DMT | 18000.0 | 567.0 | 2700.0 | 48600.0 | 525.0 | 2500.0 | 45000.0 |
| Phthalic anhydride | 8000.0 | 315.0 | 1500.0 | 12000.0 | 273.0 | 1300.0 | 10400.0 |
| Total | 42000.0 | (504.0) average | (2400.0) | 108600.0 | (462) average | (2200.0) | 100200.0 |

## 1.5 Facilities and manufacturing

Project "B" (Monomer Complex) is actually a continuation of Project A.

The Project "B" would consist of the following plants :-

- Caprolactam plant
- Terephthalic acid/DMT plant
- Phthalic anhydride plant and utilities.

The principal raw material would be :-

- Cyclohexane for caprolactam
- Para-xylene for terephthalic acid/DMT
- o-xylene for phthalic anhydride supplies by the aromatics/refinery plant (Project A).

The calculation have been made on the basis of 320 days (7680) hours on full operation per year).

All required utilities will be produced within the location including a cooling water electric power, steam, DM-wateretc.

It is estimated that the Project A and B which are dependent on each other can be constructed and put in operation in about 36 month from the date of start-up construction.

## 1.6. Financial.

### Required Investment

The total investment required for this Project (B) is estimated as follows :-

| | Local | Foreign | Total |
|---|---|---|---|
| | | Rs(000) | |
| Site and Plant costs | 91743.4 | 155964.5 | 247707.9 |
| Development costs | 20671.0 | 6661.0 | 27332.0 |
| Working Capital | - | - | 15082.7 |
| Total: | 127496.4 | 162625.5 | 290121.9 |

It has been estimated that the ratio between loan and equity to be about 72:28 and the most convenient investor for the Project A and B would be EPIDC. Equity capital would be provided by EPIDC in the form of shareholders equity. The balance assumed to be long term debt local and foreign. The local loan at 8%; for foreign 7% interest was calculated. The long term foreign loan would cover 100 percent of the foreign exchange components required.

The proforma capitalisation would be as shown below :-

| Type of Capital | Local | Foreign<br>Rs (000) | Total |
|---|---|---|---|
| Long term debt | 43000.0 | 162000.0 | 205000.0 |
| Shareholder equity | 85121.0 | - | 85121.0 |
| Total 100% | 128121.0 | 162000.0 | 290121.0 |

1.7 **Estimated Earnings and Fund Generated**

A summary of the estimated profit, loss and the cash generated for the first six years after start-up is shown in Table 2 below :-

**Table 2**

Summary of Estimated Earning and Fund Generated

Rs. (000)

| Yr | Net Sales | Cost of Sales | G & A | Operating income expenses | Other income and | Net Income Before Tax | Net Income After Tax | Non cash chgs | Fund generated |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 92310.0 | 65448.6 | 2628.9 | 24230.5 | 14780.0 | 9452.5 | 9452.5 | 24850.3 | 34302.3 |
| 2 | 103170.0 | 69503.6 | 2628.9 | 30737.5 | 13296.0 | 17533.4 | 17533.4 | 24850.3 | 42383.7 |
| 3 | 108600.0 | 71531.2 | 2628.9 | 34440.0 | 11280.6 | 23159.4 | [illegible]59.4 | 24850.3 | 48009.7 |
| 4 | 108600.0 | 71531.2 | 2628.9 | 34440.0 | 8932.0 | 25507.0 | 25507.0 | 24850.3 | 50357.3 |
| 5 | 108600.0 | 71531.2 | 2628.9 | 34440.0 | 6502.4 | 27937.0 | 27937.0 | 24850.3 | 52787.3 |
| 6 | 108600.0 | 71531.2 | 2628.9 | 34440.0 | 4029.0 | 30410.0 | [illegible]410.0 | 24850.3 | 55230.3 |

It may be noted that first three years reflect a reduced sales revenue by utilisation of capacity due to normal problems of start-up and efficiency of the staff. However, the complex is expected to operate at capacity after three years.

Break even was computed to be at 64 percent on a net income basis. On a funds generated basis, which is the level when cash flow equals the amount required for debt retirement, the break-even point is about 57 percent of capacity.

1.8 Interest and Debt Service Coverage.

The projected coverage of interest on long term debt as well as debt service coverage ratios are as follows :-

Table 3.

Interest and Debt Coverage

| Year | Interest Coverage 1) | Debt Service Coverage 2) |
|---|---|---|
| 1 | 1.65 | 1.40 |
| 2 | 2.35 | 1.67 |
| 3. | 3.00 | 1.88 |
| 4 | 3.55 | 2.00 |
| 5 | 4.20 | 2.13 |
| 6 | 5.30 | 2.27 |

Note: 1. Before income tax.
2. After income tax.

1.9 **Projected Balance Sheets.**

Condensed balance sheets estimated for years first and sixth are shown below :-

**Table 4**

Estimated Balance Sheets

Rs(000)

| | Year 1 | Year 6 |
|---|---|---|
| **Assets.** | | |
| Current Assets | - | - |
| Cash | 9504.0 | 10065.0 |
| Receivable trade | 6261.6 | 7700.0 |
| Inventories | 20641.7 | 20641.7 |
| Total current assets | 36407.3 | 119035.2 |
| **Liabilities** | | |
| Current liabilities | - | - |
| Payable- trade | 9504.4 | 10065.5 |
| Long term Debt due within one year | 20500.0 | - |
| Total Current Liabilities | 30004.0 | 30565.5 |
| Long Term Debt. | 164000.0 | 61500.0 |
| **Shareholders Equity.** | | |
| Capital Stock | 85121.0 | 85121.0 |
| Net retained earnings after dividends | 9452.5 | 96659.1 |
| Total shareholders equity | 94573.0 | 181780.1 |
| Total liabilities and Equity | 288577.0 | 273845.6 |

Cash build-up after providing for debt service and the assumed payments of a dividend to shareholders is substantial. It was assumed that such excess would be invested in Bank Certificates of deposit at five percent. Actually a large portion of this excess cash could be used to retire long-term debt at an accelerated rate, or be invested in additional manufacturing capability which should earn a higher return than five percent.

1.10 Estimated Return Investment.

The estimated return on investment over six year period is summarised below :-

Total Investment

- Annual average 11.5 percent

Shareholders Investment

- Annual average 26.0 percent

The payback on the total investment will be about 6.7 years, about the 4- years for the original shareholders investment.

Return on investment is shown within the six year after start-up only. Taking that the first 2 years the utilisation of capacity is lower than usual one.

1.11 Economic Feasibility.

The overall results of this study indicate that the development of monomer complex in East Pakistan is economically feasible. In forming this judgement, consideration has been given to the projected return on investment together with the value of the project to the economy and progress of East Pakistan as summarised hereafter.

1.11.1 Revenue

The problem of selling price i.e. Revenue of course will be determined by future government policy, therefore, in the final analysis, the price and profit level are matters to be decided by PIDC and the Government of Pakistan.

We are going to make two assumption on selling price and corresponding profit on it.

1.11.2. Foreign Exchange Savings.

The savings in foreign exchange by producing 42000 T/A of these important raw materials, rather than importing a like quantity will be significant.

We could summarised in Table 5 below:-

Table 5

Saving in Foreign Exchange

| Year | Rs(000) |
|---|---|
| 1 | 54,191.5 |
| 2 | 65,313.9 |
| 3 | 71,440.0 |
| 4 | 72,575.0 |
| 5 | 81,906.0 |
| 6 | 74,843.0 |
| 7 | 72,977.0 |
| 8 | 77,111.0 |
| 9 | 78,245.0 |
| 10 | 78,953.0 |

1.11.3 <u>Establishment of Basic Industry</u>

Establishment of BTX- aromatics and Monomer Complex are not important only because of the relatively higher return offered to Secondary Industries, but also will stimulate other sectors, especially Textile Industry which do utilise a greater degree of manual labour on abundant resource in East Pakistan.

1.11.4 <u>Value of the Project to the Economy and Progress of East Pakistan.</u>

The implementation of BTX-aromatics production and Monomer Complex and further processing in synthetic fibres will give impressive benefit to the economy and development of East Pakistan.

As we have mentioned the main stimulation would be the development of Textile Industry on base of own synthetic fibers production.

Among the specific benefit are these :-

- This industry will provide employment for over 1200 people. These employees, trained and up-graded in working skills, will become more productive members of the economy.
- Expenditure of salaries, goods and services relating to the complex will rise the income of the area in which the complex is located.
- Establishment of the production of raw materials for textile industry will give the great impulse to the development of Textile Industry on base of local raw materials.

- The Government will be provided with an additional source of taxable revenue.

- A housing colony for the employees will be provided, including improved living quarters for the people.

- These Projectswill be nearly independent of the export market for disposition of its output. Moreover it will be based primarily on the current import of crude oil used for Petroleum products it means, implementing these Projects, the Refinery production will be rationalised.

- A development of synthetic fibers production is indirect contribution by freeing cotton for export i.e. an additional income of foreign exchange.

# S E C T I O N 2
## MARKETING

## 2.0 Estimated Market

Estimation of market figures are based on the growing market potential in whole Pakistan and taking in consideration the overall economic objectives prevailing in Pakistan. As we have mentioned the implementation of this project should be for the market of both Wings.

Table 6 shows the estimated production in the monomer complex(Project "3") which would be available for sale in the market of Pakistan.

**Table 6**

Monomers Complex Production

| | Items | Ton/annum by 1980 |
|---|---|---|
| 1. | Caprolactam | 16,000.0 |
| 2. | Terephthalic acid/DMT | 18,000.0 |
| 3. | Phthalic anhydride/PA | 8,000.0 |

All production of caprolactam and DMT is destined for production of synthetic fibers- Nylon and polyester fibers respectively, then we would analyse market conditions of these two fibers.

Currently, total world production of synthetic fibers is about 6.5 millions tons/ annum. It is growing at about 20% per annum and showing only slight signs of slacking its rate of growth. The estimated market share and rate of growth of each main categories is :-

| | % of Total | % p.a. growth |
|---|---|---|
| Nylon fibre | 38.4 | 13 |
| Polyester fibre | 33.1 | 20-25 |
| Acrylic | 19.5 | 20-25 |
| Other synthetic fibres | 9.0 | |
| | 100 | |

A production capacity of man-made fibres in some countries of the world by 1970 is shown in Table 7 below :-

Table 7

Production capacity of man-made fibres in some countries of the world by 1970

| | Cellulosic<br>Million of pounds | Synthetic Fibres<br>Million of pounds |
|---|---|---|
| **Most Developed Countries.** | | |
| U.S.A. | 1575.0 | 3484.0 |
| Japan | 1093.0 | 1777.0 |
| W.German | 549.0 | 796.0 |
| England | 571.0 | 801.0 |
| France | 257.0 | 292.0 |
| **Several Developing Countries.** | | |
| Yugoslavia | 82.0 | 33.0 |
| Spain | 45.0 | 192.0 |
| Argentina | 27.5 | 117.5 |
| Brazil | 96.0 | 99.0 |
| Venezuela | 9.0 | 21.5 |
| Iran | - | 8.8 |
| Hungary | 9.1 | 17.5 |
| Greece | 1.7 | 31.0 |
| Mexico | 52.0 | 138.0 |
| Pakistan | 15.0 | 8.2 |
| India | 129.5 | 54.8 |
| China-Mainland | 40.0 | 26.0 |
| Egypt | 17.5 | 1.9 |

Textile Organon.

## 2.1 Caprolactam

### 2.1.1 Situation in the World

Virtually all the caprolactam produced is destined for Nylon 6 production, its position is essentially tied to the Nylon 6 market. Within this filed the bulk of production goes to the fibres industry with textiles, carpeting and tire cord as the dominant outlets. A limited proportion is also used as a resin for moulding and extrusion, plastics and films, synthetic leather, plasticizers, paint, vehicles, as a cross linking agent for curing polyurethane and as the base material for synthetic resin.

Although production in any industry does depend on the availability of feedstock, at the present time this is not a criterion in the caprolactam field. The current position and immediate future of caprolactam is not related to cyclohexane production, it is directly linked to its main outlet, Nylon 6.

Over the past few years or so the polyamides market has been through a rather rough time. The polyamides have felt rather keenly the increasing competition from the newer synthetic fibres-acrylics and polyesters and although the market for polyamides has continued to grow, chiefly as a result of the success of synthetic fibres as a whole, Nylon is not expected to ever attain its former growth rates, mainly because of the increasing competition from polyesters. About 12 years ago, polyamides accounted for two thirds of the world's total synthetic fibres production, followed by acrylics with about 14% of the market, with polyester still further behind. Figures for 1968 still show polyamides as the main synthetic fibre but their lead has been reduced to some 50% of the total synthetic market. Polyesters have now overtaken acrylics and, within the next several years, will overtake polyamides.

Both Nylon 6 and Nylon 66 were in fact introduced in 1930's; Nylon 66 Du Pont in USA, and Nylon 6 by Schlach in West Germany, while acrylics and polyesters are both essentially post war development. Nylon consumption will undoubtly continue to go up since synthetic fibres have a long way to go before their full potential is realised in the textile field. Today synthetic hold over 25% of the market. Even so, the time when synthetics account for even half of textile fibres is not very far. When the time comes, it is anticipated that the natural fibres wool and cotton will become the high quality, high priced product.

As far as the individual synthetic are concerned future growth will tend to be at the expense of these natural fibres although there will be some inter-synthetic competition. Poly-amides have already suffered considerably in this way from the polyesters. Currently over a third of the world's total synthetic fibres output is produced in USA, EEC and Japan.

Caprolactam Producers

At present West Germany is the biggest exporter of caprolactam within EEC countries. In the Table 8 are shown the major caprolactam producers.

Table - 8

Major Caprolactam Producers

| Location | Company | Present Capacity t/annum | Projected capacity |
|---|---|---|---|
| Belgium | Bayer | 70,000 | - |
| | BASF | 60,000 | - |
| Czechoslovakia | - | 7,500 | 26,000 |
| East Germany | Leuna | 40,000 | 64,000 |
| Hungary | - | 20,000 | - |
| Italy | Montecatini Edison | 75,000 | - |
| | Rhodiatoce | 9,000 | - |
| | Snia Viscosa | 60,000 | - |
| | SIR | 12,000 | - |
| | ANIC | 20,000 | - |
| India | Gujarat State | - | 20,000 |
| Japan | Mitsubishi | 90,000 | - |
| | Ube Kosan | 105,000 | - |
| | Toyo Rayon | 95,000 | - |
| | Nippon Lactam | 40,000 | - |
| | Fuji Steel Co. | 25,000 | - |
| | Honshu Kagaku | 14,000 | - |
| Netherland | DSM | 110,000 | 120,000 |
| Poland | - | 15,300 | - |
| Rumania | - | 65,000 | 70,000 |
| South Korea | Toyo Caprolactam | 10,000 | - |
| | Dong Yang Caprolactam | 7,200 | - |
| | Allied Chemicals/Chungju | - | 25,000 |
| Spain | Productos Quimicos | 20,000 | 40,000 |
| | ESSO | 20,000 | - |
| | Rio Tinto/BASF | 20,000 | - |
| | Productos del Aquitania | - | 35,000 |
| Switzerland | Emswerke | 16,000 | 21,000 |
| Turkey | Petkim | - | 25,000 |
| U.K. | Nypro | 20,000 | Expansion announced |
| U.S.A. | Allied Chemical | 135,000 | - |
| | Dow Badische | 100,000 | - |
| | Columbia/Nipro | 22,000 | 30,000 |
| | Union Carbide | 20,000 | - |
| U.S.S.R. | - | 100,000 | 200,000 |
| West Germany | Bayer | 123,000 | - |
| | BASF | 160,000 | - |

2.1.1.1 <u>Application of Polyamide Fibres</u>

While it is possible to obtain fairly accurate data for the consumption of Nylon fibres in certain major markets, such as tire cord and broadloom carpets, it is difficult to determine exactly how much is used in many smaller markets.

The main application of Nylon can be summarised into followings groups and percent of participation:-

| | |
|---|---|
| <u>Tire Cord</u> | with 28.5 percent |
| <u>Apparel</u> | -"- 28.3 -"- |
| Men's | |
| Women's | |
| Children's | |
| <u>Home Furnishings</u> | 27.0 -"- |
| - Broad loom carpets | |
| - Other home furnishings | |
| <u>Industrial Uses</u> | 6.2 -"- |
| Other consumers products | 6.0 -"- |
| | 100% |

2.1.1.2 <u>Tire Cord</u> - By 1967 Nylon held about 70% of the replacement tire market for cars, and about 90% of the replacement market for truck and busss. Tough competition between Nylon, Rayon and Polyester fibers is existing during recent years.

2.1.1.3 <u>APPAREL</u> - Nylon is extensively used in both the textile and the industrial field. Its first major use was in the field of ladies hosiery, where it soon displaced silk in addition to its very good abrasion resistance, the heat-setting properties of Nylon made it possible to set the stockings in the desired shape which was then retained indefinitely in use. The elastic nature of Nylon prevented sagging or bagging as a result of flexing while being worn. The high tenacity of Nylon made it possible to produce stocking of increasing sheerness by the use of finer yarns. Nylon staples are used in blends with wool for many textile applications. The incorporation of Nylon in the blends increasing the breaking strength and resistance to abrasion of the resulting yarns and fabrics. The use of Nylon also increases the processing efficiency and enables finer yarns to be spun. In this sector the Nylon is represented with 2[illegible] percent of total non-cellulosic fibres application in the following products:-

- hosiery
- Nightwear
- Underwear -knit
- Underwear -women
- Sports shirts-knit
- Dress shirts
- Work & uniform shirts
- Utility clothing
- Polysuits
- Swimclers
- Outdoor jackets
- Overcoats
- Separate slackes
- Sweaters
- Robes and neckties
- Rainwear
- Brassieres

Nylon's major competitor on the basis of both properties and price is Polyester Nylon has the advantages of higher elasticity and being easier to dye. Acrylic fibers also compete with Nylon fibers in many areas, particularly in knitted markets formerly dominated by wool for example men's hose and knitted outwear.

2.1.1.3 Home Furnishings

Broadloom Carpets

The use of Nylon in carpet manufacture(generally alone but also in blends with Natural or other synthetic fibers) is attributed primarily to the growth of tufted carpets, which now make up 90% of the pile floor-covering market. Carpeting has sold extremely well in both residential and commercial markets. Important factor in the residential market have been increasing disposable income. In the commercial area, carpets are effectively competing with hard floor coverings. They reduce noise, provide insulation, are safer, provide a psychological lift and are cheaper to maintain. Nylon carpets have been merchandised in a wide price range from the high quality residential types that compete with wool and acrylic carpets to the inexpensive residential and contract variety.

Polyester fibers, recently have been competing with Nylon for the carpet market.

Other home furnishings

Bedspreads, Blankets, Sheets, Rugs, Curtains Drapery and upholestery.

2.1.1.4 Industrial Uses.

Nylon fibers have done well in a variety of industrial application where fibers stand or fall in price and performance alone- unlike apparel and home furnishings, in which esthetics, tradition, and other more subjective value are after a prime consideration.

Nylon is particularly valued in tow ropes because its elasticity allows the rope to withstand sudden increases in force. Tarpaulins, tents, and other such coverings made from nylon are much stronger than similar items of cotton and are moisture and mildew- resistant other industrial nylon markets of importance are in transportation upholstery (particularly in aircraft) horse power transmission, and conveyor belting and sewing thread.

2.2 <u>Dimethyl Terephthalate/Polyester Fibers</u>

The polyester fibers compete with the other synthetic fibers in nearly all textile markets apparel, households, tire and industrial so that a synthetic fiber producers not making polyester fibers must consider making them or face loss of markets. At present the contribution in various fields and application approximately can be summarised as follows :-

| | |
|---|---|
| - Apparel | 62 percent |
| - Household | 18 percent |
| - Tire cord | 10 percent |
| - Other consumer products | 5 percent |
| - Industrial | 5 percent |
| | 100 % |

2.2.1 <u>Polyester Fibers Staple</u> currently accounts for about 75% of total fibers output. The staple is generally combined into polyester/cotton, polyester/wool or polyester/rayon blends to take advantage of such quantities imported by the polyester as abrasion resistance and wrinkle resistance.

In apparel, polyester blends are used in shirts, slacks, skirts, suits and uniforms. Use of polyester staple in tufted carpets has grown rapidly in other household items, polyester blends are used primarily in such items as sheets and curtains.

2.2.2 Polyester Yarn Output Currently accounts for about 28% of total production. Industry sources indicate that yarn production is more profitable to the fiber producer than staple production. Yarn is used mostly in knit apparel particularly textured yarns, and in tire cord. The high strength and resistance to stretch of polyester yarns makes them especially suitable for tires and for such industrial application as hose and belt reinforcement polyester yarn use in carpets was introduced recently.

The growth of polyester/cotton and other durable press textiles has been phenomenal. Probably over 80% of all women shirts are durable press. Other apparel in which durable-press treatments are almost universal are in polyester/cotton and polyester/rayon slacks, skirts, dresses, blouses uniforms, jackets, raincoats and nightwear. Durable press is also making heavy inroad into sheets pillowcases, table cloth and other napery, slip covers, curtains and draperies.

Polyester fibers have grown faster through their use in blends, chiefly with cotton, wool and rayon.

2.2.3 Apparel- the biggest market for polyester fibers is in apparel, mainly as staple, although filament yarn-especially textured yarn is becoming increasingly important.

The outstanding characteristics that make polyester fibers so attractive in apparel are ease of care, high strength, high resistance to stretching and shrinking, crisp resilience when wet and dry(meaning fabrics that do not wilt or droop) and the ability to be shaped by heat and to retain heat-set shapes through many washings.

In this category the men, boys, children and women's wear, the polyester fibers contribute about 40% of total synthetic fibers consumption in the following goods :-

- Suits
- Uniform
- Sport jackets
- Overcoat
- Outdoor jacket
- Coat, raining coats
- Outdoor jackets
- Work and uniform shirts
- Dress shirts
- Sport shirts- woven
- Sports shirts - knit
- Underwear - woven
- Underwear - knit
- Nightwear
- Hosiery

The most dynamic application of polyester fibers in apparel has been as staple in polyester/cotton durable press blends. These blends now dominate the dress and woven sports shirt market. Blends with cotton and rayon are widely used in slacks, suits and uniform, rainwear and nightwear are also proving important markets. Polyester/wool blends are widely used in suits of a variety of weights and in separate slacks and sport coats.

Durable press polyester/cotton blends are used in blouses and skirts, dresses, slacks, shirts sports, sports and leisure wear, rainwear and service apparel. Polyester/rayon blend are also penetrating certain of these market as in skirts and slacks. Poly-ester yarn consumption in women's wear has grown much more rapidly than in men's wear.

2.2.4 Carpets

In appearance, spun staple polyester carpets most closely resemble acrylic carpets but have the higher abrasion resistance of nylon carpets. Continuous filament polyester carpets are similar to Nylon continuous filament carpets in such properties and durability and resilience but are perhaps a little less synthetic- like in hand appearance. One of the biggest advantage polyester fibres have in carpets is that "polyester" is name that is well known to consumers and has a good reputation. Most industry sources believe that broad-loom carpets will continue to provide a fast- growing market for polyester fibers.

2.2.5. Tire-Cord.

The penetration of polyester fibers into the tire-cord market in recent years is remarkable. Polyester fibers are being used predominantly in belted tires, although some are also used in conventional bias-ply tires.

As we have mentioned the polyester fibers have made sharp inroad into many of cotton's markets, most notable in polyester/ cotton blends when first introduced, polyester staple was much more costly than even the expensive long-staple varieties of cotton but substantial polyester price cuts have made them comparable in price on a utility basis. In fact, polyester/cotton blends have been selling below the cost of equivalent all cotton fabrics.

In the developed countries the staple fibres prices have bottomed out because in view of the fact that capacity is growing faster than expected consumption. In Table 9 is shown the trend of polyester fibers price during the last twenty years in U.S.A.

Table 9.

Polyester, Nylon prices trend 1951/71
(cents/pound)

| | Regular | | Tire Cord | | Carpet Yarn | | Staple | |
|---|---|---|---|---|---|---|---|---|
| | Nylon | Poly-ester | Nylon | Poly-ester | Nylon | Poly-ester | Nylon | Poly-ester |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 1951 | 225 | 235 | - | - | - | - | 180 | 180 |
| 1952 | 225 | 235 | - | - | - | - | 180 | 180 |
| 1953 | 225 | 235 | - | - | - | - | 180 | 180 |
| 1954 | 225 | 235 | - | - | - | - | 153 | 180 |
| 1955 | 225 | 235 | - | - | - | - | 153 | 160 |
| 1956 | 190 | 190 | - | - | - | - | 127 | 135 |
| 1957 | 201 | 201 | - | - | - | - | 130 | 141 |
| 1958 | 201 | 201 | - | - | - | - | 130 | 141 |
| 1959 | 201 | 191 | 120 | - | - | - | 130 | 136 |
| 1960 | 201 | 191 | 97 | - | - | - | 130 | 136 |
| 1961 | 201 | 197 | 92 | - | 147 | - | 126 | 124 |
| 1965 | 201 | 182 | 82 | - | 117 | - | 98 | 84 |
| 1966 | 201 | 167 | 82 | 110 | 128 | - | 98 | 84 |
| 1967 | 201 | 167 | 82 | 90 | 123 | - | 98 | 88 |
| 1968 | 201 | 167 | 82 | 90 | 119 | - | 98 | 61 |
| 1969 | 201 | 167 | 82 | 90 | 119 | 135 | 84 | 61 |

Notes:- 1. Apparel Du Pont's 40 den, 13 filament, type 280; standard multifilament yarn first grade, bobins.

