

## EXECUTIVE SUMMARY

1. There are three types of xylenes i.e. Ortho, Para and Meta xylenes with the same chemical formula  $C_6H_4(CH_3)_2$ . Of these para-xylene and O-xylene are the ones in greater demand.

Meta-xylene is generally isomerised to produce valuable P-xylene. Technologies are available to produce more valuable products P-xylene and O-xylene while minimizing production of lower value products such as C<sub>7</sub>, C<sub>9</sub> aromatics.

2. Xylenes are currently being manufactured in India at three petrochemical complexes with installed capacities as below :

IPCL, Baroda	P-Xylene	-	1,700 MTA
	O-Xylene	-	21,000 MTA
BRPL, Bongaigaon	P-Xylene	-	29,000 MTA
	O-Xylene	-	6,000 MTA
Reliance, Patalganga	P-Xylene	-	87,500 MTA

IPCL have recently expanded their capacity to 43,960 MTPA of P-Xylene and 41,000 MTPA of O-Xylene.

Two letters of intent have been issued for additional capacities proposed to be set up at Saleempur and Madras.

3. The only use of P-Xylene is the production of DMT/PTA. O-Xylene is largely converted to Phthalic Anhydride used as plasticiser, for PVC. There have been no exportable surpluses of Xylenes from India.
4. A modern integrated world-scale aromatic complex comprise of the following key sections.
  - \* Ultra-low pressure (3.5 kg/cm<sup>2</sup>g) continuous catalyst regeneration (CCR) reformer. Such a reformer shall process a wider boiling range feed stock to produce a much larger quantity of aromatics.

- \* Sulpholane extraction section for extraction of benzene/toluene.
  - \* Disproportionation of toluene and transalkylation of toluene and C<sub>9</sub> aromatics to Xylenes.
  - \* Adsorption process for para-xylene recovery.
  - \* Isomerisation section.
5. State of the art technology for the complex as a whole or for individual sections is available from a number of technology vendors.
  6. Over the last two decades all areas of design engineering have improved. Major developments are in terms of heat recovery and integration, reactor design and fractionator design.

In a modern complex the actual heat requirement can be as low as 110% of the theoretical minimum. The energy required to produce a metric tonne of aromatic in the modern complex can be less than half that required for the base complex of early seventies. Nearly 60% of the total energy requirement for the base complex is due to fractionation separations. Advances in chromatography and more accurate equations of state now allow a better understanding of what components are in a particular feed and how they interact with one another during fractionation. Efficient computerised algorithms developed over the last 10 years now allow rigorous calculations to be done routinely.

A number of engineering tools developed over the last 10 years assist the designer in the design of reactors. Maldistribution in radial flow reactors can now be accurately studied and reduced through such software models. Scope exists to revamp existing complexes making use of present day design engineering tools.

7. Such a complex can produce atleast 100,000 tonne of p-xylene.
8. The major source of Xylenes is the Naphtha fraction 110<sup>0</sup> C-140<sup>0</sup>C. All the three Indian plants i.e. IPCL, Bongaigaon Refinery and Reliance Industries are based on this cut. The

investment per tonne of Xylenes will be the least if sufficient quantity of 110<sup>o</sup> C-140<sup>o</sup> C naphtha is made available.

However due to large demand for Xylenes particularly P-Xylene, disproportionation and transalkylation of toluene and C-9 aromatics generally becomes necessary. Hence large scale integrated BTX complexes have become common internationally.

9. The first Xylene Complex was commissioned in early seventies by IPCL at Baroda. The basic engineering was done by UOP and detailed engineering was entirely carried out by EIL. For Bongaigaon complex commissioned in 1985, EIL was assigned single point responsibility to optimise and integrate all the process units based on technology available from multiple sources.

Technology for the expansion of IPCL Xylene Complex was totally indogenous except for the Parex Unit. EIL was responsible for the process design and basic engineering. Reliance opted for UOP technology for the various sections in their complex.

All the three Indian plants have performed well without any problems. Xylene technology has been absorbed well by the three organisations who are fully capable of getting the best out of their complexes.

10. IPCL/IIP have developed and commercialised both mono (IRC series) and bi-metallic (IPR Series) reforming catalysts suitable for semi-regenerative processes. Zeolite based Xylene isomerisation catalyst in the Encillite series have been developed and commercialised.

