## OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

## DISCLAIMER



## FAIR USE POLICY



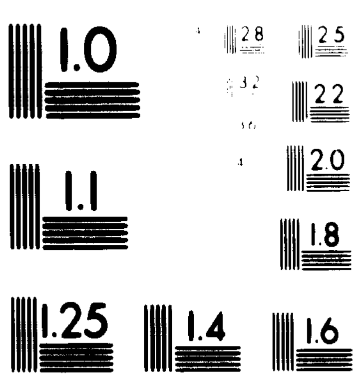
## CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

1 OF 2




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

24x
F

04396



**UNIDO**

**PROJECT PAK-28**

# UNITED NATIONS DEVELOPMENT PROGRAMME/SPECIAL FUND

**"PRE–INVESTMENT STUDIES FOR THE PROMOTION OF FERTILIZER AND PETROCHEMICAL INDUSTRIES IN PAKISTAN"**

Pakistan.

## PROJECT "A"

# FEASIBILITY STUDY FOR THE PROMOTION OF BTX-AROMATICS AND CYCLOHEXANE IN EASTERN REFINERY CHITTAGONG

PREPARED FOR THE GOVERNMENT

*BY*

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

UNIDO–EXPERT

ISLAMABAD–PAKISTAN

FEBRUARY, 1971

Restricted
For official use only

Draft

UNIDO

PAK-26 PROJECT

UNITED NATIONS DEVELOPMENT PROGRAMME/SPECIAL FUND

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

---

PROJECT "A"

# FEASIBILITY STUDY FOR THE PROMOTION OF BTX-AROMATICS AND CYCLOHEXANE IN EASTERN REFINERY CHITTAGONG


PREPARED FOR THE GOVERNMENT

BY

T.V. JANAKIEVSKI, D.CH.E.

UNIDO-EXPERT



ISLAMABAD-PAKISTAN

FEBRUARY,1971

## Abstract

In this Volume a techne-financial evaluation of BTX-aromatics production unit has been worked out. The two schemes (possibilities) have been described and the main objectives for both schemes presented The Eastern Refinery in Chittagong and Pokistan Refinery Ltd., Karachi as possible location have been considered. After making conclusion we have evaluated the scheme No.1, in the scope of Eastern Refinery Ltd - Chittagong. The implementation of BTX-plant as joint Project with primary processing plants Monomer Complex was recommended. The financial evaluation of this project proves that this project itself and joint with Project B is economically viable.

PROJECT "A"

FEASIBILITY STUDY FOR THE PROMOTION OF BTX-AROMATICS AND CYCLOHEXANE IN EASTERN REFINERY - CHITTAGONG

---

CONTENTS

SECTION 1



SECTION 2



Contd....ii

SECTION 3



Cont'd....iii

Cont'd....iv

Cont'd.....v

## SECTION 1

## 1. SUMMARY

### 1.1 History, Background and Conclusion

This study came out in the scope of investigation for the promotion of Petrochemical Industry in Pakistan on base of refinery by products and existing fraction in refinery production.

The study is continuation of the previous work "Preliminary analysis about the promotion of BTX-aromatics in Pakistan" issued April 5, 1970.

Production of BTX-aromatics normally is an extended activity of refinery production in order to produce BTX-aromatics for the correction of octane number in motor gasoline and for chemical use.

Analysing the Pakistani situation in this respect we have found that there are two possibilities for the promotion of BTX-aromatics and cyclohexane and further processing in Pakistan.

1. Scheme No. 1 East Pakistan - in the scope of Eastern Refinery - Chittagong using catalytic reformate as feedstock. At present East Refinery has catalytic reformer unit with normal capacity of 75,000 T/A. This unit on the higher severity could reach a capacity to 90,000 T/A. The utilisation of this unit at present is about 45% on severity of 90 ON. Adding another unit of about 80,000 T/A. this refinery could be able

to produce sufficient catalytic reformate for gasoline pool correction and for aromatics for chemical use. In this case all quantity of BTX-aromatics by products as raffinate and surplus of BTX-fractions could replace the part of reformate in gasoline pool. (See Material Balance on page ......) Since the motor gasoline pool in East Pakistan is very low (See the Table ..... ERL-long term production plan 1970 through 1980). An establishment of BTX-aromatics in Eastern Refinery for all Pakistan demands is favourable. This solution is attractive from the following aspects :-

a) Some kind of balance could be established in the promotion and development of Petrochemical Industry in West and East Pakistan. The Trade balance between Wings in Petrochemical field could be established.

Implementation of sanctioned Fauji Foundation Olefins plant (60,000 T/A of ethylene) in Karachi, on the one side which will produce olefin based products (ethylene/polyethylene, propylene/polypropylene plastics, PVC, Detergents etc) for whole Pakistan's demand. One project of this kind for both wings is sufficient and it could grow up to optimum capacity more successfully than two (one in each Wing ). The development of Pakistan market demand for olefin products for the next 15 years can not justify the establishment of economical capacity of olefin production in both wings separately.

The present Fauji Foundation olefin plant of 60,000 T/A which is already under construction can not be economical and an optimal increase of capacity of this plant could be done if it would be considered to satisfy the whole Pakistan demand for the next 15 years.

b. The implementation of BTX-amomatics production and further processing in East Pakistan would be resonable solution from the following point of view :-

- The economical and technical balance could be established.
- In regard to development of this project all reasons that we have mentioned for Fauji Foundation olefin based production could be applied to BTX-aromatics production complex.
- By implementation of BTX-aromatics production the economy of Eastern Refinery would be improved.
- BTX-aromatics production makes possible the promotion of processing plants as :-
  - Caprolactam/Nylon 6
  - TPA/DMT/Polyester fibers
  - Phthalic anhydride (PA)/DOP and other products.

Therefore, olefins based Petrochemical Complex Industry in Karachi on one side and BTX- aromatics Complex Industry in Chittagong on the other side would be complete solution in the promotion of Petrochemical Industry field for total Pakistan demands. Such a solution could makes possible optimal development of Petrochemical Industry in both Wings for the next 15 years. It sould be emphasised that the development of this two complexes is possible with the current import of crude oil for existing refinery production. Production of BTX-aromatics offer bright prospect for development of above mentioned three monomers:-

- Caprolactam-monomer for Nylon 6 fiber for total Pakistan demands.
- Terephthalic acid monomer for so known most consumed polyester fibers for both Wings.
- Phthalic anhydride monomer for production of Dioctylphthalate for PVC-plastic production (PVC production is included in the production programme of chemical complex based on Natural gas).

Phthalic anhydride will be consumed for production of Alkyd Resin.

The proposed Complex will have an annual balance production capacity of :-

1. BTX-aromatic and Cyclohexane plant

| | |
|---|---|
| - Benzene | 21,000 T/A |
| - Toluene | 5,000 T/A |
| - Ortho-xylene | 9,000 T/A |
| - pxylene | 13,000 T/A |
| - Mixed xylene | 5,000 T/A |
| Total | 53,000 T/A |
| -Cyclohexane | 16,000 T/A |
| | 63,000 T/A |

2. Monomer Complex:-

| | |
|---|---|
| - Caprolactam | 16,000 T/A |
| - Terephthalic acid/ DMT | 18,000 T/A |
| - Phthalic anhydride | 8.000 T/A |

The selected location is Chittagong on the exisging plot of Eastern Refinery. Adequate raw materials, labour and skilled supervision will be available.

Total investment required for these two plants or bett r to say an extension of refinery could be summarised as follows:-

1. BTX-aromatics and Cyclohexane plants in the scope of Eastern Refinery.

| | | |
|---|---|---|
| Total | | Rs. 91,836,600 |
| | F.E. | Rs. 47,842,000 |
| | L.C. | Rs. 43,993,600 |

2. Monomer Complex would be located on the plot of Eastern Refinery as joint project with BTX-aromatics/Refinery.

| | | |
|---|---|---|
| Total investment | | Rs.190,121,000 |
| | F.E. | Rs.162,625,500 |
| | L.C. | Rs.127,496,400 |

(Details for item 2 will be given in Block No. 2 under Project "F").

2. <u>Scheme No. 2</u> The production of BTX-aromatics in Karachi under Joint Project of Fauji Foundation/National or Pakistan Refinery Ltd., using as feedstock:

- Pyrolysis gasoline from naphtha cracker and
- Straight-run-Naphtha from National or Pakistan Refinery Ltd.,

No significant difference between these two schemes in foreign exchange, but there is the difference in local currency. The custom duty in West Pakistan is 15% higher than in East Pakistan. Therefore, the capital investment in West Pakistan would be higher for the value of local currency investment.

One advantage in West Pakistan Scheme is the availability of pyrolysis gasoline from naphtha cracker which is rich of benzene fraction. The availability of 40-43000 t/t pyrolysis gasoline is helpful to extract about 12,000 t/a benzene by the simplified method.

Since this pyrolysis gasoline as two-stage hydrogenated can be used in gasoline pool. The existing Fauji Foundation conception will be benefited in any way.

1.2 <u>Marketing</u>

Based on the growing market potential and taking into consideration the overall economic objectives and needs of East and West Pakistan. These products and quantities of production anticipated from the proposed complex are as follows:-

Table 1

Estimated Production-metric ton

A. BTX-aromatics and cyclohexane plant (Project "A")

| Product | 1) Open market | For further processing | Total |
|---|---|---|---|
| - Benzene | 6000 | 15000 | 21000 |
| - Toluene | 5000 | - | 5,000 |
| - Ortho-xylene | - | 9000 | 9,000 |
| - Para-xylene | - | 13000 | 13,000 |
| - Mixed xylene | 5000 | - | 5,000 |
| Total | 16000 | 37000 | 53,000 |

B. 2) Monomer Complex (Project "B" - See book No.2) (Caprolactam, Terephthalic acid and Phthalic anhydride)

| | | | |
|---|---|---|---|
| - Caprolactam | 16,000 | - | 16,000 |
| - Terephthalic Acid/ DMT | 18000 | - | 18,000 |
| - Phthalic anhydride | 8000 | - | 8,000 |

Note:- 1) Open market means distribution to other processing plants in both Wings.

2) Monomer complex will be considered as separate unit on the same location alternatively as one joint project for stimulaneous implementation.

As can be seen in the next Chapters the Market forecast is given for a period of 1975-80. This means the implementation of whole conception should start by 1975, start-up to come at the end by 1977, full production during 1980.

## 1.3 Principal Products

Project A)

a. Benzene most consumed aromatic 75° per cent or about 16,000 t/y will be processed into cyclohexane/caprolactam on the same location 25% will be exported (sold) to various processing plant in West and East Pakistan for insecticides, DDB and other.

b. Toluene will be consumed 50:50 in existing East and West Pakistan plant.

c. Ortho-xylene will be consumed hundred per cent on the same location for processing into phthalic anhydride.

d. Para-xylene will be consumed hundred per cent on the same location for processing into Terephthalic acid DMT.

e. Mixed xylene will be consumed by various manufacturers in both wings as solvent.

Project B)

f. Caprolactam will be consumed by existing and new-coming manufacturers of Nylon 6.

g. Terephthalic acid/DMT will be consumed by projected two new manufacturers of polyester fibers in West and East Pakistan.

h. Phthalic anhydride will be consumed by new coming DOP-plant in the scope of PVC-production in East Pakistan and producers of alkid resin in both wings.

## 1.4 Proposed Selling Price

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

In the alternative of joint project A & B the prices are taken on the level of intermediate not on final product i.e. on production cost level.

Table 2

Proposed Selling Price and Production cost per unit

| | Total quantity | Production Cost | | Proposed ex-factory selling price | | Revenues (000) Rs. |
|---|---|---|---|---|---|---|
| | | $/t | Rs/t | $/t | Rs/t | |
| Benzene | 21,000 | 76.0 | 361.76 | 120.0 | 571.2 | 11995.2 |
| Toluene | 5,000 | 60.0 | 285.6 | 110.0 | 523.6 | 2618.0 |
| p-xylene | 13,000 | 140.0 | 668.0 | 240.0 | 1124.4 | 14851.0 |
| o-xylene | 9,000 | 77.0 | 366.5 | 130.0 | 618.0 | 5569.0 |
| Mixed xylene | 5,000 | 60.0 | 571.2 | 110.0 | 523.6 | 2889.0 |
| Total | 53,000 | - | average 400.09 | - | - | 37889.0 |
| Cyclohexane | 16,000 | 72.70 | 346.07 | 127.36 | 606.28 | 9700.5 |
| | | | | | | 47589.0 |

1) This is operational cost including interest on loans, insurance and all other fixed costs.

## 1.5 Facilities and Manufacturing

### Project A. (BTX-aromatics & Cyclohexane)

The Project (A) actually is some kind of extension of Eastern Refinery.

The Project (A) will consist the following plant units:-

1. Additional catalytic reforming unit
2. Extension of hydrotreater
3. Aromatic extraction unit
4. Aromatics fractionation
5. $C_8$-splitter
6. Parex process unit
7. Tortory unit
8. Isomerisation unit
9. Cyclohexane unit
10. Extension of existing power unit
11. DM-small unit
12. Extension of cooling tower.

The principal raw material would be naphtha (65-170°C cut) i.e. catalytic reformate. This part will be coupled with existing production of reformate namely motor gasoline. The major quantity of reformate will go direct to aromatic extr - action and by-products from extraction (Raffinate) and surplus of aromatics will be used together with certain percent of reformate in gasoline blonds for gasoline pool. As we have mentioned BTX-aromatics will be carried out with current import of crude oil for normal refinery production. The production of BTX-aromatic would represent some kind of more Rational Refinery production. Gas-fraction from catalytic reforming would be used as fuel in power plant.

Design capacity in some units as Tortory and isomerisation units is about 20% higher than actual necessity because the fore-casted units are one of standards. The calculation have been made on the basis of 320 days (7680 hours) of full operation per year. All required utilities will be produced within the location including cooling water, electric power and steam.

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

As we have mentioned hitherto the Project A (BTX-aromatics and Cyclohexane) should be in the frame of Eastern Refinery synchronized with existing production. Project (B) - Monomer Complex is recommended to be installed adjacent to the Project A using the same utilities plant but with separate technical management.

1.6. Financial

1. Required Investment

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

| | Local | Foreign Rs(000) | Total |
|---|---|---|---|
| Site and Plant cost | 33,457.0 | 43,549.0 | 77,006.0 |
| Development cost | 5,336.6 | 4,293.0 | 9,630.6 |
| Working Capital | 5,200.0 | - | 5,200.0 |
| Total | 43,993.6 | 47,842.0 | 91,836.6 |

It has been estimated that the ratio between loan and equity to be 68.0:32.0 and as 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 and Government debentures the balance assumed to be long term debt at an interest of 7% for foreign loan 8% for local long term loan and 9% for short term loan.

The long term foreign loan would cover 100% of the foreign exchange components required.

The proforma capitalization would be as shown below:-

| Type of Capital | Local | Foreign | Total |
|---|---|---|---|
| Long term debt. | 6,387.0 | 47,742.2 | 54,129.2 |
| Short term debt. | 12,000.0 | - | 12,000.0 |
| Shareholders equity | 25,707.6 | - | 25,707.6 |
| Total | 100% | - | 91,836.8 |

1. Earning Forecast, Return and Pay-out

Earning forecast return on investment are given in Table 3 and 4 below. The complete cash flow statement can be seen in Section 4 Table ..........

Table 3

Earning Forecast
(Rs.(000)

| | 85% 1st | 95% 2nd | 100% 3rd | 100% 4th | 100% 5th |
|---|---|---|---|---|---|
| 1. Total Revenue | 40,450.60 | 45,209.50 | 47,589.00 | 47,589.00 | 47,589.00 |
| 2. Oper. expenses | | | | | |
| - Raw materials | 7,280.36 | 8,136.87 | 8,565.13 | 8,565.13 | 8,565.13 |
| - Utilities | 4,982.61 | 5,568.80 | 5,861.90 | 5,861.90 | 5,861.90 |
| | 12,262.97 | 13,705.67 | 14,427.03 | 14,427.03 | 14,427.03 |
| - Oper.Super and Labours | 1,141,48 | 1,141.48 | 1,141.48 | 1,141.48 | 1,141.48 |
| - Maintenance | 2,067.02 | 2,067.02 | 2,067.02 | 2,067.02 | 2,067.02 |
| - Fringe benefit | 654.00 | 654.00 | 654.00 | 654.00 | 654.00 |
| - Total oper. expenses | 16,125.47 | 17,568.17 | 18,289.53 | 18,289.50 | 18,289.50 |
| - Gross profit | 24,325.13 | 27,641.33 | 29,299.47 | 29,299.47 | 29,299.47 |
| 3. General Expenses | | | | | |
| Overhead | 342.20 | 342.20 | 342.20 | 342.20 | 342.20 |
| Insurance and Taxes | 1,391.68 | 1,391.68 | 1,391.68 | 1,391.68 | 1,391.68 |
| Depreciation | 8,180.35 | 8,180.35 | 8,180.35 | 8,180,35 | 8,180.35 |
| Total general exp. | 9,91 23 | 9,914.23 | 9,914.23 | 9,914.23 | 9,914.23 |
| Oper.profit | 14,410.90 | 17,727,10 | 19,385.24 | 19,385.24 | 19,385.24 |
| 4. Other Expenses | | | | | |
| Interest on loans | 4,781.90 | 4,095.70 | 3,392.10 | 2,696.90 | 2,311,60 |
| Net amount before tax | 9,629.00 | 13,631.40 | 15,993.14 | 16,688.34 | 17,073.64 |
| 5. Return on invest.% | 10.5 | 14.80 | 17.4 | 18.20 | 18.20 |
| 6. Pay-out time-yr. | 5.1 | 4.1 | 3.7 | 3.5 | 3.4 |

1.8 **Estimated Earning and Fund Generated**

Financially in one case this Project "A" we will consider as completely separate Project and we will estimate profit and loss and the cash generated for the first six years after start-up.

A summary of the estimated profit and loss and the cash generated for five years after start-up is shown in Table 4 below:-

Table 4

Summary of estimated Earnings and Funds Generated

Rs(000)

| Yr. | Net Sales | Cost of Sales | G & A | Opor. income | Other income and expense | Other Income Before tax | Other Income After tax | Non cash chgs. | Fund generated |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40450.6 | 22498.6 | 342.0 | 14410.9 | 4781.9 | 9629.0 | 9628.0 | 8180.3 | 17808.3 |
| 2 | 45209.5 | 25748.5 | 342.0 | 17727.1 | 3902.5 | 13824.6 | 13824.6 | 8180.3 | 22004.6 |
| 3 | 47589.0 | 26469.8 | 342.0 | 19385.0 | 2765.5 | 16619.5 | 16619.5 | 8180.3 | 24799.8 |
| 4 | 47589.0 | 26469.8 | 342.0 | 19385.2 | 1339.9 | 18045.0 | 18045.0 | 8180.3 | 26225.3 |
| 5 | 47589.0 | 26469.8 | 342.0 | 19385.4 | 244.6 | 19140.8 | 19140.8 | 8180.3 | 27322.4 |

It may be noted that the first two 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 40% percent on a net income basis. On a funds generated basis which is the level when cash flow equals to amount required for debt retirement the break-even point is about 38 percent of capacity.

Table 5

Estimated Funds Available for Servicing Interest and Debt

| Estimated Interest Coverage | | | | Estimated Debt Service Coverage | | |
|---|---|---|---|---|---|---|
| Year | Profits before interest and income tax 1) | Interest | Times interest earned | Cash generation before interest and other income taxes 2) | Debt Service | Times earned |
| 1 | 6929.0 | 4781.0 | 2.00 | 17709.0 | 14193.8 | 1.25 |
| 2 | 14017.6 | 4095.7 | 3.50 | 22197.6 | 13507.8 | 1.65 |
| 3 | 17246.2 | 3392.1 | 5.4 | 26534.0 | 12704.0 | 2.1 |
| 4 | 19402.0 | 2696.9 | 7.60 | 28711.3 | 8109.8 | 3.5 |
| 5 | 213070.0 | 2311.6 | 9.20 | 29521.3 | 7724.5 | 3.9 |

Note:- 1. Operating income plus interest income

2. Include depreciation and amortization

3. Interest plus debt retirement.

Actually a large protion of this excess cash could be used to retire long term debt at an accelerated rate, or be invested in additional manufacturing capacity.

The payback on the total investment will be about 4 years.

1.9 Economic Feasibility

The overall results of this study indicate that the development of BTX-aromatics in East Pakistan is economically feasible.

