Processing of Refinery Wastes for Quench and Feed-Cycle Injection in Delayed Cokers

A VWA HPI Service

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Sr. Business Development Manager
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Who we are...

- Leader in On-site Refinery Waste Processing with 50 Long-term DBOOM Projects
- Veolia Environment has >250,000 Employees Worldwide
- With >28,000 Employees in North America
- Revenues Exceeding $40 billion
- Publicly-traded on the NYSE and French Bourse Exchange
Why Process and Recycle Refinery Wastes Back to the Coker?

- Environmental - Recycling of hazardous wastes via introduction into the coking process presents the refinery with the least amount of environmental liability. In this scenario, the material is not classified as a waste because it is being recycled as part of legitimate production, so a number of the regulatory liabilities are removed.
- Cost Savings - Provides a means to manage wastes “within-the-fence” without incurring outside disposal or transportation costs.
- Oil Recovery - During Feed-Cycle Injection the oil will go through the entire coking process. The oil will go into the coke bed or go overhead with the lighter products. During the Coker Quench process any residual amounts of entrained oil will pass through the coke bed and either go into the coke product or go overhead with the lighter products.
Case Study: Texas Refinery – Quench-Side Coker Injection

- Contract for oil bearing secondary materials separation and quench-side Coker injection
  - Processing of 3,000 bbl/day, injection of 400 bbl/cycle into Coker drums
  - On Site since 1999
  - Comprehensive DBOOM approach on a service fee basis
  - Includes processing of third party oil bearing materials into coker at incremental fee
  - Eliminates hazardous waste leaving the refinery gates
- Savings and revenue to the refinery in excess of USD $1,500,000/year
Case Study: California Refinery Feed–Side Coker Injection

- Contract for oil bearing materials separation and feed-side coker injection
  - Processing of 600 bbl/day, injection of 100 bbl/cycle into Coker drum
  - On Site since 2004
  - Comprehensive DBOOM approach on a service fee basis
  -Eliminates hazardous waste leaving the refinery gates
  -Recycles oil to the Coker
  -Savings to the refinery are in excess of USD $1,000,000/year
Fluid coking is a continuous process in which heated coker feeds are sprayed into a fluidized bed of hot coke particles which are maintained at 20-40 psi and 500°C. The feed vapors are cracked while forming a liquid film on the coke particles. The particles grow by layers until they are removed and new seed coke particles are added.

Contract for oil bearing materials separation and feed-side injection

- Processing of 500 bbl/day, injection of 100 bbl/day into Coker drum
- On Site since 1993
- Comprehensive DBOOM approach on a service fee basis
- Remove 97% of water w/centrifuge and dryer eliminates hazardous waste leaving the refinery gates
- For every bbl of water injected, you need to back out 4 bbls of feed into the Coker
Average Sludge Processed: 14,000 bbl/month
Water Content in Feed: 70%
Remove 97% of water (centrifuge and dryer): 9,506 bbls (water removed)/month
For every bbl of water injected, you would need to back out 4 bbls of resid into the Coker
4 (bbl of resid) x 9,506 (bbl of water) = 38,024 (additional bbls. of resid available to the Coker)
38,024 x $18/bbl Coker margin = $684,432/month
Monthly Cost of Feed-side slurry Program: $200,000 (includes chemicals, utilities, and material transfer)
$684,432 (Benefit) - $200,000(Processing Cost) = $484,432 per month (Benefit)
x 12 months = $5,813,184 (annual benefit)
VWA

Dewatering
Bio-sludge

Oily Sludge

Tank Cleaning Projects

VWA HPI

API Separator
DAF, DNF, IAF
Slop Oil System

Plant Sewers

Water

ASTU

Outfall

O&G Club Americas
Houston, 3rd November 2008

9 Projects
Waste Types:

- Refinery Oil Sludge
- DAF Float
- Slop Oil Emulsions
- Heat Exchanger Bundle Cleaning Sludge
- Tank Bottoms
- Petroleum Oil Water Solids Separation Sludge
- Secondary Emulsified Oil Water Separation Sludge
- Crude Oil Storage Tank Sediment
- Clarified Slurry Oil
- Desalter Emulsions
- Tank Cleanouts
- WAS (Bio-Sludge)
First Stage Waste Reduction - Centrifugation

Oily Sludge → 3 Phase Centrifuge → Cake → Further Processing

- Oil Return <3% BS&W
- Water to WWTU <1,500 ppm TSS
3-Phase Centrifugation

- Process Solutions 3000/3 Centrifuge
- Up to 3,000 x “g” (Variable Frequency Drive Bowl Speed Control)
- Hydraulic Scroll Drive (Controls Differential)
- Adjustable Oil Nozzles
## Centrifuge Cake - Typical Mass Balance

<table>
<thead>
<tr>
<th>Basis:</th>
<th>1000</th>
<th>bbl Feed (approximately 160 m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solids Capture =</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Feed Specific Gravity =</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Oil Specific Gravity =</td>
<td>0.904</td>
<td></td>
</tr>
</tbody>
</table>

| Feed Composition: | 5% | Solids | 8000 kg |
|                  | 15%| Oil    | 24000 kg |
|                  | 80%| Water  | 128000 kg |

Solids Captured = 7200 kg

### Centrifuge to Produce Cake

Cake produced = 18000 kg

| Cake Composition: | 40% | Solids | 7200 kg |
|                  | 10% | Oil    | 1800 kg |
|                  | 50% | Water  | 9000 kg |

Oil returned = 22200 kg or 154 bbl
Coker Quench - Second Stage Processing

Oily Sludge → 3 Phase Centrifuge → Cake

- Clean Oil (<3% BS&W)
- Water to WWTU (<1,500 ppm TSS)

