CDAlky® Alkylation Technology

Overview

CDAlky is recognized as the sulfuric acid alkylation technology of choice, with eight units in commercial operation and a total of 14 awarded projects since 2013. CDAlky advantages are now evident:

- Higher product quality
- Lower capital investment and operating costs
- Lower maintenance costs due to reduced corrosion
- Simplified, proven process scheme
- Feed flexible

A Simplified Process Scheme

- No rotating mixer or alkylation product post-treatment
- Provides improved alkylate quality and yields
- Reduces acid consumption by 30-50%
- Improves reliability and on-stream time
- Operates at significantly lower temperatures than conventional sulfuric acid alkylation technologies.
- Able to break the low temperature barrier

<table>
<thead>
<tr>
<th>Licensee</th>
<th>Licensed Capacity</th>
<th>Start-up</th>
<th>Awarded</th>
<th>Feedstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sincier, PRC (1, 3)</td>
<td>5,000 BPD</td>
<td>2013</td>
<td>2012</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>Haiyue, PRC (1, 3)</td>
<td>15,000 BPD</td>
<td>2014</td>
<td>2011</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>Tianheng, PRC (1)</td>
<td>5,000 BPD</td>
<td>2014</td>
<td>2012</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>YuTianHua, PRC (1)</td>
<td>6,800 BPD</td>
<td>2017</td>
<td>2014</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>S-Oil, Korea (1, 2)</td>
<td>16,000 BPD</td>
<td>2018</td>
<td>2014</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>Pertamina, Indonesia (2)</td>
<td>7,400 BPD</td>
<td>2019</td>
<td>2016</td>
<td>FCC C4s</td>
</tr>
<tr>
<td>Valero St. Charles (2)</td>
<td>25,000 BPD</td>
<td>2020</td>
<td>2016</td>
<td>FCC Olefins</td>
</tr>
<tr>
<td>Zhejiang Pet. Co. (ZPC), PRC</td>
<td>14,000 BPD</td>
<td>2019</td>
<td>2016</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>Yanchang, PRC</td>
<td>5,000 BPD</td>
<td>2018</td>
<td>2016</td>
<td>C4 Raffinate</td>
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<tr>
<td>PetroChina Dalian, PRC</td>
<td>9,000 BPD</td>
<td>2019</td>
<td>2017</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Urumqi, PRC</td>
<td>5,000 BPD</td>
<td>2019</td>
<td>2017</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Jinzhou, PRC</td>
<td>6,500 BPD</td>
<td>2019</td>
<td>2017</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>PetroChina Jilin, PRC (1)</td>
<td>9,000 BPD</td>
<td>2018</td>
<td>2017</td>
<td>C4 Raffinate</td>
</tr>
<tr>
<td>Zhejiang Pet. Co. (ZPC), PRC</td>
<td>45,000 BPD</td>
<td>2020</td>
<td>2018</td>
<td>Mixed C4s, iC4= rich</td>
</tr>
</tbody>
</table>

Footnotes:
(1) Licensed CDAlky Unit EXCEEDED all process performance.
(2) Client operates competitor’s conventional sulfuric acid alkylation technology – CDAlky technology selected over incumbent technology.
(3) Licensors conducted successful turnaround of their CDAlky unit.
Innovative Reactor Design and Proprietary Equipment

A simple and robust reactor design:
- Vertical down-flow packing easy to scale-up
- No moving parts
- Low temperature operation achieved via direct cooling
- Controlled acid/olefin ratio with innovative distributor
- Small foot print - single reactor up to 12,500 BPD

CDA/ky’s innovative reactor design and proprietary equipment are key to its success in achieving technical breakthroughs:
- Higher product quality
- Economical operation at lower temperatures
- Elimination of alkylate post treatment unit
- Reduction in piece count
- High catalyst utilization
- Significant reduction in corrosion

Commercially Proven

CDA/ky’s advantages have been proven in all 8 operating units, in particular the reduction in maintenance costs associated with lower corrosion rates were observed during scheduled unit turnarounds. As an example, no fouling or signs of corrosion were observed at Haiyue’s 15,000 BPD plant.

DIB reboiler bundle at Haiyue

High Octane Fuel (HOF)

Tier III Solution

Advantage & Cheap Feedstock

Butane to Alkylate (BTA)

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