1.10 Revenue

The problem of selling price i.e. revenue of course will be determined by Government and solution of the further processing of BTX-aromatics in the Project "B". We would suggest that the Project should be joint with Project "B" i.e. BTX-aromatics to be processed on the same site. In that case BTX-aromatics would be transferred by production coost price, and profitability will be calculated as in a joint venture.

1.11.1 Foreign Exchange

The savings in foreign exchange by producing aromatics rather than importing a like quantity will be significant. This is given in Table 6.

The saving in foreign exchange by producing BTX-aromatics is summarized in the Table 6.

Table 6

Savings in Foreign Exchange

| Year | F.E. Rs(000) |
|---|---|
| 1 | 20,108.6 |
| 2 | 23,099.0 |
| 3 | 25,058.5 |
| 4 | 25,392.7 |
| 5 | 25,727.0 |
| 6 | 26,061.0 |
| 7 | 26,395.3 |
| 8 | 26,729.5 |
| 9 | 27,063.7 |
| 10 | 27,397.8 |

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

The special aspect should be given to the desirability of this project because of the relatively higher return offered to secondary and tertiary industries, which should result from the establishment of this project.

This project "A" BTX-aromatics and cyclohexane are precursors for valuable intermediate (raw materials) for most consumed synthetic fibers - Nylon and Polyester and other chemicals for production of PVC plastics.

The Project "B" (Monomer Complex) would take over the BTX-aromatics for production of caprolactam, terephthalic acid/ DMT and phthalic anhydride.

The Project "A" and "B" will give impressive benefit to the economy and development of East Pakistan. The implementation of these projects will give a significant impact to the development of Textile Industry on base of local raw materials. The PVC-plastics industry would get the valuable chemicals for PVC-plastics composition.

### 1.11.3 General Conclusion

Following the reasons have mentioned above we came to the conclusion that the BTX-aromatics production Project "A" together with the "Monomer Complex" (Project B) should be located in the scope of Eastern Refinery - Chittagong. The promotion of the Project A + B in East Pakistan would represents a complementary solution with West Pakistan Petrochemical Project in Karachi. About seventy five percent of BTX-aromatics would be processed in Project "B" and as final products - monomers would be distributed for further processing in secondary industries in both wings.

Since the aromatics are the precursors of most consumed synthetic fibers from one side, East Pakistan has no own cotton production for the development of textile industry to other side, the promotion of synthetic fiber sources is very reasonable. The promotion of man-made fiber sources could make possible. The development of Textile Industy with faster paces.

# SECTION 2
## MARKETING

2. **Estimated Market and Production of Materials from the Proposed Project.**

2.0 **BTX-Aromatics - Introduction**

A prediction of Marketing Experts in this field that the demand for aromatics derivatives will continue its relatively rapid growth over the next decade. The underlying force sparking this demand, in addition to the normal population growth is increasing number of uses being discovered for the products derived from aromatics. The market for BTX-aromatics in the world will continue to grow with 8-10% per year. Fiber and plastics are two outlets accounting for most of the growth.

The three major aromatics, benzene, toluene and xylenes move into petrochemical along with the routes shown in Fig. 1 below and Fig. 2 (Appendix).

**Figure 1**

AROMATIC DERIVATIVES

| | | | |
|---|---|---|---|
| | Ethyl Benzene | Styrene | Synthetic Rubber<br>Polystyrene |
| | Cumene | Methylstyrene | |
| | Dodecyl-Benzene | | |
| Benzene | Phenol | | |
| | Meleic Anhydride | | |
| | Adipic Acid | | |
| | Benzene Hexachloride | | |
| | Trinitrotoluane | | |
| Toluene | Toluene di-izocyanates | | polyurethane |
| | Phthalic - isophthalic and terephthalic acids | | |
| | Paraxylene | terephthalic acid | |
| Xylene | Metaxylene | isophathalic acid | |
| | Orthoxylene | phathalic anhydride | |

In the Table 7 is shown estimated world demand for aromatics for the manufacture of chemicals.

Table 7

DEMAND FOR AROMATICS FOR THE MANUFACTURE OF CHEMICALS
( 1000's Metric Tons )

| | 1970 | 1975 | 1980 |
|---|---|---|---|
| **U.S.A.** | | | |
| Benzene | 3,500 | 4,550 | 5,600 |
| O & P Xylene | 650 | 1,300 | 2,050 |
| **W. Europe** | | | |
| Benzene | 2,750 | 4,200 | 5,600 |
| O & P Xylenes | 740 | 1,140 | 1,725 |
| **Japan** | | | |
| Benzene | 850 | 1,400 | 2,000 |
| O & P Xylenes | 235 | 525 | 900 |
| **Other** | | | |
| Benzene | 500 | 1,000 | 1,800 |
| O & P Xylenes | 65 | 165 | 325 |
| **Total Non-Communist Areas** | | | |
| Benzene | 7,600 | 11,150 | 15,000 |
| O & P Xylenes | 1,690 | 3,130 | 5,000 |

At present there is no existing production unit of aromatics in Pakistan, however, the demand is growing with significant pace. The BTX-aromatics are basic intermediate for production of very consumed products. The lack of BTX-aromatics production has been retarding the promotion of industries based on latter ones.

Major consumers of BTX-aromatics in Chemical Industry are synthetic fibers and plastics and some chemicals for various purposes.

Estimated consumption of BTX-aromatics in Pakistan is given in the Table 8 below.

2.1.0 Benzene Consumers

In the estimated consumption of benzene we have taken the following products :-

- Nylon 6
- Insecticides (BHC/DDT)
- DDB (Dodecylbenzene)

2.1.0.1 Nylon-6 According to estimated figures of Nylon-6 we have selected the plant capacity of caprolactam of 16000 t/y equivalent of 16000 t/y of Nylon 6 fibers (including about 4.5% content of water). This capacity is very close to our estimate of the 1979-80 demand. The capacity of 15/16,000 t/y we have chosen because (a) implementation will take time and production would be planned to start 1976-77 (b) According to a preliminary analysis showed it to be about a minimum economic capacity and one of standard size for which there may be some economy in engineering cost. Let us see the position of man-made fibers.

**Table 8**

**Estimated Demand of Aromatics in Pakistan**

| Product Consumers | 1975 W.P. t/y | 1975 E.P. t/y | 1975 Total t/y | 1975 In term of Benzene t/y | 1980 W.P. t/y | 1980 E.P. t/y | 1980 Total t/y | 1980 In Term of Benzene t/y | 1985 W.P. t/y | 1985 E.P. t/y | 1985 Total t/y | 1985 In term of Benzene t/y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Consumption Figures for Benzene | | | | | | | | | | | | |
| Nylon | 6000 | 2000 | 8000 | 8000 | 12000 | 5000 | 17000 | 15000 | 16000 | 8000 | 24000 | 24000 |
| DDT/BBC | | | | 1300 | | | | 2000 | | | | 3000 |
| DDB | 4000 | 1000 | 5000 | 2700 | 7500 | 3500 | 11000 | 4000 | 10000 | 8000 | 16000 | 8800 |
| Misc. | | | | | | | | | | | | 5000 |
| Total t/yr. of Benzene | | | | 11000 | | | | 21000 | | | | 40800 |
| 2. Consumption figure for PARA-XYLENE | | | | In term of p.x. | | | | In term of p.x. | | | | In term of p.x. |
| Polyester fibers | 5500 | 2500 | 8000 | 6000 | 12000 | 6000 | 18000 | 13000 | 18000 | 12000 | 30000 | 22500 |
| For Turkey and Iran t/y | | | 5000 | 3750 | | | | | | | | |
| Total consumption of p-xylene | | | | 6000 | | | | 13000 | | | | 22500 |
| Including export to RCD-Country | | | | 9750 | | | | | | | | |
| 3. Consumption Figures for ORTO-XYLENE | | | | In term of o.x. | | | | In term of o.x. | | | | In term of o.x. |
| DOP | 4000 | 6000 | 10000 | 4300 | 6000 | 10000 | 16000 | 7800 | 12000 | 12000 | 24000 | 9600 |
| Alkyd resins | 1500 | 500 | 2000 | 400 | 2000 | 1000 | 3000 | 1000 | 3500 | 1500 | 5000 | 1000 |
| Total consumption of Ortho-xylene t/y | | | | 4700 | | | | 8800 | | | | 10600 |
| 4. MIXED XYLENE | | | | 2500 | | | | 5000 | | | | 10000 |
| 5. TOLUENE | | | | 2000 | | | | 4600 | | | | 8000 |
| Total consumption of Benzene + Toluene + Xylene (BTX) = | | | | 29950 t/y | | | | 52800 t/y | | | | 92000 t/y |

Estimated consumption of man-made fibers for the current decade is shown in Table 9 below :-

Table 9

Estimated Consumption of Man-made Fibers 1970-80 (in thousand tans)

| | Cellulosic | | Nylon | | Polyester | | Acrylic | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 8000 | 29.2 | 8000 | 29.6 | 10.800 | 39.3 | 680 | 1.9 | 27500 | 100 |
| 1980 | 15000 | 26.2 | 17000 | 32.1 | 20.000 | 38.7 | 1500 | 2.8 | 54000 | 100 |

This is taken from the survey "Some facts about consumption and processing of man- made fibers in Textile industry of Pakistan. UN-PAK 26 - T. V. Janakievski (More details about synthetic fibers can be found in above mentioned survey and H & G - Report).

2.1.0.2 Insecticide

Estimated consumption of Benzene in this Sector is based on the existing production capacity and consumption of BHC/DDT and additional ones which would come during the next two plan period 1970-80.

Assumed figures of 2000 t/y of Benzene are taken as minimum demand by 1978-79 in Pakistan at present there are three factories producing DDT, two of them in West Pakistan and one in East Pakistan :-

- DDT-factory, Nowshera.
- Insecticides factory, Kala Shah Kaku near Lahore.
- DDT-factory, Barabakund near Chittagong.

- The first company established for DDT in Pakistan in Nowshera, which is now run under the management of Technical enterprise Inc., New York/USA for the Ministry of Health. Originally, the plant was operated by WPIDC. The capacity of this plant is 6000 t/y of technical DDT per year. The production programme also includes powder formulations.

The Kala Shah Kaku was put into operationin 1967 with capacity 1500 t/y. This plant manufactures powder and dust formulations and could also produce liquid manufactures.

- The plant in Barabkund near, Chittagong belongs to EPIDC. Its capacity at present is about 1600 t/y. Production was started in October 1966.

All these plants are operating on imported benzene, while chlorine and alcohol are purchased from local sources. The ratio of the production between East and West Pakistan was about 1:3 in 1968 in favour of West Pakistan. The production capacities are nearly equally distributed (55 ÷ 45 in favour of West Wing).

According to the Battelle Institute Observers (Battelle Institute Report page 426) on future demand "It has already been pointed out that the demand of the major consumer, i.e. The Malaria Eradication Programme is going to disappear. This does not affect the actual demand of DDT-factories in operation but it takes way a big potential market which they have not exploited because they started late because the product was not up to the mark and because the prices were too high.

Another small but increasing potential market which is vanishing is insecticide formulation while production is increasing by at least 25% every year, the demand of this sector for DDT will go down if the DDT producers do not make special marketing effort. But if the formulators of house-hold insecticides could be induced to put 1% of DDT in all their formulations, the resultant demand would be about 10 tons per annum. The future of DDT production therefore, lies in agriculture, in the sanitation programme of the towns and cities and perhaps in a few new developments such as special packing materials for food items. The largest potential demand can be in agriculture. If DDT mixtures in the form of dust or emulsions were used for cotton alone the demand would be sufficient to virtually solve the DDT problem in Pakistan. For calculation purposes we assume that 30% of the cotton dust containing 10% DDT, and the percentage of field coverage corresponds to the actual percentage of spraying at present. The insecticide is a kind of standard cotton dust the number of treatments is assumed to be 5 and the quantity of dust to be 15 kg/ha for each treatment.

The total requirements are therefore 1.5 kg x 5 x 1600,000 ha 03 = 3,600,000 kg.

The 3600 tons which could thus be utilized for cotton protection would represent about 100% of the capacity of all the plants operating in Pakistan. Considering the fact that the protection measures for cotton will definitely be expanded, the full utilization of the existing capacity in Pakistan should not be a problem at all.

One of the biggest problem is very high selling price. For comparison only we can take the ex-factory price of 75% WP which is Rs. 8.80/kg. The CIF price on which US-Aid supplies have been based were as follows for 75% WP $. 491/t. i.e. Rs. 2.3/kg.

The main for those price are:-

- Small plant sizes.
- High raw materials prices
- Low utilization of capacity
- Fairly high packing charges etc.

Hexa-Chloro-Cyclo-Hexane (BHC)

In Pakistan there are only two factories for the production of BHC.

- Insecticides (Pakistan) Ltd., Kala Shah Kaku
- Chemical Industries of Pakistan Ltd., Barabakund Chittagong.

According to the Battelle Institute Survey the Insecticides Ltd., has a production of about 1500 t/y of technical BHC containing 25% gamma isomers East Pakistan plant has a production of 1000 t/y.

Dodecil Benzene/DDB

Complete market analysis for DDB and DDBS can be found in Battelle Instituto Market Survey 5.7 Page 445 and 8.5 Page 632. In this paper we will take some data from that survey.

The Production of DDBS in Pakistan.

The main manufacturers of DDBS at present is Futehally Chemicals Ltd., Karachi with useable sulphonation capacity of 200 kg/h and spray drying capacity of 500 kg/h with full capacity per year the factory could produce 3600-4000 t of washing powder. The consumption of DDBS would be then about 720 tons. Futehally sells the major part of his production to Lever Bros. (Pakistan) Ltd., Karachi. Lever Brothers have successfully introduced household washing powder under the branch name "Surf" in Pakistan Burmah Shell sell an Industrial detergent named "Teepol", mainly to the textile industry.

There are two more smaller producers of detergent items - Textile Chemical Industries and Shuja Industries, both located in Karachi. In 1968 was imported about 1000 t of alkylates (an average 92%).

Production of DDBS and ready-made Detergents in 1968 was as follows:-

| | |
|---|---|
| - DDBS | 625 |
| - Detergents formulation | 3125 |

In the 1969 the capacity and production of detergents based on DDB increased to the figure of 6000 t.

Estimated consumption DDBS - based on surface Active Substances by 1975 (Standard Washing powder equivalent) would be about 80,000 t. This means the requirements in term of DDBS would be about 10,000 t/y or about 7000 t DDB.

| | |
|---|---|
| - Washing powder | 19000 t |
| - Industrial detergent | 21000 t |
| Total | 50000 t |

This estimate means that 1975 with a prospective population of 156 million, the per capital consumption would be 320 gr. of all kinds of detergents, or approximately 120 g. of household detergents. At present under construction is Fauji Foundation Olefin Complex in Karachi (Korangi). In the production programme of this Complex is planned 10,000 t/y DDB with the possibility for the extension to 15,000 t/y. This capacity will cover the demand up to 1980. The start of production is expected by 1973-74.

In Pakistan at present DDBS types of detergents preparations are used in :-

- households, mainly for washing textiles.
- the textile industry for washing purposes and as a disbursing agent.
- the paper industry as a disbursing agent
- hotels for washing purposes
- laundries for washing purposes
- train cleaning by the Railway Authorities
- the insecticide industry as an emulcifer

2.1.1 Touene

As it is shown in the Table No.8 estimated demands for toluene are :-

| | |
|---|---|
| 1975 | 4000 t |
| 1980 | 5000 t |

These demands are chiefly intended for industrial processing 1:1 in West and East Pakistan.

2.1.2 Para-xylene

Estimated demand of para-xylene is intended for processing in Polyester fibers only.

Estimated requirements of polyester fibers in Textile Industry of Pakistan by 1975-80 are shown in the Table 9 & 10.

Table 10

Estimated consumption of polyester fibers in Textile industry of Pakistan for period 1975-80

| Cotton Industry | | Woollen Ind. | | Filament use Ind. | | Total |
|---|---|---|---|---|---|---|
| 1975 | 1980 | 1975 | 1980 | 1975 | 1980 | 1980 |
| 8000.0 | 15000.0 | 800.0 | 1500.0 | 2000 | 4000 | 20,300 |

The Table is taken from the Survey "Some fact about consumption and processing of man-made fibers in Textile Industry of Pakistan UN-Pak-26 T. V. Janakievsko.

More details about synthetic fibers requirements can be found in above mentioned survey ref.....

Following the market figures of polyester fibers, the demands of para-xylene would be about 13000 t/y by 1978-79.

2.1.3 Ortho-xylene (8720 t/y)

The requirements of ortho-xylene are intended for production of Phthalic anhydride and further processing into Dioctyl phthalate for DOP and Alkyde resins.

As it is shown in the Table ..... the requirements of DOP are estimated at 16,000 t/y which will be included in EPIDC petrochemical Complex. The potential demand and consumption of phthalic anhydride in Pakistan could be:

| | 1975 | 1980 |
|---|---|---|
| DOP | 8000 t/y | 16000 t/y |
| Phthalic anhydride (x385) | 3080 t/y | 1660 |

According to Battlle Institute Marketing Report followed by Interim Report of H & G and our estimation (Ref......) the domestic production and consumption would be as it is shown in the Table 11.

Table 11

| | 1975 | 1980 |
|---|---|---|
| Alkyd Resine consumption | 5800 t/y | 8500 t/y |
| Alkyd Resine production | 3500 t/y | 5100 t/y |
| Phthalic anhydride consumption for Alkyde resins | 1150 t/y | 1700 t/y |

At present, existing and sanctioned capacities for alkyd resins production are entirely in the West, however, we assume that in the next period will be developed cca. 30% in East Pakistan (H & G Vol.III. 2-3)

Total Phthalic anhydride demand/consumption would be:

| | East | West | Total |
|---|---|---|---|
| 1975 potential demand | 800 | 3430 | 4230 |
| 1980 consumption | 1190 | 6670 | 7860 |

2.1.4 Mixed-xylene

Mixed xylene mostly are used as a solvent or diluent in surface coatings, insecticide formulations and industrial uses.

When available at domestic market and with reasonable price from local production use of solvent xylene is likely to be extended significantly.

In this project we included an estimation with following capacity.

| | 1975 | 1980 |
|---|---|---|
| Solvent xylene | 2500 t/y | 5000 t/y |

2.1.5 Cyclohexane

Since we selected the cyclohexane process for the production of caprolactam in this project we are including the unit for cyclohexane with a capacity of 16,000 t/y for nearly the same capacity for caprolactam.

On base of above estimated market demand we have selected the following units capacity:-

| | |
|---|---|
| - Benzene | 21000 t/y |
| - p-xylene | 13000 t/y |
| - o-xylene | 9000 t/y |
| - Toluene | 5000 t/y |
| - Mixed xylenes | 5000 t/y |
| Total | 53000 t/y |

1. <u>Benzene:</u>

| | |
|---|---|
| - for cyclohexane/caprolactam | 16000 t/y |
| - for insecticide - E. F. | 500 t/y |
| - for DDB | 5000 t/y |
| | 21500 t/y |

2. <u>p-xylene</u>

| | |
|---|---|
| - for terephthalic acid/ polyester fiber | 13000 t/y |

3. <u>Ortho-xylene</u>

| | |
|---|---|
| - for phthalic anhydride for processing into DOP and Alkyd resin | 9000 t/y |

4. <u>Toluene</u>

| | |
|---|---|
| - for processing in existing Ordinance Factory | 5000 t/y |

5. <u>Mixed xylene</u>

| | |
|---|---|
| - As solvent | 5000 t/y |

This scheme assumes that the Integrated Chemical Complex would be build up on the plot of Eastern Refinery with the following plants :-

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

These three plant would consume 75% per cent of BTX-aromatics as it is shown under item 1,2 and 3 above.

The final products from above mentioned complex would be :-

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

Caprolactam, Terephthalic/DMT and phthalic anhydride monomers would be distributed to various location in West and East Pakistan for further processing into:

- Nylon 6 fibers
- Polyester fibers
- DOP and Alkyd resins respectively.

This scheme assumes also the BTX-aromatics, chemical complex and synthetic fibers capacity would synchronize the construction and start-up of production.

The synchronization of construction would avoid the loss from the partial utilization of capacity. The remainder small quantity of BTX-aromatics would be distributed to the existing plant in West and East Pakistan.

2.2.0 <u>Proposed Selling Prices</u>

Informing our judgement about selling prices of the products produced in the plant, we have taken into consideration the current domestic prices i.e. CIF prices and landed price of imported products and world market prices.