Mix Tank

Particle Size Reduction

Coker Quench System
## Coker Quench - Typical Mass Balance

<table>
<thead>
<tr>
<th>Basis: 1,000 bbl Feed (approximately 160 m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cake Produced = 18000 kg</td>
</tr>
<tr>
<td>Cake Composition:</td>
</tr>
<tr>
<td>40%</td>
</tr>
<tr>
<td>10%</td>
</tr>
<tr>
<td>50%</td>
</tr>
<tr>
<td>Coke Produced = 1000 tonne per day</td>
</tr>
<tr>
<td>Allowable ash (solids) addition = 1% of coke made = 10000 kg of solids per day</td>
</tr>
<tr>
<td>Quench Slurry Composition</td>
</tr>
<tr>
<td>15%</td>
</tr>
<tr>
<td>4%</td>
</tr>
<tr>
<td>81%</td>
</tr>
<tr>
<td>Quench Slurry Specific Gravity = 1.036</td>
</tr>
<tr>
<td>Total Quench Slurry = 48000 kg = 46 m³ = 290 bbl</td>
</tr>
</tbody>
</table>
Free oil is removed from the cake which is then blended with water to produce a slurry that is approximately 15% by weight solids. This aqueous slurry is injected into the coker during the water quench phase of the coking cycle.

Because this material is introduced to the coker after the coke bed has formed, the solid particles must be reduced in size to increase their permeability through the bed (>70% must be <100 microns for even distribution through the coke bed).

Coker quench injection is economically attractive because it does not require additional equipment or energy to remove water from the waste prior to injection.

Quench-side coker injections do not have the same impact on coker feed rates that are seen with feed-side injections because the aqueous slurry simply replaces quench water that would otherwise be used after coking is completed.

May only be added at the start of the quench cycle. Must stop when overhead temperature reaches 550 F. Maximum slurry weight 15% solids. Must be less than 5% oil by volume.
Coker Feed-Side Slurry – Second Stage Processing

- **Oily Sludge**
  - 3 Phase Centrifuge
  - High Energy Mix Tank
  - Cake
  - Patented Slurry Dryer
  - Clean Oil <3% BS&W
  - Water to WWTU <1,500 ppm TSS
  - Oil

**Patented Process and Composition**

- O&G Club Americas
- Houston, 3rd November 2008
### Coker Feed-Side Slurry - Typical Mass Balance

**Basis:** 1000 bbl Feed (approximately 160 m³)

<p>| | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Cake Produced</strong></td>
<td>=</td>
<td>18000</td>
<td>kg</td>
</tr>
<tr>
<td><strong>Cake Composition:</strong></td>
<td>40%</td>
<td>Solids</td>
<td>7200</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>Oil</td>
<td>1800</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>Water</td>
<td>9000</td>
</tr>
</tbody>
</table>

Adjust oil to solids ratio to produce dry fuel

<p>| | | | |</p>
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<tr>
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</thead>
<tbody>
<tr>
<td><strong>Feed-side slurry composition:</strong></td>
<td>45%</td>
<td>Solids</td>
<td>7200</td>
</tr>
<tr>
<td></td>
<td>52%</td>
<td>Oil</td>
<td>8320</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>Water</td>
<td>480</td>
</tr>
</tbody>
</table>

**Feed-side slurry Produced = 16000 kg = 83 bbl (recycled in coker)**

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<tr>
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</thead>
<tbody>
<tr>
<td><strong>Oil to add:</strong></td>
<td>8320</td>
<td>kg oil required</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-1800</td>
<td>kg oil in cake</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6520</td>
<td>kg oil to add</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>bbl oil to add</td>
<td></td>
</tr>
</tbody>
</table>

Oil returned = 15680 kg or 109 bbl
Coker Feed - Summary Points

- Feed-side injection can be performed in the period where the resid is being fed to the drums which translates into a wide timing window to introduce feed-side slurry. It may be added at any time after 1 hour of starting the coking cycle to 1 hour prior to ending the coking cycle.

- Feed-side slurry is introduced at a Low Feed Rate (30-70 gpm) and Low Water (3%)%

- Because modifications to coke drums are costly and can only be completed during unit turnarounds, the use of existing nozzles and piping is generally desired. Possible injection points exist in the residual feed line, the antifoam injection line, and virtually any existing nozzle large enough to accommodate the necessary flow.

- Ash Increases of 0.2% to 0.7% are to be expected.

- Cat slurry oil from the bottom of the ash tanks, stock can be fed into Waste Streams and some crude tank bottoms if cut with the feed tank without centrifugation.

- There is no chance of odors or hotspots when the drum is deheaded.

- Feed-side slurry Allows for 35%-45% Solids Loading

- Greater solids loading allows for approx. 2/3 less waste volume going to the coker than quench side injection.
# Typical Mass Balances Comparisons

<table>
<thead>
<tr>
<th>Process</th>
<th>Oil Used (bbls)</th>
<th>Oil Returned (bbls)</th>
<th>Solids to Coker (kg)</th>
<th>Total Volume Sent to Coker (bbls)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coker Quench</td>
<td>12 (mostly entrained)</td>
<td>154</td>
<td>7200</td>
<td>290</td>
</tr>
<tr>
<td>Feed-side slurry</td>
<td>58</td>
<td>109</td>
<td>7200</td>
<td>83</td>
</tr>
</tbody>
</table>

Although there are equal amounts of solids going to the coker, you need to inject 3.5 times more volume with Quench side injection.
Muito Obrigado!
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