2. Celanese's to denier, 36 filament, type 700 regular tenacity yarn for general textile application, semi-dull, bobins.

3. Du Point's 840 den, 140 filament, type 702, tire quality yarn, beams.

4. Midland ross crop; high tenacity yarn, 1300 den. 250 filament, beams.

5. Du Pont's 3700 den, 204 filament, type 845 carpet yarn, tube.

6. 4400 den, bulked continuous filament yarn.

7. 3 den. type 201 staple first grade.

8. 3 den, staple length 1½ - 4½ inches.

2.2.6 <u>World Production of Synthetic Fibers</u>

The trend of production of synthetic fibers in the world is shown in Table 10 below :-

**Table 10**

World Production of Synthetic Fibers
(000) ton/year.

| | 1963 | % | 1964 | % | 1966 | % | [illegible] | % | 1970 | % |
|---|---|---|---|---|---|---|---|---|---|---|
| Nylon fibers | 740.0 | 55.3 | 902.7 | 53.2 | 1216.8 | 48.9 | 1628.2 | 43.2 | 2493.0 | 38.4 |
| Polyester fibers | 2636.6 | 19.7 | 339.1 | 20.1 | 590.0 | 23.7 | 1078.2 | 28.6 | 2142.7 | 33.1 |
| Acrylic fibers | 211.8 | 15.8 | 300.9 | 17.8 | 458.2 | 18.4 | 738.2 | 19.6 | 1265.0 | 19.5 |
| Other synthetic fibers | 119.5 | 9.2 | 151.8 | 8.9 | 222.7 | 9.0 | 323.6 | 14.7 | 590.0 | 9.0 |
| Total synthetic fibers | 1337.2 | 100.0 | 1694.5 | 100.0 | 2487.7 | 100.0 | [illegible] | [illegible] | 6490.0 | 100.0 |

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Textile Organon June, 1970

Polyester fibers are actually the fastest growing synthetics in the world and are expected to increase their share of the total market for synthetics from [illegible] in 1968 to [illegible] in 1975.

Although the other major synthetic fibers have been somewhat limited in the number and kinds of textile applications for which they may be best utilised, polyester appears to be the best " all-round synthetic" textile fiber.

Nylon as the veteran, has over the year been tried in almost every conceivable end use, but today is essentially only a continuous filament fiber. It is well utilised in industrial carpeting and certain knitted apparel areas.

Acrylics on the other hand are essentially only staple fibers. With their wool-like appearance and handle, they have followed the wool types of end uses; floor coverings blankets and other home furnishings and knitted outer wear.

Polyester fibers on the other hand have achieved considerable stature in both staple and continuous filament forms as has been said hitherto.

2.3.0 <u>Situation in Pakistan</u>

<u>Facts about Textile Industry</u>.

Textile industry of Pakistan is most developed sector of Pakistan's industrial structure in terms of :-

- Value of fixed assets
- employments

- value of production
- foreign exchange earning
- steady process in development of production and export prospects.

By June 1969 the textile industry had following capacity.

2.3.1 <u>Cotton Industry</u> by 1969-70 was composed of 186 textile mills consisting of the installed 2,906,000 spindles and 37,800 looms. Working capacity: 2700,000 spindles and 31000 looms.

Fourth Five Year Plan (1970-75) estimate increasing of capacity to the following figures :-

- about 3800,000 spindles
- about 30,000 looms

The per capita availability of cloth for consumption was 12.4 yds. by 1969-70. The projected increase by Fourth Five Year Plan is to 18 yards/per capita. To achieve these figures, about 2610 million yards of cloth will be required to meet the demands of grown population by 1974-75(about 145 million people) [illegible]% of above is expected to be produced in mill sector 20% by private loomers.

Export of cotton fabrics is estimated to grow 300 million yards 1974-75 and yarn to about 300 million lbs.

Fourth Plan targets in production of cotton yarn are assumed as follows :-

| | | |
|---|---|---|
| -East Pakistan | 400 million lbs | (182,000 t/y)by 1974-75 |
| -West Pakistan | 700 " " | (318,000 t/y)by 1974-75 |
| Total | 1100 million lbs(500,000 t/y) | |

Total target in production of cloth should be:-

- for local market 2,610 million yds
- for export 500 " "

Total 3,110 million yds.

The total yarn production should be:-

- for production of cloth 800 million lbs
- yarn for export 300 million lbs.

Total 1100 million lbs.

2.3.2 Woollen Industry- Existing Facts.

Woollen compared with cotton industry is a very small sector.

The woollen industry now consist of :-

- Worsted sector about 42000 spindles
- woollen sector about 29000 spindles

and 800 worsted/woollen looms.

Almost the entire existing capacities are located in West Pakistan. The first woollen mill of East Pakistan (Valika) is at present under construction.

The capacity in the field of carpets for machine-made carpets(existing and sanctioned is about for 3 million sq.yards).

On the basis of PIDC survey the output in 1967-68 is roughly estimated as :-

- yarn 16 million lbs
- Cloth 8 million yards.
- Blankets 07 million pcs.
- Carpet and rugs 1.5 million sq.yards.
- Miscellaneous goods 2.6 million lbs.

In the above products the local and imported wool as well as yarn and tops were used.

The annual import of worsted yarn was averaged about 800,000 lbs. and in form of tops 2500,000 lbs.

In addition about 1.5-2.0 million lbs. of superior quality wool is also imported to feed the domestic textile industry.

The total availability of woollen textiles has steadily increased and currently placed at about 19-20 million lbs.(1960) based on the Rs. 1.5/pound realising of Rs.27 million in foreign exchange.

## 2.3.3 Existing Carpet Industry in Pakistan.

Pakistan has been produced hand-knitted carpets both for home consumption and export, machine made carpets production was first started in 1958 with the establishment of machinery for the production of jute carpet in Chittagong. In 1962 WPIDC started production of woollen carpets in Quaidabad. In 1960 machine made carpets were first exported from Pakistan.

Pakistan has quite good position for production of carpets both woollen and jute type as all the raw materials required wool, jute and cotton are available.

At present five mechanised units are operated in Pakistan 4 in West Pakistan and I unit in East Pakistan. The installed capacity and production of these units are as follows :-

| | Installed capacity sq.yds. | Current production sq.yds |
|---|---|---|
| Milton carpets | 675,000 | 350,000 |
| Administer carpets | 230,000 | 165,000 |
| Tufted carpets | 420,000 | 80,000 |
| Total | 1,324,000 | 595,000 |

| | |
|---|---|
| East Pakistan | 80,000 |
| West Pakistan | 1,244,000 |
| | 1,324,000 sq.yds. |

Consumption of carpets inside the country.

| | |
|---|---|
| Machine made woollen | 60% |
| Hand knitted woollen | 30% |
| Machine made jute | 10% |

Pakistan export performance in the field of carpets is very optimistic. The foreign exchange earning is steadily increasing. Till now hand made carpets were mostly exported. With establishment machine manufacturing, machine made carpets are gaining importance both for home consumption and for export.

As can be seen from the installed capacity which is 1324,000 sq.yards, but production is less than 50% which shows the lack of selling ability.

Export of carpets from Pakistan in Rs/million.

| | 1965/66 | 1966/67 | 1967/68 |
|---|---|---|---|
| Woollen Carpets | 13.0 | 26.0 | 31.0 |
| Jute carpets | 2.9 | 6.6 | 2.4 |
| | 15.9 | 32.6 | 33.6 |

## 2.3.4 Estimated requirements of woollen textiles in Pakistan.

On basis of assessment in PICIC Survey, the trend of consumption of woollen textiles in Pakistan is going at the rate of 5-7% per annum. On this basis estimated requirements by 1970-75 should be :-

**Table 11**

**Estimated Future Requirements in Woollen Textile in Pakistan.**

| Year | Total yarn m/lbs | Cloth m/yds | Blankets m/Nos | Carpets & Rugs m/sq.yds | Misc. products m/lbs | Total raw wool required |
|---|---|---|---|---|---|---|
| 1969-70 | 16.9 | 9.0 | 068 | 2.0 | 2.90 | 20.0 |
| 1970-71 | 17.7 | 9.2 | 074 | 2.2 | 2.92 | 21.0 |
| 1971-72 | 18.5 | 9.4 | 0.80 | 2.4 | 2.94 | 22.0 |
| 1972-73 | 19.3 | 9.6 | 096 | 2.6 | 2.96 | 23.0 |
| 1973-74 | 20.1 | 9.8 | 093 | 2.8 | 2.98 | 24.0 |
| 1974-75 | 21.0 | 10.0 | 1.00 | 3.0 | 3.00 | 25.0 |

Sources :- PICIC Survey, 1969.

- In above estimation is included expected export.

The total requirements of rawwool to meet the above demands would be about 25 million lbs. On the basis of the past pattern of consumption, the industry may require over 6 millions lbs of imported wool (yarn and tops).

Assumption : 1. One lb. of raw wool = 0.887 lbs of yarn
2. One lb. of yarn = 1.1 yards of cloth
3. One lb. of yarn = 075 sq.yd. carpet
4. Five lbs of yarn = One blanket.

The current output of raw wool is about 36 million lbs. on the basis of 70% clean content. The produced wool in Pakistan is coarse, with a spinning value of 44s and suitable for production of :-

- Carpets
- Blankets
- Ordinary woollen goods

For worsted industry products demands the better quality wool about 56s+ should be imported. A certain quantity of top superior quality of imported wool in worsted industry for medium quality of products.

2.3.5 Silk Industry

The silk industry at present is in the stagnate position in term of utilisation of capacity because of very high Government taxes.

The installed total capacity (in the settled and unsettled area) for production of silk fabrics are as follows:-

- 120,000,000 Yards in the settled area with 14000 looms
- 45,000,000 Yards in the unsettled area with 5000 looms

165,000,000 | 19000 looms

In terms of used yarn should be 23 million lbs/yr.

- Production of silk fabrics in 1968 was about 90,000,000 Yards in term of used yarn was 13 million lbs.
- Production in 1969 has dropped to the 67 million yards of fabrics. In terms of used yarn was 9.580 million lbs.

Pakistan silk industry consumes mostly man-made filament and small quantity of natural silk. Therefore, the raw material for silk industry are as follows :-

- Acetat cellulose filament

| | | |
|---|---|---|
| - Produced locally about | 8700 | t/y. |
| - Imported | 4000 | t/y. |
| - Nylon filament (local production) | 3000 | t/y. |
| - Imported about | 1000 | t/y. |
| - Polyester filament (imported) | 400-600 | t/y. |

2.3.6 <u>Domestic production of Nylon</u>

Four plants for production of nylon 6- nylon yarn already exist in Pakistan, one of them in East Pakistan and three in West Pakistan based on the imported raw material. Manufacturers of nylon 6 and nylon yarn are shown in Table 12 below :-

<u>Table 12.</u>

Manufacturers of nylon 6

| Name of Producers | Equipment | Polymerisation process | Required raw material | Present capacity T/A |
|---|---|---|---|---|
| 1. Pearl Nylon Mad Lyallpur | Polymerisation melt spinning | batch | Caprolactam | 450.0 |
| 2. Nylon Industries Ltd. Chittagong | Melt spinning | - | Nylon chips | 1000.0 |
| 3. Bound Industries Ltd. Karachi | | batch | Caprolactam | 1000.0 |
| 4. Bengal Fibers Ltd. Karachi | Polymerisation melt spinning | batch | Caprolactam | 1500.0 |
| | | | | 3950.0 |

1. **Zenal Nylon Ltd. Lyallpur** was the first firm to start production of Nylon yarn in Pakistan 1965. At present this plant is producing the yarn and twine, various types of guts for sports articles made in Sialkot make up a part of production. Recently the chips as material for injection moulding, for manufacture of gear wheels brushes and tyre. The production of yarn is in full swing for silk industries of Pakistan.

2. Nylon Industry Ltd - Chittagong started the production of yarn on the basis of imported chips in 1966. This factory has only a spinning plant and the associated stretching and coiling machines, the capacity of which was extended to 1000 T/A in 1967/68. The production programme covers yarn, tyre cord and twine.

3. **Dawood Industries Ltd- Karachi** Started production by 1968 with polymerisation and spinning with a capacity 1000 t/annum. The 4000 T/A for yarn and 600 T/A tire-cord and twine.

4. Bengal Fibre Ltd- Karachi started production of yarn 1969 on base of imported caprolactam. The production programme covers- yarn twine and tire cord.

The extension of production capacities has been facing the problems of high taxes. Thanks to production by tariff and bonus voucher imports and the heavy demand for nylon yarn. This industry achieved a favourable economic climate. Taxation of local industry, however, is considered too high. On imported copralactam for instance, fees totaling 43 percent of the C & F value are charged. In addition, a sales tax of 20 percent ad valorem and excise duty of Rs. 11 per kg. are levied on locally manufactured Nylon yarn. The resulting high prices for Nylon yarn make Nylon material a kind of luxury commodity with a limited market i.e. is retarding the extension of potential market.

A serious handicap to the Nylon Industry is import of twine for fishing nets by the fishermen's Corp. Society with lessend taxes and Pakistan's producer can not compete with those import. The small capacity of existing plants is another set-back of market extension.

2.3.7 Market Dynamics.

The consumption of Nylon is fiber from more than doubled in the course of three years in Table 13 below can be seen the consumption of polyamides during past period.

Table 13

Consumption of polyamide 1965-70
(in tons)

| | | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|---|---|---|
| West Pakistan | Twine | 160 | 125 | 145 | 140 | 150 | 160 |
| | Cord | 150 | 160 | 135 | 20 | 30 | 50 |
| | Yarn | 1350 | 3670 | 3530 | 3760 | 3800 | 3920 |
| | Guts | | | | | | |
| | Total | 1685 | 3955 | 3810 | 3920 | 3980 | 4130 |
| East Pakistan | Twine | 100 | 140 | 190 | 105 | 200 | 220 |
| | Cord | - | - | - | - | 100 | 120 |
| | Yarn | 130 | 120 | 110 | 145 | 180 | 240 |
| | Guts | | | | | | |
| | Total | 230 | 260 | 300 | 250 | 480 | 580 |
| All Pakistan | Twine | 260 | 265 | 335 | 245 | 350 | 380 |
| | Cord | 150 | 160 | 135 | 20 | 130 | 170 |
| | Yarn | 1505 | 3440 | 3440 | 3905 | 3980 | 4160 |
| | Guts | | | | | | |
| | Total | 1915 | 3910 | 3910 | 4170 | 4460 | 4710 |

Battell Institute Marketing Survey.

**Tire-Cord** the only consumers of tire cord last years were General Tyre and Rubber Co., Karachi. This enterprise used Nylon cord for the manufacture of automobile tyres. The Pakistan Belting Co., Lahore is using Nylon cord into driving belts and conveyor belt. Textile Industries is using the Nylon for making the following items :-

- Fabrics for ladies, wear, saris 60%
- Shirt cloth, pure or blended with artificial silk 20%
- Suitings 15%
- Other(Curtains for export hosiery etc.) 5%

## 2.2.3 Forecast of Consumption Trends

Analysing the present situation in Textile Industry of Pakistan and trend of demands of synthetic fibres we found that the consumption of Nylon, by textile industry and other sectors would be as it is shown in Table 14.

Table 14.

| | Twine | Cord | Yarn | Total. |
|---|---|---|---|---|
| 1975 | 320 | 350 | 5200 | 5870 |
| 1975 | 390 | 500 | 7710 | 8000 |
| 1980 | 580 | 1000 | 15420 | 17000 |

Major consumers of Nylon 6

The major consumers of Nylon yarn could be summarised to the following terms :-

- Marilin Silk Mills - Chittagong.
- Royal Textile Industries/ Chittagong
- Karim Silk Mills- Karachi.
- Sabina Ltd- Karachi
- H.M. Silk Mill- Karachi
- Dadabhoy Silk Mills- Karachi
- National Silk and Rayon Mills, Lyallpur.
- Liberty Silk Mill- Karachi
- Iqbal Ltd., Karachi
- Abid Industries- Karachi.

These ten mills at present are absorbing about 80% of Nylon yarns.

2.39 Prices

The whole sale prices in Karachi for yarn produced in Pakistan are :-

40-60 Rs./kg.for 40-15 denier. This prices include

20 % sales tax and

11 Rs/kg excise duty.

The total tax payable, including customs duties on caprolactam, thus comes to

34 to 42% of the whole sale price.

For import, only yarns of substandard quality are admitted. Their present price, C & F at Karachi :-

1.36 to 1.54 $/kg. (40 to 20 denier).

The import charges are as follows :-

25% duty on C & F value

15% sales tax on duty paid value

1% rehabilitation tax on duty paid value

25% defence surcharge on sale tax

17% on C& F value for bonus voucher.

If these figures are added up, it is found that the total charge for imported yarns is a remarkable.

48% on the C & F value

The landed cost thus amounts to

38 - 43 Rs/kg.

Nylon Twine is imported by the fishermen's corporative Societies duty free under foreign loan. The C & F price is 1.76 $/kg. for Japanese twine and 2.64 $/kg. for US twine.

The data above are showing in which extent the policy of the government can stimulate and retard the extension of synthetic fibers market.

2.3.10 DMT/Polyester Fibers Market

Polyester fibers are not yet manufactured in Pakistan. Under the present Government policy the Pakistan's Textile Industry imported an insignificant quantity of polyester fiber.

Past consumption figures are listed in Table 15.

Table 15.

| | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 |
|---|---|---|---|---|---|---|
| Staple fibers | 20 | 50 | 30 | 30 | 50 | 80 |
| Filament | 80 | 110 | 50 | 50 | 80 | 90 |
| Blends | 5 | 80 | 15 | 15 | 20 | 35 |
| Effect yarn | 45 | 75 | 105 | 105 | 130 | 200 |
| Total | 150 | 315 | 200 | 200 | 280 | 405 |

Normally the staple fibers is consumed by cotton and woollen industries. Filament and filament yarn are consumed by silk industries.

The landed cost is so extremely high, then the mills have so far imported polyester only to a very limited extent. This is understandable, because the polyester fabrics produced in Pakistan face the competition of the local cotton articles as well as of the Japanese fabrics which can be obtained on bonus voucher; both groups are much cheaper. Thus, up to now no continous production of polyester/cotton fabrics has developed in Pakistan.

2.3.11 Forecast of Consumption Trends.

As is shown by the above statements, the actual consumption figures can not be taken as yard stick of the latent demand for polyester fibers.

The all analysis directed us that the potential consumption power in Pakistan conditions are in favour of polyester fibers and in the near future, will gain the leading position. This could be achieved with availability of this fiber. The promotion of domestic production is best solution to remove the hindrance of normal development.

Reference to the World trends of synthetic fibers is the best indication for Pakistan as well as polyester fibers are fastest growing of synthetic fibers, owing their outstanding features in the all textile system( cotton,woollen/ worsted and silk).

The properties of fibers can be considered by providing the various types of fibers into three main groups :-

- high tenacity filament yarn
- medium tenacity filament yarn
- staple fibers.

These groups differ considerably from each other in respect of certain physical properties, but within any one group, the differences are generally only slight, although alternation in denier may affect some characteristics.

Normally polyester filament yarn is produced in the following yarn deniers 25,40,50,75,100,125,150,250. In the widely used yarn deniers of 50,75,100 and 150 the individual filaments are each of approximately 2 den.

Staple fibers are made in a range of filament denier from 1.5 to 10 in dull lustres. Various types, which may differ appreciably in properties are designed specifically for use on the various spinning systems, such as worsted woollen cotton or flax system.

Polyester filament as supplied shrinks apprximately 3% in air at temp. of 100°C and 10% at 150°C.

Polyester staple fibers differ from the filament yarn in being heat stablized during manufacture and staple fibre shrinks less than 1% in boiling water etc.

The end uses of polyester fibers have developed largely on basis of these important characteristics, enabling polyester fibers to become one of the most versatile of all modern synthetic fibers.

The introduction of polyester fibers in the blends with natural and other synthetic fibers started nearly twenty years ago. A marvellous customer acceptance during the past years stimulate a rapid growth of polyester blends.

According to certain statistics the production and consumption of various polyester blends in the recent years were as follows :-

| With Cotton | With Wool | With Rayon | With Nylon Cotton and acrylic |
|---|---|---|---|
| 42% | 6% | 12% | 10% |

Remnant of 30% is used as 100%

The popularity of these is based mainly on the excellent wrinkel resistance of polyester fibers and polyester fibers becomes the most popular in wash-and-wear garments. Blends of various proportion are marketd. The most consumed blends are as follows :-

| | |
|---|---|
| 65/35 | Polyester/Cotton |
| 67/33 | -------- "-------- |
| 25/75 | -------- "-------- |
| 50/50 | -------- " ------ |
| 55/45 | -------- " ----- |
| 50/50 | -------- " ----- |
| 55/45 | -------- " ----- |

2.3.12 A <u>Field of application</u>

<u>Polyester/Cotton Blends</u> are used largely in shirts, slacks, dresses, blouses, rain coat, underwear, jacket, sportswear and uniform.

<u>Polyester/Wool</u> blends are used mostly in men's and women's suiting motoriels.

<u>Polyester/Rayon</u> blends are used in the nearly same products as it is with cotton.

<u>Polyester/Acrylic</u> blends are used in Sweater.

Apparel 100% polyester fibers are used mostly in men's suits.

Polyester fibers made very successfully penetration in textured filament yarn for knitwear ( "Crcmplene" ).

Filament of polyester fabrics have found important outlets in curtains, ties, shirts and lingerie.

The best use of polyester fibers in home furnishings other than carpets has been in sheets, pillowcases, sewing thread, convayor belts, ropes nets, sailcloth awning etc.

The recent inroad very successful is in the tire cord field.

2.3.13 Cotton Industry

Estimated production of cotton yarn by 1974-75 is 1100 million lbs/yr.(500,000 t/y) for this quantity of yarn a consumption of cotton should be about 1,353 million lbs (615,000 t/y)

| | | | |
|---|---|---|---|
| - West Pakistan | 60% | 4,800 | t/y. |
| - East Pakistan | 40% | 3,200 | t/y. |
| Total consumption | | 8,000 | t/y. |

From the total production of cotton yarn of 1100 million lbs (550,000 t/y) is taken about 3% or 33 million lbs/y. of yarn should be produced in form of polyester/cotton blends, as it was described.

Consumption by variety should be estimated as follows:-

| | | |
|---|---|---|
| - for the corase yarn | 2,500 | t/y. |
| - for the medium | 4,400 | t/y. |
| - for fine | 800 | t/y. |
| - for super fine | 300 | t/y. |
| Total | 8,000 | t/y |
| | ( 22 million lbs/y.) | |

This quantity would represent about 2% of total consumption of cotton only.

2.3.14 Possibilities for the Consumption of Polyester Fiber in Woollen/Worsted Industry in Pakistan.

Analysing the local situation in regard to the consumption of polyester fibers. The position would be following :-

1. Woollen cloth demand by 1974-75 should be about 10 millionyds. in terms of yarn about 9 million lbs.

   The estimated import of wool (6 million lbs) is mostly for cloth and knitting yarn and some quantity for blending with domestic wool for cloth industry.

The part of estimated import of superior wool of men's and ladies suiting materials could be replaced by polyester fibers. Polyester/wool blends 55/45 are very popular for the suit material (tropical and normal type) and suitable for the Pakistan climatic conditions.

In the cloth sector 20 -25 % of polyester/wool blends could be consumed particularly 55/45. It means a consumption of polyester fibers of about 600 t/yr.( by 1974-75).

Since the polyester fibers is not established in Pakistan yet, the consumption could not be on the reasonable level as it is in other developing country.

On other hand Pakistan has a simbolic production of cellulosic fibers (3000 t/y) in the form of rayon filament and not staple fibers. There is not raw materials for economical extension of this production significantly. Therefore, Pakistan should be orientated mostly to the production of synthetic fibers. After well establishment of polyester fibers processing in Textile Industry it is expected the consumption will grow faster.

Estimated production of cotton yarn and cloth by 1974-75 (to the end of the Fourth Five Year Plan) by variety on the basis of present trend could be assumed as follows :-

Production of yarn by variety at 1974-75.

Table - 16

| | Total | Less than 21 counts coarse | % of total | 21-34 counts medium | % of Total | 35-37 counts fine | % of Total |
|---|---|---|---|---|---|---|---|
| Yarn/Million lbs | 1100 | 330.0 | 30 | 660.0 | 60 | 110.0 | 10 |

* Fourth Five Year Plan figures.