2.2.1 Present prices of imported BIX-aromatics in Pakistan.

1) <u>Benzene</u>:

| | | | |
|---|---|---|---|
| CIF price Rs/ton | 566 | $ | 118 |
| Landed price including insurance, custom duty clearance Rs/ton | 985 | $ | 205 |

2) <u>Para-xylene</u> is not imported but ex-factory selling price is in the range of $ 180-200 ton -856-960 Rs/t

| | | |
|---|---|---|
| CIF price should be | 1000-1200 | Rs/t |
| Landed price including all expenses | 1850-2000 | Rs/t |

3) <u>Toluene</u>

| | |
|---|---|
| CIF price Rs/t | 480 |
| Landed price Rs/t | 900 |

4) <u>Ortho-xylene</u> is not imported, but ex-factory selling price at present is in the range of 70-80 $/t,335-280 Rs/t

| | |
|---|---|
| CIF price would be Rs/t | 620- 700 |
| Landed price would be Rs/t | 1150 -1300 |

5) <u>Mixed-xylene</u>

| | | |
|---|---|---|
| CIF price | 510 | Rs/t |
| Landed price including all expenses is coming to | 900 | Rs/t |

6) <u>Cyclohexane</u> was not imported but factory selling price in the developed regions is in the range 90-100 $/t.

| | |
|---|---|
| CIF price would be | 660-700 Rs/t |
| Landed price including all expenses is coming | 1200-1300 Rs/t |

Table 12

World Market Price of BTX-aromatics and Cyclohexane

| | U.S.A | | Germany | | Holland | | U.K. | | Italy | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $/t | Rs/t | $/t | Rs/t | $/t | Rs/t | $/t | Rs/t | $/t | Rs/t |
| Benzene | 70.0 | 333.2 | 80.0 | 380.8 | 80.0 | 380.0 | 86.0 | 409.4 | 78.0 | 371.3 |
| Toluene | 66.0 | 314.1 | 66.0 | 314.0 | 63.8 | - | 66.0 | - | 68.2 | - |
| o-xylene | 86.0 | 409.3 | 92.0 | 437.0 | 88.0 | 418.8 | 90.0 | 428.4 | 88.0 | 418.0 |
| p-xylene | 200.0 | 952.0 | 200.0 | 952.0 | - | - | 210.0 | 999.6 | 205.0 | 975.0 |
| m-xylene | 75.2 | 357.0 | 66.0 | 314.0 | 60.0 | 285.0 | 64.0 | 304.0 | 68.2 | 324.6 |
| Cyclohexane | 100.0 | 476.0 | 110.0 | 523.6 | - | - | 100.0 | 523.6 | - | - |

Source:- ECN, January, 1971.

- The Oil Paint and Drug Reporter Nov.23, 1970.
- Another paper sources.

## Proposed Selling Price and Estimated Revenue

We propose the ex-factory selling price for the products of these plants should be as follows :-

### Table 13

### Estimated Sales Revenue

| | Quantity for selling in tons | Proposed Selling Price | | Revenue |
|---|---|---|---|---|
| | | $/t | Rs/t | Rs/year (000) |
| Benzene | 21,000.0 | 120.0 | 571.2 | 11,995.2 |
| Toluene | 5,000.0 | 110.0 | 523.6 | 2,618.0 |
| p-xylene | 13,000.0 | 240.0 | 1,142.4 | 14,851.0 |
| o-xylene | 9,000.0 | 130.0 | 618.8 | 5,569.0 |
| Mixed xylene | 5,000.0 | 120.0 | 571.2 | 2,856.0 |
| Total Revenue of BTS. | (53,000.0) | - | - | 37,889.0 |
| Cyclohexane | 16,000.0 | 127.37 | 606.28 | 9,700.5 |
| All Total | (69,000.0) | - | - | 47,589.0 |
| Average selling price would be | | | 689.69 | |

Note:- Utilization of capacity for the first 3-years would be 65% and 95% respectively. Therefore, sales revenue would be respectively accoring to the utilization.

# SECTION 3

## FACILITIES AND MANUFACTURING

## 3.0 Operating Facilities

### 3.1 Plant location and site description

As we have mentioned there is no alternative site for BTX-aromatics production than Eastern Refinery - Chittagong. There is no doubt that aromatics processing operations are part of refinery processes. Aromatics production clearly cannot be considered without full regard for the overall petroleum and chemical pictures.

Eastern Refinery in Chittagong is very convenient solution for BTX-aromatics production because the gasoline pool is very low. In this scope the considerable quantity of aromatics are not used economically.

Establishmet of BTX-aromatics operation in Eastern Refinery would improve the economy of Refinery and will open the possibilities for the promotion of new industries for further processing of aromatics.

#### 3.1.1 Description of the Existing Project - Eastern Refinery Ltd., -

Total plot area of land in possession of refinery is 200 acres only, 10% of this is under refinery installation and storage. More than 50% of the required land intended to be utilized for other projects. 22 acres of land separately is required for housing colony.

The fixed assets of existing project is shown in Table 14 below:-

Table 14

| Particulars | L6 (000)Rs | FC (000)Rs | Total Rs(000) |
|---|---|---|---|
| 1. Land incl. housing estate | 6300.0 | - | 6300.0 |
| 2. Land development | 5426.0 | - | 5500.0 |
| 3. Civil engineering water R. | 11200.0 | - | 11200.0 |
| 4. Hosing Estate | 3300.0 | - | 3300.0 |
| 5. Plant and Machinery | 2169.0 | 41145.0 | 43314.0 |
| 6. Plant and Machinery Exten. | 1362.0 | 3238.0 | 4600.0 |
| 7. Erection | 10621.0 | 17607 | 28228.0 |
| 8. Services | - | 17121.0 | 17121.0 |
| 9. Custom duty, insurance | | | |
| a) | 12000.0 | - | 12000.0 |
| b) | 2400.0 | - | 2400.0 |
| 10. Catalyst | - | 753.0 | 753.0 |
| 11. Royality and licencing | - | 685.0 | 685.0 |
| 12. Rep. service | - | 3102.0 | 3128.0 |
| 13. Interest on Capital loan | 1276.0 | - | 1275.0 |
| 14. Pre-production and start-up | 9168.0 | - | 9168.0 |
| 15. Consultancy | 442.0 | 924.0 | 1366.0 |
| 16. Contingency | 400.0 | 1000.0 | 1400.0 |
| Total | 66089.0 | 85649.0 | 151738.0 |

Design capacity of Eastern Refinery is 1.5 million tons of crude oil annually to produce various petroleum products shown in Table 15 below. As it can be seen capacity will be fully utilized by 1972-73.

C O P Y

**ERL - LONGTERM PRODUCTION PLAN (1971-80)**
**(BASED ON OCAC TRADE ESTIMATE)**

( all figures in Tons)

Table 15

| PRODUCT | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
|---|---|---|---|---|---|---|---|---|---|---|
| M.S. | 79,000 | 83,000 | 87,000 | 91,500 | 96,000 | 1,01,000 | 1,06,000 | 1,11,000 | 1,17,000 | 1,23,000 |
| H.O.B.C. | 4,800 | 6,000 | 7,200 | 8,400 | 9,600 | 10,100 | 10,600 | 11,100 | 11,700 | 12,300 |
| J.P.I. | 48,000 | 53,000 | 54,000 | 59,000 | 55,500 | 72,000 | 75,000 | 87,000 | 96,000 | 1,06,000 |
| S.K. | 2,35,000 | 2,58,000 | 2,84,000 | 3,12,000 | 3,43,000 | 3,77,000 | 4,15,000 | 4,56,000 | 5,02,000 | 5,52,000 |
| T.K. | 1,42,000 | 1,58,000 | 1,86,000 | 1,94,000 | 2,74,000 | 2,85,000 | 2,96,000 | 3,08,000 | 3,20,000 | 3,33,000 |
| H.S.D. | 1,36,000 | 1,47,000 | 1,59,000 | 1,72,000 | 1,86,000 | 2,01,000 | 2,17,000 | 2,34,000 | 2,53,000 | 2,73,000 |
| L.D.O. | Nil | 79,000 | 79,000 | 80,000 | 80,500 | 82,500 | 84,600 | 87,000 | 89,400 | 91,700 |
| J.B.O. | 44,000 | 49,500 | 54,500 | 57,800 | 61,300 | 65,000 | 69,000 | 73,100 | 77,500 | 82,100 |
| F.O.(H.S) | 5,29,000 | 5,28,000 | 6,19,000 | 6,45,000 | 7,47,000 | 7,61,000 | 7,74,000 | 7,86,000 | 7,99,000 | 8,12,000 |
| F.O.(L.S) | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 |
| Total | 1,267,800 | 1,414,000 | 1,570,700 | 1,615,700 | 1,902,900 | 2,004,700 | 2,097,200 | 2,203,000 | 2,315,000 | 2,453,000 |

Sd/- ( KAMAL RASHID )
Planning Engineer.

Eastern Refinery consists of the following unit:-

- Atmospheric distillation.
- Hydrotreating and hydrodesulphursing units
- Merox
- Reforming unit (IFP)          75000 T/A

The refinery at present alternated between the use of Aghajary and Marban (Abu Dhaby) crudes in the ratio of about 2:1. This crude are both available at the same price of 62 Rs/t landed plus 4 Rs/t. Tax, plus 6.5 Rs/t port dues. Total cost then ....... Rs. 72.5/T ($.15.23/t).

Aghajary has the higher potential for aromatics, and the 100-150°C cut used at present as feed to the reformer unit was obtained in 8% yield on crude. For aromatics production the cut could be widened to 70-160 °C at 13-14% yield.

The present 100-150 naphtha cut, reformed at 90 ON severity gave 85% yield of liquid of 50% aromatic content. Estimated gasoline consumption by 1975 would be about 124,000 T/A in which reformate would share with about 50%. This means even by 1980 the existing capacity of reformer unit will have 15,000-20,000 T/A spare capacity. Part of reformate can be replaced by raffinate + $C_9$ fraction from aromatics plant which together with satisfactory ON.

3.1.2 <u>Availability of land suitable for the construction of BTX-aromatics Project</u>

Present plot of Eastern Refinery is more than enough for the extension of Refinery from 1.5 to 2.5 million tons and additional plant for BTX-aromatics.

3.1.3 Availability of Water

Raw water usage for boiler feed and cooling tower make-up is at present 600 $m^3$/day, from the tuve wells of which there are five on the site only two normally being used at one time. Sodium chloride content is from 250 ppm. up to 1,500 ppm. at the very worst. A well costs about 40,000 Rs. to bring into operation, for a maximum flow rate of 7000 to 15,000 gallons/hour. The life of well is uncertain and may be limited by increase of salinity rather than reduction of flow, however, it can be taken into consideration three to ten year.

Recently, Eastern Refinery has taken in practice the collection of atmospheric and surface water in a simple pond excavated in the rather impervious silty soil i.e. "tank" water, which is the standard source of water of the region would be much more economical. Eastern Refinery has built one "tank" on which was invested about 100,000 Rs. complete including ancillary equipment, which it is expected to supply an average of 300 $m^3$/day over the year. It is considered that this system is very reliable as stand by supply.

3.1.4 Availability of steam and electricity

Steam - 200 psig steam was supplied by two package boilers of french manufacture (one working one spare) and a further boiler will be added at the same time as the extension will come during Fourth Five Year Plan.

3.1.5 **Electricity** - can be brought at about 26 paise/kwh from WAPDA, but normally all requirements are met by diesel generators, running on light diesel oil, at an estimated cost of 16 paisas/kwh. There are three such generators of 1100 KW nominal output but their actual capacity is only 700 to 800 KW. The normal peak load is at present 1600 KW maximum and it is proposed to add a fourth generator.

3.1.6 Cooling Water

Cooling tower capacity is very generous, so that the present cooling towers will be adequate for the next extension up to $2.5.10^6$ tons crude intake.

3.2 Feedstock and Processes

The bulk of petrochemicals (olefins and diolefins) are coming from **the** light hydrocarbons gases as feedstock by pyrolysis of light naphtha.

The three most consumed aromatics are used as raw materials. Benzene, toluene and xylene, briefly known as BTX, can be obtained either from coal or petroleum. Prior to world War II - Coke even gas was the only source. Because of treamendous military requirements, petroleum refineries developed methods for producing and extracting toluene and xylene from pet oleum. The so called "hydro-forming" plant were also built during the same period to supply toluene. After the war these plants continued operation, not for the production of toluene but to up-grade gasoline stock for antinock quality. The so called "Octane rate" brought about by the higher compression ratios of modern automotive engines, forced other refineries to install catalytic reforming equipments.

On an average, aht distribution of aromatics in reformate is:-

| | |
|---|---|
| - Benzene | 10 |
| - Toluene | 40 |
| - Xylene | 50 |

This ratio is quite contrary to the market demand as is shown in Table 2. In an attempt to supply benzene for a tight market the refineries were glutted with toluene and xylene. For this reason the hydrodealkylation processes appeared.

The quantity of coke-oven benzene, which consists of thiophene, other sulphur compounds and high boiling aliphatic hydrocarbons is not suitable for many chemical uses without extensive purification process. However, hydrodealkylation process has somewhat alleviated this problem.

The tremendous growth of the requirement of aromatics for the manufacture of chemical has been primarily for styrene monomer, phenol, nylon, polyester fibers, synthetic detergent and others.

Fortunately, catalytic reformers do not have to be used specifically for aromatics production, but they may be used to produce high octane gasoline. Similarly, hydrodealkylation units are adopted for the production of naphthalene and jet fuel etc.

The appearance of catalytic reforming processes in about 1940 and its tremendous post war expansion revolutionized the production of aromatics from petroleum. The combination of demand for high octane gasoline rich in aromatics, with the development of new catalysts, and new methods for separating aromatics has not only resulted in a high output but also created a much greater potential output of aromatics from petroleum.

In the course of building a petrochemical industry, Pakistan has taken into consideration the promotion of aromatics hydrocarbons. Since the aromatics and derivatives are mostly coming as co-products or by-products of petroleum refineries and petrochemical industry, there are no significant differences in feedstock and processes compared with other countries in the world. Thus, feedstock and processes in case of Pakistan would be in conformity with other regions in the world. Since Pakistan has no production of coke, the entire production of aromatics should be based on petroleum in the frame of existing refineries or as joint ventum between petrochemical complex industry and refineries, because the first capacity of petrochemical complex (olefin) industry in Karachi can not give sufficient feedstock for the economical production of aromatics.

There are, generally speaking two basic possibilities for the promotion of aromatic production.

1. The production of BTX-aromatics in East Pakistan in the scope of Eastern Refinery - Chittagong using the catalytic reformate i.e. straight Naphtha as feedstock (65-170°C cut).

Since the motor gasoline consumption in East Pakistan is very low (See Table 15, ERL-Longterm production 1970 through 1980). The promotion of BTX-aromatics production in Eastern Refinery would solve the demands for Pakistan.

Although, at present the majority of the market demands are in West Pakistan (about 70%). The promotion of BTX-aromatics in East Pakistan is reasonable from the following point of view:-

- By the implementation of aromatics production in Eastern Refinery. The economy of Eastern Refinery could be improved.
- BTX-aromatics production in East Pakistan could make possible further processing, some of them into procursors of synthetic fibers and other products which could give a great impulse in textile industry in East Pakistan and inter wing trade.
- Certain balance could be established in inter-wing trade with petrochemical products. The West Pakistan petrochemical (olefin) complex would supply the olefin based products to East Pakistan market, East Pakistan aromatics complex would supply aromatics based products to West Pakistan Market.
- With this possibility would be prevented the present intention of implementation of acrylonitrile/acrylic fibers on base of acetylene, which is very wrong solution from the point of view of market demand economically and technically. The implementation of

polyester fibers production processed from p-xylene aromatics would be right solution in Pakistan's conditions.

- Since the transport facilities from East to West Pakistan used to be utilized 30-40% only, there are possibilities to transport from East to West to be cheaply.

2. Second solution of BTX-aromatics production can be Karachi location, under joint project of Fauji Foundation/ National or Pakistan refinery, using as feedstock:

- <u>Pyrolysis gasoline</u> from Naphtha cracker of Fauji Foundation in Korangi nearby of National and Pakistan Refinery.

  In the second phase of Fauji Foundation Olefin Complex 43,000 t/y pyrolysis gasoline would be available which can be one of feedstocks for BTX-aromatics production especially benzene. Pyrolysis gasoline with high content of benzene (30-32%) offers to some extent more economical production of benzene than cat. reformate.

- <u>Catalytic Reformate</u> (from Naphtha cut 65-170$^{o}$C) Since pyrolysis gasoline from FF will be in limited quantity the second feedstock should be cat.reformate.

Typical composition of pyrolysis gasoline and cat. reformate (at the RON-clear on the various severity level is shown below:-

Table 16

Typical composition of pyrolysis gasoline and catalytic reformate of Aghajary naphtha cut 70-163°C

| | Pyrolysis gasoline wt% | Cat. reformate at the various severity wt% | | |
|---|---|---|---|---|
| $C_5$ + RON clier | 96 | 95 | 98 | 101 |
| Benzene | 32.0 | 5.5 | 6.6 | 7.8 |
| Toluene | 15.0 | 19.5 | 27.1 | 25.9 |
| Xylene | 12.0 | 27.1 | 29.5 | 32.0 |
| $C_9$-aromatics | 11.0 | 13.1 | 13.1 | 16.3 |
| Total aromatics | 70.0 | 65.2 | 73.5 | 82.0 |
| Total non-aromatics | 30.0 | 34.8 | 26.5 | 18.0 |
| Grand Total | 100.0 | 100.0 | 100.0 | 100.0 |

The actual distribution of aromatics in any reformate is dependent of course on the precursore in the naphtha of the severity and cut of naphtha etc. High severity reforming processes with new improved catalysts, recently produced 70-80% of aromatics from full boiling naphtha.

$C_8$-aromatics feedstock

Table 17

Typical distribution of $C_8$ aromatics vol%

| | Hydrostablized pyrolysis gas vol% | Catalytic reformate vol% | Toluene dispro-proportionation vol% |
|---|---|---|---|
| Ethylbenzene | 46.0 | 16.0 | 0.0 |
| Para-xylene | 11.0 | 19.0 | 28.0 |
| Metaxylene | 30.0 | 45.0 | 48.0 |
| Ortho-xylene | 13.0 | 20.0 | 24.0 |
| Total | 100.0 | 100.0 | 100.0 |

The production of $C_8$-aromatics is complicated by the fact that there are four isomers, with very similar physical constants, but also because of the rapidity of growth in demand for some of these compounds. A recent research and commercial implementation have led to process which can transform one aromatic structure into another giving to producers greater flexibility.

The source of $C_8$-aromatics are catalytic reformate, pyrolysis gasoline and recently those produced from the disproportionation of toluene. The distribution of isomers within each stream is decidedly different as shown in the Table 17.

The value of each of these mixed xylene streams may be different depending on their use. For example, if it is desired to produce paraxylene, the mixed xylenes from toluene disproportionation have a substantial advantage over the other because of the inherent higher concentration of paraxylene. In addition, the low ethylbenzene content of the mother liquor from the paraxylene separation process represents an incremental yield and operating cost advantage when using an isomeriser.

The high concentration of ethylbenzene in pyrolysis gasoline to some extent is disadvantage in the production of p-xylene.

Considering the composition of two feedstock (pyrolysis gasoline and catalytic reformate) we should come to the conclusion that pyrolysis gasoline has a high priority for the straight production of benzene only.

Catalytic reformate having low percent of benzene and high content of $C_7$ and $C_8$-aromatics is more convenient in the production of para and ortho xylene. For bigger production of benzene would require the dealkylation or disproportionation unit for transfaring toluene to benzene. Including the new technique "Disproportionation" of toluene this feedstock is more flexible than pyrolysis gasoline.

3.2.1 Processes

A recent develonment of aromatics market demands for the chemical products requirements and fuel the aromatics processing operations are becoming commercially more important. The interdependance of Petroleum and Petrochemical Industry are becoming greater and the tendency of careful integration of operation into the "Chemical Refinery" is often a reality.

Since Pakistan has no other sources for aromatics than petroleum feedstock. The processes which have to be considered are:-

- Catalytic reformate processes.
- Pyrolysis gasoline based processes, this one mostly for production of benezene.

Since the quantity of pyrolysis gasoline in this decade in Pakistan is limited the only solution has to be taken, the production of BTX-aromatics on base of:-

- Catalytic reformate or
- Mixed feedstock catalytic reformate/pyrolysis gasoline.

The East Pakistan scheme of BTX-aromatics allows the catalytic reformate feedstock be the used because there is no other feedstock. As we have mentioned the recent commercial production experience proved the successful adoption of new methods which can transform one aromatics structure into another. By this possibility catalytic reformate processes followed with others became the most important in production of BTX-aromatics.

