Paraxylene Production via BP Crystallization Technology

ERTC Conference 2017

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Paraxylene Introduction

• Isomer in the mixed C₈ aromatics family
  • Para, Ortho, Meta & Ethylbenzene

• Primary feedstock for PTA
  (Purified Terephthalic Acid)

• PTA feeds the polyester fiber market

• 50 M Ton Annual Market
• 5%-7% Growth
  • 2 x Global GDP Growth
Polyester Demand is Growing

Polyester Balance

Source: PCI Xylenes & Polyesters
BP PX Technology is the Technology of Choice

100+ Years of experience
50 Years of continued improvements

2 Million MT PX Plant
>$30M Annual OPEX Savings
>$75M CAPEX Savings (USGC basis)

BP pX Technology licensed by CB&I

>99+% Reliability
>$4M Annual Savings
*2 Million MT Plant

Rapid Debottlenecking
Shortest Turnaround times

27% Lower GHG emissions
66% Lower Flaring
Vs. Competing Processes
A Closer Look at the BP PX Process

Reformate Splitter

- Light Reformate
- Light Aromatics

Xylene Recovery

- Offgas: *includes Ethane & Benzene

Crystallization

State-of-the-art crystallizer and centrifuge technology

Separate via large differences in freezing point of xylene isomers

Paraxylene

Isomerization

Isomerize o- & m- xylenes to maximize p-xylene production

De-ethylate EB, isomer that competes with px

Refinery or Imported Xylenes*

*BP PX: no requirement for O2 Stripper or Clay Towers

Light Reformate

Heavy Aromatics

Hydrogen
Separation by Crystallization, Lower Energy

2 Primary Commercial Routes

- Crystallization
- Selective Adsorption

Chemical Properties, °C

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Melting</th>
<th>Boiling</th>
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<tbody>
<tr>
<td>Para-xylene</td>
<td>+13</td>
<td>138.4</td>
</tr>
<tr>
<td>Ortho-xylene</td>
<td>-25</td>
<td>144.4</td>
</tr>
<tr>
<td>Meta-Xylene</td>
<td>-48</td>
<td>139.1</td>
</tr>
<tr>
<td>EthylBenzene</td>
<td>-95</td>
<td>136.2</td>
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</tbody>
</table>

Heat of Fusion pX: 38.5 kCal/kg
Heat of Vaporization pX: 82.2 kCal/kg

Δ 38°C
Δ 0.7°C

Large differences in melting points result in lower energy to recover pX

Source: National Institute of Standards and Technology
BP PX consumes less energy than competing technologies

Lower fuel consumption by BP PX

Lower environmental footprint

<table>
<thead>
<tr>
<th>Basis</th>
<th>ME</th>
<th>EU</th>
<th>SEA</th>
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<tbody>
<tr>
<td>Fuel, $/MMkCal</td>
<td>$30</td>
<td>$45</td>
<td>$60</td>
</tr>
<tr>
<td>Electricity, $/kWh</td>
<td>$0.09</td>
<td>$0.09</td>
<td>$0.09</td>
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</tbody>
</table>

Relative Overall Energy Cost (EU Basis), $ / MT

- ME
- Europe
- SEA

(Base) BP PX
Showcase: Geel, Belgium Plant 705,000 MTA

- Average PX purity > 99.8%; higher product purity easily achievable
- Average reliability over last 10 years = 99%+
- Exceeds strict European emissions criteria
BP PX’s Industry Leading Position

3rd party benchmarking study vs competing technologies

Performance Quartiles

1st 2nd 3rd 4th

Power

Steam

Fuel

Total Energy

Raw Mat’s

Environmental Impact
BP PX vs Industry Average

-10%

-27%

Industry Average
Eutrophication Potential
Global Warming Potential

In 2016, output has been validated by independent third party: Environmental Resources Management (ERM)
Conclusion

Lower fuel consumption: Industry-leading environmental footprint, validated by 3rd parties:

- Low Pressure operation leads to CAPEX and OPEX Savings
- Thermodynamic advantage: crystallization vs. vaporization

Non-noble Metal Catalyst
- 10 year life, in-situ regeneration
- No adsorbent/desorbent

BP Paraxylene (pX) Technology
- 2017 Best Petrochemical Technology by Hydrocarbon Processing

High Reliability & Continuous improvement