Application Note

August 26, 2026

Zeolite Molecular Sieve in

High selectivity o-/p- xylene separation

Executive Summary

Para-xylene (p-xylene or PX) is the foundational chemical feedstock required to produce Purified Terephthalic Acid (PTA), which is subsequently polymerised to manufacture polyester fibres, packaging, and clothing. However, industrial PX production inevitably generates a mixture of closely related C8 aromatic isomers. Because these isomers act as highly detrimental impurities in downstream polymerisation, achieving ultra-high purity PX is non-negotiable for the synthetic fibre industry. Traditional separation methods are severely constrained by extreme energy requirements and volatile raw material costs, prompting a major industry push toward next-generation membrane-based molecular sieving technologies

Market Overview

With increasing paraxylene demand and limited capacity addition, India is expected to become a net importer by 2030

Analysis of India's paraxylene capacity stagnation (2019-2025) and market structure | Source: Industry Sources, MoPNG, PwC Analysis

• RELIANCE INDUSTRIES dominates India's paraxylene market, accounting for a massive 74% share of total installed capacity (4,441.5 KT of the 6,002 KT total).

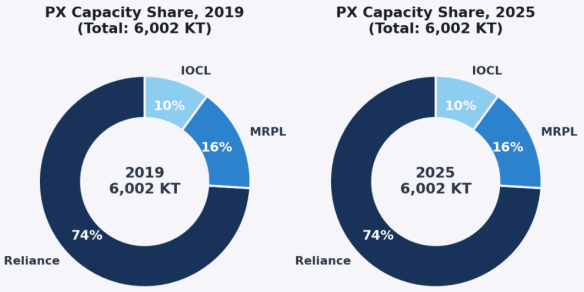
• MRPL (ONGC) holds a significant 16% share (~960.3 KT) and maintains an active supply contract of ~800 KT to JBR Petrochemicals.

• IOCL operates the remaining 10% of installed capacity (~600.2 KT), primarily integrated with its own refinery operations.

• EXPORT PROFILE: Major importers of Indian paraxylene currently include China, Malaysia, Indonesia, and the USA.

• PLANNED EXPANSIONS: IOCL plans to add 800 KT of PX capacity at Paradip (target CY 2026-27), with Haldia and Nayara also planning additions.

• THE 2030 DEFICIT: Stagnant capacity through 2025 against rising polyester demand is projected to tip India into a net importer position by 2030.

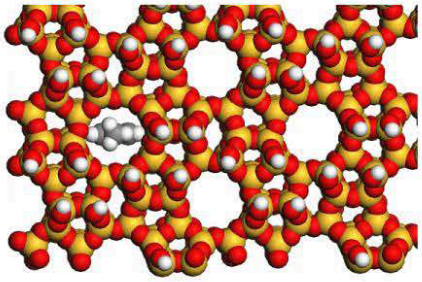


Technology Introduction

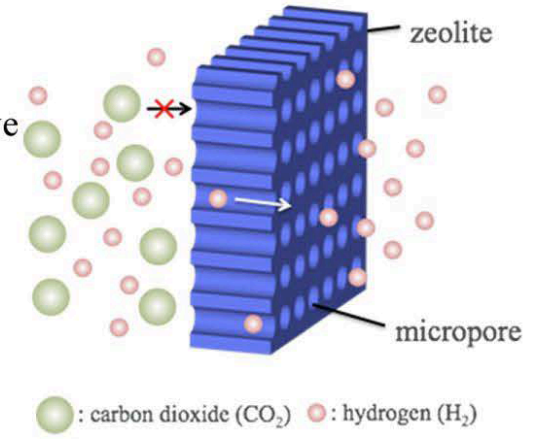
There is a great need for robust, defect-free, highly selective molecular sieve (zeolite) thin film membranes within separation of aromatics such as p-/o-xylene separation. Current separation membranes are based on Pt, Pd, Ag, Rh alloys or on chemically and mechanically unstable organic polymer membranes. The use of molecular sieves brings a stable (chemically and mechanically stable) inorganic matrix to the membrane. The crystalline frameworks have “tunable” pores that are capable of size exclusion separations. The frameworks are made of inorganic oxides (e.g., silicates, aluminosilicates, and phosphates) that bring different charge and electrostatic attraction forces to the separation media. The resultant materials have high separation abilities plus inherent thermal stability over 600°C and chemical stability. Furthermore, the crystallographically defined (<1Å deviation) pore sizes and shapes allow for size exclusion of very similarly sized molecules. In contrast, organic polymer membranes are successful based on diffusion separations, not size exclusion. Therefore, Zeolite based Thin Films *(< 50nm thickness)* are far more effective in lowering the cost of the system by replacing precious metals, being able to cover large areas and increasing selectivity, flux and significantly saving energy in chemical production.

Zeolites

Zeolites:
ordered micropores of molecular size
Gas separation using zeolite membranes:
an approach that can significantly save energy in chemical production.

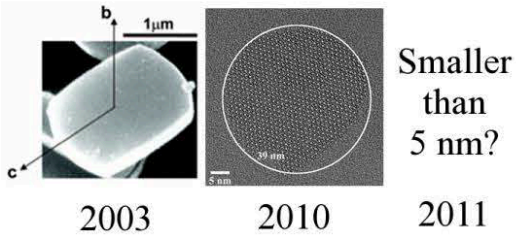


Para-xylene in zeolite MFI

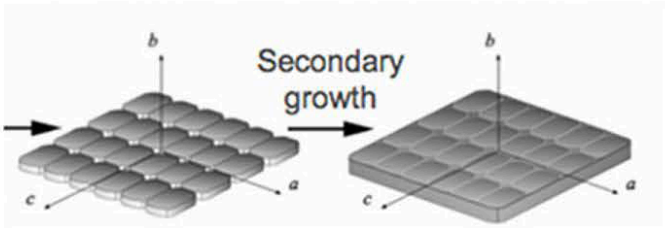


Zeolite membrane in hydrogen fuel purification

The importance of zeolite nanosheets



Seed particles



Coating Continuous Membrane

Smaller seeds: thinner membranes, less defects, and higher flux.

Approach

Molecule structure is MFI based. Membrane structure, coating thickness was determined using

- SEM (Scanning Electron Microscopy),
- AFM (Atomic Force Microscopy),
- XRD (X-ray Diffraction),
- TEM (Transmission Electron Microscopy)

Example Usage

Zeolite membranes use 2-stage technique during the separation of aromatics. In the first step, VOC molecules are caught until the Zeolite membrane is saturated. In the second step, the zeolite membrane is heated, whereupon the isomers are released in higher concentrations. Then, depending on the application these isomers are then collected in a separate chamber or incinerated.

Benefits

- Mechanical and thermal stability compared to existing solutions
- System is flexible and capable of handling low concentrations of VOCs in combination with very high concentrations
- Cost effective compared to the current precious metal catalytic systems
- Capable to produce large reactors with high flux and high selectivity
- The patented coating process without crack formation and minimizes other non-selective defects

Business Plan and Investment

NxTBrane India Pvt Ltd is a joint venture between NxTBrane (USA) and Maharashtra Minerals Corporation Ltd. (MMCL).

MMCL has been engaged in the business of mining, mineral processing and marketing of mineral products since 1962. Application mentioned above is protected by patent and NxTBrane is a license holder. NxTBrane India Pvt Ltd and MMCL are currently working to deploy a pilot plant to produce the material by 2027.

Note: Detailed project charter and business plans are available for subsequent discussions.

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