In our further consideration of East Pakistan BTX-aromatics production scheme, we will take catalytic reformate at the RON-clear 96-98 level of severity of Aghajary naphtha feedstock.

In the Fig. 2 is shown a simplified scheme for the manufacture of BTX-aromatics.

### 3.2.2 Toluene disproportionation

Recently, the technology of aromatics advanced by new commercialized technique for reacting.

- two toluene molecules to form benzene and xylene molecules by movinga moethyl group from one toluene molecule to another. This reaction is called "Disproportionation".
- Normally during the course of catalytic reforming to produce BTX, the refiner will make a relatively small amount of $C_9$-aromatics which are predominantly trimethyl benzenes. The development of disproportionation technology led to the ability to react a molecule of trimethyl benzene with a molecule of toluene to form two molecules of xylenes by transfer of a mothyl group. This reaction is called "Transalkylation".

Advantage of disproportionation process compared with toluene dealkylation is in that, that the methane molecule which is split off has a very low value per ton compared with either toluene or benzene. It accounts for some 15% of the weight of the toluene or benzene. It accounts for some 15% of the weight of the toluene molecule and this loss erodes much of the benefit of the benzene from molecules of toluene. In the Tortory process this is carried out by a catalytic reaction.

The process has the flexibility to accept $C_9$-aromatics in addition to toluene and thus increase the production of xylenes to benzene. It is possible to roduce mole ratios of xylenes to benzene 07 to 10. The xylenes produced have the composition 23-25% para-xylene, 20-23% ortho-xylene 48-55% meta-xylene, with traces of ethyl benzene. The catalyst system has a life of around two years. Reactor operation conditions are in the range of 10-12 atm. pressure and 350-530°C.

Unfortunately, however, the extra capital cost and utilities charges of the disproportionation route largely associated with the extra work up chains is one disadvantage.

"Disproportionation" and "Transalkylation reaction offers more to the manufacturer a method for increasing xylenes production without a corresponding increase of feedstock i.e. in gasoline production. Thus, the producer is able to maintain the required balance between fuels and aromatics for chemical.use. Furthermore, greater flexibility in marketing strategy is attained.

### 3.2.3 Selection of the Process Scheme

The production of BTX-aromatics nd cyclohexane would be integrated in the frame of East Pakistan Refinery.

The plant for the production of BTX- romatics from naptha fraction (65-170°C cut) would consist of the following units:-

- Hydrotreating unit
- Reformer unit
- Aromatics extraction unit
- Fractionation unit
- Isomerisation-disproportionation unit
- Parex unit
- $C_8$-splitter

General flow sheet is attached at Page .....

### 3.2.4. Hydrotreating

Hydrotrating is reducing the content of materials in a feedstock which would otherwise poison processing catalyts this is the largest single use for the process. Hydrotreating is used to improve qualities of a wide range of petroleum stocks by the removal of sulfur, nitrogen, heavy metallic contaminents. The process used is hydrogents olefinies and aromatics hydrocarbons.

The feedstock is prehe ted in the presence of hydrogen to a temperature of 752 $_{o}$F max. The mixture then process through a fixed bed reactor vessel and after cooling goes to a high pressure separator where hydrogen rich gas is separated in order to be recycled to the reactor or used in other operations. After this separation the product stream is stabilised in a stripper column where light ends and residual hydrogen sulfide are removed. Operating process conditions and catalysts are selected according to the feedstock characte-ristics and the specifications required for the products.

Typical conditions are:

| | | |
|---|---|---|
| - Temperature | °F | 600-800 |
| - Pressure psig | | 200-1000 |
| - Space velocity | | 1-10 |
| - $H_2$ recycle, scf/bbl | | 900 |

3.2.5 Catalytic Reforming

From the hydrotreating unit the feedstock is conducted to the reforming reactors. On base of recent improvements of catalysts. The conversion to aromatics is carried out at low pressure with higher space velocity and lower recycle ratio than before. Different types of catalysts are available and selected according to the type of operation severity and feedstock. It could be used catalysts with 0.35 to 06% pt. The chemical reactions involved are mainly dehydrogenation of naphthenes to aromatics, dehydrocyclisation of paraffins and naphthenes and partial hydrocracking of heavy paraffins to light paraffins.

3.2.6 Aromatics extraction unit

On a technical scale, aromatics are almost exclusively separated from non-aromatics of the same boiling range by liquid extraction. A prerequisite for the application of the process is that the organic solvents used and the mixture to be separated in two phases. The solvents and aromatics are separated by distillation. As solvents only such materials are of use which contain a polar group. For economic reasons solvent with boiling point, which exceed that of the aromatics to be extracted, are given preference.

The solvent is fed to the top of a multi-stage extractor where it travel downwards and preferentially dissolves the aromatics. The mixture to be separated is charged to the centre of the extraction tower. The solvent loaded with aromatics leaves the tower bottom while the non-aromatics go overhead. The extract is distilled off from the extract phase and subsequently fractionated into pure products. As aromatics and non-aromatics shall be separated completely a reflux has to be recycled to the extraction tower similar to other separation processes using the countercurrent principle. Part of the aromatics is therefore returned to the base of the extraction tower.

There are a number of process **for** extraction of aromatics:

- Arocolvan process
- Sulfolan and others.

The Arosolvan process was developed by "Lurgi Guselshaft" Frankfurt/M for the extraction of BTX-aromatics from mixed aromatics and non-aromatics hydrocarbons, preferably reformed gasoline and hydrogenated pyrolysis gasoline, oil gasification and coke-oven aromatics. The used solvent in this process is N-methyl pyrolidone with boiling point of 206°C. It is entirely neutral, thermally stable and distilable at atmospheric pressure without destruction. The high solvent capacity of N-methyl-pyrolidone (NMP) can be easily adjusted over a wide range of strength by addition of water. Owing to its physical properties e.g. its low melting point of 24°C and its low viscosity extraction can be carried out at low temperatures contrary to other process. The solubility of NMP in non-aromatics mixture recovered as raffinate phase from the extraction of hydrogenated pyrolysis gasolines and reformates the solubility for a water content of 10 to 20% is between 3 and 05 per cent by volume. Owing to its extremely high partition sufficient only small quantities of water are required for NMP recovery. The water used for this purpose returns to the process so that the water cycle is entirely closed.

In lieu of antisolvent or aromatics Reflux, the Aroxolvan process uses a mixed Reflux consisting of aromatics and non-aromatics. The non-aromatics contained in the "mixed Reflux" are low boiling hydrocarbons. They are present in all hydro-refined products and reformates. Because of this "mixed Reflux", the higher boiling non-aromatics, physically dissolved in the extract in the lower section of the extractor, are replaced by low boiling non-aromatics which are easy to seperate from the aromatics by distillation. This applies in like manner to paraffins, naphthenes and olefins in particular. Hence, an additional clay treatment at increased temperature and pressure to remove olefins is not required.

As shown in Figure No..... the solvent is charged to the top of multi-stage extractor, from which it travels downwards. The mixture to be separated is fed to the solvent pass upwards and leave the extractor at the top while the solvent follows downwards and becomes loaded with aromatics. In a distillation tower extract and solvent are separated, the latter being returned to the process. The water, which is azeotropically carried over with the hydrocarbons, is separated and recycled to the extractor together with aromatics free NMP.

The distillate from extract distillation, aromatics and low boiling non-aromatics goes to the aromatics stripper where low boiling non-aromatics and part of the benzene are distilled off. The residue, the pure aromatics, is fracticnated subsequently. Fractionation tower with a few trays are sufficient for this step.

The non-aromatics hydrocarbons from the top of extractor enter the non-aromatics stripper where they separated from the low boiling components, which are supplied, together with the distillate from the aromatics stripper as "Mixed Reflux" to the extractor bottom.

The hydrogenated mixture of aromatic and non-aromatics is supplied to a mixer-setter type extraction lower comparising some 20-30 extraction stages. The solvent an NMP/water mixture, is charged to the top of the tower, from which it travels downwards. The loaded solvent is stripped in two stages. In the first stripper all low boiling hydrocarbons and part of the benzene are distilled off. To avoid pentane losses, this stripper operates under slightly increased pressure. The distilled water is partly returned to the top of the tower, the remainder being supplied to the bottom to maintain concentration. The bottoms product, which is free from non-aromatics is separated in the second stripper into distillite, the pure aromatics and a bottoms product, the aromatics free solvent. The solvent returns to the extractor.

The reffinate is withdrawn from the top of the extractor and all low boiling hydrocarbons are distilled off in the pentane tower. This tower operates under pressure, too. The distillate of the pentane tower and that of the first stripper are supplied as mixed reflux to the extractor.

The bottoms product of the pentane tower is separated in a washer from NMP by means of the watery distillate of the second stripper. The NMP/water mixture is routed to the bottom of the second stripper. Thus, the water cycle is entirely closed.

However, the process is not at all limited to the production of benzene, toluene and xylenes plus ethylbenzene. It is also possible by means of small alternations to extend the process to the production of $C_9$-aromatics.

Apart from the consumption of energy and chemicals there are other factors influencing the applicability of a process, such as low investment costs, possibility of home manufacture, adoptability of the process to local conditions, use of other energy instead of steam, air fan coolers instead of water, adopability of the process to changing raw material composition, easy maintenance as well as easy mainpulability. The arosolvan process is able to meet all these requirements.

In addition to the almost constant consumption of utilities such as heat, refrigaration, electric power and solvents the costs are influenced by the size of plant.

Benzene and toluene are easy to separate because of their boiling points, this is not true, however, of $C_8$-aromatics as can be seen from Table 14.

Table 18

Constants of pure Aromatics

| | Crystallization °C | Boiling point °C | Refractive index ND.20 | Specific gravity at 20 °C |
|---|---|---|---|---|
| Benzene | + 53.00 | 80.10 | 1.5011 | 0.8790 |
| Toluene | - 94.99 | 110.63 | 1.4969 | 0.8669 |
| Ethylbenzene | - 94.98 | 136.19 | 1.4959 | 0.8670 |
| m-xylene | - 47.87 | 139.10 | 1.4972 | 0.8642 |
| p-xylene | + 13.26 | 138.35 | 1.4958 | 0.8610 |
| oxylene | 25.18 | 144.41 | 1.5054 | 0.8802 |

All four isomers are recovered commercially now-a-days. Ethylbenzene with the lowest boiling point, only 20 below p-xylene is separated by superfractionation. The production of pure ethylbenzene requires towers with up to 360 trays, a reflux. Ratio of 1:120 and a heat consumption of about 20t steam/t ethylbenzene. The expense involved is reasonable only in special circumstances.

Separation of meta and p-xylene by distillation is not possible at all. They are distilled off together from o-xylene. For separation of both isomers from o-xylene towers with about 120 trays and reflux ration of 1:20 are required. The purity of o-xylene is at least 95% the reaminder consisting of both isomers and traces of non-aromatics.

Owing to their different points of crystallization (-48 and + $13^{o}C$) m and p-xylene are separated by fractional crystallization.

Recent advances in technology have been directed at using techniques other than crystallization for separating para-xylene from metaxylene. A newly commercialized process of extracts meta-xylene by forming a complex with $BI_3$ (Japan Gas Chemical Process). Another method suggests that para-xylene can be selectively separated by use of a new absorbent without the necessity of low temperature crystallization (UCP-Parex-Process).

3.2.7 Para-xylene Separation - PAREX Process

Up to date process for separation of p-xylene no doubt is "Parex". This process is for separating p-xylene from mixtures with other isomers, ethylbenzene and non-aromatic hydrocarbons. The p-xylene is recovered at a purity in excess of 99.5% and extraction efficiency can be above 98.4%. The process can be operated to extract p-xylene in a once-through operation from either a $C_8$-aromatic mixture derived from extraction or from a $C_8$-cut of reformate. Alternatively, it can be operated in conjunction with xylene isomerisation process to yield any required proportion of the $C_8$-aromatics products as p-xylene

Para-xylene is recovered by adsorption from the liquid phase in a fixed bed of solid adsorbent. The absorbed p-xylene is then recovered from the absorbent by washing it with a desorbent liquid having a boiling point different from that of any of the $C_8$-aromatics. The products are separated from the desorbent by fractionation. The process arrangement stimulates continuous contercurrent flow of absorbent and liquid without actual movement of the solid. A single bed of absorbent is used and the flow of feed and products to and from the bed is continuous.

Temperatures are in the range of 250-300 $^{o}F$ and pressures are moderate. No refrigeration or conveyance of solids is required.

3.2.8 Isomerisation and Dsiproportionation

Unfortunately, the composition of $C_8$-aromatics concentrate from reformate does not normally correspond with desired product distribution. This is illustrated in Table 17 and 14 depicts some physical constants of $C_8$-aromatics.

As we have mentioned hitherto the o-xylene is separated from the $C_8$-aromatics stream by fractionation, para-xylene by crystallisation or by Parex process and occessionally ethylbenzene by a difficult and expensive superfractionation. The ethylbenzene fractionation of $C_8$-aromatics has been justified by improving the economics of a subsequent isomerisation process which did not isomorise ethylbenzene to any great extent.

After removal of useful ortho and/or para-xylene there remain a "mother liquor" containing a high proportion of meta-xylene plus unseparated o-and p-xylene and ethylbenzene. This mother liquor may be sold as solvent xylenes or converted to a high octane motor gasoline pool.

In our case the demand of p-xylene and other aromatics (See Table ) require to be established isomerisation/disproportionation unit to convert the mother liquor in higher yield of para-xylene, ortho-xylene and benzene. The mother liquor undergoes complete or partial isomerisation in the presence of catalysts until a mixture containing near equilibrium concentrations of the $C_8$-aromatics is obtained. The isomerisate is recycled to the separation process where o-and/or p-xylene may be removed, again leaving a mother liquor to be isomerised. In this way the available $C_8$-aromatics concentrate is converted almost completely into required isomers.

As can be seen in Table the contribution of BTX-aromatics in market demand are as following:-

| | 1975 | 1980 |
|---|---|---|
| - Benzene | 11,000.0 t/y | 21,000 t/y |
| - Paraxylene | 9,750.0 t/y | 13,000 t/y |
| - Ortho-xylene | 4,700.0 t/y | 9,000 t/y |
| - Mixed xylene | 2,500.0 t/y | 5,000 t/y |
| - Toluene | 2,000.0 | 5,000 t/y |
| | 29,950.0 t/y | 53,000 t/y |

Above demands require the disproportionation of toluene mode would be used because of the inherent higher concentration of paraxylene. In addition, the low ethylbenzene content of the mother liquor from the para-xylene separation process represents an incremental yield and operating cost advantage when using an isomerizer.

Therefore, the establishment of isomerisation/disproportionation unit connected with "Parex" one would be an optimal solution.

3.3. Cyclohexane

The cyclohexane route to caprolactam is most common route. On the other hand the cyclohexane production should be close to the refinery because of the cheapest form of hydrogen.

Process Outline (Houndry Process and Chemical Co.,)

The benzene can be converted to cyclohexane by catalytic hydrogenation as it is shown in figure .... The benzene is combined with recycle and fresh hydrogen, preheated and introduced to the catalytic reactors. The close boiling points and freezing points of the benzene feed and cyclohexane product are such that the reaction must proceed to completion since the high quality cyclohexane product required cannot be separated from unreacted benzene. This is accomplished by keeping the reaction temperature low enough to favour thermodinamically only cyclohexane and by having a sufficiently active catalyst to drive the reaction to completion at such temperature. The only other problem is cyclohexane production is control of the very large exothermic heat of reaction. This is accomplished through careful application of reaction kinetics and the thermal properties of the flowing stream. Product from the reactors is condensed and stablis-ed to give final specificat-ion grade (99.9% purity, 6.4°C minimum freeze point cyclohexane product.

## 3.4 Raw Material and Utilities Consumption

In the Figure 2. is given BTX-aromatic production scheme and balance of raw material. In Table 19 is given the balance of utilities.

As we have decribed the raw feedstock for BTX-aromatics would be Naphtha (65-170°C cut) namely the catalytic reformate which would feed gasoline pool and BTX-aromatics plant. BTX-aromatics plant by-products would feed also the gasoline pool. This means that BTX-aromatics production would be syncronized with the normal production of motor gasoline, Kerosine and Jet fuel. Raw material for cyclohexane unit-benzene will come out from the BTX-aromatics unit. Hydrogen from the catalytic reformate unit.

Utilities will be supplied from the extended utilities plant on the site.

## 3.5 Estimated project Construction Cost

The installed cost of the proposed project is estimated to be Rs.86,600, including a contingency. A summary of the estimated cost is given in Table (Page ). Some explanation for various item we are presenting below :-

**Balance of Utilities**

Basis: 53,000 T/A BTX-aromatics

Table 19

| One year 75000 h. | Basis | Electrical power | | Steam | | Cooling water m3 | | Catalysts | | Fuel $10^6$ Kcal | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Kwh/t | Total $10^6$ Kwh | t/t | Total (000) | $m^3$/t | Total $m^3 10^3$ | $/t | Total $/A | $10^6$ Kcal per ton | Total $10^6$ Kcal |
| **BTX-Aromatics** | Feed | | | | | | | | | | |
| Hydrotreater (160,000 T/A) | Feed | 10.0 | 1.60 | - | - | 8.0 | 1.28 | 0.05 | 8,000 | 0.19 | 30,400 |
| Reformer (160,000 T/A) | Feed | 46.0 | 7.36 | - | - | 10.0 | 1.60 | 0.23 | 36,800 | - | 5,850 |
| Aromatics extraction (118,000 T/A) | Feed | 4.0 | 0.47 | 0.4 | 47.2 | 11.0 | 1.30 | 0.53 | 62,540 | - | - |
| Aromatics fractionation ( 96,000 T/A | Feed | 2.0 | 0.19 | 0.2 | 19.2 | 19.0 | 1.82 | - | - | 0.53 | 50,880 |
| | | 62.0 | 9.62 | 0.6 | 66.4 | 48.0 | 6.00 | 0.81 | 107,340 | - | 87,130 |
| 2. o-xylene splitting | Feed | | | | | | | | | | |
| C-splitter o-xylene ( 40,000 T/A) | Feed | 20.0 | 0.80 | 1.2 | 48.0 | 115.0 | 4.60 | - | - | - | - |
| 3. p-xylene product | Product | | | | | | | | | | |
| - Parex ( 13,000 T/A) | | 172.0 | 2.23 | - | - | 208.0 | 2.70 | 8.9 | 115,700 | 5.25 | 68,250 |
| - Isomerisation (40,000 T/A) | Feed | 44.0 | 1.76 | 0.3 | 12.0 | 0.6 | 0.02 | 2.24 | 89.600 | 0.58 | 23,200 |
| Disproportionation (30,000T/P) | Feed | 85.0 | 2.55 | 1.7 | 51.0 | 4.0 | 0.12 | 1.70 | 51,000 | credit 0.91 | 27,300 |
| Total p-xylene utilities | | | 6.54 | | 63.0 | | 2.84 | | 256,300 | | 118,750 |
| All Total utilities | | | 16.96 | | 177.4 | | 13.44 | | 363,640 | | 205,880 |

3.5.1 Land and Land Development

As it was mentioned in an earlier section the selected site for the proposed project is in the scope of Eastern Refinery, Chittagong. The existing plot of 200 acres is enough for extension of Refinery and suggested project.

3.5.2 Communication and Road

Eastern Refinery plot is well developed with approach and internal road, it will be necessary to extend the internal road to the new unit and railway siding with various spurs for handling wagons, internal telephone exchange with new lines. It is estimated that Rs. 1.48 million will be spent on this account including site development.

3.5.3 Civil Engineering and Buildings

An expenditure of Rs. 4.807 million in foreseen for this items because nearly all units will be built up on the open space as it is usual. Estimated expenditure are for extension of cooling towers, deep wells foundation for storage tanks, laboratories for lighting equipment, technical offices, labour welfare buildings canteen, security and time offices and main gate.

