Automation of Separation for More Bottom of the Barrel Return

Author- Victor Scalco, GULFTRONIC
Abstract

- The Search for better “bottom of the barrel”
- Particle Sensor Introduction
- FCC/RFCC
- Slurry Oil products
- Solid Removals option
- Slurry Yields and Properties
- Mechanical vs. Electrostatic Separation
- Economics
- Conclusions
Maximize Your Return from Every Barrel

- **Heavier Crudes**
  - Residual upgrading
  - Increased catalyst use

- **Catalyst Concerns**
  - Refiners are seeking to add value to Residual Fuel Oil
    - Have to remove catalyst
  - Downstream Catalyst in fuel oil and feedstock increases maintenance and fouling
    - Heavy Oil Processing
  - Higher concentrations of catalyst in clarified oil presents only a narrow range of applications
  - Build up of sludge in downstream refinery processes
  - Loss of catalyst in deteriorating FCC units
    - Catalyst contains Rare Earth Metals and ZSM5
FCC/RFCC

• Heavier crudes increase FCC catalyst consumption.
• FCC vital in the growing demand for propylene
• Increased economic demands require more residual to be sent to the FCC/RFCC
• Degrading FCC reactor side cyclone efficiency increases Catalyst lost. Recovery is key
• FCC/RFCC units approx. 20-25 tons of catalyst per day turnover with petrochemical driver.
• Catalyst removal from Fractionator bottoms:
  – Upgrade in (CSO) quality/ value
  – Hazardous waste reduction
  – Decrease in downstream maintenance, downtime
  – Reduction in landfill and catalyst loss
The Real Deal – What is it Worth?

- FCCU 80,000 B/D – SLURRY AVERAGE 6%
- Removal of fines <5 microns at 3000ppm to <100ppm
- 5 tons/ day of fines removed from settling tanks
- Separation of fines upgrades CSO value
- Assuming $4.0 per barrel product increase
- Waste Savings $1.8 Million/year
- 4800 BPD*365*$4.0/ BPD = $7.0 Million/ year

- Think Millions!
CSO Value – More Valuable End Products

- Average FBO/CSO Differential: $4.00 - $6.00 USD Per Barrel
- Related Annual Increased Revenue: $4.7M USD Per Year
- CSO Payout from Increased Revenues: 7.7 Months

<table>
<thead>
<tr>
<th>CSO Market</th>
<th>Clarified Slurry Oil (CSO) Clarity (PPM)</th>
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<tbody>
<tr>
<td>Carbon Black Feedstock</td>
<td>100 – 500</td>
</tr>
<tr>
<td>Refinery Fuel</td>
<td>50 - 150</td>
</tr>
<tr>
<td>Marine Fuel</td>
<td>50 - 100</td>
</tr>
<tr>
<td>Pitch Feedstock</td>
<td>25 - 100</td>
</tr>
<tr>
<td>Needle Coke Feedstock</td>
<td>25 - 100</td>
</tr>
<tr>
<td>Hydrotreater Feedstock</td>
<td>10 - 50</td>
</tr>
<tr>
<td>Carbon Fiber Feedstock</td>
<td>5 - 10</td>
</tr>
</tbody>
</table>
Solids Removal Options

• Decant Oil – Settling Tanks
  – Time vs. cost
  – Settling agents
  – Hazardous waste

• Mechanical Filtration/ Centrifuge
  – Limited filtration size.
    • \( \geq 100 \text{ppm} \)
  – Susceptible to plugging with Asphaltenes, waxes
  – Deterioration of liners Q2yrs= increased cost
  – Membrane filters

• Electrostatic Separation
  – Effective on particle sizes <5\( \mu \)
  – Not susceptible to blockage
  – Increased throughput
Table 2 Typical Particle Size Distribution in Slurry oils

<table>
<thead>
<tr>
<th>Particle Diameter, microns</th>
<th>% in Range</th>
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</thead>
<tbody>
<tr>
<td>0-5</td>
<td>30-60</td>
</tr>
<tr>
<td>5-15</td>
<td>30-55</td>
</tr>
<tr>
<td>15-25</td>
<td>2-12</td>
</tr>
<tr>
<td>25+</td>
<td>1-5</td>
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</tbody>
</table>
Dark Oil Particle Sensor and Analyzer
Electrostatic Separation Results with Particle Sensor Automation
Dark Oil Particle Sensor Automation Results
**Electronic Separators – Increased Value**

- **Catalyst Regenerator**
- **FCC/RFCC Reactor**
- **Fractionator**
  - Light Gases
  - Gasoline
  - Light Cycle Oil
  - Heavy Cycle Oil
- **Slurry Hydrocracker/H-Oil unit**
- **Inventory Tank**
- **Settling Tank**
- **Gulftronic® Separator**
  - Clarified Slurry Oil
- **Backflush**
  - Light Cycle Oil
- **Slurry Oil**
- **FCC/RFCC Feed Return Loop**
- **FCC/RFCC Feed for Backflush**
- **FCC/RFCC Feed**
- **Air**
Conclusions

• Drive to more resid FCC favor solution to recover catalyst without coking and Asphaltenes.
• Heavier Crude slates has inevitably effected every FCC/RFCC operation and increase in Catalyst fines during processing
• Increased profit is lost without proper catalyst recovery.
• Mechanical Filtration is questionable with new refinery demands in safety and processing.
• Electrostatic Separation; Safe, Reliable and Effective.