Value Driven Catalyst Developments in FCC Pretreatment Service

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Value Driven Catalyst Developments in FCC Pretreatment Service

A New Family of FCC Pretreatment (PT) catalysts

DN-3551 NiMo

DC-2551 CoMo

to help refiners meet clean fuel requirements.

Improved Life Cycle Value
DN-3551 NiMo and DC-2551 CoMo for FCC Pretreat Applications

The Reason for the Highest Score on Life Cycle Value

- Top tier performance
- Wide pore catalyst technology improved
- Strength/activity recovery from conventional regeneration
- Flexible delivered state
- Reduced catalyst density

- FCC conversion
- FCC properties
- Flexible feedstock capability/stability
- Multi cycle use economics
- Loading/shipping/turnaround cost
The Making of a Great FCC PT Catalyst

Start with a commercially proven optimized pore size distribution.

Comparison of Pore Size Distribution

Increase of MPD and removal of small feeder pores allows the 200 extrudates to have increased metals pickup and deactivation tolerance.

DN-3551 and DC-2551 exhibit similar pore size distribution.
Start with a commercially proven optimized pore size distribution of 200 series of catalysts.

DN-3551 and DC-2551 improve on metals uptake and hence stability.
The Making of a Great FCC PT Catalyst
DN-3551 NiMo and DC-2551 CoMo Improve Diffusion

Modified the pore shape geometry using

FCC Pretreat Feedstocks have diffusion limitations

Metals Accumulation

Pore Shape Design Change Reduced Bottlenecking

200 Series
DN/DC200, DN3110/DC2118

DN-3551 NiMo and DC-2551 Improve Metals Uptake
Improved Diffusion + **ASCENT** = ......

More Active Sites and Improved Metals Efficiency
DN-3551 Improves on CENTINEL Performance

DN-3551 NiMo Catalyst for FCC PT services

Relative Volumetric Activity

Conventional NiMo

Type II NiMo

ASCENT DN-3551 NiMo

HDS
HDN
DN-3551 Improves on CENTINEL Performance

Major Global Refiner Criterion FCC PT Catalysts Ranking

Pilot Conditions
LHSV: 1.0
H2 PP: 1200 psig
H2/Oil: 2000 scf/bbl
WABT: 650/690

DN-3551 Improves on CENTINEL Performance
DN-3551 NiMo Increases Demet Capacity
Commercial Unit FeedBack
5 ppm Metals in Feed

Increased metal capacity translates into better stability
FCC Pretreat (FCC PT) and FCC Technology Application

**FCC Feed Components:**
Naphtha, Diesel, VGO/HVGO, KGO/HKGO, Resid, DAO

**FCC Pretreat Unit**

**FCC Unit**
- Dry Gas
- C3/C4=
- Gasoline
- Light Cycle Oil
- Heavy Cycle Oil
- Slurry
Maximize FCC Conversion with DN-3551 NiMo

### FCC Pretreat Unit

<table>
<thead>
<tr>
<th>Conv. NiMo</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produced FCC Feed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### FCC Unit

<table>
<thead>
<tr>
<th>Gasoline Yield, v%</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0.6</td>
<td>+1.2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FCC Conv, v%</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0.8</td>
<td>+1.6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Econ Benefit $MM/yr</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>+4.5</td>
<td>+8.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gasoline Sulfur, ppm</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
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</thead>
<tbody>
<tr>
<td>-12</td>
<td>-26</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LCO Yield, v%</th>
<th>NiMo Type II</th>
<th>DN-3551 NiMo</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.4</td>
<td>-0.8</td>
<td></td>
</tr>
</tbody>
</table>

*S.Yields Relative to Conventional NiMo Conv. NiMo FCC gasoline sulfur = 112 ppm*
Maximize FCC Gasoline Sulfur Reduction with DC-2551 CoMo

FCC Pretreat Unit

Conv. CoMo DC-2551
NiMo Type II CoMo

Produced FCC Feed

S, wt% 0.15 0.10 0.09
N, ppm 900 900 900
Di+ Aro, wt% 5.5 5.5 5.3

Minimize FCC Conversion Loss

*Yields Relative to Conventional NiMo
Conv. NiMo FCC gasoline sulfur = 112 ppm
New Additions to the Family of Catalysts

SOR VGO Unit Commercial Performance – Example 1

Activity Improvement

<table>
<thead>
<tr>
<th>Catalyst Combination</th>
<th>Activity Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN-3110 / DC2118</td>
<td>HDS 6 °F</td>
</tr>
<tr>
<td>DN3551 / DC2551</td>
<td>HDS 12 °F</td>
</tr>
</tbody>
</table>

40% / 60% NiMo / CoMo
50% / 50% NiMo / CoMo
New Additions to the Family of Catalysts

SOR VGO Unit Commercial Performance – Example 2

Activity Improvement

<table>
<thead>
<tr>
<th>Catalyst Type</th>
<th>Activity</th>
<th>Improvement</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitor 30% / 70% NiMo / CoMo</td>
<td>HDS</td>
<td>10 °F</td>
<td></td>
</tr>
<tr>
<td>DN3551 / DC2551 50% / 50% NiMo / CoMo</td>
<td>HDN</td>
<td></td>
<td>10 °F</td>
</tr>
</tbody>
</table>
Multi-Cycle Usage Economics

ASCENT Improves Regenerability of High Activity Catalysts

HDS Activity Recovery ≥ 90%

Regenerated Type II Site Catalyst

Base

FRESH

Catalyst Age
Multi-Cycle Usage Economics

**DN-3551 Crush Strength versus Competition**

- Relative Crush Strength:
  - DN-3551: 100%
  - Competition: 80%

**DN-3551 High Activity Competition**

**DN-3551 Attrition Index**

- Attrition Index:
  - DN-3551: 100%
  - Competition: 99%

Maximize Regeneration Recovery
## Multi-Cycle Usage Economics

<table>
<thead>
<tr>
<th>Multi-Cycle Use Cost Analysis</th>
<th>Catalyst A</th>
<th>DN-3551</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Recovery from Regeneration</td>
<td>85%</td>
<td>95%</td>
</tr>
<tr>
<td>Make-Up Catalyst Requirement, ft3</td>
<td>877</td>
<td>292</td>
</tr>
<tr>
<td>Cost of Regeneration, US $</td>
<td>$920,000</td>
<td>$120,000</td>
</tr>
<tr>
<td>Make-Up Catalyst Cost, US $</td>
<td>$370,000</td>
<td>$110,000</td>
</tr>
<tr>
<td>MultiCycle Use Cost, US $</td>
<td>$1,290,000</td>
<td>$230,000</td>
</tr>
<tr>
<td>MultiCycle Use Cost Benefit, US $</td>
<td></td>
<td>$1,060,000</td>
</tr>
</tbody>
</table>
New Additions to the Family of Catalysts

- Top tier performing catalysts to deal with severe FCC PT services
- Another step out in metals uptake and tolerance
- Catalysts that provide ease of handling
- Catalysts that easily regenerate by conventional techniques

**ASCENT CATALYST TECHNOLOGY**

**DN-3551 NiMo**
- 3.5 MMlbs Sold
- 5 Units

**DC-2551 CoMo**
- 0.6 MMlbs Sold
- 2 Units