3.5.4 Plant and Machinery

This includes the following plants:

3.5.4.1 Hydrotreater unit for input-output of 160/180,000 T/A naphtha treatment.

3.5.4.2 Reformer, unit capacity of 150,000 T/A naphtha.

3.5.4.3 Aromatics extraction unit of 120,000 T/A.

3.5.4.4 Aromatic fractionation of 100,000 T/A

3.5.4.5 $C_8$-Splitter unit of 40,000 T/A

3.5.4.6 Parex process unit including sieve chamber and fractionation unit of 60,000 T/A charge.

3.5.4.7 Tortory unit of 50,000 T/A.

3.5.4.8 Insomerisation unit of 50,000 T/A charge.

3.5.4.9 Cyclohexane unit of 15,000 T/A.

3.5.4.10 Extension of existing power plant.

The expenditure CIF Chittagong basis is estimated at Rs. 38,107.0

It is estimated that Rs. 6,959,000 is required for purchase of equipment for utilities units services both from and within Pakistan and abroad. The equipment would be for power plant, cooling tower, distribution deep wells pumps, electrical cables switch gear, transformers, lighting fixtures, power distribution to plant central laboratories, machine and hand tools for workshop handling equipment, fire fighting and safety equipment and engineering fees for the design of the above services.

3.5.5 Spares

Spares of about 3% of equipment cost FOB are included in the initial cost of plants in the Working Capital part.

3.5.6 Preliminary and Consultancy Expenses

Amount of Rs. 2:0 million is included to cover the preliminary expenses during the pre-investment period and also the expenditure towards seeking export advise during different phases of the planning and during actual contracting with suppliers.

3.5.7 Training of Personnel

This item includes training abroad of senior engineers, junior engineers, supervisors.

3.5.8 Office-Equipment and Transport Facilities

Amount of 1,500,000 Rs. is included for expenditure for office equipment and transport facilities.

3.5.9 Start-up Expenses

All expenses for start-up which covers the consumption of raw materials, utilities, wages and salaries of personnel during that period. For this purpose the amount of Rs.2,294,000 is estimated including Rs.693,000 in foreign exchange.

3.5.10 Interest During Erection

This is calculated on the basis of the present condition of loan term from the international and local financial agencies and is calculated at 7%. It is calculated that the period of construction will last about 30 months. Estimated capital requirements are given in Table .... and details of interest during construction in Table ........

3.5.11 Contingencies

These figures are estimated as total 8% of CIF costs. About 1:1 foreign and local components.

3.5.12 Engineering and Know-how and Consultancy

The amount of Rs. 3.631 million of about 11.4% FOB equipment costs. This amount covers all expenses for engineering know-how and some consultancy.

3.5.13 Custom duties, Insurance, Transport to the Site, etc.

This items have been calculated on the following basis: for imported equipment of CIF basis (FOB price + overseas transport). The break up is as follows :-

| | | |
|---|---|---|
| 1. | Custom duties | 35% |
| 2. | Insurance, clearance forwarding and internal freight to site. | 4% |
| | | 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 fees 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 100% of equipment value CIF making some hidden reserve of local costs.

3.5.14 Erection

This heading covers the fees chargeable by supplier for deputing their erection, inspection and supervisory staff, their travel bills, and the local subsistance 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 about18% of CIF cost an erection value. On this, foreign component is about 6% and 12% to cover local expenses.

3.5.15 Utilities and Services.

Electricity will be generated within the plant and necessary equipment for extension of power plant is included in the main equipment supply. In the view of this factor only the fuel components of electricity generating cost is taken. In addition the Government levies a surcharge of one paisa (Rs. 0.01) per kwh from plan power houses is included. Price of electricity of Rs. 0.04 (0.9¢) kwh is taken. The fuel price is taken of Rs.100/ton.

3.5.16 Project Schedule

As shown in figure 3. it is anticipated that this project would be under construction and test period for 36 months. After this period it is estimated that the full production would come during the 2.5-3 year. This means by 1980:-

| | | | |
|---|---|---|---|
| 1st Year | 1977/78 | 85% | utilisation |
| 2nd Year | 1978/79 | 95% | --"-- |
| 3rd Year | 1969/80 | 100% | --"-- |
| 45h Year | 1980 | 100% | --"-- |

## 3.6 Organisation, Management, Personnel and Remuneration.

### 3.6.1 Executive, Supervisory and Labours.

Since the BTX-aromatics will be in the scope of the current refinery production as the extended activity then the production management will be under existing executive Management.

The extension of man-power is given in Table .....

The total additional personnel is estimated as 239 men:

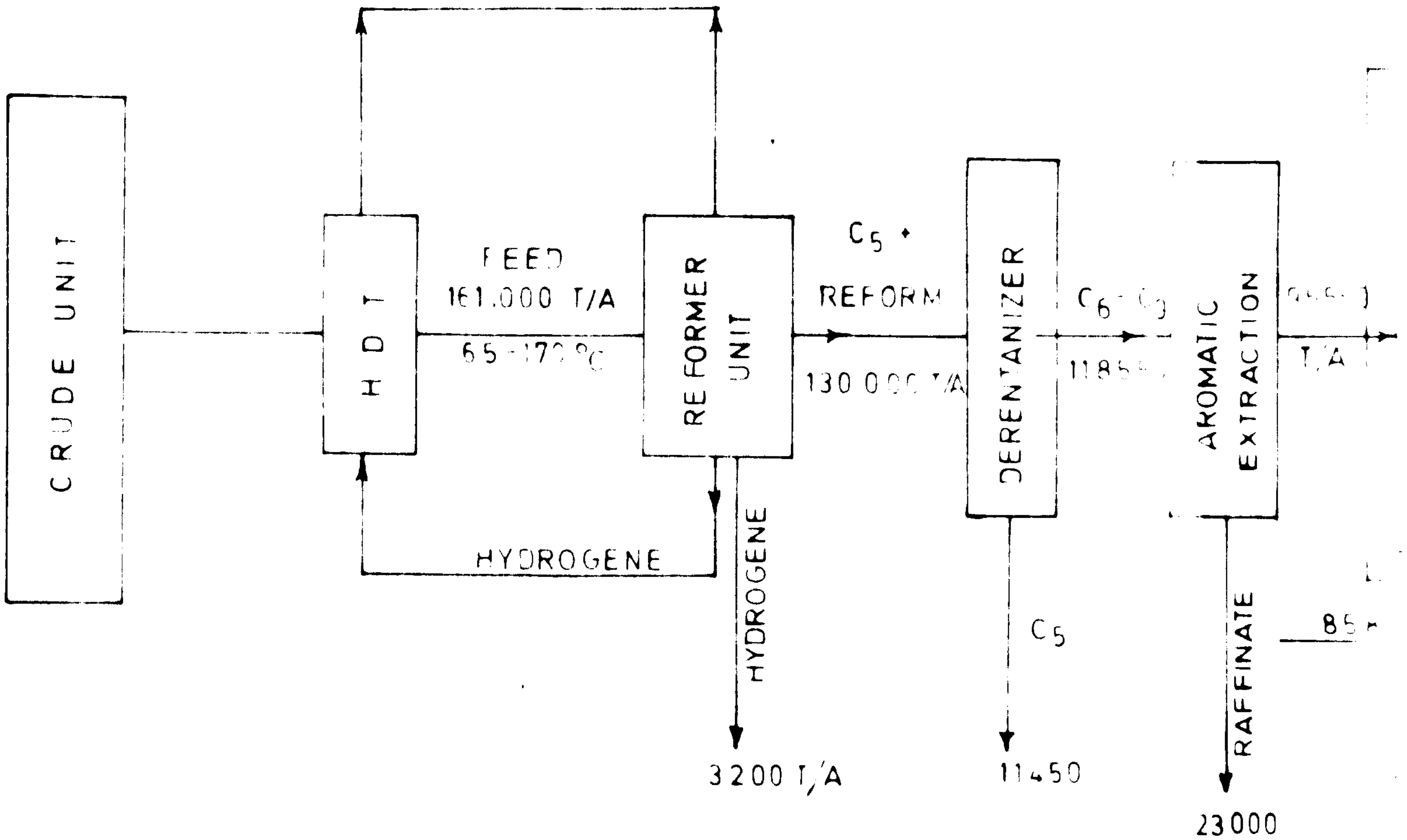
| | | |
|---|---|---|
| - Production | = | 144 |
| - Maintenance | = | 40 |
| - Administratives | = | 55 |
| Total | | 239 |

The training of production personnel will be carried out in the refinery because of some specific nature of the processes involved, however, provision has been made for overseas training of supervisory and certain number of operating personnel. Provision has been made for 20 supervisory trainees to go abroad for training in their respective job functions for a period of six month prior to the start- up of the Project.

Training for local labours staff covers 6 month before start-up of the Project.

BTX AROM

BALA




SEVERITY RON-CLEAR-98

BALANCE AROMATICS T 53000 T/A - TO MARKET

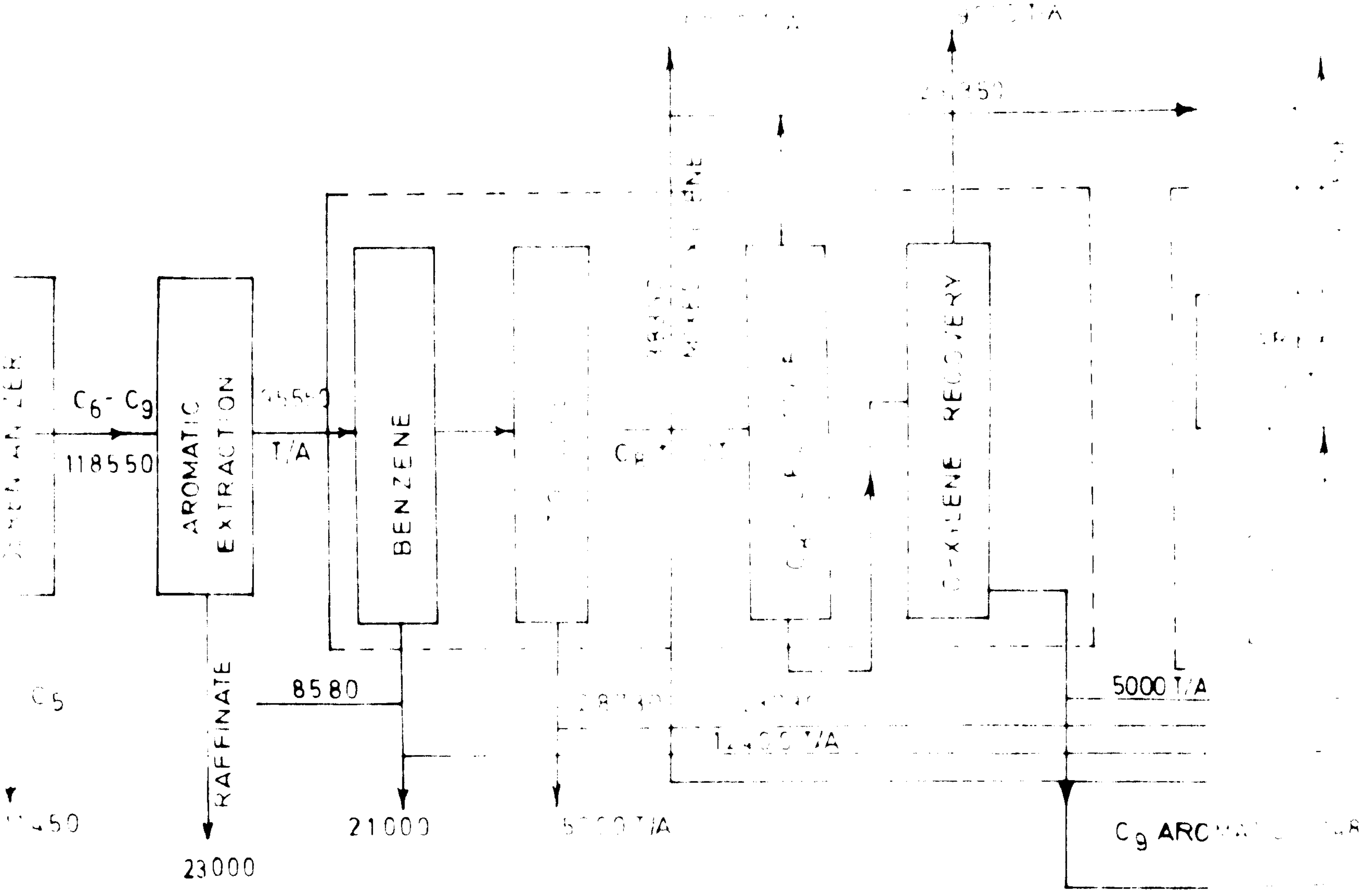
BY PRODUTCS

- $H_2$ + $C_1$ - $C_3$ FUEL GAS T.30000 - FUEL GAS
- RAFFINATE 34450 - TO GASOLINE AND
- $C_8$ $C_9$ BY PRODUCTS LIQUED T. 43550 TO GASOLINE POO

TOTAL NAPHTHA FEED 161,000 T/A

SECTION 1

# BTX AROMATICS PRODUCTION SCHEME
## BALANCE OF MATERIAL




T/A - TO MARKET

T.30000 - FUEL GAS

34450 - TO GASOLINE AND JET FUEL POOL (RON 75/80

T. 43550 TO GASOLINE POOL (RON 95/101

161,000 T/A

BENZENE

TOLUENE

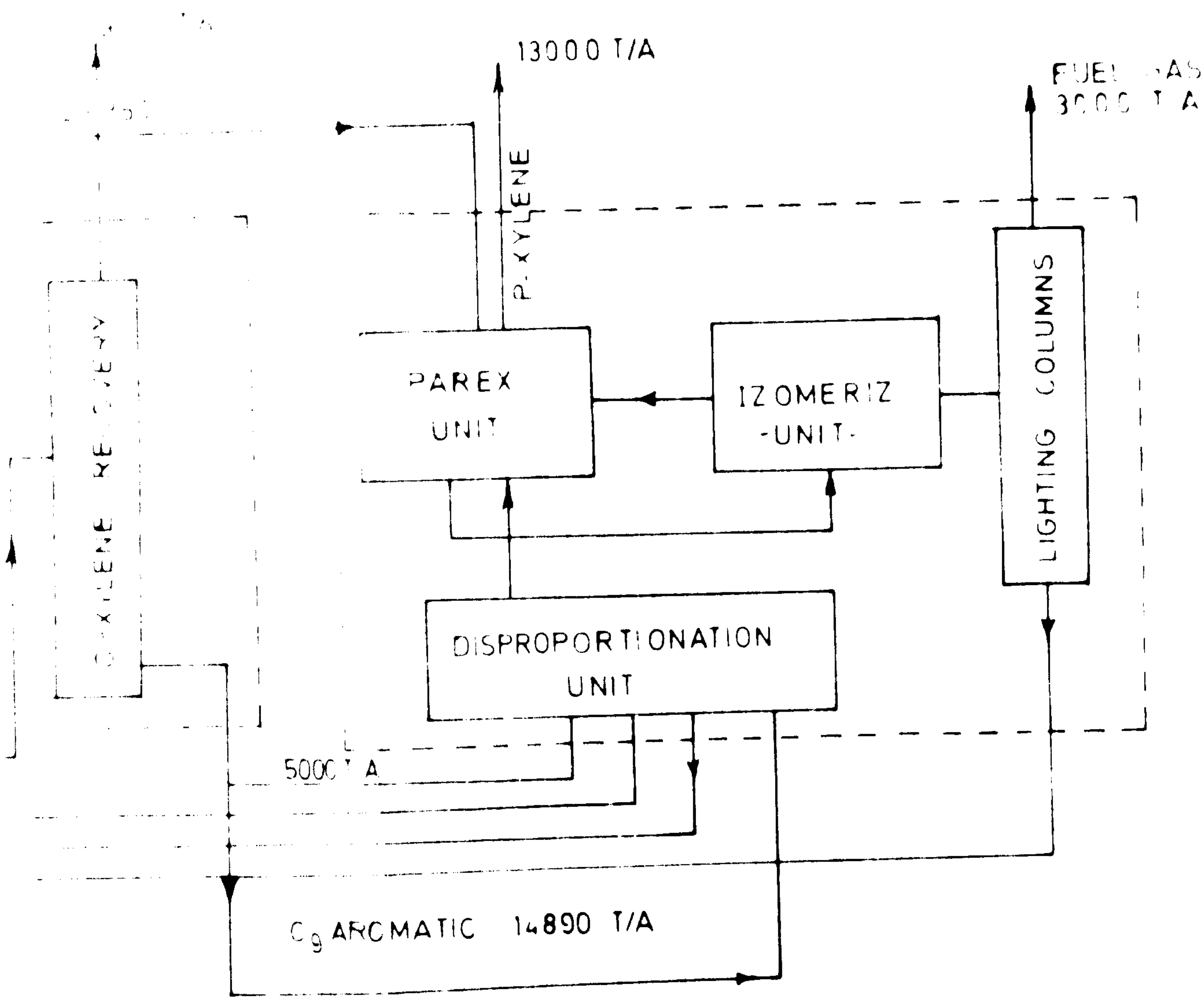
O-XYLENE

P-XYLENE

MIXED XYLENE

**SECTION 2**

# SCHEME




| | |
|---|---|
| BENZENE | 2[illegible] T/A |
| TOLUENE | 5000 T/A |
| O-XYLENE | 3000 T/A |
| P-XYLENE | 13000 T/A |
| MIXED XYLENE - | 5000 T/A |

# SECTION 4

## 4.0 Estimated Cost of Operation

### 4.1 Total Cost

The estimated annual costs for the project at full capacity is Rs. 31,243,800. Detailed production costs are given in Table 25,26 & 27. This is based on 7680 operating hours per year which permits adequate down time based on experience in similar plant.

Table 26 and 27 shows costs for total BTX-production and Cyclohexane respectively.

These costs calculation includes the following items:-

- Raw materials
- Utilities
- Oper. Supervision and Labours.
- Overhead
- Taxes and insurance
- Maintenance
- Fringe benefits
- Depreciation and
- Interest on loan.

Estimated expenses for the wages and salaries are given in Table 20 and 21. Fringe benefits are given in Table 22.

Each of the various cost and expense elements are discussed at next pages.

4.2 Basis of Economical Analysis.

The estimation of annual production costs for BTX-aromatics & cyclohexane plants is based on the following assumption.

1. Normal operation is taken at 320 days or 7680 operating hours/per year.

2. In early years the actual consumption of raw materials may be slightly higher. In financial evaluation item "Operating losses" is taken with 5% higher costs of raw materials.

3. Cost of Material and Services

3.1 Unit Cost of Raw Materials and By-Products

Material:

| | | |
|---|---|---|
| 1. | Naphtha | Rs. 96.62 per ton |
| 2. | Fuel oil | Rs. 96.62 per ton |
| 3. | $C_1$-$C_9$ Hydrocarbons as fuel (average) | Rs. 96.62 per ton |
| 4. | Reformate | Rs.126.00 per ton |
| 5. | Raffinate $C_4$-$C_{10}$ | Rs.126.00 per ton |
| 6. | $C_7$-$C_9$ aromatics | Rs.126.00 per ton |

The raffinate from aromatic extraction, unused aromatic fraction will replace reformate for correction of octane number and its value is taken as credit.

| | | |
|---|---|---|
| * | Hydrogen (make-up) | Rs. 45.00 per ton |
| | Sulphur | Rs.190.00 per ton |
| | Caustic Soda | Rs.670.00 per ton |

Note:- * The price of hydrogen in our calculation with Rs.45/- is taken as by-product from catalytic reformer.

Utilities

| | | | |
|---|---|---|---|
| 1. | Steam | t | Rs. 6.00 per ton |
| 2. | El. power | kwh | Rs. 0.040 per ton |
| 3. | Cooling water | $m^3$ | Rs. 0.003 per ton |
| 4. | Raw water | $m^3$ | Rs. 0.003 per ton |
| 5. | Process water | $m^3$ | Rs. 0.07 per ton |
| 6. | Deminiralised water | $m^3$ | Rs. 0.07 per ton |

3.2 Interest on loans

The rate of interest is estimated as follows :-

- On foreign loan 7% p.a.
- On local 8% p.a.

including Hypothecation charges and Debentures charges.

3.3 Repair and Maintenance

It is estimated that expenditures on repair and maintenance, charges for common services and utilities, spare parts, will be in the vicinity of 5% of FOB-equipment cost on a yearly basis. This cost includes custom duties etc and purchase of foreign spares on cash-cum-bonus basis.

3.4 Rent, Taxes and 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 plant cost.

3.5 Remuneration

Salaries and wages estimation to be paid to personnel are based on current rates of various function in East Pakistan.

Actually this expenses will be for additional staff in the refinery. All additional new employees will not exceed 259 persons.