IPCL's CATAD plant located at Thane near Bombay is well equipped. The above international quality of catalysts are produced at CATAD.

11. Toluene disproportionation catalyst has been developed by IPCL and pilot plant studies are currently on. IPCL is also working on the development of molecular sieves for P-Xylene separation.

12. EIL over the years has developed design engineering capabilities of international standards. They have extensive design tools developed in-house for flow sheet simulation & simulation of energy recovery schemes based on latest state of art Pinch Technology.

Their R&D centre at Gurgaon covers equipment development for certain major areas such as distillation, extraction, furnaces, gas-liquid separators etc.

13. Indigenous capability for process design exists for all units of an aromatic complex except paraxylene recovery, toluene hydroalkylation and CCR naphtha reforming.

For CCR technology IFP and UOP are the two technology vendors. IFP's Dualforming technology is interesting to revamp existing semi-regenerative plants.

14. Indian vendors for plant and machinery have developed excellent capabilities. The new thrust should be on indigenous manufacture of items such as low NPSH pumps, precision dosing pumps, centrifugal compressors in high pressure process services, electronic instrumentation etc.

To further cutdown imports and for timely delivery certain raw materials eg. boiler quality plates, pipes and other components that go into the manufacture of fabricated equipment should be made available to the manufacturers at reasonable cost freely either through liberalised imports or through their manufacture in the country. Proprietary equipments can be manufactured in India on a selective basis through technology transfer agreements.

15. Scope exists to revamp existing complexes making use of present day design engineering tools. Reliance xylene complex by itself is a modern one. IPCL has already revamped its xylene complex. Bongaigaon may find some interesting possibilities of cutting down on energy consumption.

16. Indigenous R&D efforts have produced satisfactory results. Both mono and bimetallic catalyst for semi-regenerated naphtha

reforming process have been developed and are now produced at IPCL's CATAD near Thane. Development and commercial production of Encilite catalyst for xylene isomerisation is a commendable effort. Basic process design for naphtha reforming and xylene isomerisation can now be undertaken indigenously.

Indigenous technology is available for implementation of Xylene complex except for CCR type reformer, Para Xylene recovery and TA/DP units. Also process basic engineering for all units except the CCR reformer & PARA XYLENE UNIT are available indigenously. All detailed engineering for Xylene complex can be done by Indian engineering companies.

The highlight of indigenous R&D effort has been the development of catalyst for semi-regenerative reformer and Xylene Isomerisation and also the technology for aromatic extraction process using Sulfolane as solvent. These technologies are competitive to the best available in the world. Moreover Indian companies have proved their capabilities as single point agency to optimise, integrate the number of technologies, into an optimum, energy integrated workable complex and offer overall guarantees.

## **RECOMMENDATIONS**

17. Continuing R&D work for the development of molecular sieves for p-xylene separation and catalyst for disproportionation and transalkylation of toluene and C<sub>9</sub> aromatics may remain the thrust areas.
18. EIL can keep abreast of developments taking place overseas in the area of engineering design so as to produce designs with energy requirements close to the theoretical minimum.
19. For further development of vendor capabilities; the thrust should be on indigenous manufacture of items such as low NPSH pumps, precision dosing pumps, lobe and centrifugal compressors in high pressure process services, electronic instrumentation etc.

20. To further cutdown imports and for timely delivery certain raw materials e.g. boiler quality plates, pipes and other components that go into the manufacture of fabricated equipment can be made available to the manufacturers at reasonable cost freely either through liberalised imports or through their manufacture in the country. Proprietary equipments can be manufactured in India on a selective basis through technology transfer agreements.
21. In the area of environmental protection, plant safety and risk management, allout efforts should be made to enhance employee awareness and appreciation of potential hazards and to carry out risk analysis and safety studies making use of the latest methodologies and techniques.
22. Safety deserves a special mention. There appears a general lack of appreciation and understanding of potential hazards faced by such hazardous process industries. The techniques of risk identification and quantitative evaluation have made rapid strides during the past decade. A lot more is currently being researched in advanced countries. Since such safety assessments employ specialist knowledge and experience the regulatory authorities are well advised to insist on such studies to be undertaken by competent agencies. This will bring about professionalism in the area of safety and may lead to unbiased findings for corrective measures.