CORAL™ FCC catalysts – Improving residue FCC unit performance through enhanced catalyst accessibility

Mass transfer limitations
Many FCC units experience losses in conversion and bottoms selectivity as a result of mass-transfer limitations. These are due to the problems that high-molecular-weight, sterically hindered feed molecules experience when diffusing into catalyst particles.

Albemarle offers the breakthrough catalyst CORAL to overcome this problem, especially in residue FCC units.

Root causes
Catalyst-particle diffusion limitations typically have multiple root causes. The most common include short-contact time operations in which the oil riser residence time is less than 2–3 sec; running heavy feedstocks; and high concentrations of contaminant metals on the equilibrium catalyst.

High concentrations of contaminants such as iron, calcium, nickel, and vanadium form deposits on the catalyst particle surfaces, which block the entrance pores. A few extreme cases have been observed in which eutectic melts have formed glazed surfaces. These deposits create barriers to the diffusion of the high-molecular-weight, sterically hindered feed components into the catalyst particle and result in reduced heavy oil conversion.

Empirical observations consistently demonstrate that many refiners experience a critical accessibility level. This critical level is extremely unit specific and is a function of feed quality, feed–catalyst contact efficiency, riser residence time, equilibrium catalyst metal levels and regenerator conditions. Operating with accessibility levels below this critical point results in conversion losses, reduced motor fuel production and increased slurry yield.

Figures 1 and 2 show the presence of an inflection point in the accessibility curves. These yield shifts are consistent for all mass transfer-limited operations. The absolute value of the inflection point differs unit by unit, but the trends are consistent. For this FCC unit, the critical accessibility, shown by the dashed line, is about 4.5.
Enhanced-accessibility technology

CORAL™ FCC catalyst delivers a high level of particle accessibility by utilizing a novel catalyst assembly technology for enhanced catalyst accessibility.

CORAL is specifically designed for moderate to high total equilibrium metals and for mass-transfer-limited residue operations. Furthermore, it has greater resistance to metals poisoning than other competitive catalyst. As metals loading on equilibrium catalyst increases, the higher accessibility of CORAL provides substantially more capacity to absorb metals without pore blockage. The conclusion is simple: higher fresh accessibility translates into higher metals tolerance, including for iron and calcium.

Commercial results

The commercial data in Table 1 demonstrate the bottoms destroying ability of CORAL.

Figures 3–5 give another commercial example of the ability of CORAL to enhance profitability by upgrading bottoms into gasoline at constant feed quality.

Let our ingenuity and developments in heavy feed cracking work for you. CORAL catalyst is a proven catalyst featuring excellent metals tolerance and is designed for premium performance in residue operations.

Table 1: Example 1 – CORAL increased the gasoline yield by 2.2 wt% while the catalyst addition rate was reduced by 27%.

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th>BASE</th>
<th>CORAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel density, kg/L</td>
<td>0.9436</td>
<td>0.9438</td>
</tr>
<tr>
<td>Basic nitrogen, ppm</td>
<td>1032</td>
<td>1128</td>
</tr>
<tr>
<td>Feed rate, m³/d</td>
<td>Base</td>
<td>Base</td>
</tr>
<tr>
<td>Reactor temperature, °C</td>
<td>545</td>
<td>548</td>
</tr>
<tr>
<td>Regenerator temperature, °C</td>
<td>705</td>
<td>710</td>
</tr>
<tr>
<td>Catalyst addition rate, t/d</td>
<td>Base</td>
<td>0.73 × base</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yields</th>
<th>BASE</th>
<th>CORAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry gas, wt%</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td>LPG, wt%</td>
<td>14.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Gasoline, wt%</td>
<td>42.6</td>
<td>44.8</td>
</tr>
<tr>
<td>LCO, wt%</td>
<td>17.9</td>
<td>17.9</td>
</tr>
<tr>
<td>Slurry, wt%</td>
<td>14.5</td>
<td>12.8</td>
</tr>
<tr>
<td>Coke, wt%</td>
<td>5.7</td>
<td>5.6</td>
</tr>
</tbody>
</table>

For more information on this or other Albemarle products and technologies, please contact your Albemarle representative.

AMERICAS
2625 Bay Area Blvd
Suite 250
Houston, TX 77058
USA
Tel: +1 281 480 4747
Email: catmaster@albemarle.com

EUROPE AND AFRICA
Nieuwendammerkade 1–3
1030 BE Amsterdam
The Netherlands
Tel: +31 20 634 7300
Email: catmaster@albemarle.com

MIDDLE EAST AND INDIA
PO Box 293774
6W Block A, Office 512
Dubai Airport Free Zone
Dubai
Tel: +971 4 701 7770
Email: catmaster@albemarle.com

ASIA PACIFIC
Room 2208, Shui On Plaza
No. 333 Huai Hai Zhong Rd
Shanghai 200021
China
Tel: +86 21 6103 8666
Email: catmaster@albemarle.com

www.albemarle.com

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