**Production**

| | |
|---|---|
| Operators | 120 |
| Helpers | 20 |
| Shift Engineers (Foremen) | 8 |
| Plant Engineers(Supervisors) | 5 |
| Plant laboratory chemist | 10 |
| Sub-Total | 163 |

**Maintenance**

| | |
|---|---|
| Workers (Engineers) | 16 |
| Helpers | 8 |
| Foremen | 8 |
| Supervisors | 5 |
| Sub-Total | 37 |
| Total | 200 |

Additional Executive and Administrative Personnel

| | |
|---|---|
| - Assistant General Manager | 1 |
| - Assistant Financial Manager | 1 |
| - Technical Manager | 1 |
| - Accountants, Lowers, Planners and other professional officers | 20 |
| - Secretaries, Clerks, Chauffers Guards and others | 16 |
| - Unskilled labours | 16 |
| Total | 55 |
| All Total | 255 |

## Administrative and Head Office additional expenses

This includes expenses on the administrative staff, office expenses and salaries of additional employees in the refinery, it is estimated as Rs. 321,800 per year as it is specified in Table 21.

The fringe benefit is included that is Rs. 654,290 per year as 60% of total renumeration

Table 20

Estimated Salaries and Wages
- Operating Personnel -
Rs.

| Categories | Annual Employee Wage | | | No of employ-ees | Total annual |
|---|---|---|---|---|---|
| | Hourly rate | Annual hours | Annual wages 1 | 2 | 3 |
| - Plant Operator | 2.2 | 1760 | 3872.0 | 120 | 464,640.0 |
| - Plant helper | 1.0 | 1760 | 1760.0 | 28 | 49,280. |
| - Maintenance Workers | 2.2 | 1760 | 3872.0 | 16 | 61,952.0 |
| - Shift Engineers(Foremen) | 4.0 | 1760 | 7040.0 | 16 | 112,640.0 |
| - Plant Engineers(Supervisors) | 8.0 | 1760 | 14080.0 | 10 | 140,800.0 |
| - Plant laboratory chemist | 7.0 | 1760 | 12320.0 | 10 | 123,200.0 |
| Total | | | | 200 | 952,512.0 |

Table 21

Estimated salaries and wages

- Additional executive and administrative personnel -

| | Annual employee Salary | No of employees | Total Annual Pay Roll |
|---|---|---|---|
| Assistant General Manager | 28,000.0 | 1 | 28,000.0 |
| Assistant Financial Manager | 18,000.0 | 1 | 18,000.0 |
| Technical Manager | 28,000.0 | 1 | 28,000.0 |
| Accountant, Lowers, Planners & other professional officers | 6,000.0 | 20 | 120,000.0 |
| Secretarires, Clerks, Chauffers Guards and other | 4,800.0 | 16 | 76,800.0 |
| Unskilled labours | 3,200.0 | 16 | 51,200.0 |
| Total Rs. | | | 322,000.0 |
| Salaries and wages of production and maintenance | | | 952,512.0 |
| Grand Total | | | 1,274,512.0 |

Table 22

Gringe Benefit Allocation

| | Salaries | Fringe Benefit |
|---|---|---|
| Total salaries and Fringe benefit | 1274,512 | 764.707 |
| | **Percent** | **Amount** |
| Graduity | 1.0 | 12,740.00 |
| Rent Housing Contribution | 17.5 | 223,039.00 |
| Bonuses (1 month) | 8.0 | 101,960.00 |

Contd......

Table Contd' 22

| | Percent | Amount |
|---|---|---|
| Vacation | 8.0 | 101,960.00 |
| Sick leave | 4.0 | 50,980.00 |
| Holiday | 4.0 | 50,980.00 |
| School | 2.0 | 25,490.00 |
| **Pension/Provident Fund** | | |
| Officers | | |
| Workers | | |
| Average | 7.0 | 89,215.84 |
| Social & Recreation | 2.0 | 25,490.00 |
| Hospital - Medical and social insurance | 5.0 | 63,725.60 |
| Miscellaneous | 1.5 | 19,117.68 |
| Total | 60.0% | 764,707.00 |

5.17 Depreciation

Due to special concessions granted to new industrial undertakings in East Pakistan, depreciation for tax purposes now consists of three categories as follows:-

- Normal
- Extra
- Initial

Table 23

Estimated General and Administr. expenses
for additional personnedl in Refinery "A"
Rs.

| | | Rs. |
|---|---|---|
| Salaries and Wages | | 322,000.0 |
| Fringe benefit 60% | | 193,200.0 |
| **Maintenance:-** | | |
| - Labours | 15,000 | 40,000.0 |
| - Fringe benefit | 9,000 | |
| - Prod. overhead | 6,000 | |
| - Supplies | 10,000 | |
| | 40,000 | |
| Amortisation | | |
| Utilities - Additional | | 10,000.0 |
| Additional local expenses as telephone, stationery and others. | | 100,000.0 |
| Total expenses | | 665,200.0 |

Fringe Benefits
Rs.

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

| | Salaries | Fringe benefit |
|---|---|---|
| Additional production and maintenance salary | 952,512.0 | 571,507.0 |
| Additional Administr. salary | 322,000.0 | 193,200.0 |
| Total | 1,274,512.0 | 764,707.0 |

1. **Normal Depreciation**

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 detailed in Table below :-

Estimated normal Depreciation Rate for
BTX-aromatic & Cyclohexane Plant

| Class of Asset | Year | Percent |
|---|---|---|
| Fixed 1) | | |
| Land | - | - |
| Site preparation | 20 | 5.0 |
| Buildings production | 20 | 5.0 |
| Buildings other | 40 | 2.5 |
| Production equipment | 10 | 10.0 |
| Transportation equipment | 4 | 25.0 |
| Office equipment | 10 | 10.0 |
| Other 2) | | |
| Development cost | 15 | 6.7 |

1) Based on physical lives of assets with no consideration as to obsolescent or salvage value

2) Includes preoperating expense, training and start-up and interest during construction.

2. **Extra Depreciation**

The extra tax depreciation rate is 50 percent of the normal rate for plants operating double shift, and 100 percent for triple shift operations. Since this plants will be assigned to operate on triple shift basis extra depreciation is included at 100 percent on the normal rate.

3. Initial Depreciation

The initial depreciation allowance is equal to 25 percent on plant and machinery and 15 percent on industrial building, motor vehicles and office equipment in the initial year of installation.

However, this allowance is granted only for those firms which do not receive a tax holiday Therefore, the initial tax depreciation should not be considered due to the probability that the complex will qualify for a six year tax holiday.

Depreciation for tax purpose is computed by following the Pakistani practice of applying the prescribed tax rate to the written down value of the assets brought forward from the previous year. However, because tax depreciation does not commence until after the six year tax holiday, it cannot be considered realistic for computing production cost. For this reason, book depreciation is also computed on a straight line basis over the useful lives of the various assets.

We simplified the book of depreciation using only four categories on straight line basis :-

| | | |
|---|---|---|
| - 10 years period for installed machinery including all expenses in erected cost | = | 10 percent |
| - 20 years for Civil work including site development and various building and foundations. | = | 5 --"-- |

- 5 years for transport, furniture = 20 per cent

- 15 years for costs of development in that is included-training and start-up, interest during the construction and preliminary expenses = 6.7 per cent

Table 24

Estimated Depreciation and Amortisation
Rs(000)

| | Total | BTX-aromatics plant | Cyclohexance plant | Total plant |
|---|---|---|---|---|
| 1. Site Development | | | | |
| Civil work-buildings, foundations etc. | 6,287.0 | 299.35 | 15.0 | 314.35 |
| 2. Production Equipment: | | | | |
| Erected cost, contingency including eng. etc. | 69,219.0 | 6,518.0 | 413.0 | 6,931.00 |
| 3. Transport and office fac. | 1,500.0 | 280.0 | 15.0 | 300.0 |
| 4. Training & start-up exp. interest during construction and preliminary exp. | 9,567.0 | 608.0 | 32.0 | 640.00 |
| Total depreciation and amortization | 85,573.0 | 7,705.35 | 475.0 | 8,180.35 |

## Annual Cost of Production

### Table 25

| | |
|---|---|
| Plant Unit | Catalytic Reformate |
| Capacity | 130,000 T/A |
| Feedstock | Naphtha (65-170°C) |
| Capital Investment | |

| Cost Element | Base unit | Consumption per ton | Unit price | Cost per ton Rs. | Total Cost (000) Rs Per Year |
|---|---|---|---|---|---|
| **A. Variable Oper.Costs** | | | | | |
| 1. Feedstock | t | 1.23 | 96.62 | | 15,555.8 |
| Credit | | | | | 2,898.0 |
| Total Feedstock-Net | | | | | 12,657.0 |
| **2. Utilities:** | | | | | |
| Fuel | | | | | 273.0 |
| Cooling Water | | | | | 132.6 |
| Catalysts and Chemicals | | | | | 233.6 |
| El. power | | 56.0 | 004 | 22.4 | 358.4 |
| Maintenance supplies | | | | | 240.0 |
| Total utilities | | | | | 1,237.6 |
| Total variable costs | | | | | 13,894.6 |
| **B. Fixed Oper. Cost** | | | | | |
| - Production and maintenance labours and supervision | | | | | 190.5 |
| - Insurance 2% | | | | | 436.0 |
| - Interest on loan (average) | | | | | 539.2 |
| - Fringe benefit | | | | | 114.3 |
| - Overhead | | | | | 76.2 |
| - Depreciation and Amortization | | | | | 1,233.7 |
| Total fixed oper. costs | | | | | 2,589.9 |
| Total production cost | | | | | 16,484.5 |
| Production cost per 1 ton | | | | Rs.126.07<br>$ . 26.47 | |

Annual Cost of Operation
- Production Cost -

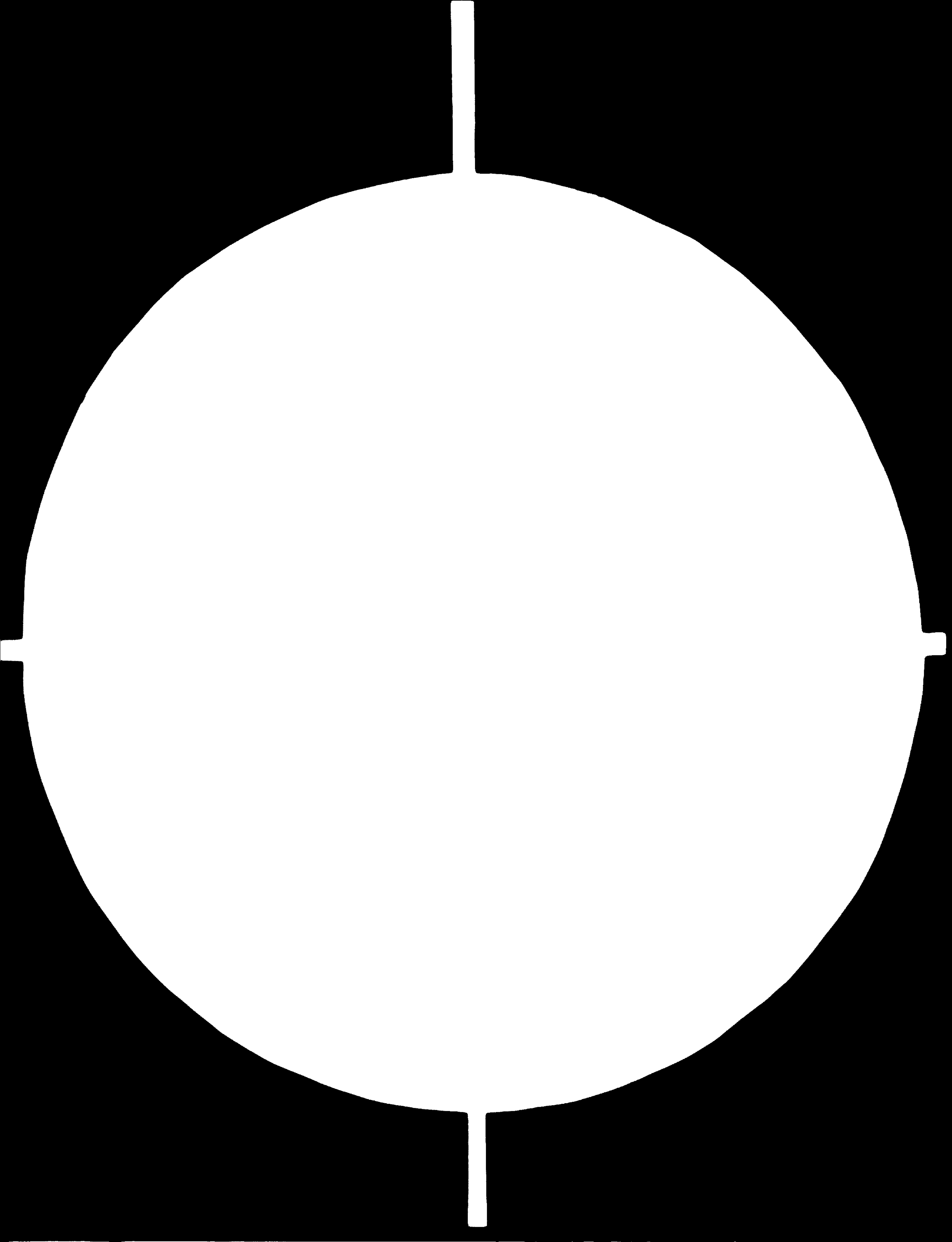
Table 26

- Plant unit : BTX-aromatics
- Capacity : 53,000 T/A
  - Benzene 21,000 T/A
  - Toluene 5,000 T/A
  - Mixed xylene 5,000 T/A
  - Ortho xylene 9,000 T/A
  - Para xylene 13,000 T/A
- Feedstock : Naphtha (65-170°C)

| Cost Element | Base | Unit price | Consumption per ton | Cost per ton Rs. | Total cost Rs(000) Per Year |
|---|---|---|---|---|---|
| A. Variable Oper. Costs | | | | | |
| 1. Feedstock-Reformate Net | t | 123.57 | 1.0 | 126.0 | 6,678.63 |
| 2. Utilities: | | | | | |
| - El. power | kwh | 0040 | 320.0 | 12.8 | 678.40 |
| - Steam | t | 6.0 | 3.34 | 20.0 | 1,060.00 |
| - Cooling water | $m^3$ | 0.030 | 253.0 | 7.60 | 402.80 |
| - Fuel | $10^6$Kcal | 7.0 | 3.0 | 21.00 | 1,113.00 |
| - Catalyst and chemicals | Rs. | . | 32.6 | 32.6 | 1,590.54 |
| - Maintenance supplies | | | | | 1,140.00 |
| Sub-Total utilities | | | | | 5,984.74 |
| Total Variable oper. costs | | | | | 12,663.37 |
| B. Fixed Oper. Costs | | | | | |
| - Production & maintenance labours and supervision | | | | | 747.65 |
| - Insurance | | | | | 1,462.00 |
| - Interest on loan (average) | | | | | 2,561.00 |
| - Fringe benefit 60% | | | | | 448.59 |
| - Overhead 40% | | | | | 299.06 |
| - Depreciation and Amorisation | | | | | 6,537.35 |
| - Total fixed oper. costs | | | | | 12,055.65 |
| Total annual cost of production at capacity | | | | | 24,719.02 |
| Production cost per 1 ton | | | | Rs.466.39<br>$. 98.02 | |

C-821

85.09.23
AD.86.07
ILL 5.5+10



1.0 2.8 2.5 3.2 2.2 3.6 4.0 2.0 1.1 1.8 1.25 1.4 1.6

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

24x
F

Annual Production Cost at Full Production

Table 27

Plant unit : Cyclohexane
Capacity : 16,000,000
Raw material : Benzene (Own production)
Total investment: Rs. 4,624,000
F.E. Rs. 2,931,000
L.C. Rs. 1,693,000

| | Base unit | Unit price | Consumption per ton | Cost per ton | Total costs Rs(000) Per Year |
|---|---|---|---|---|---|
| A. Variable Oper. Costs | | | | | |
| 1. Raw materials | | | | | |
| - Benzene | t | 361.76 | 0.940 | 340.05 | 5,440.80 |
| - Hydrogen | t | | | 9.52 | 152.32 |
| - Maintenance supplies | | | | | 60.00 |
| Sub-Total | | | | | 5,653.12 |
| 2. Utilities | | | | | |
| El. Power | kwh | 0.04 | 30.0 | 1.20 | 19.20 |
| DM-Water | $m^3$ | | 016 | 035 | 5.60 |
| Cooling Water | $m^3$ | 0.03 | 2.5 | 0.075 | 1.20 |
| Catalysts & Chemicals | Rs. | 4.8 | 4.8 | 4.80 | 76.80 |
| Sub-Total | | | | | 102.80 |
| Total variable oper. costs | | | | | 5,745.92 |
| B. Fixed Oper. Costs | | | | | |
| - Production and maintenance labours and supervision | | | | | 47.62 |
| - Insurance | | | | | 80.00 |
| - Interest on loan average | | | | | 130.00 |
| - Fringe benefit | | | | | 28.57 |
| - Overhead | | | | | 19.05 |
| - Depreciation and Amorization | | | | | 475.00 |
| Total fixed oper. costs | | | | | 780.24 |
| Total production costs | | | | | 6,526.16 |
| Production cost per 1 ton | | | | Rs. 407.8<br>$. 85.67 | |

Table 28

Distribution Production Costs

| | Quantity | Cost price | Cost price Rs/t | Total Annual cost (000) Rs. |
|---|---|---|---|---|
| Benzene | 21,000.0 | 76.00 | 361.76 | 7,596.96 |
| Toluene & mixed xylene | 10,000.0 | 60.00 | 285.60 | 2,856.00 |
| o-xylene | 9,000.0 | 77.00 | 366.52 | 3,298.50 |
| paraxylene | 13,000.0 | 177.23 | 843.65 | 10,967.56 |
| Total | 53,000.0 | - | - | 24,719.02 |
| Cyclohexano | 16,000.0 | 85.67 | 407.80 | 6,524.80 |
| Total | | | | 31,243.82 |

## Estimated Annual Variable Production Cost Rs(000)

Table 29

| | General & Administr | Reforming unit | Cyclo-hexane | Extraction Fractions | o-xylene | Para-xylene unit | Total | Total Variable Cost F.E. | L.C. | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 20% | 5% | 15% | 5% | 55% | 100% | | | |
| Feedstock-Naphtha | - | 12657.00 | - | - | - | - | 12657.0 | 12657.0 | - | 12657.0 |
| Hydrogen | - | - | 152.0 | - | - | - | 152.0 | - | 152.0 | 152.0 |
| Fuel | - | 273.00 | - | 286.00 | - | 487.00 | 1046.0 | - | 1046.0 | 1086.0 |
| Cooling Water | - | 132.60 | 1.20 | 245.70 | 26.82 | 81.12 | 487.4 | - | 487.4 | 487.4 |
| Catalysts and Chem. | - | 258.40 | 76.80 | 495.04 | - | 410.73 | 1215.8 | 1215.8 | - | 1215.8 |
| Fuel for power plant for steam and electricity | - | 358.40 | 20.00 | 889.00 | 7.20 | 76.44 | 1351.04 | - | 1351.0 | 1351.04 |
| Sub-Total | | | | | | | | 13872.8 | 3036.4 | 16909.2 |
| Other Supply: | | | | | | | | | | |
| Maintenance | 10.0 | 240.00 | 60.00 | 180.00 | 60.00 | 660.00 | 1210.0 | 1210.0 | - | 1210.0 |
| Total | 10.0 | 13894.24 | 310.00 | 2095.74 | 94.02 | 1715.29 | 18119.2 | 15082.8 | 3036.4 | 18119.2 |

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

Table 30

| | Production Labour | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Plant operators | Plant Helpers | Maintenance worker | Chief Foremen | Plant Superv. | Plant Chemist | Total | Fringe benefit at 60% | Prod. over | Depreciation | Total fixed cost |
| Reformer Unit 20% | 92.928 | 9.856 | 12.390 | 22.528 | 28.160 | 24.640 | 190.502 | 114.301 | 76.200 | 1233.744 | 1614.747- |
| Extraction and Fractionation unit 15% | 69.696 | 73.92 | 92.92 | 16.895 | 21.120 | 18.480 | 142.876 | 85.725 | 57.150 | - | - |
| o-xylene spliter 5% | 23.232 | 24.64 | 30.97 | 56.32 | 70.40 | 6.160 | 47.625 | 28.575 | 19.050 | - | - |
| Para-xylene unit 55% | 255.552 | 27.104 | 34.073 | 61.952 | 77.440 | 67.760 | 523.881 | 314.328 | 209.552 | - | - |
| Cyclohexane unit 5% | 23.232 | 2.464 | 30.97 | 56.32 | 70.40 | 6.160 | 47.625 | 28.575 | 19.050 | 475.000 | 570.250- |
| Total Plant | 464.640 | 49.280 | 61.949 | 112.640 | 140.800 | 123.200 | 952.509 | 571.507 | 381.003 | 8180.350 | 10092.369- |
| Gen.& Administr. | - | - | 25.000 | - | - | - | 25.000 | 15.000 | 10.000 | - | 50.000- |
| Grand Total | 464.640 | 49.280 | 86.949 | 112.640 | 140.800 | 123.200 | 977.509 | 586.507 | 391.003 | 8180.350 | 10142.369- |

# SECTION 5

## 5. Financial Evalution

The capital investment with foreign exchange and local currency requirements are estimated as shown in Table below:-

Table 31

Estimated Capital Investment by Categories in (000)Rs

| Item | F.E. Rs(000) | L.C. Rs(000) | Total Rs(000) |
|---|---|---|---|
| A. Cost of the Project "A" | | | |
| 1. Land Acquisition | - | - | - |
| 2. Site Development | - | 1,480.0 | 1,480.0 |
| 3. Buildings | - | 4,807.0 | 4,807.0 |
| 4. Production Equipment | 43,049.0 | 26,170.0 | 69,219.0 |
| 5. Transportation Equipment | 500.0 | 1,000.0 | 1,500.0 |
| 6. Office Equipment | - | - | - |
| Sub-Total | 43,549.0 | 33,457.0 | 77,006.0 |
| B. Development Cost | | | |
| 1. Preliminary expense | 2,000.0 | - | 2,000.0 |
| 2. Training and start-up | 2,293.0 | 3,310.0 | 5,603.0 |
| 3. Interest during constr. | - | 3,336.6 | 3,336.0 |
| Sub-Total B | 4,293.0 | 6,646.6 | 10,939.0 |
| Sub-Total A + B | 47,842.0 | 40,203.6 | 87,945.6 |
| C. Working Capital | | | |
| 1. Inventory | 2,837.8 | 1,052.9 | 3,890.6 |
| 2. Account payable | - | - | - |
| 3. Cash | - | - | - |
| Total cap.investments | 50,679.8 | 41,155.9 | 91,836.6 |

5.1 Project Costs

Of the total investment cost of Rs.91,836,600.0, Rs.77,006.0 will be required for site and project cost. This total includes all cost for materials, equipments, cost of erection, installation engineering, and other similar associated costs.