Table 17.

Production of cloth by variety at 1974-75

| ---- | Total | Coarse Cloth | % | Medium | % | Fine | % |
|---|---|---|---|---|---|---|---|
| Cloth/Million Yds | 3110.0 | 933.0 | 30 | 1866.0 | 60 | 311 | 10 |

analysing the structure of estimated production of yarn and textiles articles we could see that the variety is not so rich. The consumption of polyester/cotton blends yarn from 21-48 + counts should be estimated about 6,000 t/y. (by 1974-75) staple fibers for both wings market and export.

In the miscellaneous items about 25% could be replaced. In term of polyester fibers about 200 t/y. Therefore, the whole woollen industry by 1974-75 could consume total quantity maximum of about 800 t/y. of polyester fibers by 1974-75.

It means that about 800 t/y of imported wool would be replaced by polyester wool type fibers. It means about 40% of estimated import of wool by 1974-75 could be replaced by polyester tops and staple.

2.3.15 Silk Industry

The silk industry at present is in the stagnate position in term of utilisation of capacity because of very high Government taxes.

The installed total capacity (in the settled and unsettled area) for production of silk fabrics are as follows :-

| | | |
|---|---|---|
| - 120,000,000 Yards in the settled are with | | 14000 looms |
| - 45,000,000 Yards in the unsettled area with* | | 5000 looms |
| 165,000,000 Yards | Total | 19000 looms |

In terms of used yarn should be 23 million lbs/yr.

*Unsettled area are north part of the country which are not under direct control of Government tax control.

- Production of silk fabrics in 1968 was about 90,000,000 yds. in term of used yarn was 13 million lbs.

- Production in 1969 has droped to the 67 million yards of fabrics. In terms of used yarn was 9.580 million lbs.

Pakistan silk industry consumes mostly man-made filament and small quantity of natural silk. Therefore, the raw material for silk industry are as follows :-

- Acetat cellulosic filament
  - Produced locally about 2700 t/y.
  - Imported 4000 t/y.
- Nylon filament(local production) 3000 t/y.
- Polyester filament(imported) 400-600 t/y.

Table 18.

Estimated requirement of Polyester and Acrylic fibers in Textile Industry of Pakistan by 1974-75.

| | Consumption | | t/y | 1974-75 |
|---|---|---|---|---|
| | Cotton Industry | Woollen Industry | Filament use Industry | Total |
| Polyester fibers | 8,000.0 | 800.0 | 1,200.0 | 10,000 |
| Acrylic fibers | * 100.0 | 585.0 | - | 685 |
| Total | 8,100.0 | 1,385.0 | 1,200,0 | 10,685 |

* Acrylic fibers in cotton system is taken in the simbolic quantity for start with some variety as upholestery, some kind of gabordine and lady winter dresses mostly in West Pakistan.

The total consumption of polyester and acrylic fibers could be about 10,685 t/y. and about 8,000 t/y. nylon and 8000 t/y. viscose and acetate rayon.

Therefore, the possible consumption figures by 1974-75 for man-made fibers could be :-

| | |
|---|---|
| - Polyester fibers | 10,000 |
| - Nylon* | 8,000 |
| - Arylic fibers | 685 |
| - Viscose and acetate rayon filament | 8,000 |
| Total | 26,685 t/y. |

On the basis of these estimated figures and expected population by 1974-75 (145 million people), the production figures per capita of man-made fibers should be about 02 kgr/per capita 045 lbs.

Total production of textiles by 1974-75 should be about 3.7 kgr/per capita (8.1 lbs). According to estimated figures the synthetic fibers consumption by textile industry should be about 0.180 kgrs/per capita.

Following the estimated figures for synthetic fibers by 1974-75, the logical trend of consumption (on the basis of long term plan for development of textile industry) of synthetic fibers for the period 1975-80 and further could be predicted.

Table 19

Prediction in consumption of the main synthetic fibers in textile industry by 1980 (polyester, nylon and acrylic)

| | Consumption t/y by 1980 | | | |
|---|---|---|---|---|
| | Cotton Industry | Woollen Industry | Filament use Industry | Total |
| - Polyester | 14,500 | 1,500 | 4,000 | 20,000 |
| - Nylon | 500 | 200 | 16,300 | 17,000 |
| - Acrylic | 500 | 1,000 | - | 1,500 |
| Total | 15,000 | 2,700 | 20,300 | 38,500 |

Table 20

Estimated consumption of Nylon 6 and Polyester fibers in West and East Pakistan.

| | 1975 | | 1980 | | Total 1980 |
|---|---|---|---|---|---|
| | East Pakistan t/a | West Pakistan t/a | East Pakistan t/a | West Paks t/a | |
| Polyester Fibers | 2500.0 | 5500.0 | 6000 | 12000 | 18000.0 |
| Nylon 6 | 2000.0 | 6000.0 | 5000 | 12000 | 17000.0 |

## 2.3.16 Price of Polyester Fibers

**Table 21**

Price Development for Polyester Fibers in bigger producer Countries $/kg.

| | Filament 100/36 den. in tubes | | | Staple fiber 3 denie, normal tenacity | | |
|---|---|---|---|---|---|---|
| | West Germany | U.K. | U.S.A. | West Germany | U.K. | U.S.A. |
| 1962 | 4.70 | 3.58 | 4.16 | 3.36 | 2.84 | 2.50 |
| 1963 | 3.96 | 3.58 | 3.84 | 3.36 | 2.84 | 2.50 |
| 1964 | 3.96 | 3.58 | 3.84 | 2.81 | 2.30 | 2.15 |
| 1965 | 3.96 | 3.58 | 3.84 | 2.81 | 2.04 | 1.85 |
| 1966 | 3.96 | 3.58 | 3.84 | 2.81 | 2.04 | 1.85 |
| 1967 | .. | 3.58 | 3.56 | 2.15 | 1.52 | 1.58 |
| 1968 | .. | 3.58 | 3.50 | 2.15 | 1.52 | 1.34 |
| 1970 | .. | 3.00 | 3.50 | 2.00 | 1.30 | 1.34 |

The world market price of filament yarn of 1st quantity at present is between 2.75–415 $/kg depending on the denier number, shrinkage and twisting for staple fibers the price in the world is quoted as 1.10 to 1.40 $/kg. German producers, do not think that export prices will continue to fall; the rather expect increases of 10–20 percent.

In Pakistan only yarn imports of substandard quality are permitted. The C & F price of Japanese twisted filament yarns of substandard quality is :

1.54 to 2.20 $/kg (100 to 45 den.)

The same taxes, duties and bonus vouchers are levied on them as on Nylon yarn i.e. a total of :

489 percent on C & F value

The landed costs thus are :

43 to 62 Rs/kg.

The charges levied on staple fibers are :

320 percent on C & F value.

The landed costs of staple fibers thus:

20 to 28 Rs/kg.

2.4 Phthalic anhydride

2.4.1 For Dioctyl Phthalate

According to our estimates and Humphreys & Glasgow Limited, through Interim Report that about 16,000 T/A of DOP capacity should be included in EPIDC Petrochemical Complex. We estimate that the following potential demand and consumption of phthalic anhydride, located in East Pakistan.

| | 1975 Potential demand | 1980 Consumption |
|---|---|---|
| DOP | 8,000 | 16,000 |
| Interm of Phthalic Anhydride | 3,080 | 6,160 |

However, it is considered that DOP plant should be planned to come in stream in 1977.

2.4.2 <u>For Alkyd Resin</u>

According to Battelle Institute our estimation and H & G, the estimated consumption of PA for Alkyd Resin would be :

| | 1975 | | 1980 | |
|---|---|---|---|---|
| Alkyd Resin consumption | 5800 | T/A | 8500 | T/A |
| Alkyd Resin production | 3500 | T/A | 5100 | T/A |
| Phthalic anhydride consumption for Alkyde Resins | 1150 | T/A | 1700 | T/A |

Therefore, the estimated consumption of phthalic anhydride would be :-

| | | |
|---|---|---|
| 1975 potential demands | 4230 | T/A |
| 1980 consumption | 7860 | T/A |

2.5 <u>Estimated Sales Revenue</u>

Applying the proposed selling prices, in Table 22 & 23 are shown annual revenues for the first 6 years of operation.

**Estimated Sales Revenue**
**First 6 years of Operation**
**Rs (000)**

Alternative No. 1.

| | Selling price | Year of Operation 1st 85% | 2nd 95% | 3rd 100% | 4th 100% | 5th 100% | 6th 100% |
|---|---|---|---|---|---|---|---|
| Total ton per year | - | 35700.0 | 39900.0 | 42000.0 | 42000.0 | 42000.0 | 42000.0 |
| Caprolactam | 3000.0 | 40800.0 | 45600.0 | 48000.0 | 48000.0 | 48000.0 | 48000.0 |
| DMT | 2700.0 | 41310.0 | 46170.0 | 48600.0 | 48600.0 | 48600.0 | 48600.0 |
| Phthalic anhydride | 1500.0 | 10200.0 | 11400.0 | 12000.0 | 12000.0 | 12000.0 | 12000.0 |
| Total Revenue | - | 92310.0 | 103170.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 |

Table 23

**Estimated Sales Revenue**
**First 6 years of Operation**
**Rs(000)**

Alternative No. 2

| | Selling price Rs/t | Year of Operation 1st 85% | 2nd 95% | 3rd 100% | 4th 100% | 5th 100% | 6th 100% |
|---|---|---|---|---|---|---|---|
| Caprolactam | 2800.0 | 38080.0 | 42560.0 | 44800.0 | 44800.0 | 44800.0 | 44800.0 |
| DMT | 2500.0 | 38250.0 | 42750.0 | 45000.0 | 45000.0 | 45000.0 | 45000.0 |
| Phthalic anhydride | 1300.0 | 8840.0 | 9880.0 | 10400.0 | 10400.0 | 10400.0 | 10400.0 |
| Total Revenue | - | 85170.0 | 95190.0 | 100200.0 | 100200.0 | 100200.0 | 100200.0 |

Production schedule ton/year

1st year 85 percent of full capacity
2nd year 95 percent of full capacity
3rd year 100 percent of full capacity

By the experience the utilization of capacity as it is shown is normal for the developing countries. Third year is expected to operate at full capacity.

# S E C T I O N  3

## FACILITIES AND MANUFACTURING

### 3.0 Operating Facilities

### 3.1 Plant Location and Site Description

As we have mentioned that the BTX-aromatics (Project "A") would be integrated part of refinery production. The best economical solution for the location of so called "Monomers Complex" (Project "B") should be on the same site with BTX-aromatics i.e. in the scope of Refinery as joint project. In our further consideration then the Project "A" (BTX-aromatics) and project "B" (Monomers Complex - Caprolactam, DMT and Phthalic anhydride) we would assume as joint Project (A + B).

An Establishment of monomers complex (Project "B") on the same location with Project "A" (Aromatics plant) is great advantage. The transport of aromatics would be avoided.

The description of the existing project - Eastern Refinery and BTX-aromatics projected plant are given in Section 3 of Project "A".

### 3.1.2 Availability of Land suitable for the Construction "Monomer Complex"

To the present plot of Eastern Refinery will be added an additional one of the same area of about 100/120 acres. For the new acquisition of land is estimated Rs.914,000 and for development of the site Rs. 3,623,000.

3.1.3 Availability of Water

The water supply would be solved on the same way as for Project "A" and Refinery.

3.1.4 Steam and Electricity

The steam and electricity supply would be centralised in one power plant for A + B Project and eventually plus refinery.

The consumption of El. power and steam for Project A+B is given below, which was taken as a design basis for study. The total consumption of El. power and steam are as follows :-

| | | Project A | Project B | Total |
|---|---|---|---|---|
| El. power | kwh | $17.10^6$/A | $48.10^6$/A | $65.10^6$/A |
| Steam | t | $180.10^3$/A | $408.10^6$/A | $589.10^3$/A |

Assuming 7500 hours per year, then the consumption per hour coming as follows :-

El. energy $55.10^6$ : 7500=8,666 kwh/h
Steam $589.10^6$ : 7500=78 t/h

These include total consumption of (A+B) Project.

The indicated figures will be affected a little bit by choice of processes in power generation. Estimated investment for utilities plant of Total ~~Rs. 44.803 is~~ sufficient
F.C.Rs. 22.287.5
L.C.Rs. 22.516.8

to meet any solution for self sufficient in power supply.

3.1.4.1 Power Plant

The problem of steam and electrical power production for (A+B) Project (BTX-Aromatics plus monomers complex) was approached by analysing the present situation in Chittagong and Eastern Refinery itself.

Since natural gas in Chittagong is not available and the prospect of the pipeline is not known, the fuel for the processing plan and power plant will be utilised from the refinery: by products from the reforming and other units and from the current commercial products.

The natural gas in Chittagong will cost not less than 22-25 $/ton. and in that case no significant difference in using Refinery fuels for power plant.

We selected the alternative of power plant for the total requirements of steam and electricity by means of 3 boilers and a back pressure automatic extraction condensing Turbo-alternator. The boilers 60 t/h each are giving the insurance to the smooth running of whole system. One boiler would be always in stand by. With this solution would be the stand by power connection with public distribution system in case of failure of the Turbo-alternator.

Therefore, the power plant includes 3 boilers each having a capacity of 60 t/h, a 9 MW back pressure alternator and relevent auxiliaries to produce all the steam and electric power required for the units of Project A+B. Certain quantity of surplus electricity can be sold to the other plant near-by or to the public distribution authority and to take in case of the failure.

<u>Description</u> - The two boilers shall produce steam as at ata and 475°C. The capacity of each boiler is of 60 t/h so that under the plant actual operating conditions the boiler will operate with optimal load to meet the requirements.

The steam at turbine inlet shall be at 63 ata and 475°C.

High pressure steam is drawn-off from the 15 ata automatic extraction provided on the turbine. A water injection desuperheater shall be provided on the header to maintain constant proper temperature of steam. The discharged steam is sent to feed the low pressure header and the deaerator.

The deaerator is fed with the plant condensate (about 30% of extracted steam), heating steam and make-up water (about 56 t/h) from the water treatment plant.

Feed water is sucked from the deaerator tank by the boiler feed pumps and is sent to the boilers. The system for steam pressure reducing and steam desuperheating shall be provided to meet the plant steam requirements in case of turboalternator failure.

These systems are provided from the main header at 63 ata that of 15 ata and from the 15 ata header to the low pressure one. A control room with relevant control equipment shall be provided in the turbine room at the same height of the turbo-alternator.

The lay-out of the control equipment will be such to avoid interfering with new equipment in case of power plant extension.

**Technical Features**

1. **Steam Generator**

- Steam production at max. continuous load — 40 t/h
- Production at economical load — 42 t/h
- Steam pressure at intake valve — 45 ate
- Steam temperature at intake valve — 475 °C
- Feed water temperature — 130 °C
- Efficiency at max. continuous load — 91 %
- Efficiency at economical load — 91.5

2. **Turboalternator**

The turboalternator set consists of a back pressure turbine, a helicoidal gear reducer and of a alternator complete with exciter and forced lubrication system:-

- Max. continuous output — 9000 KW
- Steam pressure at turbine inlet — 93 ate
- Steam temperature at turbine — 470 °C
- Max. flow at inlet — 60 t/h
- Pressure at automatic extraction — 15 ate
- Reducer efficiency — 98 %
- Alternator rated power case — 10 MVA
- Rotating speed — 1500 r.p.m.
- Alternator efficiency — 96 %

**Expenses for DM-Water make-up**

These expenses are as follows:-

(80,000 - 24,000) x 0.07 x 7500 = Rs. 2,940,000

where: 80,000 kg/h. of steam branched to the plants.

24000 kg/h of condensates coming back from the plant.

0.07 Rs/m$^3$ is of DM-Water for boilers.

7500 are the hours of operation in one year.

Heat Balance

$$\frac{80,000\ (800-130)}{0.9} \cdot 7500 = 466,666,000,000\ \text{Kcal/a}$$

Required by the boilers.

Where : 80,000 is the amount in kg/hour of produced steam.

800 is the enthalpy of steam at boiler outlet in Kcal/kg.

130 is enthalpy of feed water, in Kcal/kg.

0.9 is the boiler efficiency

7500 is the number of operating hours in a year.

The caloric values of various fuels which can be provided by refinery are:-

| | |
|---|---|
| Fuel gas | 12500 Kcal/kg. |
| Naphtha | 10000 Kcal/kg. |
| Fuel oil with | 9800 Kcal/LHV |
| Kerosene | 10000 Kcal |

The price of above fraction are estimated as follows:-

| | |
|---|---|
| Fuel gas | Rs. 96.62/t |
| Naphtha | Rs. 96.62/t |
| Fuel oil | Rs.120.00/t |
| Kerosene | Rs.125.00/t etc. |

Taking average caloric value of fuels of 10000 Kcal/kg. and price of 100 Rs./t. The requirements for the generation of process steam and electricity would as follows:-

466,666,000,000 : 10,000 = about 47000 t/annum.

Cost of fuel would be : 47000 x 100 Rs = 4,700,000 Rs/annum.

### 3.15 Availability of Personnel and of the Facilities

Chittagong area is quite developed area and Eastern Refinery, particularly, would be good source for the qualified people and offers good possibilities for training of others.

One of major advantage of this location is existing facilities of Eastern Refinery which could be used and extended economically. Tangible benefits would include the following:-

- Existing power plant, storage facilities
- Maintenance, shop, fire fighting facilities
- Communication etc.

Extension of all facilities is more economical than build-up new ones.

### 3.1.6 Plant layout, Building and Services

#### 3.1.6.1 Plant Layout

The following factors must be considered in laying out the plot plant of the monomer complex, comprising as it does a number of interdependent plants.

The relative location of each of individual plant must follow a logical sequence in order to minimise piping, transportation and communication between plants. The main roads will be laid out in the complex area so that they are functioned both during the construction of the complex and also after it is completed and operations under way.

3.1.6.2 Operating Plants and Services Buildings

The following operating plants and services will constitute the complex:-

1. Water supply and treatment
2. Demineraliser
3. Power Plant
4. Cooling tower
5. Caprolactam plant
6. Terephthalic acid/DMT-plant
7. Phthalic anhydride plant
8. General Facilities:
   - Administrative building (two storey Building)
   - Storage
   - Maintenance shop
   - Change house
   - Gate house
   - Research and control laboratory
9. Housing Colony

3.2 Raw Material and Processes

3.2.1 Raw Material

Project "B" is a continuation of Project "A" which is supplier of starting raw materials of Project "B".

3.2.1.1 Cyclohexane for Caprolactam Production

The starting raw materials for caprolactam is Cyclohexane produced in the Project "A" which is integrated part of Refinery.

3.2.1.2 Caustic Soda would be coming from the PVC-plant which will be set-up in Gomosal or Fenchuganj.

3.2.1.3 Sulphuric acid would be supplied by TSP-plant nearby of Refinery which will be extended on this account. The yearly demand of sulphuric acid for caprolactum would be about 21,000 T/a.

3.2.1.4 Ammonia

The ammonia of 11,360 T/a would be supplied by Gomosal of Fenchuganj Fertilizer Factory if in the meantime will not be set-up the ammonia production in Chittagong.

3.2.1.5 Hydrogen would be used from Refinery i.e. from the Reforming unit.

3.2.1.6 Boric acid would be imported.

3.2.2 Terephthalic acid/DMT-plant

The starting material for DMT is para-xylene which would supplied by Project "A" (BTX-aromatics Project).

3.2.2.1 Methanol is available in the both market in East and West.

3.2.3 Phthalic anhydride

oxylene supplied from the Project "A" will be processed into PA.

3.3 Selection of the Processes and Description

3.3.1 Caprolactum

Three alternative process routes were considered:-

- Cyclohexane route (DSM-Process), Cyclohexane oxidation to cyclohexanone, reaction with hydro-xylamine to the Oxime which is rearranged to caprolactam. Nitric oxid is used in place of sulphur dioxide in the preparation of hydro-xylamine in the latest version of the process, for which DSM supplied the basic assessment data. Ammonium sulphate by product is thereby reduced to 1.77 t/t caprolactam closely similar technology is available also from Inventa.

- Photo nitrosation of cyclohexane to the oxime then rearrangement as above. Ammonium sulphate by product is 2.5 t/t caprolactam (Toyota-Process).

- Toluene oxidation to benzoic acid, then hydrogenation to hexohydrobenzoic acid, which is reacted, with nitrosylsulphuric acid to give caprolactam (Snia Viscosa Process). Ammonium sulphate by product is 4.25 t/t. So far, only Snia Viscosa themselves operate the process.

Our analysis were showing us that the production cost of caprolactam is effected very little by the choice of process route. However, cyclohexane processes are offered by DSM and Inventa among others and both of these processes have a good record of successful operation. Following the conclusion that DSM process is most convenient, we would give the out-line of the process.

3.3.2 <u>Outline of the Process</u>
<u>Cyclohexane Oxidation with Boric Acid</u>

Cyclohexane is oxidized in the presence of Boric acid thereby forming cyclohexanol boric complexes. By hydrolysis of the reaction mixure boric acid is recovered in the aqueous phase.

In the reactor system, cyclohexane is oxidized in the presence of boric acid to yield a cyclohexanol - boric complex.

The reaction is carried out at 155-175°C and 8-10 atm g. pressure. As the boric acid forms complexes with the cyclohexanol, the oxidation of cyclohexanol and cyclohexanone is prevented and the conversion per pass can be kept higher than in the classical oxidation process. The conversion amounts to about 10 mol. per cent, while reaction efficiencies are around 80 mol. per cent.

The heat of reaction is removed by evaporating cyclohexane. The cyclohexane flow containing the cyclohexanol - boric complex, cyclohexanone and a minor amount of acids, is then subject to hydrolysis to separate the cyclohexanol and boric acid. The aqueous boric acid solution is sent to the boric acid recovery system.

The cyclohexane, containing cyclohexanol, cyclohexanone and a minor quantity of acids, is then sent to the sections for neutralisation of the acids, distillation of the cyclohexane, saponification of the esters, conversion of cyclohexanol into cyclohexanone and the production of pure cyclohexanone by distillation. The aqueous boric acid solution is sent to boric acid recovery.

<u>Hydroxylamine Production (Raschig)</u>

Aqueous ammonia is produced by absorption of ammonia in demineralized water. The heat of reaction is carried away by circulation through a cooler. The aqueous ammonia is then used for the production of ammonium carbonate. Carbon dioxide is absorbed in aqueous ammonia. The heat of reaction is carried away by circulation through a cooler the prepared ammonium carbonate solution is stored in a tank.

Air and ammonia are intimately mixed before introduction into a burner. On a Pt-Catalyst the following reaction is effected at a reaction temperature of 850°C.

$$NH_3 + 5\ O_2 \longrightarrow 4\ NO + 6\ H_2O$$

The heat of reaction is utilized for the production of steam. At the outlet of the waste heat boiler the temperature of the gas is above the condensation temperature. The gas is then cooled down to 10°C in a cooler, whereby dilute nitric acid acid is produced.

As it is important to control the $NO/NO_2$ ratio, a partial oxidation is carried out in an oxidation tower, which is constructed in such a way that the retention time can be controlled to yield the optimum $NO/NO_2$ ratio. The heat of reaction is removed by circulation through a cooler. Subsequently the $NO/NO_2$ gases are absorbed in a reactor in an ammonium carbonate solution to yield ammonium nitrite:

$$(NH_4)_2CO_3 + NO + NO_2 \longrightarrow 2NH_4NO_2 + CO_2$$

The heat of reaction is removed by circulation of the solution through an ammonia evaporator. The temperature at which the reaction proceeds, is kept low to avoid the destruction reaction:-

$$NH_4NO_2 \longrightarrow N_2 + 2\ H_2O$$

The ammonium nitrite solution is stored in a tank. Before the ammonium nitrite solution can be used for the production of hydroxylamine sulphate, a mixture of $NH_4OH$ and $NH_4NO_2$ with a molar ratio of about 1 must be prepared. The mixture is contacted in an absorption tower with $SO_2$ in a counter-current process:

$$NH_4OH + SO_2 \longrightarrow NH_4HSO_3$$

$$NH_4HSO_3 + NH_4NO_2 + SO_2 \longrightarrow NOH(SO_3NH)2$$

The heat of reaction is removed by circulating the process liquid through an ammonia evaporator. The reaction is carried out at atmospheric pressure and at low temperature. The formed hydroxylamine disulphonic acid is hydrolyzed by heating:

$$NOH\ (SO_3NH_4)2 + H_2O \longrightarrow NHOHSO_3\ NH_4 + NH_4HSO_4$$

Monosulphonic acid hydroxylamine sulphate is hydrolyzed by boiling:

$$2NHOHSO_3NH_4 + 2H_2O \longrightarrow (NH_2OH)_2\ H_2\ SO_4 + (NH_4)_2SO_4$$

After neutralization the hydroxylamine is stored and ready for caprolactum manufacture.

