Designing Internals to Minimize Fouling in the Bottom of FCC Main Fractionators

Dennis Schmude
FCC Unit
Simplified Flowsheet

FCC Main Fractionator

TO FCC GAS PLANT

FCC Wet Gas Compressor

FCC NAPHTHA

GAS OIL FEED

Steam

Spent Catalyst

FCC Reactor

Reactor Effluent

FCC Unit

HCO Wash Zone

Slurry PA Zone

LCO
Bottom Section Fouling

A

B

C

D
Fouling Symptoms

- **Hydraulic flooding**
  - High DP
  - Unstable operation
  - Reduction in throughput

- **Loss of efficiency**
  - Poor slurry PA heat transfer
  - Poor wash section performance
Preventing HCO Wash Section Fouling

- Maintain adequate temperature
- Maintain and control adequate wash rates
- Design for high reliability, not high efficiency
- Eliminate wash section for severe cases (if possible)
HCO Wash Section
Trays

- Large size, high lift fixed valve units (PROVALVE® trays)
  - Avoid floating valve units
  - Avoid small valve units
  - Consider directional valve units

- Minimize number of flow passes
  - Maximizes downcomer clearance

- Avoid utilizing an excess number of trays
# HCO Wash Section Packing

<table>
<thead>
<tr>
<th>Packing Type/Size</th>
<th>Sheet Metal Structured Packing</th>
<th>Traditional Grid</th>
<th>New Grid Packing (Large Crimp)</th>
<th>New Grid Packing (XL Crimp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing Type/Size</td>
<td>FLEXIPAC® 3YS</td>
<td>FLEXIGRID® 3-45</td>
<td>PROFLUX® 64</td>
<td>PROFLUX® 45</td>
</tr>
<tr>
<td>Nominal Thickness</td>
<td>0.008”</td>
<td>0.06”</td>
<td>0.04”</td>
<td>0.04”</td>
</tr>
<tr>
<td>Nominal Surface Area (ft²/ft³)</td>
<td>34</td>
<td>14</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>Fractionation Efficiency</td>
<td>Best</td>
<td>Fair</td>
<td>Good</td>
<td>Fair</td>
</tr>
<tr>
<td>De-entrainment Removal Efficiency</td>
<td>Best</td>
<td>Fair</td>
<td>Good</td>
<td>Fair to Good</td>
</tr>
<tr>
<td>Fouling Resistance</td>
<td>Moderate</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Clean &amp; Reinstall</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

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HCO Wash Section
Packing

- Proper packing selection for efficiency needs
  - Structured packing vs. grid packing
  - Most units do not take an HCO side cut product

- Utilize short packing depth (less than 1 stage)
  - 3 to 4 ft of grid type packing suitable for most units

- Proper liquid distributor selection for efficiency needs
## HCO Wash Bed Distributor Comparison

Example: 20 ft ID Fractionator, 5,000 BPD wash (0.6 gpm/ft²)

<table>
<thead>
<tr>
<th>Liquid Distributor Type</th>
<th>Spray Nozzle</th>
<th>Trough (Gravity)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Drip Point</td>
</tr>
<tr>
<td>Feed Point Density</td>
<td>0.06</td>
<td>7 - 9</td>
</tr>
<tr>
<td>No. of Feed Points</td>
<td>19</td>
<td>2500</td>
</tr>
<tr>
<td>Distributor Opening Size</td>
<td>0.343”</td>
<td>0.09”</td>
</tr>
<tr>
<td>Nominal Liquid Velocities</td>
<td>3 – 5 ft/s</td>
<td>&lt; 0.1 ft/s</td>
</tr>
<tr>
<td>Residence Time</td>
<td>8 - 10 sec</td>
<td>Parting box – 30 sec</td>
</tr>
<tr>
<td>Liquid Distributor Quality</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Coverage at Top of Bed</td>
<td>Excellent</td>
<td>Some dry areas initially</td>
</tr>
<tr>
<td>Wash Entrainment Risk</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>
HCO Wash to Slurry PA Transition

- HCO Draw Tray
- HCO Wash Bed
- No liquid collection device
- Slurry PA Bed
HCO Wash to Slurry PA Transition

Distribution/mixing of wash liquid is important
Baffle Trays for Slurry PA

Sheds

Disc & Donut
## Slurry PA Grid Packing Selection

<table>
<thead>
<tr>
<th></th>
<th>Traditional Grid</th>
<th>New Grid Packing (XL Crimp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing Type/Size</td>
<td>FLEXIGRID® 2-45</td>
<td>PROFLUX® 40X</td>
</tr>
<tr>
<td>Nominal Thickness</td>
<td>0.06”</td>
<td>0.04”</td>
</tr>
<tr>
<td>Nominal Surface Area (ft²/ft³)</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Fouling Resistance</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>Hydraulic Capacity</td>
<td>High</td>
<td>Very High</td>
</tr>
</tbody>
</table>
Fouling Resistance

FLEXIGRID® 2-45 grid

PROFLUX® 45 grid
Liquid Distributor for Slurry PA
Liquid Distributor for Slurry PA
Slurry PA After Catalyst Carryover Event
Liquid Distributor Features

- Feed notch shape
- Elevated vs non-elevated feed notches
- Feed pipe and parting box predistribution
- Parting box metering to troughs
  - Large holes vs side notches
- Beam supported design
Bed Support and Hold Down System

- Hold down system should not block liquid from distributor system

- Eliminate/minimize horizontal surfaces
  - Free flow support ring
  - Special beam designs for large diameter towers
Feed Inlet
Gas Distribution

- Most common and reliable configuration is to utilize no vapor distribution device

- Some units may warrant utilizing a vapor distribution device in the following situations:
  - Packed slurry PA
  - Excessive inlet nozzle velocities
  - Inadequate space from gas inlet to bottom of bed

- Conventional vapor distribution devices are not suitable to handle fouling
CFD Model Study
Gas Distribution

No Feed Device

With Feed Device
Conclusions

- Packing in the bottom sections is common
- Very fouling service
- Typical FCCU lengths are achievable with proper selection and design of internals
- Improvements in equipment hardware available
  - Especially compared to units with internals designs that are 15 years or older
Thank you.

Questions?

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