Expenditures for processing know-how are also included.

5.2 Development Costs

It is anticipated that Rs.10,939,000 will be required for development cost to cover expenses associated with properating, trainingand start-up and interest during construction. Preliminary consultancy, travels expenses cover the preliminary consultancy travels and others are estimated as Rs. 2,000,000.

The training programme will cover a period of one year before start-up and 6 month after start-up. The plan provides for 6 months of overseas training for 20 men. Key production, maintenance and supporting staff personnel. Total training programme will be conducted in the refinery.

Interest during the construction of Rs. 3,336,600 is given in Table 42.

5.3 Working Capital

The working capital reflects the estimated needs of the project at start-up and is summarised in Table 32. The details about working capital are given in Table 27 & 28. The final products stock is taken 1 month for all products, because a 75% of production will be processed on the same site in Chemical Complex (Project "B").

## Estimated Working Capital Required
Rs(000)

Table 32

| | Total Working Capital | | | | |
|---|---|---|---|---|---|
| | At start-up | End of the Year 1st | 2nd | 3rd | 4th |
| 1. **Inventory** | | | | | |
| - Spare part | 1841.1 | 1841.1 | 1841.1 | 1841.1 | 1841.1 |
| - Raw materials | 350.0 | 350.0 | 350.0 | 350.0 | 350.0 |
| - Maintenance | 1210.0 | 1210.0 | 1210.0 | 1210.0 | 1210.0 |
| - Work in process inventory | 489.5 | 489.5 | 489.5 | 489.5 | 489.5 |
| - Finished products inventory | - | 1468.5 | 1468.5 | 1468.5 | 1468.5 |
| Total | 3540.6 | 5359.1 | 5359.1 | 5359.1 | 5359.1 |
| 2. Account Receivable(1) | - | 1625.0 | 2000.0 | 2375.0 | 2500.0 |
| Less: | | | | | |
| 3. **Account Payable**: | | | | | |
| - Spare parts | (153.4) | (153.4) | (153.4) | (153.4) | (153.4) |
| - Raw materials | (350.0) | (350.0) | (350.0) | (350.0) | (350.0) |
| - Maintenance | (100.8) | (100.8) | (100.8) | (100.8) | (100.8) |
| - Work in process | (375.0) | (375.0) | (375.0) | (375.0) | (375.0) |
| - Finished products | (- | (731.2) | (900.0) | (1068.7) | (1125.0) |
| Total | (664.2) | (1710.4) | (1879.2) | (2047.9) | (2104.2) |
| 4. Cash Required | 664.2 | 1710.4 | 1879.2 | 2047.9 | 2104.2 |
| 5. Net Working Capital Required | 3540.6 | 6984.1 | 7354.1 | 7734.1 | 7859.1 |

Note 1) Computed at 30 days of daily sales

End of 1st year on 65% utilisation (30,000 x 65% :365 x30)

End of 2nd year on 80% etc.

**Estimated Working Capital Requirements**

**- Computation of Inventory -**

Rs(000)

Table 33

| Items | F.E. | L.C. | Inventory Before start-up | Inventory In normal capacity |
|---|---|---|---|---|
| 1. Spare Parts | | | | |
| Original Capital Cost | | | | |
| Production equipment | 32,407.0 | 5,700.0 | - | - |
| Transportation equipment | 500.0 | 1,000.0 | - | - |
| Total | 32,907.0 | 6,700.0 | - | - |
| 2. 2-Years Spare Parts Require- | 987.2 | 201.0 | - | - |
| ments3% plus import duty and 6coan fright 40% plus | 145.0 | 330.2 | - | - |
| 5% inland fright, insurance | - | 59.0 | - | - |
| Contignecies 10% | 98.7 | 20.0 | - | - |
| Total | 1,230.9 | 610.2 | 1841.1 | 1841.1 |
| 3. Raw Material | | | | |
| For 15 days 8400:12x05 | - | 350.0 | 350.0 | 350.0 |
| 4. Maintenance Supply 1 year | 1,210.0 | - | 1210 | 1210 |
| 5. Work in Process | | | | |
| 10 days of production cost before depreciation (15550.2:320x10) | 396.9 | 92.7 | 489.5 | 489.5 |
| 6. Finished Products | | | | |
| 1 month of production cost before depreciation (15550.2:320x30) | 1,190.9 | 277.6 | - | 1468.5 |
| Total before start-up | | | 3890.6 | |
| Total at normal capacity | - | - | - | 5359.0 |

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

Table 34

| Account Payable Items | Before Start-up | End of the Year 1st | 2nd | 3rd | 4th |
|---|---|---|---|---|---|
| Utilization of capacity | | 65% | 80% | 95% | 100% |
| 1. Spare parts | | | | | |
| 1 month: 1,841:12 | 153.4 | 153.4 | 153.4 | 153.4 | 153.4 |
| 2. Raw materials 1 month | | | | | |
| 8400,000:24 | 350.0 | 350.0 | 350.0 | 350.0 | 350.0 |
| 3. Maintenance supplies | 100.8 | 100.8 | 100.8 | 100.8 | 100.8 |
| 4. Work in process | | | | | |
| 10 days of variable cost 13500:36 | 375.0 | 375.0 | 375.0 | 375.0 | 375.0 |
| 5. Finished products | | | | | |
| 30 days of variable production cost | - | 731.2 | 900.0 | 1068.7 | 1125.0 |
| Total Account Payable | | | | | |
| - Before start-up | 664.2 | - | - | - | - |
| - End of 1st year | - | 1710.4 | - | - | - |
| - End of 2nd year | - | - | 1879.2 | - | - |
| - End of 3rd year | - | - | - | 2047.9 | 2104.2 |

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), the East Pakistan Industrial Development Corporation (EPIDC) and the Asian Development Bank.

It is assumed that Export Import Bank or World Bank loan can be obtained for Rs. 47.7 million with a 7% interest reate to cover all foreign exchange components required.

## 5.4 Proposed Financing

As it has been stated the requirements of capital investment are as follows:-

| | Local (000)Rs | Foreign (000)Rs | Total (000)Rs |
|---|---|---|---|
| Capital Assets | 40,203.6 | 47,742.0 | 87,945.6 |
| Working Capital | 1,052.9 | 2,837.7 | 3,890.6 |
| Total Capital Investment | 41,155.9 | 50,579.7 | 91,836.6 |

Of this amount of Rs. 87,945.6 million part of the local expenditure will be met by Government debentures and by short loans from the Bank's against stock hypothecation.

Those amounts are in (000)Rs.

| | |
|---|---|
| - Government debentures | Rs. 5.0 million |
| - Stock hypotecation | Rs. 7.0 million |
| Total | Rs.12.0 million |

The net capital requirements which need to be financed by equity and by loans are therefore as follows :-

| | Local Rs(000) | Foreign Rs(000) | Total Rs(000) |
|---|---|---|---|
| Total Capital required | 41,155.9 | 50,679.7 | 91,836.6 |
| Less: Debentures and Hypothecian | 12,000.0 | - | 12,000.0 |
| | 28,203.9 | 50,679.8 | 78,883.7 |

We would propose to finance this amount as follows:-

| Local Currency | Equity Rs(000) | Loan Rs(000) | Total Rs(000) |
|---|---|---|---|
| 1. EPIDC in the form of shareholders equity about | 22,768.0 | - | 22,768.0 |
| 2. Institutional loan | - | 6,387.0 | 6,387.0 |
| Total local | 22,768.0 | 6,387.0 | 29,155.0 |
| **Foreign** | | | |
| 1. World Bank or other Fing.Org. | 2,837.8 | 47,742.2 | 50,679.8 |
| Total Foreign | 2,837.8 | 47,742.2 | 50,679.8 |
| Grand Total | 25,705.8 | 54,129.2 | 79,836.8 |

The loan : equity ratio work out to 72:28. The above proposed plan is only one possibility, it could be found practically another solution in financing.

As stated above it is assumed that a loan of 47.7 m. can be obtained from Export Import Bank or World Bank with 7 percent interest rate to cover the financing of the foreign exchange component required excluding interest during the construction.

Table 35 below shows the timing of the estimated capital requirements of this project segregated between debt and equity capital

**Table 35**

**Estimated Timing of Capital Requirements by Type of Capital**

Rs(000)

(Project "A")

| Year before start-up | Quarter | Capital to be provided: From equity | From debt | Grand Total |
|---|---|---|---|---|
| (2.5) | First | 8,000.0 | - | - |
| | Second | 3,000.0 | - | - |
| | Third | 2,500.0 | 2,000.0 | 4,500.0 |
| | Fourth | 2,500.0 | 4,000.0 | 6,500.0 |
| | Fifth | 2,000.0 | 6,000.0 | 8,000.0 |
| | Sixth | 2,000.0 | 8,000.0 | 10,000.0 |
| | Total | 20,000.0 | 20,000.0 | 40,000.0 |
| (1.) | First | 2,500.0 | 7,000.0 | 9,500.0 |
| | Second | 1,500,0 | 7,000.0 | 8,500.0 |
| | Third | 1,000.0 | 9,129.0 | 10,129.0 |
| | Fourth | 205.8 | 11,000.0 | 11,205.8 |
| | Total | 5,605.8 | 34,129.0 | 39,836.8 |
| | Grand Total | 25,707.6 | 54,129.0 | 79,836.8 |

The long-term debt was assumed to mature in 12 years. However, after a 30 month grace period, ten equal annual sinking fund payments would retire the debt as indicated in Table below:-

Table 36

Estimated Long-term Debt
Rs(000)

| Year before and after start-up | Total debt outstanding | Sinking fund payment | Annual interest at 7% |
|---|---|---|---|
| 2 | 20,000.0 | - | 794.9 |
| 1 | 47,742.0 | - | 3,273.25 (1) |
| 1 | 47,742.0 | 4,774.2 | 3,341.9 |
| 2 | 42,967.8 | 4,774.2 | 3,007.9 |
| 3 | 38,193.6 | 4,774.2 | 2,673.5 |
| 4 | 33,419.4 | 4,774.2 | 2,339,3 |
| 5 | 28,645.2 | 4,774.2 | 2,005.1 |
| 6 | 23,871.0 | 4,774.2 | 1,670.9 |
| 7 | 19,096.8 | 4,774.2 | 1,336.7 |
| 8 | 14,322.6 | 4,774.2 | 1,002.5 |
| 9 | 9,548.4 | 4,774.2 | 668.3 |
| 10 | 4,774.2 | 4,774.2 | 334.2 |
| Total Repayment | - | 47,742.0 | - |

Note:- 1) Total interest of Rs. 3,273.25 during construction period is as included in Total capital Investment as it is shown in Table.....

2) Charged interest is included in the cost of operation.

Table 37

Estimated long-term Debt Pay off and interest
first 10 years of operation
Rs(000)

| Year | Beginning debt balance | Annual year-end payment | Ending debt balance | Interest at 7% |
|---|---|---|---|---|
| 1 | 47,742.0 | 4,774.2 | 42,967.8 | 3,341.9 |
| 2 | 42,967.8 | 4,774.2 | 38,193.6 | 3,007.7 |
| 3 | 38,193.6 | 4,774.2 | 33,419.4 | 2,673.5 |
| 4 | 33,419.4 | 4,774.2 | 28,645.2 | 2,339.3 |
| 5 | 28,645.2 | 4,774.2 | 23,871.0 | 2,005.1 |
| 6 | 23,871.0 | 4,774.2 | 19,096.8 | 1,670.9 |
| 7 | 19,096.8 | 4,774.2 | 14,322.6 | 1,336.7 |
| 8 | 14,322.6 | 4,774.2 | 9,548.4 | 1,002.5 |
| 9 | 9,548.4 | 4,774.2 | 4,774.2 | 668.3 |
| 10 | 4,774.2 | 4,774.2 | - | 334.2 |

Table 38

Interest calculation on short term local
loan
Rs.7,000,000 Payout 3 years: interest 9%
Rs(000)

| Year | Loan Out-standing | Payment | Balance | Interest 9% |
|---|---|---|---|---|
| 0 | 7,000.0 | - | - | - |
| 1st | 7,000.0 | 2.333 | 4,767.0 | 630.0 |
| 2nd | 4,767.0 | 2.333 | 2,334.0 | 429.0 |
| 3rd | 2,334.0 | - | - | 210.0 |

## Table 39

Interest calculation on Government Debentures
Rs. 5,000,000 Payout 3 years
interest : 6%

| Year | Loan Out-standing | Payment | Balance | Interest 9% |
|---|---|---|---|---|
| 0 | 5,000.0 | - | - | - |
| 1st | 5,000.0 | - | 3,334.0 | 300.0 |
| 2nd | 3,334.0 | 1,666.0 | 1,668.0 | 200.0 |
| 3rd | 1,668.0 | 1,666.0 | - | 99.9 |
| Total | | | | |

## Table 40

Interest calculation on long term
local loan
Rs.6,387.0 8%/payout 10 years

| Year | Loan Out-standing | Payment | Balance | Interest 9% |
|---|---|---|---|---|
| 0 | 6,387.0 | - | - | - |
| 1st | 6,387.0 | 638.7 | 5,748.3 | 510.9 |
| 2nd | 5,748.3 | 638.7 | 5,109.6 | 459.8 |
| 3rd | 5,109.6 | 638.7 | 4,470.9 | 408.7 |
| 4th | 4,470.9 | 638.7 | 3,832.2 | 357.6 |
| 5th | 3,832.2 | 638.7 | 3,193.5 | 306.5 |
| 6th | 3,193.5 | 638.7 | 2,554.8 | 255.4 |
| 7th | 2,554.8 | 638.7 | 1,916.1 | 204.3 |
| 8th | 1,916.1 | 638.7 | 1,272.4 | 153.2 |
| 9th | 1,272.4 | 638.7 | 638.7 | 101.7 |
| 10th | 638.7 | 638.7 | - | 51.0 |

Interest on the Loans
Rs(000)

Table 41

| Name | Loan Rs (000) | Rate of interest | Interest on Loans after start-up: 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year | 6th Year | 7th Year | 8th Year | 9th Year | 10th Year | Total interest |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Short term loc. loan | 7000.0 | 9 | 630.0 | 429.0 | 210.0 | - | - | - | - | - | - | - | 1269.0 |
| Govern. Debentures | 5000.0 | 6 | 300.00 | 200.0 | 99.0 | - | - | - | - | - | - | - | 599.0 |
| Local long term loan | 6387.0 | 8 | 510.0 | 459.8 | 408.7 | 357.6 | 306.5 | 255.4 | 204.3 | 153.2 | 101.7 | 51.0 | 2809.1 |
| Foreign loan | 47742.0 | 7 | 3341.9 | 3007.7 | 2673.5 | 2339.3 | 2005.1 | 1670.9 | 1336.7 | 1002.5 | 668.3 | 334.2 | 13380.1 |
| Total | 66129.0 | - | 4781.9 | 4095.7 | 3392.1 | 2696.9 | 2311.6 | 1925.3 | 1541.0 | 1155.7 | 769.0 | 385.2 | 23057.2 |

Interest during Construction
Rs(000)

Table 42

| Year before Start-up | Quarter | Total loan commitment | Loan draw down | Unused balance | Interest on: Drown down 7% interest: Per Year | Interest on: Drown down 7% interest: Per quarter | Interest on: Unused Balance 1%: Per Year | Interest on: Unused Balance 1%: Per quarter | Total Interest |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F | G | E + G |
| (2) | 3 | 54,129.0 | 2,000.0 | 52,129.0 | 140.0 | 35.0 | 52,129.0 | 130.32 | 165.32 |
| | 4 | 54,129.0 | 4,000.0 | 50,129.0 | 280.0 | 70.0 | 50,129.0 | 125.32 | 195.32 |
| | 5 | 54,129.0 | 5,000.0 | 49,129.0 | 350.0 | ~~1~~87.50 | 49,129.0 | 122.82 | 210.32 |
| | 6 | 54,129.0 | 8,000.0 | 46,129.0 | 560.0 | 140.0 | 46,129.0 | 115.32 | 255.32 |
| Total for year (2) | | | | | | | | | 826.32 |
| (1) | 1 | 54,129.0 | 14,000.0 | 40,129.0 | 980.0 | 245.00 | 40,129.0 | 103.20 | 348.20 |
| | 2 | 58,129.0 | 25,000.0 | 29,129.0 | 1,750.0 | 437.50 | 29,129.0 | 72.82 | 509.82 |
| | 3 | 54,129.0 | 38,000.0 | 16,129.0 | 2,660.0 | 665.00 | 16,129.0 | 41.32 | 705.32 |
| | 4 | 54,129.0 | 54,129.0 | - | 3,789.0 | 947.00 | - | - | 947.00 |
| Total for year (1) | | | | | | | | | 2,510.34 |
| Total interest during construction | | | | | | | | | 3,336.62 |

## 5.5 Estimated Sales Revenue

Estimated sales price and revenue is discussed in Section 2. Summarised sales revenue by utilisation is given in Table 43.

**Table 43**

**Estimated Sales Revenue for 4 Years**
Rs(000)

| | Sales price per ton | 1st 85% | | 2nd 95% | | 3rd 100% | | 4th 100% | |
|---|---|---|---|---|---|---|---|---|---|
| | | T/A (000) | Rs/A (000) | T/A (000) | Rs/A (000) | T/A (000) | Rs/A (000) | T/A (000) | Rs/A (000) |
| **Products:** | | | | | | | | | |
| - Benzene | 571.2 | 17.85 | 10195.9 | 19.95 | 11395.4 | 21000 | 11995.2 | 21000 | 11995.2 |
| - Toluene | 523.6 | 4.25 | 2225.3 | 4.75 | 2487.1 | 5000 | 2618.0 | 5000 | 2618.0 |
| - o-xylene | 618.8 | 7.65 | 4733.8 | 8.55 | 5290.7 | 9000 | 5569.2 | 9000 | 5569.2 |
| - p-xylene | 1142.4 | 11.05 | 12623.3 | 10.4 | 14108.6 | 13000 | 14851.2 | 13000 | 14851.2 |
| - Mixed xylene | 523.6 | 4.25 | 2225.3 | 4.75 | 2487.1 | 5000 | 2618.0 | 5000 | 2618.0 |
| - Cyclo-hexene | 606.28 | 13.60 | 824.5 | 15.2 | 9215.4 | 16000 | 9700.5 | 16000 | 9700.5 |
| Total | | 45.05 | 40450.6 | 47.55 | 45209.0 | 53000 | 47589.0 | 53000 | 47589.0 |

The first two years the plant normally will work with reduced capacity 85, 95 respectively.