<u>New hydroxylamine Process</u>

The new hydroxylamine process can be divided into 4 process steps:-

1. The manufacture of hydroxylamine by hydrogenation of nitrate-ions over a noble metal catalyst.
2. The reaction of hydroxylamine with cyclohexanone in the presence of a solvent.
3. The separation of the solvent from the oxime.
4. The simultaneous destruction of ammonium-ions in the circulating inorganic process liquid and the absorption of $NO/NO_2$ in the liquid.

This process was developed by DSM and has been in operation for three years in the DSM pilot plant. All physical and technological data has been compiled to computorise the design and a 50,000 tons/year single stream unit is being designed for DSM's own expansion of caprolactam production. The manufacture of hydroxylamine is effected in a gas-liquid contractor wherein hydrogen gas is contacted with a circulating inorganic liquid containing nitrate ions, a buffering acid and noble metal catalyst.

In this reactor hydrogenation of nitrate ions produces hydroxylamine:

$$NO_3 + 2H^+ + 3H_2 \longrightarrow NH_3OH^+ + H_2O$$

buffering acid $HX \longrightarrow X^- + H^+$

A small amount of by-product such as ammonium ion is formed:

$$NO_3 + 2H_2^+ + 4H_2 \longrightarrow NH_4^+ + H_2O$$

This ammonium ion does not interfere in the reaction and is destroyed later. In the second stage the hydroxylamine is reacted with pure cyclohexanone in the presence of a solvent:

$$NH_3OH^+ + (CH_2)_5\ C{=}O \longrightarrow (CH_2)_5\ C{=}NOH + H^+ + H_2O$$

The oxime is extracted, the separation between the inorganic liquid and the disolved oxime is effected.

Caprolactam Production

Oxime is rearranged into caprolactam according to the Beckmann reaction. During the rearrangement no substances are added or removed from the reacting oximes the rearrangement is an internal shifting in the oxime molecule. The rearrangement takes place in the presence of oleum which serves as absorbent to the water dissolved in the oxime. The heat of reaction is discharged by cooling, the sulphuric acid in the reaction mixture is neutralised and the ammonium sulphate is removed from the lactam solution.

The crude caprolactam is purified using Stamicarbon's patented purification system which guarantees continuous and constant production of pure caprolactam. The crude caprolactam is first extracted with benzene and re-extracted with water. Thereafter a series of physic-chemical purification steps completes the sequence. The aqueous lactam solution is the concentracted in a series of evaporators.

<u>Process Limitations</u>

One of the distillation columns in the cyclohexane oxidation plant becomes too large at capacities above 35,000 ton/year to be transported. Therefore two columns are recommended above this capacity. The same holds for the two reactors in the hydroxylamine production section (Raschig synthesis). For the rest there are no process or mechanical limitations on the size of a single train-unit up to 70,000 ton/year.

| Caprolactam Quality | Expected | Guaranteed |
|---|---|---|
| Colour (° Hazen) | 0-1 | 5 |
| Solidification point (°C) | 69 | 68.8 |
| Permanganate number (3 per cent solution) | 10 000 sec.min | 10 000 sec. min |
| Volatile bases meq/kg | 0.3-0.5 | 0.8 |
| Alkalinity meq/kg | 0.01 | 0.05 |
| Water wt per cent | 0.03-0.06 | 0.1 |

In the Rasching synthesis hydroxylamine process 4.5 tons ammonium sulphate/ton caprolactam is produced. In the new hydroxylamine process only 1.8 tons ammonium sulphate/ton caprolactam is produced.

## 3.4 Terephthalic Acid (DMT)

The first commercial process for preparing the acid was by Nitric acid oxidation of p-xylene. The acid was then reacted with methanol to produce the diester. After being highly purified, the diester was reacted with ethylene glycol eventually to produce the linear polyester.

Meanwhile, work was proceeding on a number of other process routes. Many of these have never been brought to commercial status. Today the following processes are believed to account for most of the terephthalic acid produced:-

1. Bromine promoted catalytic air oxidation of p-xylene or mixed xylene.
2. Catalytic oxidation of p-xylene in the presence of Methyl ethyl ketone activator.
3. Catalytic high temperature rearrangement of the potassium salt of phthalic anhydride or benzoic acid followed by acidification.
4. Nitric acid oxidation of p-xylene.

Most of the dimethyl terephthalate is produced by the following processes:-

1. Esterification of the acid produced by the above processes
2. From p-xylene by successive oxidations and esterifications.

## Dimethyl Terephthalate (DMT)

1. Witten process originally developed by Chemische Werke Witten GmbH but later modified by several companies as a Califorina Research Corporation, Hercules incorporation and Hystron Fibers incorporated. The bulk of world production of dimethyl terephthalate is based on the Witten-Imhausen type of technology. A more recent version of the process, with refinements in the air oxidation steps, has been selected for several new installations.

In this process, p roxylene in the liquid phase is oxidized by air under relatively mild conditions of temperature and pressure to para-toluic acid which esterified to para-methyl toluene, this compound is further oxidized under pressure to monomethyl therephthalate, which upon subsequent esterification, is converted to pure dimethyl terephthalate. The process does not involve terephthalic acid as an intermediate.

| | | | |
|---|---|---|---|
| $C_6H_6(CH_3)_2$ | air & catalyst | $C_6H_5(CH_3, COOH)$ | $CH_3OH$ |
| p-xylene | 130-140 °C | p-toluic acid | |
| mol.wt: 106.2 | | 136.1 | |
| $C_6H_6(COOCH_3, CH_3)$ | air & catalyst | $C_3H_6(COOCH_3, COOH)$ | |
| Methyl para-toluate | 200 °C | mono-methyl terephthalate | |
| 150.2 | | 180.1 | |
| $C_6H_6(COOCH_3, COOH)$ + $CH_3OH$ | | $C_6H_6(COOCH_3)_2$ | |
| mono-methyl terephthalate | | Dimethyl terephthalate | |
| 180.1 | | 194.2 | |

## 2. Terephthalic Acid

Technologically, the purification of terephthalic acid to fiber-grade levels became commercially feasible in the mid-1960s, but continues to be an area of development activity.

Amoco Chemicals Corporation and Mobil Chemical Company developed effective and economical oxidation and purification technology by different methods, and in 1966-67 Amoco's production capacity for the first time assured an ample supply of fiber-grade terephthalic acid. Consequently, polyester producers developed production technology based on this acid in preference to that based on dimethyl terephthalate, in order to capitalise on the potential economic advantage offered by the direct terephthalic acid route. These aspects are further examined on page 695.4022 L of this report.

The three important processes described in the following paragraphs of this section are currently used or available for fiber-grade terephthalic acid production. Other companies that are facture. All of these processes are based on the oxidation of para-xylene and differ primarily in the oxidation conditions and catalyst systems.

| | | |
|---|---|---|
| | $C_6H_4(CH_3)_2$ | $C_6H_4(COOH)_2$ |
| | p-xylene | terephthalic acid |
| mol wt: | 106.2 | 166.1 |

(a) Amoco Process. Developed originally by the Mid-Century Corporation, now a wholly owned subsidiary of Standard Oil Company (Indiana) but previously a joint venture with Halcon International, Inc., this process is a liquid-phase oxidation of para-xylene with air at about 200°C and 400 psi. The para-xylene is diluted with glacial acetic acid, and small amounts of manganese acetate or cobalt acetate, and a bromide, are added as catalysts. Presence of the bromide makes for highly corrosive conditions, requiring reactors made of expensive alloys. The process has been widely licensed, especially in Japan, and is also used in Europe. U.S. Patents 3,399,277 and 3,497,552 (issued to Standard Oil Co., (Indiana) on August 27,1968, and February 24,1970, respectively) describe the purification (by crystallisation) of terephthalic acid produced by this process.

(b) Mobil Process. This process is described in U.S. Patent 3,036,122 (issued May 22,1962, to Olin Mathieson Chemical Corporation); it was commercially developed by Mobil Chemical and involves liquid-phase oxidation of para-xylene with oxygen using methyl ethyl ketone as an oxygen carrier and small amounts of cobalt acetate as a catalyst. The reaction is carried out at a temperature of about 130°C (markedly lower than in the Amoco process), and at a pressure of 400 psi. Whereas the Amoco process requires only para-xylene as feedstock, this process requires pure oxygen and methyl ethyl ketone as additional feeds; it is understood that much of the methyl ethyl ketone is converted to acetic acid, which must be disposed off. Further comparison with the Amoco process shows purity requirements for the para-xylene feed to be higher and the product purity after oxidation to be higher in the Mobil process. Thus, purification costs for the Mobil process may be lower.

Purification ofthe crude product by sublimation in superheated steam is described in Mobil's British Patent 1,110,649 (issued April 24,1968), whereas a purification process employing fractional condensation is the subject of Mobil's U.S. Patent 3,362,989 (issued January 9,1968). Replacement of methyl ethyl ketone by n-butane as an oxygen carrier is described in Mobil's French Patent 1,507,996 (issued December 29,1967).

(c) Teijin Process. This process, developed by Teijin, Ltd., of Japan, also involves liquid-phase oxidation of para-xylene with air in glacial acetic acid. The use of substantial amounts of cobalt acetate as a catalyst, permitting a reaction temperature of about 130°C and a pressure of 142 psi, sets this process apart from those described above. A properietary purification method is part of the process.

As the basis of cost estimation, we have selected the combined esterification and oxidation of p-xylene by well proven Witten process. This route is slightly cheaper than those via esterification of crude terephthalic acid, where only DMT is required as product.

## 3.5 Phthalic anhydride

Phthalic anhydride is one of the world's most versatile basic intermediates. It is used in the preparation of resins, plasticisers, polyesters, and a multitude of other end products.

Although it has been of commercial importance since the last century, the main growth in the market for phthalic anhydride has come since the Second World War. In the 24 years between 1945 and 1968, there was a sevenfold increase in world phthalic anhydride production capacity. In 1945 the world capacity was some 200,000 tons and this had grown to 1,400,000 tons by 1968.

Rapid growth in the market for phthalic anhydride can be traced directly to the rapid growth of the plastics industry and to the increase in use of synthetic alkyds as replacement for natural resins in the paint trade.

Whereas in pre-war years the main markets for phthalic anhydride were in the manufacture of dyestuffs and pharmaceuticals, by 1968 the picture had changed considerably.

In 1968, the end use distribution in the market for phthalic anhydride was approximately as follows:-

| | | |
|---|---|---|
| Alkyds | | 27% |
| Plastics | : Plasticisers | 55% |
| | Polyesters | 9% |
| Miscellaneous (e.g. dyestuffs, pharmaceuticals, etc). | | 9% |

This growth in the market for phthalic anhydride has been accompanied by a general tightening in the raw material situation.

In pre-war years the whole of the world's phthalic anhydride was manufactured from naphthalene. This material was originally obtained solely from coal tar destillation.

As the coal gasification industry slowly contracted naphthalene started to be made available from petrochemical sources. This material tended to be more expensive than the original coal tar based material.

This situation stimulated much development work in the phthalic anhydride processing industry to produce processes capable of using ortho-xylene as basic feedstock. This material, which is obtained from petrochemical sources was generally much more freely available than petrochemical naphthalene, since it could be extracted by fractionation, whereas naphthalene requires a chemical preparation from the source.

In recent years even the supply of ortho-xylene has been somewhat problematical, due to the growth of the use of paraxylene in the manufacture of synthetic fibres, which led to the development of processes to isomerise o-xylene to p-xylene, and due also to the growth of the use of xylene as petrol additives.

This trend in turn has led to the development of processes, and catalysts, capable of operating on either feedstock.

There are currently some ten processes available on licence for the production of phthalic anhydride. Of these nine are vapour phase processes. The tenth being liquid phase.

These processes can conveniently be grouped into four classes. These classes are as follows:-

1. Low space velocity fixed bed vapour phase processes.
2. High space velocity fixed bed vapour phase processes
3. Fluidised bed vapour phase processes.
4. Liquid phase process.

Very little information is available on the liquid phase process, but the basic mechanics of the other three types of process are essentially similar.

In all three cases the vapourised raw material, either ortho-xylene or naphthalene, is mixed with air the mixture passed through a catalyst bed at a controlled temperature. The reaction is exothermic, and the temperature in the catalyst bed varies between 360°C and 500°C depending on which type of process is being operated.

The phthalic anhydride produced, entrained in excess air, is passed from the reactor into vapour coolers and thence into switch condensers where the bulk of the phthalic anhydride is condensed and cooled to a solid.

The efficiency of these condensers is such that, with o-xylene feedstock, no further condensation equipment is required, but where naphthalene feed is used, a cyclone system is incorporated to remove the main impurities.

The final off-gases are passed to atmosphere, either through burners, which convert the residual organic material to carbon dioxide and water with or without the aid of a catalyst, or in some cases via scrubbers directly to atmosphere. The choice of method depends on various factors, such as plant location, fuel costs, etc.

Crude phthalic anhydride, which has been collected in the switch condensers, is melted out and passed to a molten phthalic anhydride reservoir.

The crude phthalic anhydride is held in the molten state for a number of hours to allow polymerisation of by-products to occur. It is then transferred to the distillation unit, where it is heated to just above its boiling point, under total reflux, to dehydrate any phthalic acid present and concentrate volatile impurities at the top of the column.

Distillation is begun by removing these impurities as forerunnings, which are returned to the crude tank when naphthalene is used as feedstock or discarded where o-xylene is being used.

The main distillation is carried out under vacumm at a pressure of about 60mm.Hg. Some plants include a residues stripping still.

Pure phthalic anhydride obtained from the distillation is sent to a pure storage tank. This material can be sold directly in the molten from or alternatively flaked and sold as a solid.

The four main types of process will now be discussed in some detail under the heading given above.

3.51 <u>Low space velocity fixed bed processes</u>

The only process which can be said to genuinely fall into this class is the original Von Heyden process.

Recent developments of this process, which involve the building of much larger reactors and the development of a new catalyst have allowed the use of higher space velocities---approximately double those of the original plants. Thus the current Von Heyden process, together with the BASF process, which also operates at about this velocity, should now be referred to as medium space velocity fixed bed processes.

Between them, these two processes account for most of the new phthalic anhydride capacity currently being installed.

Processes of this type operate generally in the temperature range 350°C--410°C and use a lower activity catalyst than is the case with the high space velocity types. The air to raw material ratio used is about 38:1, by weight.

For these reasons, the reaction in this type of process is more fully controlled and by-product formation is relatively low and hence yield relatively high, as compared to the high space velocity types, although in recent years this yield gap has been considerably narrowed.

Yields from this type of process are between 92 and 100 kg of product per 100 kg of 95 percent ortho-xylene raw material.

3.5.2 <u>High space velocity fixed bed processes</u>

There are five major processes which fall into this class which are:-

1. Ftalital process
2. Scientific Design Company process.
3. Pechiney-Sain-Gobain process
4. Japan Gas Chemical process.
5. Ruhrol process.

Processes in this class operate in the temperature range 450°C-510°C. A high activity catalyst is used, tending to give a lower measure of reaction control than both the lower space velocity types. This in time leads to higher by-product formation and hence generally lower yields.

Yields from processes of this type generally run in the range 80-94 kg. phthalic anhydride per 100 kg of feed material.

Air is compressed, usually by a centrifugal type of compressor, either single or multistage.

The compressed air is passed through an air heater, which is usually steam heated. The hot air is then mixed with the raw material in a vaporiser. The vaporiser may be either a carburettor or a type of falling film evaporator.

The former is used only with ortho-xylene feedstock whilst the latter type is only suitable for use with naphthalene. The ratio of air to fueldis carefully controlled at between 17:1 and about 20:1, by weight.

The mixture of air and raw material then passes into from the top of the reaction chamber.

Reaction is exothermic and in order to control the reaction temperature the catalyst tubes are surrounded by a heat transfer medium. In some older plants, the medium used was mercury, but more recently, heat transfer salt has been used.

Where mercury is used as the heat transfer medium its boiling point and hence the reaction temperature is controlled by applying an inert gas pressure to the surface of the mercury. The mercury vapour is condensed in, usually, overhead condensers, generating high pressure steam in the process. This This high pressure steam, usually at about 200psig, is let down to various pressures for use in the process.

Where heat transfer salt is used the temperature control is exercised by the amount of water fed to the steam generator heated by the heat transfer salt. Again high pressure steam is generated and this is used in other parts of the process.

The fuel is oxidised completely during its passage through the catalyst tubes, phthalic anhydride being produced, in combination with a number of by-products.

These by-products are chiefly carbon dioxide and water from complete combustion of the raw material, maleic anhydride from slight over-oxidation of the fuel and, where naphthalene is used as raw material, some naphtha-quinone is formed by under-oxidation. Benzoic acid, from o-xylene, is a troublesome by product, due to its high chemical stability.

This mixture, together with excess air is passed from the reactor usually through vapour coolers, again generating steam this time at a lower pressure and then into switch condensers. The switch condensers are heated alternately by hot and cold oil or by steam and water.

When the reactor effluent gases are being passed into the condenser, the cooling circulation is in use. This condenses the bulk of the phthalic anhydride from the gas steam direct to the solid state. A number of switch condensers, manifolded together, are used, sized so that at any one time one can be "melting out", whilst the remainder are capable of condensing the entire output from the reactors.

These condensers are generally so efficient that no further condensing equipment is required, but in some cases a cyclone is provided to remove any residual solid material from the gas stream.

Final waste air, containing carbon dioxide, water and traces of organic impurities is then passed to atmosphere. In some cases this gas stream is passed through a burner, which may be either catalytic or direct combustion type, where any residual organic material is burnt to carbon dioxide and water prior to being passed to atmosphere, or alternatively may be passed through a simple wet scrubber and then to atmosphere.

The crude molten phthalic anhydride from the switch condensers, together with the material collected in the cyclone, where these are used, is then fed to the crude storage tank. Here it is digested for some hours to condense impurities such as naphthaquinone and maleic anhydride, prior to being fed to the distillation unit. The main distillation is carried out under vacuum, at 60 mm. Hg.

Fore-runnings are taken off at atmospheric pressure after a period at total reflux, to concentrate the low-boiling impurities at the top of the column. These fore-runnings are returned to the crude storage when naphthalene is the raw material, but are discarded when o-xylene is being used. Some plants also incorporate a residues stripping still.

Pure product is passed to a main storage tank, where it is stored in the liquid form.

The material can be used or sold in the liquid form or alternatively passed to a flaker.

The flaker consists of a water cooled rotating drum which runs in a trough of liquid phthalic anhydride. As the drum revolves the phthalic anhydride solidifies and cools on its surface and is eventually flaked off by an appropriately positioned knife. This flaked material is bagged off and is then ready for sale.

Capital costs are somewhat higher for the low space velocity processes than the high space velocity type, but the higher yields obtained tend to off-set this disadvantage in terms of operating costs.

Recently developed continuous distillation systems of the multi-column type have gone still further towards improving the operating economics of processes.

Fluidised Bed Processes

There are two main processes in this class:

1. Sherwin-Williams process
2. UCC process.

Until very recently, fluid bed processes have only been designed to use naphthalene and particularly refined or petrochemical naphthalene, as feedstock. Recently, however, it has been reported that at least one Sherwin-ortho-xylene uses it.

The basic mechanics of a fluid bed process may be described as follows:-

Air is compressed, usually through a multi-stage centrifugal blower and is then heated and fed into the reactor through a distribution plate, which also supports the catalyst. The raw material is sprayed into the airstream just above the distribution plate, where it is instantly vaporised by the hot air.

The fuel/air mixture passes upwards through the catalyst bed, which is fluidised by this gas stream, and oxidation takes place.

Air to fuel ratio used in plants of this type is usually of the order of 10:1 which is well within the explosive limits. This high concentration of raw material is made possible by the very fine control of temperature which can be exercised in a plant of this type. It is also claimed that the catalyst particles in the reactor tend to suppress any fast moving flame front and thus inhibit explosions.

Reaction heat is removed, normally by raising steam from water fed cooling elements immersed in the catalyst bed. This obviates the need for expensive heat transfer fluids, such as heat exchange salt or mercury.

Mixed vapours leaving the catalyst bed pass through a group of filters, which remove the catalyst fines entrained in the gas stream. There are normally four of these filters, three of which are in use, and one being blown back with air at any one time.

The catalyst fines removed from the filters in this way are returned to the catalyst bed.

The gas stream then passes to a condensing system, where because of the high concentration of phthalic anhydride in the gas stream it is possible to condense the phthalic anhydride to a liquid, rather than to a solid as is the case in processes using more dilute systems. These condensers are normally water cooled and again are used as steam raisers.

Residual gases pass to switch condensers where the remaining small quantity of phthalic anhydride remaining is condensed to solid. The phthalic anhydride from the initial condensers is fed direct to a distillation system, where it is joined by the re-melted material from the switch condensers.

Because of the much higher concentration of phthalic anhydride in the gas stream with this type of plant, process lines and switch condensers can be very much smaller for a given tonnage output than is the case with the fixed bed processes. The reduced quantity of air used in these processes makes it possible to use much smaller compressors than with other types.

Lower by-product formation with fluid bed processes makes it possible to dispense with the catalytic burning equipment, a wet scrubber being sufficient to remove the noxious byproducts.

Yields from fluid bed processes are claimed to be between 88 kg. of product per 100 kg. when using refined naphthalene and 96 kg. per 100 kg. when using petrochemical naphthalene.

A disadvantage of the process is the high erosion rate which is experienced in the reactor due to the moving catalyst particles.

The catalysts used in all the above types of process are based on vanadium pentoxide, suspended on an inert support such as silica.

Initially, catalysts were only capable of operating with one or other of the feedstocks available, but more recently catalysts are being developed which are capable of operating with both feedstocks. With the development of vapourisation equipment capable also of using either feedstock, this is leading to the building of much more versatile process equipment.

The main liquid process currently in operation is the Progil Process. Limited information is available, but the basic outline of the process is as follows:-

Oxidation takes place usually in an organic acid solvent in the presence of a heavy metal salt catalyst with a catalyst promoter. The organic acid normally used is acetic acid, the catalyst is cobalt acetate and the promoter a metal bromide. The oxidation can be carried out using either oxygen or air as the oxygen source. Oxidation occurs at a temperature between 100°C and 275°C and at pressures between atmospheric and 1,500 psi.

The oxidation produces phthalic acid, which is separated a crystalline product. This is then heated to convert the acid to anhydride.

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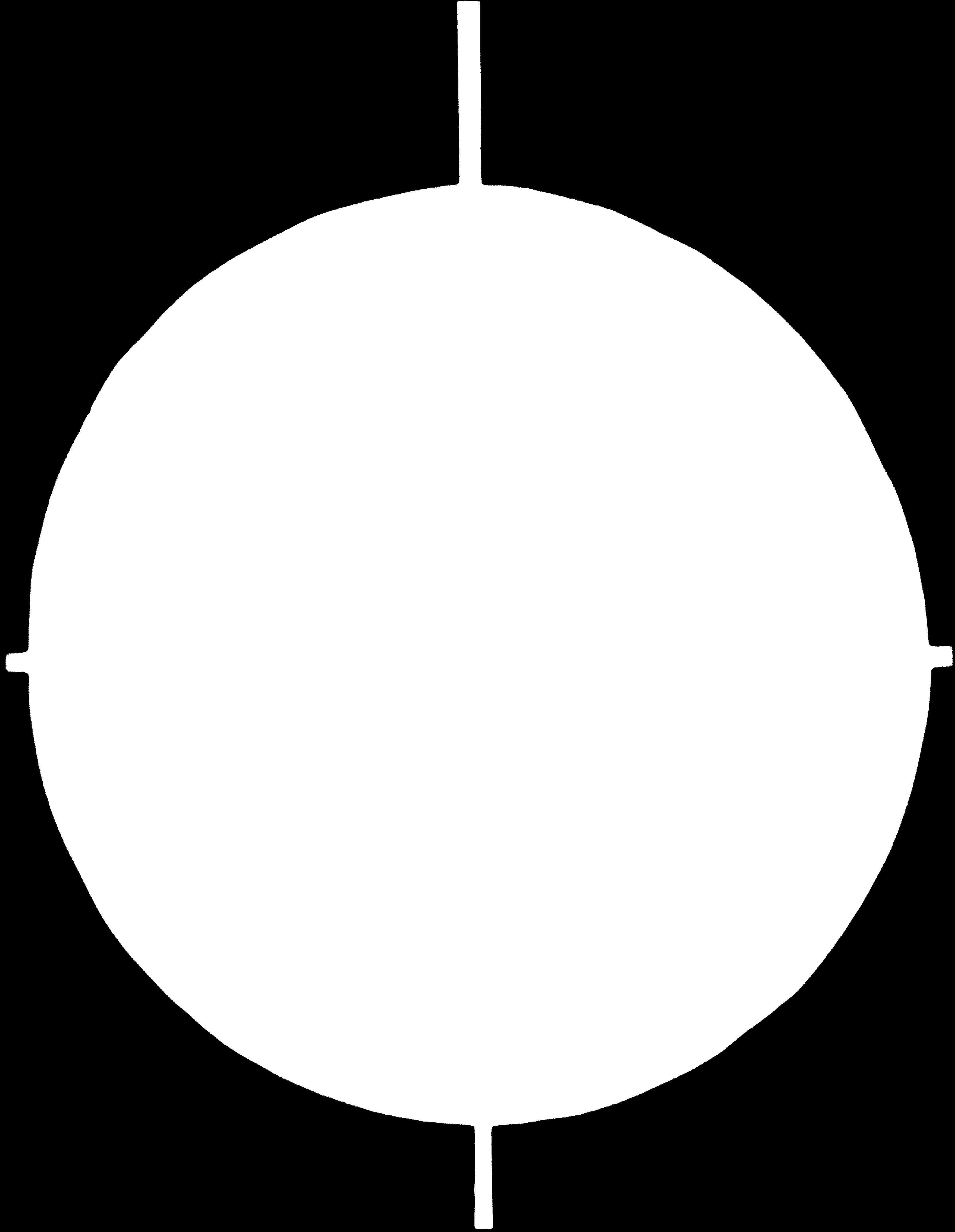

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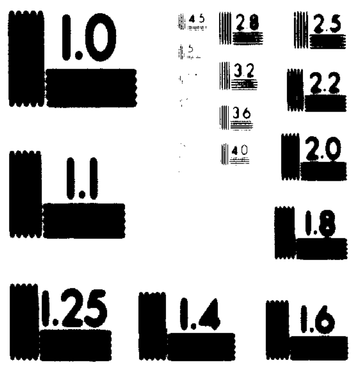


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

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A solvent recovery and re-cycle system is incorporated in the process.