5.6 <u>Estimated Cost of Production</u>

Production cost as developed on Table through summarized in Table 44.

<u>Production cost of Benzene, Toluene, Xylene and Cyclohexane.</u>

Production cost of Benzene, Toluene and Xylene could be distributed as it is shown in Table 44 below :-

Table 44

| | Quantity per year | Production Cost | | Total value Rs(000) per year |
|---|---|---|---|---|
| | | $/t | Rs/t | |
| Benzene | 21,000.0 | 76.00 | 361.76 | 7,596.96 |
| Toluene | 2,000.0 | 60.00 | 285.00 | 1,428.00 |
| Mixed xylene | 5,000.0 | 60.00 | 285.00 | 1,428.00 |
| Ortho Xylene | 9,000.0 | 77.00 | 366.52 | 3,298.50 |
| Para-xylene | 13,000.0 | 177.23 | 843.65 | 10,967.56 |
| Sub-Total | 53,000.0 | - | - | 24,719.02 |
| Cyclohexane | 16,000.0 | 91.27 | 407.80 | 6,524.80 |
| Total | --- Average --- | | 408.05 | 28,156.35 |

5.7 **Income Taxes**

Following other progressive countries Pakistan Government have provided certain concessions in order to quicken the pace of industrialisation. Most probably investor of this project will be EPIDC (so called public sector) we assume that six years tax-holiday would be granted as it was established more than five years ago.

At the end of tax holiday, new industrial undertakings are entitled to get depreciation allowances on the full cost of capital assets.

Corporate taxes in Pakistan are of two types:-

- Income tax
- Super tax

All companies are obliged to pay a basic flat income tax rate of 30 percent plus a super tax rate upto a maximum of 30% 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 percent is given to firms declaring dividends in Pakistan.
- A rebate of 10 percent is allowed for companies in public sector.

Therefore, the effective tax rate is estimated at 45 per cent.

| | |
|---|---|
| - Basic tax rate | 30% |
| - Super tax rate | 30% |
| | 60% |
| Less rebates (5+10) | 15% |
| Total tax rate | 45% |

## 5.8 Funds Generated From Operation

A summary of the estimated funds generated from operations for the ten years period after start-up is shown in Table 45.

**Estimated Funds Generated From Operation**
Rs(000)

Table 45

| Year | Sales | Operating income | Net income before tax | Net income after income tax | Depreciation and Amortization | Funds generated from operations |
|---|---|---|---|---|---|---|
| 1 | 30,932.0 | 16,612.2 | 2,996.00 | 2,996.00 | 8,180.35 | 11,178.35 |
| 2 | 38,071.2 | 21,587.3 | 8,658.18 | 8,658.18 | 8,180.35 | 16,838.20 |
| 3 | 45,209.5 | 26,562.5 | 14,336.67 | 14,335.67 | 8,180.35 | 22,513.70 |
| 4 | 47,589.0 | 28,220.0 | 16,688.45 | 16,688.45 | 8,180.35 | 24,869.40 |
| 5 | 47,589.0 | 28,220.0 | 17,073.95 | 17,073.95 | 8,180.35 | 25,354.70 |
| 6 | 47,589.0 | 28,220.0 | 17,727.95 | 17,727.95 | 8,180.35 | 25,910.30 |
| 7 | 47,589.0 | 28,220.0 | | 10,175.60 | 8,180.35 | 18,355.95 |
| 8 | 47,589.0 | 28,220.0 | | 10,386.20 | 8,180.35 | 18,566.55 |
| 9 | 47,589.0 | 28,220.0 | | 10,595.60 | 8,180.35 | 18,775.95 |
| 10 | 47,589.0 | 28,220.0 | | 10,810.00 | 8.180.35 | 18,990.35 |

The cash generated funds from the operation will enable the Project to retire long-term debt, replace facilities at the end of their useful lives and to expand the production of other chemical products essential to the economy of East Pakistan.

## 5.9 Discount Cash flow

The basis was taken according to the general conditions usually given by financial institutions. 5% of foreign exchange part, down payment at contract conclusion.

10% 18 month after contract conclusion.
85% in equal half yearly instalments, the first instalment 24 month after contract conclusion.
Start-up is assumed 24 month after contract conclusion, with turn key basis.

Table 16

**Earning Forecast**
Rs(000)

| | 85% 1st | 95% 2nd | 100% 3rd | 100% 4th | 100% 5th |
|---|---|---|---|---|---|
| 1. Total Revenue | 40,450.50 | 45,209.50 | 47,589.00 | 47,589.00 | 47,589.00 |
| 2. Other-expenses | | | | | |
| - Raw materials | 7,280.36 | 8,136.87 | 8,565.13 | 8,565.13 | 8,565.13 |
| - Utilities | 4,982.61 | 5,568.80 | 5,861.90 | 5,861.90 | 8,861.90 |
| | 12,262.97 | 13,705.67 | 14,427.03 | 14,427.03 | 14,427.03 |
| - Oper.Super and Labours | 1,141.48 | 1,141.48 | 1,141,48 | 1,141.48 | 1,141.48 |
| - Maintenance | 2,067.02 | 2,067.02 | 2,067.02 | 2,067.02 | 2,067.02 |
| - Fringe benefit | 654.00 | 654.00 | 654.00 | 654.00 | 654.00 |
| - Total oper. expenses | 16,125.47 | 17,568.17 | 18,289.53 | 18,289.50 | 18,289.50 |
| Gross profit | 24,325.13 | 27,641.33 | 29,299.47 | 29,299.47 | 29,299.47 |
| 3. **General Expenses** | | | | | |
| Overhead | 342.20 | 342.20 | 342.20 | 342.20 | 342.20 |
| Insurance and Taxes | 1,391.68 | 1,391.68 | 1,391.68 | 1,391.68 | 1,391.68 |
| Depreciation | 8,180.35 | 8,180.35 | 8,180.35 | 8,180.35 | 8,180.35 |
| Total general exp. | 9,914.23 | 9,914.23 | 9,914.23 | 9,914.23 | 9,914.23 |
| oper.profit | 14,410.90 | 17,727.10 | 19,385.24 | 19,385.24 | 19,385.24 |
| 4. **Other Expenses** | | | | | |
| Interest on loans | 4,781.90 | 4,095.70 | 3,392.10 | 2,696.90 | 2,311.60 |
| Net amount before tax | 9,629.00 | 13,631.40 | 15,993.14 | 16,688.34 | 17,073.64 |
| 5. Return on invest.% | 10.5 | 14.80 | 17.4 | 18.20 | 18.20 |
| 6. Pay-out time-yr. | 5.1 | 4.1 | 3.7 | 3.5 | 3.4 |

5.10 Savings in Foreign Exchange

The foreign exchange savings is one ofthe most important national aspect in consideration of any project in the course of industrialisation.

The National Saving in Foreign exchange of this project is given in Table No.47.

These are based on the estimated sales revenue which is based mostly on the CIF price reduced with Foreign Exchange required for purchasing imported materials, spare parts and capital equipment replacement, pay-back of foreign loan and payment of interest.

Using these adjusted CIF prices, the savings in Foreign Exchange are calculated at Rs.30.648 million per year on 100% of utilization of installed capacity at the end of 5th year and 33.2 million at the end of 10th years.

Even amortisation of the foreign exchange costs of the project (Rs. 47.8 million) is taken over 10 years. The net savings are over Rs. 25 and 28 million per year respectively, which represents a substantial bendfit to the economy of East Pakistan.

5.11 Earning Forecast

The 5 years earning forecast is given in Table
The net profit before taxes increases from Rs. 9.6 million per year in the first year to Rs.18.0 million in the 5th year.

**Estimated Foreign Exchange Savings**
**Rs(000)**

Table 47

| | Year After Start-up | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Net Sales | 40450.6 | 45209.5 | 47589.0 | 47589.0 | 47589.0 | 47589.0 | 47589.0 | 47589.0 | 47589.0 | 47589.0 |
| Less Foreign Exchange required for purchased chemicals & supplies Feedstock element | 10753.4 | 12024.1 | 12657.0 | 12657.0 | 12657.0 | 12657.0 | 12657.0 | 12657.0 | 12657.0 | 12657.0 |
| Catalyst and chemicals | 1033.4 | 1155.0 | 1215.8 | 1215.8 | 1215.8 | 1730.6 | 1730.6 | 1730.6 | 1730.6 | 1730.6 |
| Sub-Total | 11197.8 | 13179.1 | 13872.8 | 13872.8 | 13872.8 | 13872.8 | 13872.8 | 13872.8 | 13872.8 | 13872.8 |
| Spare parts and capital equipment replacement | 1028.0 | 1149.5 | 1210.0 | 1210.0 | 1210.0 | 1210.0 | 1210.0 | 1210.0 | 1210.0 | 1210.0 |
| Pay back of foreign loan | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 |
| Payment interest | 3341.9 | 3007.7 | 2673.5 | 2339.3 | 2005.1 | 1670.9 | 1336.7 | 1002.5 | 668.3 | 304.2 |
| Total Foreign Exchange R-d | 20342.0 | 22110.5 | 22530.5 | 22196.3 | 21862.0 | 21527.9 | 21193.7 | 20859.5 | 20525.3 | 20191.8 |
| Balance Foreign Exchange Savings | 20108.6 | 23099.0 | 25058.5 | 25392.7 | 25727.0 | 26061.0 | 26395.3 | 26729.5 | 27063.7 | 27397.8 |

As there is no income tax in Pakistan for 6 years in chemical Industry Production these profits may be considered after tax.

The profits as a percentage of sales total capital employed and Share Capital are as follows :-

Table 48

| Capacity utilization | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year |
|---|---|---|---|---|---|
| | 85% | 95% | 100% | 100% | 100% |
| % of Sales | 25.31 | 33.97 | 36.67 | 36.67 | 37.83 |
| % of Total Capital | 10.4 | 16.48 | 19.24 | 19.24 | 19.61 |
| % of Share Capital | 37.0 | 59.73 | 67.89 | 67.89 | 70.03 |

Cash Flow

The cash flow statement is given in Table it can be seen that plant can easily repay the foreign loan assumed to be a 10 years loan, and repay all short term loan in 3 years and still maintain a healthy cash flow

Assuming dividends at 6 percent in the 2nd, 10 percent in 3rd year 12 per cent in 4th year and 15% in 5th year. The cash surplus at the end of 5th year amounts to Rs. 16;200 million i.e. 46.041 million cash reserves.

Interest Shares

The interest shares are based upon the following interest rates:-

- Government debentures = 6%
- Short term local loans (hypothecation) = 9%
- Local long term loan = 8%
- Foreign loans = 7%

5.12 Break-even Levels

In order to compute the break-even point it was necessary to develop the following overall composite selling. Since the project will be selling more than one product as shown in Table.

Table 49

Average Overall Selling Price

| Products | Metric tons sold | Selling price per metric ton | Total sales revenue |
|---|---|---|---|
| Benzene | 21,000.0 | 571.2 | 11,995.20 |
| Toluene | 5,000.0 | 523.6 | 2,618.00 |
| o-xylene | 9,000.0 | 1,142.4 | 11,851.00 |
| p-xylene | 13,000.0 | 618.8 | 5,696.00 |
| Mixed xylene | 5,000.0 | 571.2 | 2,856.00 |
| Cyclohexane | 16,000.0 | 606.28 | 9,700.50 |
| Total | 69,000.0 | - | 47,589.00 |
| Average overall selling price. | - | 689.69 | - |

Estimated Profit and Loss (1)
At Capacity and at Break-even Points
Rs(000)

Table 50

| | At Capacity 100% 4th Year 3) | At Capacity 40% 2) | At Capacity 38% 4) |
|---|---|---|---|
| Metric ton sold | | | |
| Average selling price | | | |
| Total Revenue | 47,589.0 | 19,035.0 | 18,083.8 |
| Cost of Operation: | | | |
| A. Variable cost | 14,427.0 | 5,654.0 | 5,482.2 |
| B. Fixed oper. costs | 11,700.0 | 11,700.0 | 11,700.0 |
| C. General & Admin. | 665.2 | 665.2 | 665.2 |
| Total cost of operation | 26,792.2 | 18,019.0 | 17,847.2 |
| Operating profit | 20,797.8 | (1,339.0) | 236.6 |
| Other income and expense: | | | |
| - Interest income | 1,357.0 | 1,357.0 | 1,357.0 |
| - Interest expense | 2,696.9 | 2,696.9 | 2,696.9 |
| Total other - Net | 1,339.0 | (1,339.9) | (1,339.0) |
| Net income befor tax | 19,458.0 | - | (1,102.4) |
| Income tax | Tax holiday | - | - |
| Net income after tax | 19,458.0 | - | (1,102.4) |
| Add Depreciation & adm. | 8,180.3 | 8,180.3 | 8,180.3 |
| Total cash generated 5) | 27,638.3 | 8,180.3 | 7,078.0 |

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% utilization

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

5) Cash generated before payment of any dividends to equity shareholders.

Table 51

Estimated Interest Income
Rs(000)

| Beginning balance year | Annual Cash | Invested in certificate of deposit | Interest income at 5% |
|---|---|---|---|
| 1 | 1,745.4 | - | - |
| 2 | 6,864.9 | 3,864.9 | 193.2 |
| 3 | 15,534.9 | 12,534.9 | 626.7 |
| 4 | 30,140.9 | 27,140.0 | 1357.0 |
| 5 | 46,140.2 | 43,341.2 | 2167.0 |
| 6 | | | |

Assuming that the proposed selling price will continue at all level of production, the project would be able to sell 40,710 t/annum of products and still break-even on net income basis. This represents a level of production of 59 per cent of capacity.

Break even on a fund generated basis that is, at that level of operations when cash flow would equal the amount required for debt retirement is indicated to be 62% percent of capacity.

## Table 52

### Cash Flow Statement
Rs(000)

| | Constr period | 1st Year | 2nd Year | 3rd Year | 4th Year | 5th Year |
|---|---|---|---|---|---|---|
| Net amount before tax. | - | 9629.0 | 13631.4 | 15993.1 | 16688.4 | 17073.9 |
| Depreciation | - | 8180.3 | 8180.3 | 8180.3 | 8180.3 | 8180.3 |
| Total | - | 17709.3 | 21811.7 | 24173.4 | 24669.4 | 25354.7 |
| Fund generated by oper issues of shares | 25707.6 | - | - | - | - | - |
| Foreign loan | 47742.0 | - | - | - | - | - |
| L.T. Local loan | 6387.0 | - | - | - | - | - |
| S.T. Local loan | 7000.0 | - | - | - | - | - |
| Government Debent. | 5000.0 | - | - | - | - | - |
| Total Fund generated | 91836.6 | 17709.3 | 21811.7 | 24173.4 | 24869.4 | 25354.7 |
| **Allocation of Funds** | | | | | | |
| - Investment in cap. assets | 91436.6 | - | - | - | - | - |
| - Spares | - | 751.9 | 751.9 | 751.9 | 751.9 | 751.9 |
| - Amortization of Foreign L. | - | 4774.2 | 4774.2 | 4774.2 | 4774.2 | 4774.2 |
| - Amortization of S.T. Local L. | - | 638.7<br>2333.0 | 638.7<br>2333.0 | 638.7<br>2333.0 | 638.7<br>- | 638.7<br>- |
| - Amortization of Govern. Deb. | - | 1666.0 | 1666.0 | 1666.0 | - | - |
| - Amortization of Start-up exp. | - | 429.0 | 429.0 | 429.0 | 429.0 | 429.0 |
| - Dividents | - | - | 1542.4 | 2570.7 | 3084.9 | 3856.1 |
| - Increase in assets | - | - | 1000.0 | 2000.0 | 2000.0 | 2000.0 |
| Total allocation of Funds | 91436.0 | 9830.9 | 12373.9 | 14401.0 | 10916.8 | 9708.0 |
| Cash surplus | 400.0 | 7878.4 | 9438.7 | 9772.4 | 13952.6 | 15646.7 |
| Opening balance | - | - | 7879.4 | 17318.1 | 27090.5 | 41043.0 |
| Cash reserves | 400.0 | 7879.4 | 17318.1 | 27090.5 | 41043.1 | 56689.7 |

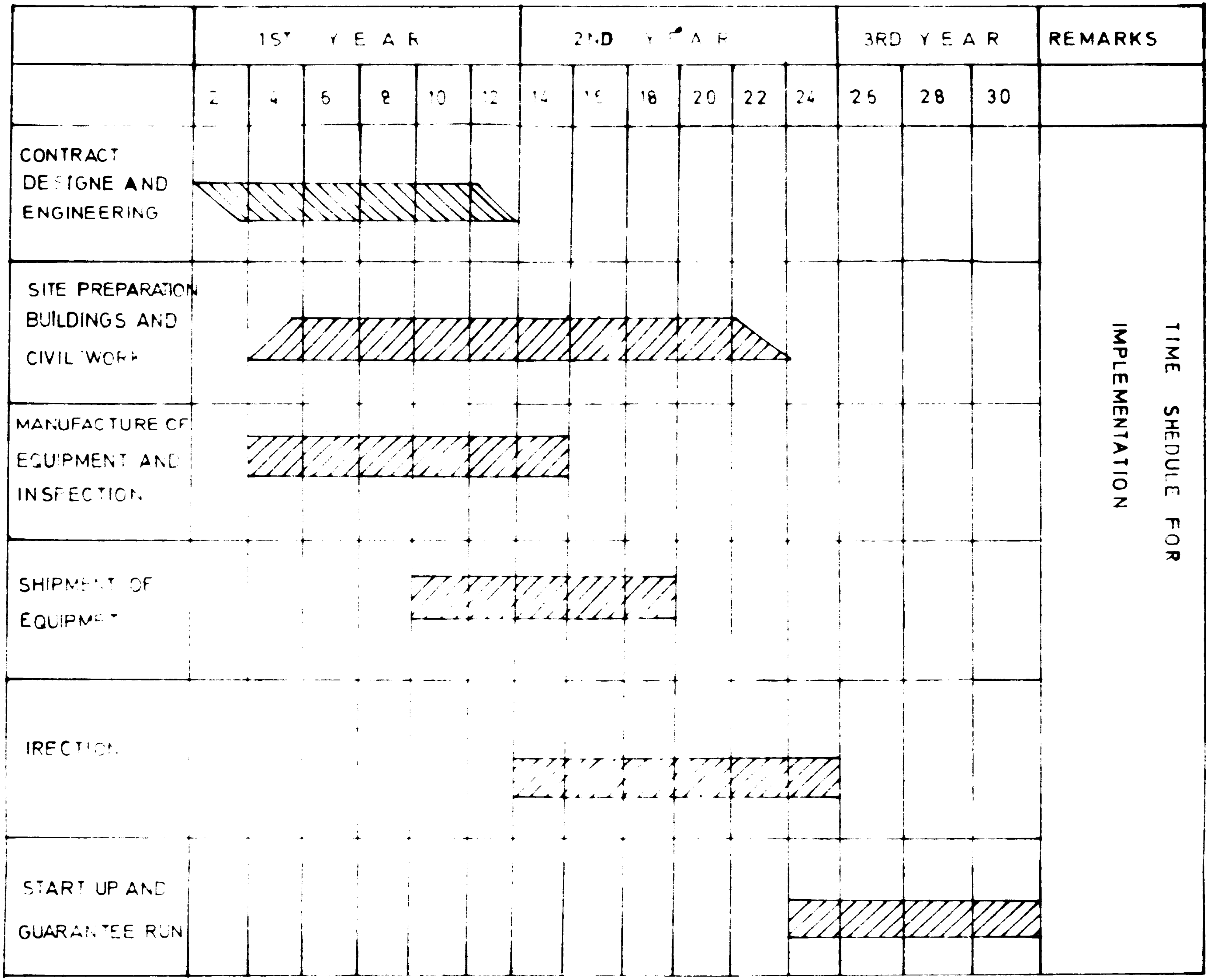
## Acknowledgement

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.



1ST YEAR
2ND YEAR
3RD YEAR
REMARKS
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
CONTRACT DESIGNE AND ENGINEERING
SITE PREPARATION BUILDINGS AND CIVIL WORK
MANUFACTURE OF EQUIPMENT AND INSPECTION
SHIPMENT OF EQUIPMENT
IRECTION
START UP AND GUARANTEE RUN
TIME SHEDULE FOR IMPLEMENTATION

C-821

85.09.23
AD.86.07
ILL5.5+10