Yields from this process are claimed to be extremely high, of the order of 125 kg of phthalic anhydride per 100 kg. of ortho-xylene.

To offset this main advantage of the process, there are some disadvantages. Namely the use of an acetic acid solvent, with attendant corrosion problems which requires much of the plant to be made of stainless steel or other expensive materials - and it is also believed that ortho-xylene of higher than 95 percent purity is required as basic feedstock.

## 3.6 Estimation of Site and Construction Costs

The installation cost of the proposed Chemical Complex is estimated to be Rs. 247,707,000 including a contingency of 10% percent.

A summary of the estimated cost is given in Table 26 below. More details of cost are given in Table 41.

The estimate for land acquisition is Rs. 914,000. This would covers a total about 150 acres of which the part would be for Housing Colony about 25-30 percent and 70 percent plants area.

Preparation of the site requires piling, fill, improving grading, sewerage and draining estimated at Rs.30,633,000.

Cost of machinery and equipment are based on current estimates of suppliers and represent delivered cost including freight and insurance, import duties and landing expense erection and installation, engineering and fees. Total estimated costs for machinery and equipment is Rs.211,098,000/-.

Table 26

Summary
Estimated Site and Complex Construction Costs.

| Items | | Estimated cost Rs(000) |
|---|---|---|
| 1. | Land | 914.0 |
| 2. | Site preparation and development | 3,623.0 |
| 3. | Buildings | 30,633.0 |
| 4. | Production equipment | 211,098.0 |
| 5. | Transportation equipment | 539.0 |
| 6. | Office equipment | 900.0 |
| | Total | 247,707.0 |
| | Development cost | 27,332.0 |
| | Total | 275,039.0 |

3.6.1 Spares

Spares of about 3% of equipment costs are included in the initial costs of plant with the total C & F value of Rs.6,329,780 (FE. 3,946,370 & LC. 2,383,410).

3.6.2 Development Cost

Total development cost is estimated with Rs.27,332,100 including foreign exchange of Rs.20,671,000.

This item consists of three categories.

3.6.2.1 Pre-operating Expenses which include - the all expenses in pre-constructing period, the preparing of the various documentation consultancy, preparing of the main project construction superivision, salary for personnel, travels, administrative expenses.

3.6.2.2 Training and start-up Expenses include the all expenses for local training and abroad, expenses for foreign technician (See Table 33) a start-up expenses.

3.6.2.3 Interest during the Construction

This is calculated on the basis of the present condition of loan term from the international and local financial institution. International (Foreign) loan is calculated at 7% for local at 8%. It is calculated that period of construction would last about 3 years. Estimated details of interest during construction is given in Table.....

3.6.3 Contingencies

This is estimated as total of 10% of C & F cost of equipment and.

3.6.4 Engineering and know-how are included in the fixed investment costs.

3.6.5 Custom duties, insurance, transport

This item has been calculated on the following basis for imported equipment of C & F basis (FOB + overseas transport. The break up is as follows:-

| | | |
|---|---|---|
| 1. | Custom duties | 35% |
| 2. | Insurance, clearance forwarding and internal freight to site | 4% |
| | Total | 39% |

The present regulations of Government of Pakistan considers calculation of duties on only equipment which can be estimated for this project at 80% of the equipment value CIF, the rest 20% being license, engineering and know-how feed which are exempt from duties. In addition the Government allows deferred payment on custom duties equipment to 15% of the value of equipment on which duties are payable and issues debentures payable in 6 half yearly instalments and carry an interest of 6%. In our estimation of capital costs the duties are taken as 100% of equipment value CIF making some hidden reserve of local costs.

3.6.6 Erection

This heading covers the fees chargeable by supplier for deputing their erection, inspection and supervisory staff, their travel bills, and the local subsistence allowances. It also includes the local supervisory and working staff needed for the erection, their salaries, allowances and the purchase of local materials during erection it is estimated that an expenditure equivalent to about 19% of CIF cost as erection value. On this, foreign component is about 6% and 12% to cover local expenses.

3.6.7 Utilities and Services

Electricity will be generated within the plant and necessary equipment for the power plant is included in the main equipment supply. In view of this factor only the fuel components of electricity generating cost is taken. In addition to the Government levies a surcharge of one paisa (Rs.0.01)per kwh from plan power houses is included. Price of electricity of Rs.0.040 (0.9¢) kwh is taken. The fuel price is taken of Rs.100/ton.

3.6.8 Project Schedule

In figure ...... is shown the anticipated schedule of the Project "B" which could be in start of operation after 36 month after authorisation is given to proceed with detailed design work. Thereafter it would be technically reasonable to operate according the following schedule.

| | |
|---|---|
| 1st year after start-up with | 85% |
| 2nd --------do-------- | 95% |
| 3rd --------do-------- | 100% |
| 4th --------do-------- | 100% |

3.6.9 Organisation, Management, Personnel and Remuneration.

3.6.9. 1 As we have mentioned this Project ("B") we assume to be joint project with Project "A" (BTX-aromatics) on the same site but with separate operational executive management. The head of this joint project would be The Board of Directors as the final executive Authority for the policy in this complex.

- The executive and administrative personnel is given in Table 27. ... ... ... Total 276 people
- Operating personnel (Table 28) ... Total 856 --"--

Total employees 1132

3.6.9.2 Remuneration

Salaries and wages estimated to be paid to personnel manning the complex are based on the reasonable level in the time of operation. Those salaries and wages are detailed in Table 29, 30 and 31.

This complex has a housing colony, providing housing for all employees. It is anticipated that the complex will receive rental payment from employees using such facilities at the rates specified by local requirements income from rental has not been included in the profit and loss statement.

**Table 27**

**Executive and Administrative Personnel**

| Categories | Number |
|---|---|
| - General Manager | 1 |
| - Assistant General Manager | 1 |
| - Marketing and Sales Manager | 1 |
| - Chief Financial Officer | 1 |
| - Chief Mechanical Officer | 1 |
| - Stores and Warehouse Manager | 1 |
| - Personnel Manager | 1 |
| - Administrative Officer | 1 |
| - Purchasing Agent | 1 |
| - Chief Engineer | 1 |
| - Assistant Officers | 6 |
| - Accountants, Buyers, Planners, Lawyers Engineers and other Professional Personnel | 60 |
| - Book Keepers, Draftsman, Nurses, Secretaries | 70 |
| - Clerks, Typists, Chauffers, Guards and other officer personnel | 80 |
| - Unskilled labours as porters and sweepers | 50 |
| Total | 278. |

## Table 23

## Operating Personnel

| Categories | Utilities plants | Process Plants | | | |
|---|---|---|---|---|---|
| | | Caprolactam plant | [illegible] plant | PA plant | Total |
| **1. Production** | | | | | |
| - Operators | 32 | 80 | 86 | 28 | 226 |
| - Helpers | 24 | 60 | 60 | 20 | 164 |
| - Shifts engineers (Formen) | 12 | 16 | 16 | 12 | 56 |
| - Plant Eng. (Supervisors) | 4 | 8 | 8 | 4 | 24 |
| - Plant labour. Chemists | 4 | 8 | 8 | 4 | 24 |
| Sub-Total | 76 | 172 | 178 | 68 | 494 |
| **2. Maintenance** | | | | | |
| Workers | 32 | 60 | 62 | 30 | 184 |
| Helpers | 24 | 40 | 40 | 20 | 124 |
| Engineers (Formen) | 8 | 12 | 12 | 6 | 38 |
| Engineers (Supervisors) | 4 | 4 | 4 | 4 | 16 |
| Sub-Total | 70 | 116 | 118 | 60 | 362 |
| Grand Total | 146 | 288 | 296 | 128 | 856 |

**Table 29**

**Estimated Salaries and Wages**
**- Operating Personnel -**
**Rs.**

| | Annual employee wages | | | No of employees | Total annual Pay Roll |
|---|---|---|---|---|---|
| | Hourly rate | Annual hours | Annual wages | | |
| 1. **Production:** | | | | | |
| - Operators | 2.2 | 1760 | 3872.0 | 226 | 875,072.0 |
| - Helpers | 1.0 | 1760 | 1760.0 | 164 | 288,640.0 |
| - Shift Engineers(Formen) | 4.0 | 1760 | 7040.0 | 56 | 394,240.0 |
| - Plant eng.(Supervisors) | 8.0 | 1760 | 14080.0 | 24 | 337,920.0 |
| - Plant Lab. Chemists | 7.0 | 1760 | 12320.0 | 24 | 295,680.0 |
| Sub-Total | | | | 494 | 2,191,552.0 |
| 2. **Maintenance** | | | | | |
| - M. Workers | 2.2 | 1760 | 3872.0 | 184 | 712,448.0 |
| - Helpers | 1.0 | 1760 | 1760.0 | 124 | 218,240.0 |
| - Engineers (Formen) | 4.0 | 1760 | 7040.0 | 38 | 267,520.0 |
| - Engineers(Supervisors) | 8.0 | 1760 | 14080.0 | 16 | 225,280.0 |
| Sub-Total | 7.0 | 1760 | - | 362 | 1,423,488.0 |
| Total | | - | - | 856 | 3,615,040.0 |

Note:- Does not include pay for vacation, holidays, sick leave etc. which is included Fringe benefit.

**Table 30**

**Estimated Salaries and Wages distributed to the Plant**
**Rs.(000)**

| | All Plant | | | | | | |
|---|---|---|---|---|---|---|---|
| No of employees | 226 | 228 | 184 | 94 | 40 | 2424 | 856 |
| Caprolactam | 309.76 | 176.00 | 232.32 | 197.12 | 168.96 | 98.56 | 1182.72 |
| DMT | 332.99 | 176.00 | 210.06 | 197.12 | 168.96 | 98.56 | 1213.69 |
| PA-Plant | 108.41 | 70.40 | 116.16 | 126.72 | 112.64 | 49.28 | 583.61 |
| Utilities plants | 123.90 | 84.48 | 123.90 | 140.80 | 112.64 | 49.28 | 635.00 |
| Housing Colony | - | - | - | - | - | - | - |
| Total:- | 875.07 | 506.88 | 712.44 | 661.76 | 563.20 | 295.68 | 3615.04 |

## Table 31

**Estimated General and Administrative expense Executive and Administrative Personnel**

**Rs.**

| | Categories | Annual employee salary | No of employees | Total annual Pay Roll |
|---|---|---|---|---|
| 1. | General Manager | 36,000.0 | 1 | 36,000.0 |
| 2. | Technical Manager | 30,000.0 | 1 | 30,000.0 |
| 3. | Marketing and Sales Manager | 16,000.0 | 1 | 16,000.0 |
| 4. | Financial Manager | 16,000.0 | 1 | 16,000.0 |
| 5. | Chief Medical Officer | 16,000.0 | 1 | 16,000.0 |
| 6. | Stores and Warehouse Manager | 14,000.0 | 1 | 14,000.0 |
| 7. | Personnel Manager | 14,000.0 | 1 | 14,000.0 |
| 8. | Administrative Officer | 14,000.0 | 1 | 14,000.0 |
| 9. | Purchasing Manager | 14,000.0 | 1 | 14,000.0 |
| 10. | Chief Engineer | 18,000.0 | 1 | 18,000.0 |
| 11. | Assistants Officer | 8,000.0 | 6 | 48,000.0 |
| 12. | Accountants, Lawyers, Buyers Planners, Engineers, Salesmen and other professional personnel | 5,000.0 | 60 | 300,000.0 |
| 13. | Secretaries, Book Keepers, Draftsmen, Nurses and others | 3,500.0 | 70 | 245,000.0 |
| 14. | Typist, Clerks, Chauffers Guards and others office person | 3,000.0 | 80 | 240,000.0 |
| 15. | Porters, other unskilled labours | 1,500.0 | 50 | 75,000.0 |
| | Total | | 276 | 1,0[illegible].0 |

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## Table 32

### Fringe Benefits
Rs. (000)

Fringe benefit amount is computed by applying percentage to following salaries and wages

| | Salaries | Fringe benefits |
|---|---|---|
| Production | 2,191,552.0 | 1,314,931.0 |
| Housing | 47,620.0 | 28,572.0 |
| General Administrative salaries | 1,042,041.0 | 625,208.0 |
| Maintenance | 1,123,488.0 | 854,092.0 |
| Total Pay Roll | 4,704,670.0 | 2,822,797.0 |

Allocation of Fringe Benefits

| Element | | Percent | Amount |
|---|---|---|---|
| Graduity | | 1.0 | 47,046.74 |
| Rent Housing | | 17.5 | 823,317.95 |
| Bonus (1 month) | | 8.0 | 376,373.92 |
| Vacation | | 8.0 | 376,373.92 |
| Sick Leave | | 4.0 | 188,186.96 |
| Holiday | | 4.0 | 188,186.96 |
| School | | 2.0 | 94,093.48 |
| Pension - Provident Fund | | | |
| Officers | 6.25% | | |
| Workers | 10.00% | | |
| Average | 7.00% | 7.0 | 329,327.18 |
| Social and Recreation | | 2.0 | 94,093.48 |
| Hospital - Medical and social insurance | | 5.0 | 235,233.70 |
| Miscellaneous | | 1.5 | 70,570.11 |
| Total | | 60.0% | 2,822,800.00 |

## Table 33

Estimated cost of Foreign Technicians
Rs(000)

| No | Names | Base salary | Living allowance | Total annual cost | No of years | Total | Currency component F.E. | L.C |
|---|---|---|---|---|---|---|---|---|
| 1. | General Manager | 120.0 | 50.0 | 170.0 | 2 | 340.0 | 285.0 | 55.0 |
| | Production Managers: | | | | | | | |
| 1 - | Caprolactam | 100.0 | 50.0 | 150.0 | 2 | 300.0 | 250.0 | 50.0 |
| 1 - | DMT | 100.0 | 50.0 | 150.0 | 2 | 300.0 | 250.0 | 50.0 |
| 1 - | PA | 100.0 | 50.0 | 150.0 | 2 | 300.0 | 250.0 | 50.0 |
| | | Sub-Total | | | | 1240.0 | 1035.0 | 205.0 |
| 1 | Commercial Manager | 100.0 | 50.0 | 150.0 | 1 | 150.0 | 100.0 | 50.0 |
| | Maintenance Consult. | | | | | | | |
| 1 - | Mechanical | 100.0 | 50.0 | 150.0 | 1 | 150.0 | 100.0 | 50.0 |
| 1 - | Instruments | 100.0 | 50.0 | 150.0 | 1 | 150.0 | 100.0 | 50.0 |
| 1 | Utility Division supervisor | 100.0 | 50.0 | 150.0 | 1 | 150.0 | 100.0 | 50.0 |
| 1 | Chief Chemist | 100.0 | 50.0 | 150.0 | 1 | 150.0 | 100.0 | 50.0 |
| | | Sub-Total | | | | 750.0 | 500.0 | 250.0 |
| | Total 9-Foreign technicans | | | | | 1990.0 | 1535.0 | 455.0 |
| | Family travel expenses for 9x4x5700 | | | | | 205.2 | 105.0 | 100.5 |
| | Total cost | | | | | 2195.2 | 1640.0 | 555.5 |

# SECTION 4

## COST OF OPERATION.

### 4.0 Estimated Cost of Operations.

#### 4.0.1. Total Cost.

The estimated annual production costs for the complex at full capacity is shown in Table 35. This is based on 7680 operating hours per year which permits adequate downtime based on experience in similar plant. In addition there are estimated general and administrative expenses of Rs. 2,628,982 as indicated in Table 34.

In Table 36 through 38 show cost for each individual plants comprising the complex incorporated. In this costs are raw materiel, chemicals, supplies, labour, fringe benefits, production overhead, depreciation and amortization.

Estimated expenses for the wages and salaries are given in Table 29,30,31. Fringe benefits are given in Table 32.

#### 4.0.2 Price Basis.

The estimation of annual production costs for monomer complex is based on the following assumption. The price of principal raw materials which are coming from the Project "A" have been taken on basis on manufacturing costs which include the variable costs, all fixed expense are insurance interest on loan, depreciation and amortization, overhead, fringe benefits, labour and supervision etc.

2. **Cost of Material and Services.**

**Material**

- Cyclohexone (for caprolactam Rs. 407.6/ton. This price is production cost in Project "4" which include all expenses mentioned above under 4.0.2.

| | |
|---|---|
| - Caustic Soda | Rs. 670.0 ( $ . 142/t) |
| - Oleum | Rs. 232.0 ( $ . 49/t) |
| - Ammonia | Rs. 320.0 ( $ . 67/t) |
| - Boric acid | Rs. 932.0 ( $ . 169/t) |
| - Hydrogen | Rs. 45.0 ( - ) |
| - Para-xylene | Rs. 843.0( $ . 177.0) |
| - Ortho-xylene | Rs. 336.0( $ . 76.8) |
| - Fuel | Rs. 100 / ton |
| - Steam | Rs. 6/ ton |
| - Electricity | Rs.0.004/kwh |
| - Cooling water | Rs. 0003/m$^3$ |
| - Raw material | Rs. 0003/m$^3$ |
| - DM-water | Rs. 007/m$^3$ |

4.0.3 **Interest on Loan.**

The rate of interest is estimated as follows :-

| | |
|---|---|
| - on foreign loan | at 7% p.a. |
| - on local | at 8% p.a. |

4.0.4 **Repair and Maintenance.**

The expenditure for maintenance is taken through two categories :-

- In fixed costs are taken labour charges.
- In variable cost as "another supplies" in value of 3% of equipment cost plus overseas fright and duty and local transport(See Table 46).

4.0.5 **Insurance:**

This includes insurance of plants as a whole, against fire and operational hazards, miscellaneous rent bills and local taxes levied by the Government. It is estimated 2% on erected cost.

4.0.6. **Remuneration** - are given in Section 3 (under 3.6.9.2) and Table 29 through 31/33.

**Table 34**

Estimated General and Administr. Expenses
Rs(000)

| **Expenses** | | **Rs. (000)** |
|---|---|---|
| Salaries and Wages | | 1,042,01 |
| Fringe benefit 60% | | 625.20 |
| Maintenance : | | 117.00 |
| Labours | 40.00 | |
| Fringe benefits | 32.00 | |
| Production overhead | 20.00 | |
| Supplies | 25.00 | |
| Sub-Total | 117.00 | |
| Depreciation and Amortisation | | 233.56 |
| Utilities | 40.00 | 40.00 |
| Local taxes, telephone, stationory and other miscellaneous expenses | | 571.20 |
| Total expenses | | 2.628.98 |

Table 35

Annual Production Cost at
Full Production
Rs.(000)

| | | Amount |
|---|---|---|
| **A. Variable Cost** | | |
| Raw Materials | | 20,101,0 |
| Caustic soda | 546.72 | |
| Sulphuric acid | 5,011.20 | |
| Ammonia | 3,635.20 | |
| Hydrogen | 57.60 | |
| Boric acid | 152.32 | |
| Methanol | 1,676.16 | |
| Fuel for power | 4,706.40 | |
| Chemicals & Catalysts | 1.194.00 | |
| Cooling Water | 77.64 | |
| Boiler Water | 12.00 | |
| Sub-Total | | 17,069.0 |
| Other Supplies: | | |
| Maintenance supplies ) packing material ) | 3,380.00 | 3,380.5 |
| Total variable cost | | 40,550.5 |
| **B. Fixed Costs.** | | |
| Labour | | 3,615.0 |
| Fringe benefit | | 2,169.0 |
| Production overhead | | 1,446.0 |
| Depreciation and amortization | | 23,750.7 |
| Total Fixed Cost | | 30,980.7 |
| **C. Total Production Costs.** | | 71,531.2 |

## Annual Cost of Operation.

Plant Caprolactam
Raw material : Cyclohexanone (DSM)
Capacity : 16,000 t/y.

Table 36

| Cost Elements | Unit base | Unit price Rs/unit | Consumption per 1 ton | Cost per 1 ton | Total cost Rs(000) Per Year. |
|---|---|---|---|---|---|
| **A. Variable Cost** | | | | | |
| 1. Raw Material | | | | | |
| - Cyclohexanone | t | 407.8 | 0916 | 373.54 | 5,976.64 |
| - Caustic Soda | t | 670.0 | 0051 | 34.17 | 546.72 |
| - Oleum | t | 232.0 | 1350 | 313.20 | 5,011.20 |
| - Ammonia | t | 320.0 | 0710 | 227.20 | 3,635.20 |
| - Hydrogen | t | 45.0 | 0080 | 3.60 | 57.60 |
| - Boric acid | t | 932.0 | 0010 | 9.52 | 152.32 |
| Sub-Total raw materials | | | | | 15,379.68 |
| 2. Other Supplies | | | | | |
| - Maintenance material | | | | | 1,502.75 |
| - Packing material | | | | | 128.00 |
| Sub-Total (1+2) | | | | | 17,010.43 |
| 3. Utilities. | | | | | |
| El. power | kwh | 0004 | 600 | 24.00 | 384.00 |
| Steam | t | 6.0 | 14.3 | 85.80 | 1,372.80 |
| Process Water | $m^3$ | 0.07 | 6.5 | 0.45 | 7.20 |
| Cooling Water | $m^3$ | 0003 | 1150.0 | 3.45 | 55.20 |
| Catalyst & Chemicals | Rs | 60.0 | 60.0 | 60.00 | 960.00 |
| Sub-Total Utilities | | | | | 2,779.20 |
| Total Variable Costs | | | | | 19,789.63 |
| **B. Fixed Operating Costs.** | | | | | |
| Labhours, production and maintenance. | | | | | 1,589.17 |
| Fringe benefits | | | | | 989.08 |
| Overhead | | | | | 630.58 |
| Depreciation and Amortisation | | | | | 11,068.66 |
| Sub-Total fixed costs | | | | | 14,277.49 |
| Total cost of operation per 1 ton | | | | Rs 2129.0<br>$ [illegible]7.26 | 34,067.12 |

## Annual Cost of Operation
### - At Full Production -

Plant Unit : Terephthalic acid/DMT-Plant (Witten)
Raw Material Para-xylene
Capacity : 18,000 T/A

Table 37

| Cost Elements | Base unit | Unit price | Consumption per 1 ton | Cost per ton | Total cost Rs.(000) per year |
|---|---|---|---|---|---|
| **A. Variable Oper. Costs** | | | | | |
| 1. Raw material | | | | | |
| - Para-xylene | t | 843.6 | 0.715 | 603.17 | 10,857.06 |
| - Methanol | t | 166.0 | 0.561 | 93 | 1,676.16 |
| Sub-Total raw material | | | | | 12,333.22 |
| 2. Other Supplies. | | | | | |
| Maintenance supplies | | | | | 1,435.85 |
| Sub-Total raw material and supplies | | | | | 13,969.07 |
| 3. Utilities. | | | | | |
| El. power | kwh | 0.04 | 2030.0 | 81.20 | 1,461.60 |
| Steam | t | 6.0 | 10.0 | 60.00 | 1,080.00 |
| Cooling Water | $m^3$ | 0.003 | 285.0 | 1.14 | 20.52 |
| Catalyst & Chemicals | | 8.0 | 8.0 | 8.00 | 144.00 |
| Sub-Total -Utilities | | | | | 2,706.12 |
| Sub-Total Variable Cost | | | | | 16,675.19 |
| **B. Fixed Oper. Costs.** | | | | | |
| Labours, production, maintenance and supervision | | | | | 1,624.94 |
| Fringe benefit 60% | | | | | 974.94 |
| Overhead 40% | | | | | 653.26 |
| Depreciation and Amortisation | | | | | 11,603.99 |
| Sub-Total -Fixed Costs | | | | | 14,857.99 |
| Annual cost of operation | | | | | 31,533.18 |
| Total cost of operation per 1 ton | | | | Rs. 1751.84<br>$. 368.03 | |

# Annual Cost of Operation

## - Full Production -

Plant Unit : Phthalic anhydride
Raw material: Ortho xylene
Capacity : 8,000 T/A

Table 38

| Cost Elements. | Base unit | Unit price | Consumption per 1 ton | Cost per ton | Total Costs Rs.(000) per Year |
|---|---|---|---|---|---|
| **A. Variable Oper.Costs** | | | | | |
| 1. Raw materials | | | | | |
| o-xylene | t | 366.5 | 1.110 | 406.81 | 3,270.48 |
| Sub-Total - Raw material | | | | | |
| 2. Other Supplies: | | | | | |
| - Maintenance | | | | | 244.00 |
| - Packing material | | | | | 72.00 |
| Sub-Total ( 1+2) | | | | | 3,586.48 |
| 3. Utilities: | | | | | |
| El.power | kwh | 0.04 | 1100 | 44.0 | 352.00 |
| Cooling Water | $m^3$ | 0003 | 60 | 0.24 | 1.92 |
| Fuel | $10^6$ Kcal | 7.0 | 10 | 7.0 | 56.00 |
| Catalysts & Chemicals Rs | | 10.0 | 10.0 | 10.0 | 90.00 |
| Sub-Total utilities(3) | | | | | 499.92 |
| Total variable cost | | | | | 4,086.40 |
| **B. Fixed Oper.Costs.** | | | | | |
| - Labours, production, maintenance and supervision | | | | | 672.80 |
| - Fringe benefit | | | | | 392.16 |
| - Overhead | | | | | 261.44 |
| - Depreciation & Amortisation | | | | | 1,7[illegible].87 |
| Sut-Total - Fixed Costs | | | | | 3,075.27 |
| Annual cost of operation | | | | | 7,161.67 |
| Total cost of operation per 1 ton | | | | Rs.895.20<br>$ 188.06 | |

Table 39

## Estimated Variable Production Costs for Project "B"

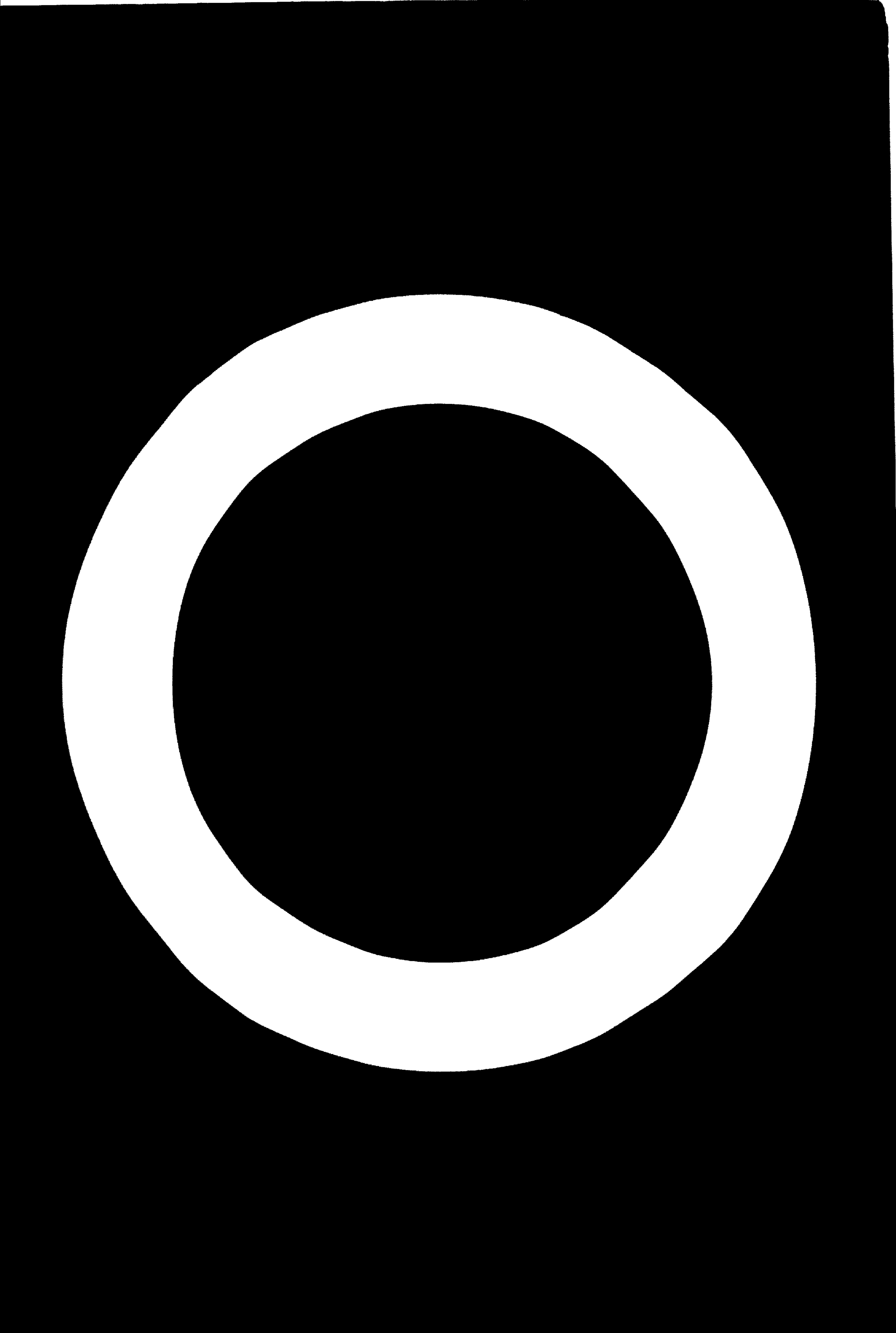
Rs.(000)

| | G & A & Housing Colony | Utilities | Caprolactam plant | DMT plant | Phthalic anhydride | Total | Total Variable Cost F.E. | L.C. | Total |
|---|---|---|---|---|---|---|---|---|---|
| Raw materials (coming from Project "A", Cyclohexane, p-xylene, o-xylene) | - | - | 5976.6 | 10854.0 | 3270.5 | 20101.0 | - | 20101.0 | 20101. |
| Caustic soda | - | - | 546.0 | - | - | 546.0 | - | 546.0 | 546. |
| Sulphuric acid | - | - | 55011.0 | - | - | 5011.0 | 3345.0 | 1666 .0 | 5011. |
| Ammonia | - | - | 3635.0 | - | - | 3635.0 | - | 3635 .0 | 3635. |
| Hydrogen | - | - | 57.6 | - | - | 57.6 | - | 57. 6 | 57. |
| Boric acid | - | - | 152.0 | - | - | 152.0 | 152.0 | - | - |
| Methanol | - | - | - | 1676.6 | - | 1676.6 | 576.0 | 1100. 0 | 1676. |
| Water | - | - | - | - | - | - | - | - | - |
| Fuel | - | 4500.0 | - | - | 56.0 | 4556.0 | - | 4556.0 | 4556. |
| Process water | - | - | 7.2 | - | - | 7.2 | - | 7.2 | 7. |
| Chemicals | - | 200.0 | - | - | - | 200.0 | 200.0 | - | 200. |
| Cooling water | - | - | 55.2 | 20.0 | 1.9 | 77.1 | - | 77.1 | 77. |
| Catalysts and Chemicals | - | - | 960.0 | 144.0 | 90.0 | 1194.0 | 1194.0 | - | 1194. |
| Boiler water | - | 12.0 | - | - | - | 12.0 | - | 12.0 | 12. |
| Sub-Total | - | 4712.0 | 16400.6 | 12694.6 | 3418.4 | 37225.6 | 5467.0 | 31757.9 | 37224. |
| Other Supplies: | | | | | | 3180.0 | 3180.0 | - | 3180 . |
| Maintenance | 55.0 | - | Total all plants | | | 200.0 | - | 200.0 | 200 . |
| Packing | - | - | 128.0 | - | 72.0 | 3380.0 | 3180.0 | - | 3180 . |
| Sub-Total | 55.0 | - | 128.0 | - | 72.0 | 40605.6 | 8647.0 | 31957.9 | 40605.6 |
| Total | 55.0 | 4712.0 | 16528.6 | 12694.6 | 3490.4 | | | | |

# Estimated Annual Fixed Production Cost
## Rs (000)

Project "B" — Table 40

| | Production Labour | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant operators | Plant helpers | Maintenance workers | Chief foremen | Plant Supr | Plant chemist | Total | Fringe benefit at 60% | Prod overhead | Depreciation & Amortization | Total fixed cost |
| 1. Caprolactam pl | 309.76 | 176.00 | 232.32 | 197.12 | 168.96 | 98.56 | 1182.72 | 709.63 | 473.08 | 8770.62 | 11136.03 |
| 2. DMT Plant | 332.99 | 176.00 | 240.06 | 197.12 | 168.96 | 98.56 | 1213.69 | 728.24 | 485.47 | 9109.64 | 11830.04 |
| 3. Phthalic anhydride (PA) | 108.41 | 70.40 | 116.16 | 126.72 | 112.64 | 49.28 | 583.61 | 350.16 | 233.44 | 1748.87 | 2016.08 |
| 4. Plant utilities | 123.90 | 84.48 | 123.90 | 140.80 | 112.64 | 49.28 | 635.00 | 381.00 | 254.00 | 4121.57 | 5391.57 |
| 5. Total Plant | 875.07 | 506.88 | 712.44 | 661.76 | 563.20 | 295.68 | 3615.03 | 2169.01 | 1446.01 | 23750.70 | 30973.75 |
| 6. General & Administr. | - | - | 100.00 | - | - | - | 100.00 | 60.00 | 40.00 | 233.56 | 433.56 |
| 7. Employee housing Colony. | - | - | 140.00 | - | - | - | 140.00 | 84.00 | 56.00 | 446.80 | 726.00 |
| 8. Grand Total | - | - | 1052.44 | - | - | - | 3855.00 | 2313.01 | 1542.01 | 24431.3 | 32431.31 |



# SECTION 5

## FINANCIAL EVALUATION.

5.0 **Estimated Capital Investment**

The total capital investment required for the Project "B is detailed in Table 40 and summarised in Table 39.

Table 41

Chemical Complex Project "B"
(Caprolactam, Terephthalic acid/DMT, Phthalic anhydride) Estimated Capital Investment
Rs.(000)

| Item | F.E. (000)Rs | L.C. (000)Rs | Total (000)Rs. |
|---|---|---|---|
| A. Site and Project Cost | | | |
| 1.Land Acquisition | - | 914.0 | 914.0 |
| 2.Site preparation and development | 304.5 | 3,319.0 | 3,623.0 |
| 3.Buildings | 2,508.0 | 28,125.0 | 30,633.0 |
| 4.Production equipment | 152,217.0 | 58,881.0 | 211098.0 |
| 5.Transportation equipment | 435.0 | 104.0 | 539.4 |
| 6.Office equipment | 500.0 | 400.0 | 900.0 |
| Sub-Total | 155,964.5 | 91,743.4 | 247,707.9 |
| B. Development Cost | | | |
| 1.Pre-operating | 4,496.0 | 4,406.0 | 9,102.0 |
| 2.Training and start-up | 2,165.0 | 4,130.4 | 6,295.1 |
| 3.Interest during contr. | - | 11,935.0 | 11,935.0 |
| Sub-Total | 6,661.0 | 20,671.0 | 27,332.0 |
| Sub-Total A+B | 162,625.5 | 112,414.4 | 275,039.0 |
| C. Working Capital. | | | |
| 1.Inventory | - | 15,082.7 | 15,082.7 |
| 2.Accounts payable (less | - | - | (5,529.0) |
| 3.Cash | - | - | (5,529.0) |
| Sub-Total | - | - | 15,082.7 |
| Total Project Costs | 162,625.5 | 127,496.4 | 290,121.9 |

5.1 **Site and Project Costs.**

Of the total investment of Rs.290,121,900, Rs.247,707,9 will be required for site and noncmer complex costs(Project "B) This total includes all cost for materials, equipment cost of erection, installation, engineering, know how and other similar associated costs. In Table 40 the detailed estimation of capital investment.

Estimated Capital Investment

**Table 42**

| | General Utilities | | Caprolactam | | DMT-Plant | | PA-Plant | |
|---|---|---|---|---|---|---|---|---|
| | FE | LC | FE | LC | FE | LC | FE | LC |
| % of Sub-Total A | 24.77 | | 31.40 | | 33.01 | | 6.24 | |
| **A. Site and Project Costs** | | | | | | | | |
| - Land Acquisition | - | 130.0 | - | 160.0 | - | 170.0 | - | 75.0 |
| - Site Development | 52.5 | 472.5 | 105.0 | 945.0 | 112.0 | 1008.0 | 35.0 | 315.0 |
| - Buildings | 340.0 | 3060.0 | 833.9 | 7506.0 | 714.0 | 6426.0 | 142.0 | 1286.0 |
| - Production Equip. | 21420.0 | 14280.0 | 59308.0 | 18840.0 | 60208.0 | 21564.0 | 11281.0 | 4197.0 |
| - Transport Equip. | 75.0 | 18.0 | 130.0 | 36.0 | 140.0 | 38.4 | 50.0 | 12.0 |
| - Office equipment | - | - | - | - | - | - | - | - |
| Sub-Total | 21887.5 | 17960.5 | 60376.9 | 27487.0 | 61174.0 | 29206.4 | 11508.0 | 5885.0 |
| **B. Development Costs** | | | | | | | | |
| - Pre-operating exp. | 400.0 | 1600.0 | 1940.0 | 952.0 | 1428.0 | 1666.0 | 714.0 | 238.0 |
| - Training & start-up | - | - | - | - | - | - | - | - |
| - Interest during constr. | | 2956.3 | - | 3747.6 | - | 3939.7 | - | 744.7 |
| Sub-Total B | 22287.5 | 22516.8 | 62290.9 | 32186.6 | 62602.0 | 34812.1 | 12222.0 | 6867.7 |
| Sub-Total A & B | | | | | | | | |
| **C. Working Capital** | | | | | | | | |
| - Inventory | | | | | | | | |
| - Less: Accoun Payable | | | | | | | | |
| - Cash | | | | | | | | |
| Sub-Total | | | | | | | | |
| Total est. cap. | | | | | | | | |

Cont'd...

| | Sub-Total FE | Sub-Total LC | General Adm. office FE | General Adm. office LC | Housing colony FE | Housing colony LC | Total Project FE | Total Project LC | Total Project Total |
|---|---|---|---|---|---|---|---|---|---|
| % of Sub-total A | | | | 1.24 | | 3.34 | | | |
| **A. Site and Project Costs** | | | | | | | | | |
| - Land Acquisition | - | 535.0 | - | 79.0 | - | 300.0 | - | 914.0 | 914.0 |
| - Site Development | 304.5 | 2740.0 | - | 175.0 | - | 404.0 | 304.5 | 3319.0 | 2623.5 |
| - Buildings | 2030.0 | 18278.0 | 203.0 | 1827.0 | 275.0 | [illegible] | 2508.0 | 28125.0 | 30633.0 |
| - Production Equip. | 152217.0 | 58881.0 | - | - | - | - | 152217.0 | 58881.0 | 211098.0 |
| - Transport Equipm. | 395.0 | 104.4 | 40. 0 | - | - | - | 435.0 | 104.0 | 539.4 |
| - Office equipment | - | - | 500.0 | 400.0 | - | - | 500.0 | 400.0 | 900.0 |
| Sub-Total | 154946.5 | 80538.4 | 703.0 | 2481.0 | 315.0 | 8724.0 | 155964.5 | [illegible] | 247707 .9 |
| **B. . Development Costs** | | | | | | | | | |
| - Pre-operating exp. | 4446.0 | 4456.0 | 50.0 | 150.0 | - | - | 4496.0 | 4406.0 | 9102.0 |
| - Training & start-up | - | - | - | - | - | - | 2165.0 | 4130.4 | 6295.1 |
| - Interest during constr. | | [illegible] | - | [illegible] | - | 398.6 | - | 11935.0 | 11935.0 |
| Sub-Total B | [illegible] | 96,382.70 | 753.0 | 2779.0 | 315.0 | 9122.6 | 6661.0 | 20671.0 | 27332.0 |
| Sub-Total A+B | | | | | | | 162625.5 | 112414.4 | 275039.0 |
| **C. Working Capital** | | | | | | | | | |
| Inventory | | | | | | | - | 15082.0 | 15082.0 |
| - Less: Accoun Payable | | | | | | | - | - | - |
| - Cash | | | | | | | - | - | - |
| Sub-Total | | | | | | | | | |
| Total est. cap. | | | | | | | 162625.5 | 127496.4 | 290121.9 |

## Table 43.

**Estimated Capital Investment for Housing Colony.**

| | Total Investment for Housing Colony | | |
|---|---|---|---|
| | F.E. | L.C. | Total |
| 1. Land Acquisition | - | 300.0 | 300.0 |
| 2. Site Preparation: | | | |
| Land Improvement | - | 150.0 | 150.0 |
| Roads and Paving | - | 60.0 | 60.0 |
| Sewerage and drainage | - | 130.0 | 130.0 |
| Contingency 10% | - | 64.0 | 64.0 |
| Sub-Total | - | 704.0 | 704.0 |
| 3. Buildings | | | |
| Housing | 250.0 | 7,000.0 | 7,250.0 |
| Import duty, ocean freight | 25.0 | - | 25.0 |
| Other expense(insurance, local transport). | - | 20.0 | 20.0 |
| Contingency | - | 725.0 | 725.0 |
| Sub-Total | 275.0 | 7,745.0 | 8,020.0 |
| Total | 275.0 | 8,449.0 | 8,724.0 |

5.2 Development Cost ( see Table 44 through 46)

It is estimated that Rs. 27,332,000.0 will be required for development cost to cover expenses associated with pre-operating, training and start-up and interest during construction.

Pre-operating expense estimated with Rs. 9,102,000 should covers all administrative cost, organisation of contractors consultances, travels and all other expenses associated with Planning and pre-operating items (See Table 44).

Training and start-up expenses are shown in Table 45 and could be summarized as follows :-

| | | |
|---|---|---|
| - Foreign Technicans | = | Rs.2,195,200 |
| - Overseas Management Training | = | Rs. 993,300 |
| - Local Staff Training | = | Rs.1,295,000 |
| - Start-up expense | = | Rs.1,811,600 |
| Total | | Rs.6,295,000 |

It is anticipated that training programme will cover a period of one year before start-up. The programme provides six months of overseas training for 35 key members of the Pakistani Management Team, production and maintenance. Local training will be conducted in Refinery- Chittagong, in Fertiliser Factory Gorosal and Fenchuganj.

The programme provides also the foreign team of 9 Experts during the first year of operation.

Start-up expenses are estimated with Rs.1,811,600 specified in Table 45.

Interest during construction is estimated to be Rs.11,935,000 as detailed in Table 46. This total reflect 7 percent interest factor and a commitment fee of 1 percent.

Table 44

Estimated Development Cost
Rs (000)

| | Development Cost | | |
|---|---|---|---|
| | F.E. | L.C. | Total |
| **1. Pre-operating Expenses** | | | |
| - Feasibility Studies, consultancy | - | - | - |
| - Preparing of main Projects | - | - | - |
| - Construction supervision personnel, travels, administr. expenses, consultancy | 4,496.0 | 4,606.0 | 9,102.0 |
| 2. Training and start-up expenses | 2,165.0 | 4,130.0 | 6,295.1 |
| 3. Interest during construction | - | 11,935.0 | 11,935.0 |
| Total Development cost. | 6,661.0 | 20,671.0 | 27,332.1 |

**Estimated Development Costs**
**Training and Start-up Programme**
**( 000 ) Rs.**

| Item | Training & Start-up Programme | | |
|---|---|---|---|
| | F.E. | L.C. | Total |
| 1. Training of Personnel. | | | |
| Foreign technicans | 1.640.0 | 555.5 | 2,195.2 |
| Overseas Management Training 35 men x 6 months = 210 months x800 | - | 168.0 | 168.0 |
| Fringe benefits 60% | - | 100.8 | 100.8 |
| Living expenses (210 months x 25000) | 525.0 | - | 525.0 |
| Transport fare 30x3700 | - | 199.5 | 199.5 |
| Sub-Total | 2,165.0 | 1,023.8 | 3,188.5 |
| 2. Local Staff Training | | | |
| 200 men x 1 year x 3500 | - | 700.0 | 700.0 |
| Fringe benefit 60% | - | 420.0 | 420.0 |
| Living expenses (25% of salary) | - | 175.0 | 175.0 |
| Sub-Total | - | 1,295.0 | 1,295.0 |
| 3. Start-up Expenses | | | |
| Labours 2 months(3,705,030:12m) | - | 617.5 | 617.5 |
| Fringe benefits 60% | - | 370.5 | 370.5 |
| Overhead 40% | - | 247.0 | 247.0 |
| Materials - 2 month 10% | - | 576.6 | 576.6 |
| Sub-Total | - | 1,811.6 | 1,811.6 |
| Total training of Personnel and start-up expenses | 2,165.0 | 4,130.4 | 6,295.1 |

# Estimated Development Cost
## - Interest during Construction -
(000) Rs.

Table 46

| Year before start-up | Quarter | Total loan commitments | Loan Drow | Unused | Interest on Draw down 7% Per year | Interest on Draw down 7% Per quarter | Interest on Unused balance 1% Per year | Interest on Unused balance 1% Per quarter | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | E + G |
| (2) | 1 | 205,000 | 5,000.0 | 200,000.0 | 350.0 | 87.5 | 2,000.0 | 500.0 | 587.5 |
| | 2 | 205,000 | 10,000.0 | 195,000.0 | 700.0 | 175.0 | 1,950.0 | 487.5 | 662.5 |
| | 3 | 205,000 | 25,000.0 | 180,000.0 | 1,750.0 | 437.5 | 1,800.0 | 450.0 | 887.5 |
| | 4 | 205,000 | 55,000.0 | 150,000.0 | 3,750.0 | 937.5 | 1,500.0 | 375.0 | 1,312.5 |
| Total year (2) | | | | | | | | | 3,447.5 |
| (1) | 1 | 205,000 | 125,000.0 | 80,000.0 | 8,750.0 | 2,187.5 | 800.0 | 200.0 | 2,387.5 |
| | 2 | 205,000 | 160,000.0 | 45,000.0 | 10,200.0 | 2,550.0 | 450.0 | 112.5 | 2,662.5 |
| | 3 | 205,000 | 195,000.0 | 10,000.0 | 13,650.0 | 3,412.5 | 100.0 | 25.0 | 3,437.5 |
| | 4 | 205,000 | 205,000.0 | - | - | - | - | - | - |
| Total year (1) | | | | | | | | | 8,487.5 |
| Total interest during the construction | | | | | | | | | 11,935.0 |

## 5.3 Working Capital

Starting working capital indicates the estimated needs of the Project at start-up and is calculated in Table 47.

Table 47.

Estimated Working Capital Required
Rs.(000)

| Item | Total Working Capital | | |
|---|---|---|---|
| | Before start-up | End of 1st Year | End of 2nd year |
| **1. Inventory** | | | |
| -Spare parts | 6,329.78 | 6,329.78 | 6,329.78 |
| -Raw material | 2,700.00 | 2,700.00 | 2,700.00 |
| -maintenance and packing | 4,200.00 | 4,200.00 | 4,200.00 |
| -Work in process inventory | 1,853.00 | 1,853.00 | 1,852.00 |
| -Finish goods inventory | - | 5,559.00 | 5,559,00 |
| Total | 15,082.78 | 20,641.78 | 20,641.78 |
| **2. Accounts receivable (1)** | - | 6,261.60 | 7,700.00 |
| Less: | | | |
| **3. Account Payable:** | | | |
| - Spare parts | (527.48) | (527.48) | (527.00) |
| - Raw material | (3,300.00) | (3,300.00) | (3,300.00) |
| - Maintenance and packing supplies | (2,000.00) | (2,000.00) | (2,000.00) |
| -Work in process | (1,246.00) | (1,246.00) | (1,246.00) |
| -Finished goods | - | (2,431.00) | (2,992.00) |
| Total | (7,073.48) | (9,504.00) | (10,065.00) |
| **4. Cash Required** | 7,073.48 | 9,504.00 | 10,065.00 |
| -Before start-up | 15,092.78 | - | - |
| -End of 1st year | | 26,902.60 | - |
| -End of 2nd year | | - | 27,765.00 |

(1) Computed at 30 days of daily sales:

End of 1st year (Rs.75,1[illegible]0,000 ÷12x1.0 = Rs.6,261,600)

End of 2nd year (Rs.92,400,000 ÷12x1.0 = Rs.7,700,000)

**Estimated Working Capital Requirements
- Computation of Inventory) -
Rs (000)**

| Inventory Items | Inventory | | | |
|---|---|---|---|---|
| | F.E. | L.C. | Before Start-up | At normal capacity |
| 1) Spare Parts | | | | |
| Original Capital Cost | - | - | - | - |
| Production equipment | 107,052.00 | 1,000.0 | - | - |
| Transport equip. | 7,669.00 | 76.0 | - | - |
| Total | 114,721.00 | 1,076.0 | | |
| 2) 2-Years Spare Parts Req.3% | 3,431.63 | 10.76 | - | - |
| Import duty and fright (35+5%) | 171.58 | 1,201.07 | - | - |
| Inland freight, insurance 5% | - | 171.58 | - | - |
| Contingencies 10% | 343.16 | 100.0 | - | - |
| Total | 3,946.37 | 2,383.41 | 6,329.78 | 6,329.78 |
| 3) Raw material | | | | |
| For 1 month | - | 2,700.0 | 2,700.00 | 2,700.00 |
| 4) Maintenance and Packing Supp. | 4,000.0 | 200.0 | 4,200.00 | 4,200.00 |
| 5) Work in Process | | | | |
| 10 days of production cost before depreciation | - | 1,853.0 | 1,853.00 | 1,853.00 |
| 6) Finished Goods | | | | |
| 30 days of production cost before depreciation. | - | 5,559.0 | - | 5,559.00 |
| Total inventory required | | | | |
| Before start-up | - | - | 15,082.78 | - |
| At normal capacity | - | - | - | 20,641.78 |

Estimated Working Capital Requirements
- Computation of accounts payable -
Rs(000)

| | Total Accountant Payable | | | |
|---|---|---|---|---|
| | Before start-up | End of 1st Year | End of 2nd year | End of 3rd year |
| | Utilization. | 65% | 80% | 95% |
| 1. **Spare Parts** | | | | |
| 1 month 6,329:12 | 527.48 | 527.48 | 527.48 | 527.48 |
| 2. **Raw Materials** | | | | |
| $40.10^6$:12 | 3,300.00 | 3,300.00 | 3,300.00 | 3,300.00 |
| 3. **Maintenance and Packing** | | | | |
| Supplies | 2,000.00 | 2,000.00 | 2,000.0 | 2,000.00 |
| 4. **Work in Process** | | | | |
| 10 days of variable production costs | 1,246.00 | 1,246.00 | 1,246.00 | 1,246.00 |
| 5. **Finished Goods** | | | | |
| 30 days of variable production cost | - | 2,431.00 | 2,992.00 | 3,553.00 |
| **Total Accounts Payable** | | | | |
| Before start-up | 5,929.00 | - | - | - |
| End of 1st Year | - | 9,504.48 | - | - |
| End of 2nd Year | - | - | 10,065.48 | - |
| End of 3rd Year | - | - | - | 10,626.48 |

Spare part inventory is based on a two-year requirement and is estimated to be approximately 3 percent of the original cost for equipment and transportation as indicated in Table 48.

Raw material inventory is estimated to include one month supplies as shown in Table 48.

Maintenance and packing supplies are estimated in Table 48 also. Maintenance supplies include one year, packing material two months.

Work in process inventory is estimated on the basis of total production cost invested at any one time, excluding depreciation. This indicates that this cost will equal about ten days of out of pocket expenses. This is summarised in Table 48. There is no provision in beginning working capital for finished goods. However, as production increases there will be a requirement for additional working capital as the work in process is converted into finished goods and then into account receivable. It is estimated that in normal production the plants will need about one month supply of finished goods in order to supply normal peak demands.

The additional requirement of working capital will be satisfied by short term-loan.

It is estimated that complex will pay all trade creditors within one month. Accounts payable at the end of any month will be only those payable accumulated from the proceeding one month period. In the case of work in process and finished goods, payables will approximate 10 and 30 days of variable production cost. This means the account payable is based on following approximation :-

| | | Before start Rs.(000) | End of 2nd Year Rs(000) |
|---|---|---|---|
| - Spare parts | 1 month | 527.48 | 527.00 |
| - Raw materials | 1 month | 3,300.00 | 3,300.00 |
| - Maintenance and packing supplies | 1 month | 2,000.00 | 2,000.00 |
| - Work in process | 10 days | 1,246.00 | 1,246.00 |
| - Finished goods | 1 month | - | 2,992.00 |
| Total | | 7,073.48 | 10,065.00 |

Beginning cash requirements are estimated to reflect a ratio to payable of 1 : 1 or Rs.7,073,480.

5.4 Depreciation and Amortization.

Normal tax depreciation rates are based on average productive lives of the assets. The rates applicable to the various classes of assets of this project are as shown down.

| | Years | Percent |
|---|---|---|
| Land | - | - |
| Site Preparation-Production | 20 | 5.0 |
| Building | 20 | 5.0 |
| Production equipment | 10 | 10.0 |
| Transportation equipment | 4 | 25.0 |
| Office equipment | 10 | 10.0 |
| Development cost | 15 | 6.7 |

Estimated Depreciation and Amortization

Total Project ("B")

Rs (000)

Table 50

| Item | Average Life In Year | % per Year | Production Division: Utilities | Caprolactam | DMT Plant | PA Plant | Sub Total | Others: Administration | Housing Colony | Total Project |
|---|---|---|---|---|---|---|---|---|---|---|
| **Depreciation** | | | | | | | | | | |
| 1. Land | | | | | | | | | | |
| 2. Site preparation | 30 | 5 | 26.25 | 52.50 | 59.60 | 17.50 | 155.85 | 8.75 | 20.20 | 184.80 |
| 3. Buildings | 20 | 5 | 170.00 | 416.98 | 357.00 | 54.40 | 998.38 | 101.50 | 400.00 | 1499.88 |
| 4. Production equipment. | 10 | 10 | 3570.00 | 7814.80 | 8177.20 | 1547.80 | 21109.80 | - | - | 21109.80 |
| 5. Transportation equipment. | 4 | 25 | 23.25 | 41.50 | 44.60 | 15.50 | 124.85 | 10.00 | - | 134.85 |
| 6. Office equip. | 10 | 10 | - | - | - | - | - | 90.00 | - | 90.00 |
| Sub/Total | | | 3789.50 | 8325.78 | 8638.40 | 1635.20 | 22388.88 | 210.25 | 420.20 | 23019.33 |
| **Amortization.** | | | | | | | | | | |
| 1. Pre-operating expenditure. | 15 | 6.7 | 134.00 | 193.76 | 207.29 | 63.78 | 598.83 | 13.40 | - | 609.83 |
| 2. Training and start-up | 15 | 6.7 | See Total | | | | | | | 421.76 |
| 3. Interest during const. | 15 | 6.7 | 198.07 | 251.08 | 263.95 | 49.89 | 762.99 | 9.91 | 26.60 | 798.50 |
| Sub-Total | | | 332.07 | 444.84 | 471.24 | 113.67 | 1361.82 | 23.31 | 26.60 | 1831.09 |
| Total depreciation and amortization | | | 4121.57 | 8770.62 | 9190.64 | 1748.87 | 23750.70 | 233.56 | 446.80 | 24850.03 |

5.5 **Proposed Financing**

The estimated capital investment by categories(FE:LC) requirements of this Project ("B") are summarised in Table 51 below :-

**Table 51**

Estimated Capital Investment Requirements
Rs(000)

| | F.E. | Local | Total |
|---|---|---|---|
| 1.Site and Project Cost | 155,964.5 | 91,743.4 | 247,707.9 |
| 2.Development Cost | 6,661.0 | 20,671.0 | 27,332.0 |
| 3.Working Capital | 7,946.3 | 7,136.4 | 15,082.7 |
| Total | 170,571.8 | 119,550.0 | 290,121.9 |

It is estimated that investor suppose to be EPIDC together with Project "A" because the Eastern Refinery belongs to EPIDC 60%. It is assumed that EPIDC will contribute with minimum 28-30 percent of total capital in the form of shareholders equity, local loan and balance will be long-term debt.

There are several local and regional institutions geared to supplying both medium and long-term loans such as the Pakistan Industrial Credit and Investment Co.,(PICIC). The Industrial Development Bank of Pakistan(IDBP); Asian Development Bank and EPIDC.

It is assumed that Asian Development Bank or World Bank loan can be obtained for about 162 millions with 7 percent interest rate to cover the financing of 100% of the Foreign exchange or about 56% of total investment.

Table 52

**Estimated Timing of Capital Requirements by type of Capital Rs(000)**

| Year before start-up | Quarter | From Equity | From Debt | Grand Total |
|---|---|---|---|---|
| (3) | First | 13,000.0 | - | - |
| | Second | 9,000.0 | - | - |
| | Third | 9,000.0 | - | - |
| | Fourth | 9,000.0 | - | - |
| Total | | 40,000.0 | - | 40,000.0 |
| (2) | First | 10,000.0 | 5,000.0 | - |
| | Second | 12,000.0 | 10,000.0 | - |
| | Third | 10,000.0 | 25,000.0 | - |
| | Fourth | 11,000.0 | 55,000.0 | - |
| Total | | 43,000.0 | 95,000.0 | 138.000.0 |
| | First | 2,121.9 | 30,000.0 | - |
| | Second | - | 35,000.0 | - |
| | Third | - | 30,000.0 | - |
| | Fourth | - | 15,000.0 | - |
| Total | | 2,121,9 | 110,000.0 | 112,121.0 |
| Grand Total | | 85,121.9 | 205,000.0 | 290,121.9 |

The long term debt was assumed to mature in 12 years. However, after a 3 years grace period, ten equal annual sinking fund payment would retire the debt as indicated in Table 53 below.

Total interest of Rs.11,935,000 during construction period is charged to development cost and includes and additional 1.0% commitment fee as computed in Table 44 and charged to operation.

## Table 53

**Estimated Foreign Long-Term Debt Pay off and Interest**
**- First 10 Years of Operation -**
**Rs.(000)**

Term of loan 10 years
interest rate 7%

| Year | Beginning Debt balance | Annual Year and payment | Ending Debt balance | Interest rate at 7% |
|---|---|---|---|---|
| 1 | 162,000.0 | 16,200.0 | 145,800.0 | 11,340.0 |
| 2 | 145,800.0 | 16,200.0 | 129,600.0 | 10,206.0 |
| 3. | 129,600.0 | 16,200.0 | 113,400.0 | 9,072.0 |
| 4 | 113,400.0 | 16,200.0 | 97,200.0 | 7,938.0 |
| 5 | 97,200.0 | 16,200.0 | 81,000.0 | 6,804.0 |
| 6 | 81,000.0 | 16,200.0 | 64,800.0 | 5,670.0 |
| 7 | 64,800.0 | 16,200.0 | 48,600.0 | 4,536.0 |
| 8 | 48,600.0 | 16,200.0 | 32,400.0 | 3,402.0 |
| 9 | 32,400.0 | 16,200.0 | 16,200.0 | 2,268.0 |
| 10 | 16,200.0 | 16,200.0 | - | 1,034.0 |
| | Total interest paid | | | 62,270.0 |

## Table 54

**Estimated Local Long-Term Debt Pay off & Interest**
**- Firt 10-years of Operation-**
**Rs(000)**

Term of loan 10 years
interest rate 8%

| Year | Beginning Debt balance | Annual Year and payment | Ending Debt balance | Interest rate at 8% |
|---|---|---|---|---|
| 1 | 43,000.0 | 4,300.0 | 38,700.0 | 3,440.0 |
| 2 | 38,700.0 | 4,300.0 | 34,400.0 | 3,096.0 |
| 3 | 34,400.0 | 4,300.0 | 30,100.0 | 2,752.0 |
| 4 | 30,100.0 | 4,300.0 | 25,800.0 | 2,408.0 |
| 5 | 25,800.0 | 4,300.0 | 21,500.0 | 2,064.0 |
| 6 | 21,500.0 | 4,300.0 | 17,200.0 | 1,720.0 |
| 7 | 17,200.0 | 4,300.0 | 12,900.0 | 1,376.0 |
| 8 | 12,900.0 | 4,300.0 | 8,600.0 | 1,032.0 |
| 9 | 8,600.0 | 4,300.0 | 4,300.0 | 688.0 |
| 10 | 4,300.0 | 4,300.0 | - | 344.0 |
| | Total interest paid | | | 18,920.0 |

## Table 55

Total Estimated Long-Term Debt
Rs(000)

| Year before and after start-up | Total Debt outstanding | Sinking Fund payment | Annual Interest |
|---|---|---|---|
| (2) | 95,000.0 | - | 3,447.5 |
| (1) | 205,000.0 | - | 8,487.5 (1)<br>11,934.0 |
| 1 | 205,000.0 | 20,500 | 14,760.0 |
| 2 | 184,500.0 | 20,500 | 17,780.0 |
| 3 | 164,000.0 | 20,500 | 11,824.0 |
| 4 | 143,500.0 | 20,500 | 10,346.0 |
| 5 | 123,000.0 | 20,500 | 8,868.0 |
| 6 | 102,500.0 | 20,500 | 7,390.0 |
| 7 | 82,000.0 | 20,500 | 5,908.0 |
| 8 | 61,500.0 | 20,500 | 4,434.0 |
| 9 | 41,000.0 | 20,500 | 2,956.0 |
| 10 | 20,500.0 | 20,500 | 1,378.0 |

The long term debt was assumed to mature in 12 years. However, after a 3 years grace period, ten equal annual sinking fund payments would retire the debt as indicated in Table 52 above.

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Note: - (1) Total interest of Rs.11,934,000 during construction period is charged to development cost.

5.6 **Income Taxes**

The levying of corporate income taxes in Pakistan follows the basic pattern found in most developing countries.

Certain tax incentives and concessions have been provided by the Government of Pakistan to quicken the pace of industrialization and to attract foreign capital and technical knowhow.

Because the final determination of taxes is subject to many variations certain conditions are assumed :-

- EPIDC would set up complex on the same basis as a private corporation.
- The Corporation would qualify as a public company (Technically known as a company in which the public is substantially interested.
- The corporation would qualify for a six year tax holiday. In the case of corporation locating in East Pakistan, the period would be six years. At the end of the tax holiday, new industrial undertaking are entitled to get depreciation allowances on the full cost of the capital assets. The benefit of the tax holiday will be allowed to new corporation fulfilling the following conditions:-

  - Must be primarily based on Pakistan raw material(approximately 50 percent).
  - Should be owned and managed by a company registered in Pakistan with paid-up capital of at least 50,000 Rs. should transfer at least 60 percent of its net profits after tax to retained earnings to be used in the development of expansion of the business or for investment in other approved industries.

Corporate taxes in Pakistan are of two types:

- Income tax
- Super tax

All companies must pay a basic flat income tax of 30 percent plus a super tax rate upto a maximum of 30 percent on total income. However, rebates on the super tax are provided for a variety of conditions two of which would apply to this project as follows :-

- A rebate of 5% is given to firm declaring dividends in Pakistan.
- A rebate of 10% is allowed for companies "in which the public is substantially interested" that is a public company as outlined previously.

Therefore, the effective tax rate estimated at 45% as shown below :-

<u>Estimated Income Tax Rate</u>

| | |
|---|---|
| Basic Tax Rate | 30% |
| Super Tax | 30% |
| Total | 60% |
| Less Rebates: | |
| - For declaring Dividends in Pakistan | (5) |
| - For Public Company | (10) |
| Total adjusted tax rate | 40% |

5.7 Estimated Fund Generated From Operation.

A summary of the estimated funds generated from operations for the six year period after start-up is shown in Table 56.

Table 56.

Estimated Funds Generated From Operation
Rs (000)

| Year | Sales | Operating income | Net income before income tax | Net income after income tax | Deprecia-tion and Amortiza-tion | Fund Generated from operation 1) |
|---|---|---|---|---|---|---|
| 1 | 92310.0 | 24232.5 | 9452.5 | 9452.5 | 24850.3 | 24302.8 |
| 2 | 103170.0 | 30737.5 | 17533.4 | 17533.4 | 24850.3 | 42383.7 |
| 3 | 108600.0 | 34440.0 | 23159.4 | 23159.4 | 24850.3 | 48009.7 |
| 4 | 108600.0 | 34440.0 | 25507.0 | 25507.0 | 24850.3 | 50357.3 |
| 5 | 108600.0 | 34440.0 | 27937.0 | 27937.0 | 24850.3 | 52787.3 |
| 6 | 108600.0 | 34440.0 | 30410.0 | 30410.0 | 24850.3 | 55260.3 |

Notes:- 1) Before Dividends.

The importance of the cash generated from operations as a source of funds to be used in perpetuating the business will be apparent from a review of the estimated cash flow which is presented in Table 58. It will be from these funds that new project will be able to retire long-term debt, replace facilities at the end of their useful lives and to expand into the production of other chemical products essential to the Economy of Pakistan.

The projected coverage of interest requirements on long-term debt as well as debt service coverage are shown in Tab. 57.

**Table 57**

**Estimated Funds Available for Servicing Interest and Debt**

| Estimated Interest Coverage | | | | Estimated Debt Service Coverage | | |
|---|---|---|---|---|---|---|
| Year | Profit before interest and income taxes (1) | Interest | Time interest earned | Cash Generation before interest & after income taxes (2) | Debt Service (3) | Times Earned |
| 1 | 24232.0 | 14780.0 | 1.65 | 49082.3 | 35280.0 | 1.40 |
| 2 | 31390.9 | 13296.0 | 2.35 | 56231.2 | 33796.0 | 1.67 |
| 3 | 35853.0 | 11824.0 | 3.00 | 60703.3 | 32324.0 | 1.88 |
| 4 | 36805.6 | 10346.0 | 3.55 | 61655.9 | 30846.0 | 2.00 |
| 5 | 37800.0 | 8868.0 | 4.20 | 62650.3 | 29368.0 | 2.13 |
| 6 | 38924.3 | 7390.0 | 5.30 | 63774.0 | 27890.0 | 2.27 |

Note :- 1) Operating income plus interest income
2) Includes depreciation and amortization.
3) Interest plus debt retirement.

Even after providing for debt retirement and a dividend to shareholders assumed to equal 40 percent of the annual net profits, the cash build-up is substantial.

As indicated in Table 58. the beginning cash balance of Rs.5929 rises to a total of Rs.99752,900 at the end of sixth year of operations of course, part of this cash will eventually be used to replace the original fixed assets as they wear out. It can be made also readjucements of selling price to stimulate the market extension. In the present case we have used the cash accomulates investing in Bank Certificates of Deposit at 5 percent. Actually it is recommendable that the large portion of the cash be reinvested in additional manufacturing capacity which should earn a higher return than 5 percent.

Table 58

## Estimated Cash Flow
Rs (000)

| | Year before Start-up 3 | 2 | 1 | Balance before | Year After Start-up 1 (85%) | 2 (95%) | 3 (100%) | 4 (100%) | 5 (100%) | 6 (100%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation of Capacity | | | | | | | | | | |
| **Source of Funds** | | | | | | | | | | |
| Financing | - | - | - | - | - | - | - | - | - | - |
| Equity capital | 40000.0 | 43000.0 | 2121.0 | 85121.0 | - | - | - | - | - | - |
| Long term loan | - | 96000.0 | 110000.0 | 206000.0 | - | - | - | - | - | - |
| Net Profit after div. | - | - | - | - | 9458.0 | 12393.5 | 16213.2 | 17855.0 | 19555.9 | 21287.0 |
| Depreciation & Amortis. | - | - | - | - | 24850.0 | 24850.0 | 24850.0 | 24850.0 | 24850.0 | 24850.0 |
| Increase in payable | - | - | 7073.0 | 7073.0 | 2430.0 | 561.0 | - | - | - | - |
| Total | 40000.0 | [illegible] | 119194.0 | 297194.0 | 36732.5 | 37714.5 | 41063.2 | 24705.0 | 44105.9 | 46137.0 |
| **Application of Funds** | | | | | | | | | | |
| Land | 914.0 | - | - | 914.0 | - | - | - | - | - | - |
| Site preparation | 3623.0 | - | - | 3623.0 | - | - | - | - | - | - |
| Buildings | 15633.0 | 10000.0 | 5000.0 | 30633.0 | - | - | - | - | - | - |
| Production equip: | 15000.0 | 118000.0 | 78098.0 | 211098.0 | - | - | - | - | - | - |
| Transport Equip: | 200.0 | 130.0 | 200.0 | 530.0 | - | - | - | - | - | - |
| Office equipment | - | 400.0 | 500.0 | 900.0 | - | - | - | - | - | - |
| Preoperating expen. | 4102.0 | 4000.0 | 1000.0 | 9102.0 | - | - | - | - | - | - |
| Training & start-up | - | 2000.0 | 4295.0 | 6295.0 | - | - | - | - | - | - |
| Interest during const- | - | 2935.0 | 9000.0 | 11935.0 | - | - | - | - | - | - |
| Beginning Inventory | - | - | 15082.7 | 15082.0 | 5559.0 | - | - | - | - | - |
| Increase in Inventory | - | - | - | - | 6861.6 | 1430.0 | - | - | - | - |
| Increase in Acc. Receivable | - | - | - | - | 3164.0 | 3164.0 | 3164.0 | 3164.0 | 3164.0 | 3164.0 |
| Replacement of spare parts | - | - | - | - | [illegible] | - | - | - | 539.0 | - |
| Replacement of Trans. Eng. | - | - | - | - | 20500.0 | 20500.0 | 20500.0 | 20500.0 | 20500.0 | 20500.0 |
| Pay back of long term debt. | - | - | - | - | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Total | 39472.0 | 137474.0 | 113265.0 | 290121.0 | 35484.0 | 25103.0 | 23661.0 | 23664.0 | 24203.0 | 23664.0 |
| **Cash** | | | | | | | | | | |
| Increase or decrease (A-B) | 528.0 | 526.0 | 5929.0 | - | 1249.5 | 12611.5 | 17402.2 | 19041.0 | 19902.9 | 22473.0 |
| At beginning of period | - | 528.0 | 1154.0 | [illegible] | 7073.0 | 8322.5 | 20934.0 | 38336.0 | 57377.9 | 77279.9 |
| At the end of period | 528.0 | 1154.0 | 7073.0 | 7073.0 | 8322.5 | 20934.0 | 38336.0 | 57377.0 | 77279.9 | 99752.9 |
| Debt service ratio | - | - | - | - | 1.4 | 1.67 | 1.88 | 2.0 | 2.13 | 2.27 |

**Estimated Interest Income**
**Rs.(000)**

| Beginning Balance Year | Annual Cash 1) | Invested in certificate of deposit 2) | Interest income 5% | Total interest income |
|---|---|---|---|---|
| 1 | 8322.5 | - | - | - |
| 2 | 20934.0 | 10869.0 | 543.4 | - |
| 3 | 38336.2 | 28271.0 | 1413.0 | 1413.0 |
| 4 | 57377.0 | 47312.0 | 2365.6 | 2365.6 |
| 5 | 77279.9 | 67214.0 | 3360.7 | 3360.7 |
| 6 | 99752.9 | 89687.0 | 4484.3 | 4484.3 |

1) See Table 63.

2) Local Pakistan Bank Certificates of Deposit is 5%.

5.8 <u>Projected Balance Sheets and Capitalization Ratios</u>.

The estimated balance sheets for the six year period after start-up are shown in Table 61. In preparing these data the following assumptions were employed:

- <u>Cash</u> Only the cash required for daily operations will be retained in working capital. This cash requirement is estimated to equal trade payables. As previously indicated, excess cash accumulated from operations were assumed invested in Certificates or Deposit.

- <u>Receivables</u> Estimated to average 30 days, or about Rs.7700.000 which is about 7% of annual sales.

- <u>Inventories</u> Approximately Rs.20 million of inventories is considered appropriate as outlined in the discussion of beginning working capital. This sum is equal to a turnover of 5.5 times or 18% of annual sales of 108.6 million.

- Payable trade creditors were assumed paid within thirty days. These payables are estimated at Rs.10.0 million or about 30% of inventories plus receivable. It should be noted that all temporary and miscellaneous items, such as prepaid expenses, salaries and wages payable, income taxes payable etc. have been excluded from the balance sheets since such items are assumed to be expanded or paid during the fiscal year incurred.

- Long term Debt Estimated at 70% of total investment required at start-up or 205 million as indicated earlier.

- Net Retained Earning Accumulated

Represents annual net profits after dividend accumulated over the six year period following start-up. Because of the build-up or retained earnings, shareholders equity almost doubles over the six year period, rising from Rs.85 million to 147.0 million Table 60 below. Detailed balance sheets is given in Table 61.

Table 60

Estimated Capitalisation and Ratios
Rs (000)

| At end of year | Long-term Debt | | Capital Stock and Surplus | | Total Capitalization and Surplus | |
|---|---|---|---|---|---|---|
| | Amount | Percent | Amount | Percent | Amount | Percent |
| At start-up | 205,000.0 | 70.66 | 85,121.0 | 29.34 | 290,121.0 | 100.0 |
| 1 | 184,500.0 | 69.50 | 80,964.0 | 29.50 | 265,464.0 | 100.0 |
| 2 | 164,000.0 | 65.73 | 85,484.5 | 34.25 | 249,484.2 | 100.0 |
| 3 | 143,500.0 | 59.54 | 97,214.5 | 40.46 | 240,714.5 | 100.0 |
| 4 | 123,000.0 | 52.11 | 112,434.5 | 47.89 | 235,434.5 | 100.0 |
| 5 | 102,000.0 | 43.95 | 129,011.9 | 56.05 | 231,011.9 | 100.0 |
| 6 | 82,000.0 | 35.54 | 147,060.9 | 64.44 | 229,060.9 | 100.0 |

**Estimated Balance Sheets** Table 61

| | Balance before start-up | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| | | At the end of year | | | | | |
| **Current Assets** | | | | | | | |
| Cash (on hand) | 7073.4 | 9504.0 | 10065.0 | 10065.0 | 10065.0 | 10065.0 | 10065.0 |
| Cash (invested in certificate of deposit) | - | - | 10869.0 | 28271.0 | 47312.0 | 67214.0 | 89687.0 |
| Accounts Receivable | - | 6261.6 | 7700.0 | 7700.0 | 7700.0 | 7700.0 | 7700.0 |
| Inventories | 15082.0 | 29641.7 | 20641.7 | 20641.7 | 20641.7 | 20641.0 | 20641.7 |
| Total current assets | 21011.0 | 36407.3 | 49275.7 | 66677.7 | 85718.7 | 105680.7 | 119036.2 |
| **Fixed Assets** | | | | | | | |
| -Land | 914.0 | 914.0 | 914.0 | 914.0 | 914.0 | 914.0 | 914.0 |
| -Site preparation | 3623.0 | 3623.0 | 3623.0 | 3623.0 | 3623.0 | 3623.0 | 3623.0 |
| -Buildings | 30633.0 | 30633.0 | 30633.0 | 30633.0 | 30633.0 | 30633.0 | 30633.0 |
| -Production equipment | 211098.0 | 214262.0 | 217326.0 | 220490.0 | 223654.0 | 226818.0 | 229982.0 |
| -Transport equipment | 539.0 | 539.0 | 539.0 | 539.0 | 539.0 | 539.0 | 539.0 |
| -Office equipment | 900.0 | 900.0 | 900.0 | 900.0 | 900.0 | 900.0 | 900.0 |
| Total Fixed Assets | 247707.9 | 250871.0 | 254036.0 | 257199.0 | 260365.0 | 263531.0 | 266697.6 |
| Less accumulated depreciation | - | (23019.3) | (46038.0) | (69057.9) | (89077.2) | (112096.0) | (135115.8) |
| Total net fixed Assets | 247707.9 | 227852.7 | 207997.0 | 188142.0 | 171288.8 | 151435.0 | 131581.2 |
| **Other Assets** | | | | | | | |
| Pre-operating expense | 9102.0 | 9102.0 | 9102.0 | 9102.0 | 9102.0 | 9102.0 | 9102.0 |
| Training and start-up | 6295.1 | 6295.1 | 6295.1 | 6295.1 | 6295.1 | 6295.1 | 6295.1 |
| Interest during construction | 11935.0 | 11935.0 | 11935.0 | 11935.0 | 11935.1 | 11935.1 | 11935.1 |
| Total other Assets | 27332.1 | 27332.1 | 27332.1 | 27332.1 | 27332.1 | 27832.1 | 27332.1 |
| Less accumulated amortization | - | 1831.0 | 3662.0 | 5493.0 | 7324.0 | 9155.0 | 10986.1 |
| Total net other assets | 27332.1 | 25501.1 | 23670.1 | 21839.1 | 20008.1 | 17177.1 | 16346.0 |
| Total Assets | 296051.0 | 289761.1 | 280942.8 | 276658.8 | 277015.6 | 274232.8 | 266962.4 |
| **Liabilities and shareholders Equity:** | | | | | | | |
| Current Liabilities | | | | | | | |
| -Accounts payable | 5929.0 | 9504.4 | 10065.5 | 10065.5 | 10065.5 | 10065.5 | 10065.5 |
| -Current maturing long.t.debt | 20500.0 | 20500.0 | [illegible] | 20500.0 | 20500.0 | 20500.0 | 20500.0 |
| Total current liabilities | 26429.0 | 30004.0 | 30565.5 | 30565.5 | 30565.0 | 30565.5 | 30565.5 |
| Long term debt. | 184500.0 | 164000.0 | 143500.0 | 123000.0 | 102500.0 | 82000.0 | 61500.0 |
| **Shareholders Equity:** | | | | | | | |
| Capital Stock | 85121.0 | 85121.0 | 85121.0 | 85121.0 | 85121.0 | 85121.0 | 85121.0 |
| Net Retained earnings accumul. | - | 9452.5 | 21766.0 | 37971.2 | 55826.2 | 75382.1 | 96669.1 |
| Total shareholders equity | 85121.0 | 94573.0 | 106877.0 | 122092.2 | 140947.2 | 160503.1 | 181780.1 |
| Total liabilities & shareholders Eq. | 296050.0 | 288577.0 | 280542.0 | 275658.3 | 274012.7 | 273068.6 | 273845.6 |

5.9 **Break-even Level**

In order to compute the break-even point it was necessary to develop the following overall composite selling price since the complex will be selling more than one product. Finding so called average overall price per ton, it is assumed that the above unit sales price and product mix would continue at all level of production.

Based on the foregoing, the complex would be able to sell 27300 tons of mixed product and still break-even on net income basis. This represents a level of production equal to about 65 percent of capacity.

Break-even on funds generated basis that is, at that level of operations when cash flow would equal the amount required for debt retirement, is indicated to be about 58 percent of capacity.

Table 62 on the following page shows the estimated profit and loss at capacity and at the net income and fund generated at break-even levels.

In Table 63 is shown the estimated profit and loss statement for a period of 6 years after start-up.

**Table 62**

Estimated Profit and Loss (1)
At capacity and at Break-even points
Rs(000)

| | At Capacity 100% (4th) (3) | Break-even points: At Capacity 64% (2) | Break-even points: At Capacity 57% (4) |
|---|---|---|---|
| Metric tons sold | 42,000.0 | 27,300.0 | 24,360.0 |
| Average selling price | 2,738.1 | 2,738.1 | 2,738.1 |
| Total Revenue | 108,600.0 | 68,418.0 | 61,902.0 |
| **Cost of Operation** | | | |
| A. Variable oper.cost | 40,550.5 | 25,546.5 | 23,113.5 |
| B. Fixed oper.cost | 30,980.7 | 30,980.0 | 30,980.7 |
| C. General & administr.exp | 2,628.9 | 2,628.9 | 2,628.9 |
| Total cost of operation | 74,160.0 | 59,155.4 | 56,723.1 |
| Operating profit | 34,440.0 | 9,262.6 | 5,178.9 |
| **Other income or Expenses:** | | | |
| Interest income | 1,413.5 | 1,413.5 | 1,413.5 |
| Interest expense | (10,346.0) | (10,346.0) | (10,346.0) |
| Total other- Net. | (8,933.5) | (8,933.5) | (8,933.5) |
| Net income before taxes | 25,506.5 | 329.1 | (3,754.6) |
| Income tax | - | - | - |
| Net income after taxes | 25,506.5 | 329.1 | (3,754.6) |
| Add depreciation & Amortisation | 24,850.0 | 24,850.0 | 24,850.0 |
| Total cash generated (5) | 50,356.5 | 25,179.1 | 21,095.4 |

Note :- 1. Computed for the year of operation following six years tax holiday.

2. Sales level at which net income equals zero.

3. Sales level at 100% utilisation.

4. Level at which funds generated nearly equals long-term debt retirement.

5. Cash generated before payment of any divide[illegible] to equity shareholders.

## Estimated Profit and Loss Statement
Rs(000)

Table 63

| | | Y e a r | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| Utilization of Capacity % | | 85% | 95% | 100% | 100% | 100% | 100% |
| . Net Sales | (1) | 92310.0 | 103170.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 |
| . Cost of Sales | (2) | | | | | | |
| - Variable cost | | 34467.9 | 38522.9 | 40550.5 | 40550.5 | 40550.5 | 40550.5 |
| - Fixed cost including depreciation and amortization for plants only | | 30980.7 | 30980.7 | 30980.7 | 30980.7 | 30980.7 | 30980.7 |
| Total cost of sales | | 65448.6 | 69503.6 | 71531.2 | 71531.2 | 71531.2 | 71531.2 |
| . Gross income | | 26861.4 | 33666.4 | 37068.8 | 37068.8 | 37068.8 | 37068.8 |
| . Operating Expense: | | | | | | | |
| General & Administr.expense | (3) | 2628.9 | 2628.9 | 2628.9 | 2628.9 | 2628.9 | 2628.9 |
| . Operating Income | | 24232.5 | 30737.5 | 34440.0 | 34440.0 | 34440.0 | 34440.0 |
| . Other income or expense: | | | | | | | |
| - Interest income | (4) | - | - | 543.4 | 1413.5 | 2365.6 | 3360.7 |
| - Interest expense long t. loans | (5) | 14780.0 | 13296.0 | 11824.0 | 10346.0 | 8868.0 | 7390.0 |
| Total other income and expense net | | 14780.0 | 13204.1 | 11280.6 | 8932.5 | 6502.4 | 4029.3 |
| . Net income before tax | | 9452.5 | 17533.4 | 23159.4 | 25507.0 | 27937.0 | 30410.0 |
| . Income tax | (6) | ---------- | ---------- | ---------- Tax | Holiday ---------- | ---------- | ---------- |
| . Net income after income tax | | 9452.5 | 17533.4 | 23159.4 | 25507.0 | 27937.0 | 30410.0 |
| . Dividents for equity shareholders at 30% | (7) | - | 5259.9 | 6946.2 | 7652.1 | 8381.1 | 9123.0 |
| . Net income to retained earnings | | 9452.5 | 12303.5 | 16213.2 | 17855.0 | 19555.9 | 21287.0 |

Note:-
(1) See Table 22 & 23
(2) Same as annual production cost see Table 36.
(3) See Table 34. (5) See Table 55.
(4) See Table 59. (6) 6-Years tax-holiday is assumed.
(7) Computed at 30% in order to qualify as Public Company (Starting after the second year)

**Estimated Sales Revenue**
**First 6 Years of Operation**
**Project "B"**
**Rs.(000)**

Table 63 a

| | Quantity for selling in full production t/y | Price Rs/t | Year of Operation 1 (85%) | 2 (95%) | 3 (100%) | 4 (100%) | 5 (100%) | 6 (100%) |
|---|---|---|---|---|---|---|---|---|
| aprolactam | 16000.0 | 3000.0 | 40800.0 | 45600.0 | 45600.0 | 48000.0 | 48000.0 | 48000.0 |
| MT | 18000.0 | 2700.0 | 41310.0 | 46170.0 | 46170.0 | 48600.0 | 48600.0 | 48600.0 |
| nthalic anhydride | 8000.0 | 1800.0 | 10200.0 | 11400.0 | 11400.0 | 12000.0 | 12000.0 | 12000.0 |
| TOTAL :- | 42000.0 | - | 92310.0 | 103170.0 | 103170.0 | 108600.0 | 108600.0 | 108600.0 |

5.10 **Return on Investment**

Estimates of the return to be earned on the total investment in the business as well as on shareholders investment will be found in Table 64.

The low returns earned in the first year results from the anticipated lower utilisation of capacity i.e. low sales. Naturally the highest returns are generally earned during the period of tax-holiday and full utilisation of capacities.

The pay back of the total investment is anticipated to be about 6.7 years, about the four years for original shareholders investment.

5.11 **Economic Feasibility.**

The overall results of this study indicate that the development of monomer complex in West Pakistan is economically feasible. In forming this judgement, consideration has been given to the projected return on investment together with the value of the project to the economy and progress of West Pakistan as summarized hereafter.

5.11.1 **Revenue**

The problem of selling price i.e. Revenue of course will be determined by future government policy, therefore, in the final analysis, the price and profit level are matters to be decided by WPIDC and the Government of Pakistan.

We are going to make two assumption on selling price and corresponding profit on it.

Estimated Return on Investment
Rs(000)

Table 64

| Year | Total Income (1) | Total Investment: Investment Original | | Total Investment: Return (percent) Original | | Net Income | Shareholders Investment: Investment Original | | Shareholders Investment: Return (percent) Original | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2[illegible]232.5 | - | - | 8.4 | - | 9452.5 | - | - | 11.0 | - |
| 2 | 3[illegible]29.4 | - | - | 10.60 | - | 17533.4 | - | - | 20.1 | - |
| 3 | 342[illegible].1 | - | - | 11.80 | - | 23159.4 | - | - | 27.3 | - |
| 4 | 358[illegible].0 | 290,121 | - | 12.30 | - | 25507.0 | 85121.0 | - | 30.0 | - |
| 5 | 36605.0 | - | - | 12.70 | - | 27937.0 | - | - | 32.8 | - |
| 6 | [illegible]7800.0 | - | - | 13.20 | - | 30410.0 | - | - | 35.3 | - |
| | 3[illegible]300.0 | ----------Average-------- | | 11.50 | -Average- | 22333.2 | ------Average--- | | 26.0 | - |

Note:- (1)Net income after income tax plus interest on long-term debt.

## Estimated Foreign Exchange Savings
Rs (000)

Table 65

| | Year After Start-up | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| t Sales | 9[illegible]310.0 | 103170.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 | 108600.0 |
| ss Foreign ch.required | - | - | - | - | - | - | - | - | - | - |
| rchased raw terial and emicals | - | - | - | - | - | - | - | - | - | - |
| lphuric acid | 2843.2 | 3177.0 | 3345.0 | 3345.0 | 3345.0 | 3345.0 | 3345.0 | 3345.0 | 3345.0 | 3345.0 |
| ric acid | 129.2 | 144.4 | 152.0 | 152.0 | 152.0 | 152.0 | 152.0 | 152.0 | 152.0 | 152.0 |
| thanol | 489.6 | 547.2 | 576.0 | 576.0 | 576.0 | 576.0 | 576.0 | 576.0 | 576.0 | 576.0 |
| emicals and talysts | 1249.5 | 1396.5 | 1470.0 | 1470.0 | 1470.0 | 1470.0 | 1470.0 | 1470.0 | 1470.0 | 1470.0 |
| her Supply: inten.:Supply | 2703.0 | 3021.0 | 3180.0 | 3180.0 | 3180.0 | 3180.0 | 3180.0 | 3180.0 | 3180.0 | 3180.0 |
| b-Total | 7414.5 | 8286.1 | 8723.0 | 8723.0 | 8723.0 | 8723.0 | 8723.0 | 8723.0 | 8723.0 | 8723.0 |
| ares parts & pital equip- ent replace- ent. | 3164.0 | 3164.0 | 3164.0 | 3164.0 | 3690.0 | 3164.0 | 3164.0 | 3164.0 | 3164.0 | 3690.0 |
| y back of foreign r term debt | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 | 16200.0 |
| yment of long e interest | 11340.0 | 10206.0 | 9072.0 | 7938.0 | 6404.0 | 5670.0 | 4536.0 | 3402.0 | 2268.0 | 1034.0 |
| ut-Total | 30704.0 | 29570.0 | 28436.0 | 27302.0 | 26694.0 | 25034.0 | 23900.0 | 22766.0 | 21632.0 | 209[illegible]4.0 |
| of l Foreign Exch. equired | 38118.5 | 37856.1 | 37159.1 | 36025.0 | 35417.0 | 33757.0 | 32[illegible].0 | 31489.0 | 30355.0 | 29647.0 |
| alance-Foreign x. savings | 54191.5 | 65313.9 | 71440.0 | 72575.0 | 81906.0 | 74843.0 | 72977.0 | 77111.0 | 78245.0 | 789[illegible]3.0 |

5.11.2 Foreign Exchange Savings

The savings in foreign exchange by producing 42000 T/A of these important raw materials, rather than importing a like quantity will be significant.

The foreign exchange savings is shown in Table 65.

5.11.3 Establishment of Basic Industry.

Establishment of BTX-aromatics and Monomer Complex are not important only because of the relatively higher return offered to Secondary Industries, but also will stimulate other sectors, especially Textile Industry which do utilise a greater degree of manual labour, an abundant resource in East Pakistan.

5.11.4 Value of the Project to the Economy and Progress of East Pakistan.

The implementation of BTX-aromatics production and Monomer Complex and further processing in synthetic fibers will give impressive benefit to the economy and development of East Pakistan.

As we have mentioned the main stimulation would be the development of Textile Industry on base of own synthetic fibers production.

Among the specific benefits are these :-

- This industry will provide employment for over 1200 people. These employees, trained and up-graded in working skills, will become more productive members of the economy.

- Expenditure of salaries, goods and services relating to the complex will raise the income of the area in which the complex is located
- Establishment of the production of raw materials for textile industry will give the great impulse to the development of Textile Industry on base of local raw material.
- The Government will be provided with an additional source of taxable revenue.
- A housing colony for the employees will be provided, including improved living quarters for the people.
- These Projects will be nearly independent of the export market for disposition of its output. More-over it will be based primarily on the current import of crude oil used for Petroleum products it means, implementing these Projects, the Refinery production will be rationalised.
- A development of synthetic fibers production is indirect contribution by freeing cotton for export i.e. an additional income of foreign exchange.

Acknowledgement

Having this opportunity I wish to express my appreciation of the help, information and cooperation given to me.

The Government Project Representative, Project Manager, Project Co-Manager, Counterpart Staff and Collegues in the Project.

The Director, Managers and Staff members of Eastern Refinery - Chittagong, Pakistan Refinery Ltd. and National Refinery.

The Director and Staff members of Humphreys & Glasgow Ltd.,

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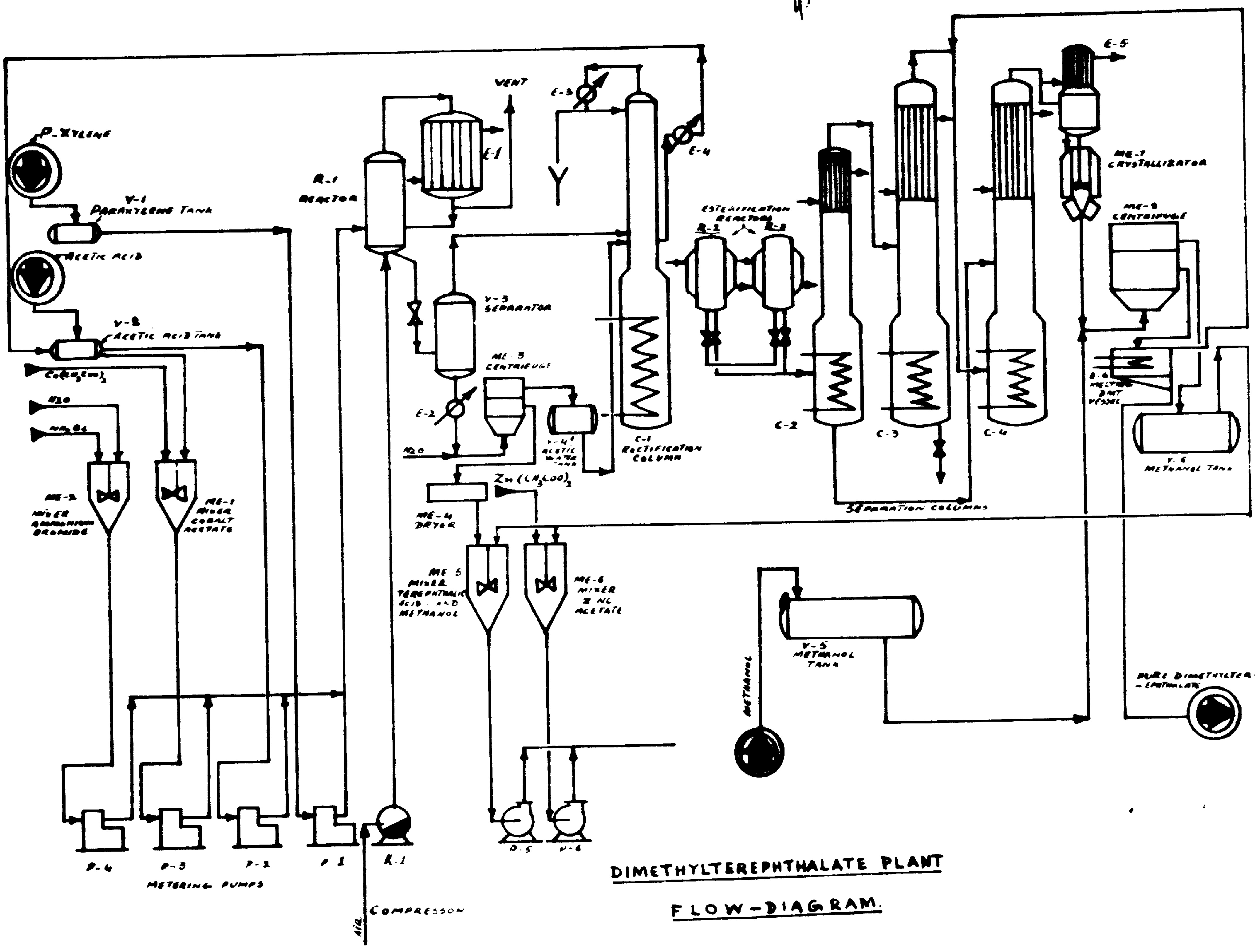
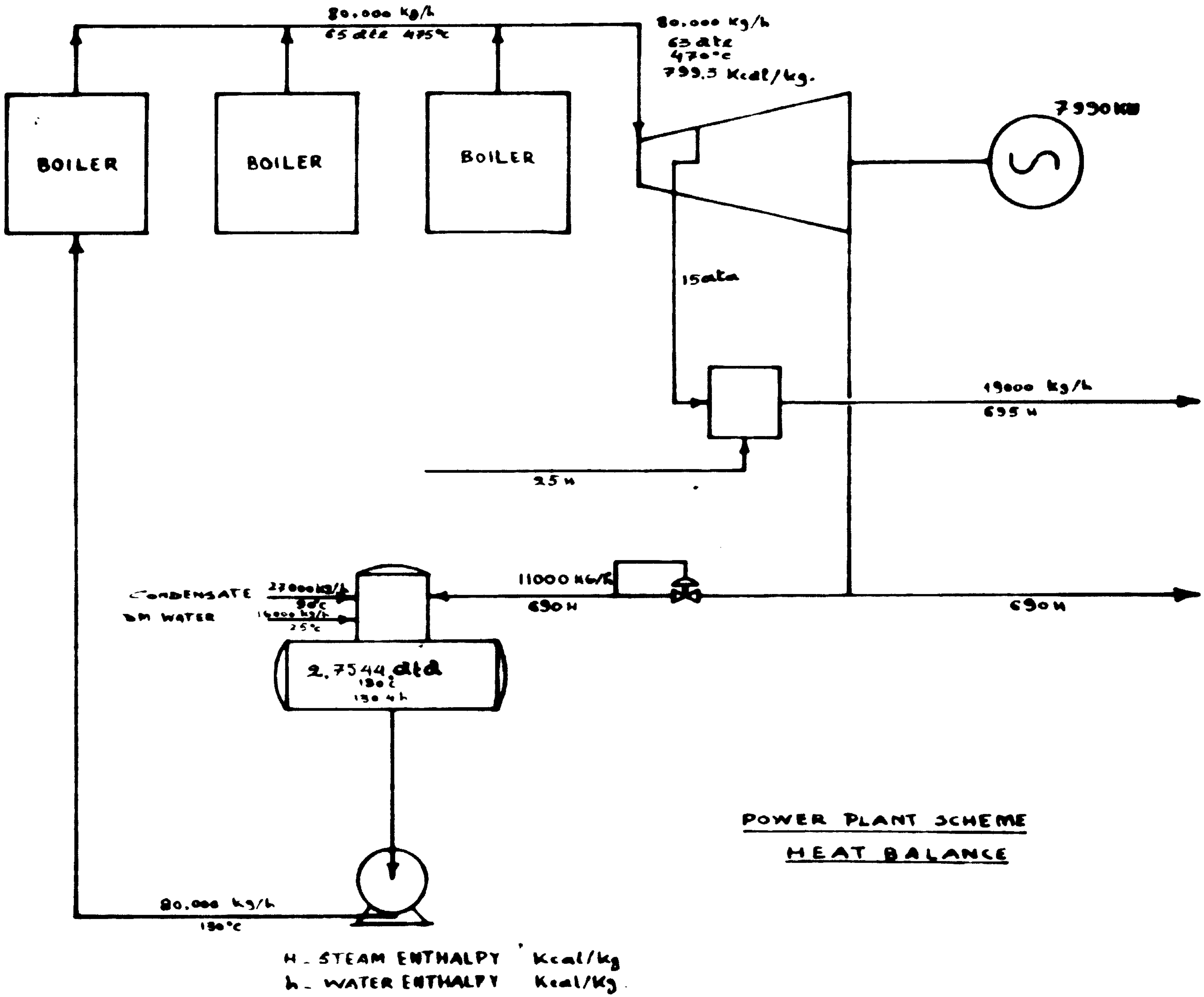



DIMETHYLTEREPHTHALATE PLANT

FLOW-DIAGRAM.




POWER PLANT SCHEME

HEAT BALANCE

C-821

85.09.23
AD.86.07
ILL5.5+10