ENHANCED V-GRID TRAYS INCREASE COLUMN PERFORMANCE

by

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**Background**

- Ethanol already plays an important role in today’s reformulated gasoline

- Fuel Grade Ethanol growth is expected to continue for the next 5 years

- Many new plants will be built and existing plants need debottlenecking.

- Older plants were built with outdated or sometimes archaic technology.
A typical modern plant has 3 main towers; Beer Mash Tower, the Rectifier and Side Stripper.

The Beer Mash tower removes all the solids and most of the water from the fermenters.

The Rectifier takes the overhead from the Beer Mash Tower and concentrates the Ethanol up to the Azeotrope.

The Side Stripper is a Beer Tower without the solids.
Typical Flow Scheme

- 30 Trays (Rectifier)
- 22 Trays (Beer Mash Still)
- 16 Trays (Side Stripper)
- 190 Proof EtOH
- Fusel Draw
- Solids/Water
- Water
- A Beer Mash Tower is a severe fouler
- Feed contains proteins, fibers, sugars, and suspended solids, as much as 14 wgt%
- Ethanol needs to be removed from not only the liquid but from these solids as well
- Any stagnation in these towers results in solids buildup and premature tower flooding
Sight Glasses

Sump Section

Tray 12
Where the downcomer pipes should be found
The Challenge

- AGP’s Beer Mash Tower had an extraordinarily high Ethanol content in the bottom at normal production levels.
- Slight changes in feed rate or feed concentration would dramatically increase the amount of Ethanol in the bottoms.
- At times Ethanol in the bottom was as high as 0.2 vol %.
- Typical operating plants see no more than 0.02 vol % Ethanol in the bottom.
Bottoms Purity vs. Feed Rate

Feed Rate, gpm

Bottoms Purity, vol% EtOH
Operating Data Oct. 2, 2001

Tray Efficiency to match the reboiler duty = 48.1%

13.9 vol% Ethanol
11.0 wt% Solids
206°F

606 GPM

22 Trays

210°F

49,700 #/hr steam

7.5 psig

0.019 vol% Ethanol
13.7 wt% Solids
238°F

374 GPM
Observations

- Low observed Tray efficiency and high sensitivity to changes in operation pointed to a need for more theoretical stages.
- Tray drawings showed that the existing trays had only a 54” flow path length for a 138” diameter tower.
- Pipe Type Downcomers forced liquid to center of tower.
- High Efficiency trays that can handle solids were determined to be needed.
• Sulzer Chemtech has numerous applications in this particular service, but never had the challenge of significantly increasing tray efficiency

• It was decided that the SVG™ Tray would be used because of its extensive experience in this service. However, an extra enhancement to liquid flow would be added
Testing at Nutter/Sulzer

- Over the past several years many different types of flow enhancement devices were tested at Sulzer Chemtech
- One of these was the Mini Jet Tab “Push Valve”
- These devices could force the liquid on the tray to go in directions it did not naturally wish to flow.
By strategically placing these devices on the tray deck, plug flow of liquid could be achieved and stagnation eliminated.

The device had to be large enough to be effective with large tray openings such as the SVG V-Grid valve.

A lot of the credit for distribution of these devices goes to Dr. Mike Lockett who’s work in this area in the early 1970’s was applied here.
Mini Jet Tab “Push” Valve

~1”
Tray Layout with MJT Valves

Flow
Operating Data Oct. 8, 2002

14.5 vol% Ethanol
9.5 wgt% Solids
205°F

649 GPM

21 Trays

208°F

Tray Efficiency to match the reboiler duty = 61%

7.5 psig

53,330#/hr steam

0.012 vol% Ethanol
12.6 wgt% Solids
240.1°F

473 GPM
### Key Hydraulic Parameters - Not very Loaded

<table>
<thead>
<tr>
<th>Name:</th>
<th>TOP</th>
<th>BOTTOM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vapor:</strong></td>
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<tr>
<td>Jet Flood</td>
<td>49%</td>
<td>43%</td>
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<td>Dry Tray Pressure Drop, &quot;H2O&quot;</td>
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<tr>
<td>System Factor</td>
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<tr>
<td><strong>Liquid:</strong></td>
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<tr>
<td>Downcomer Velocity</td>
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<td>18%</td>
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<td>Weir Loading, gpm/in.</td>
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<td>5.7</td>
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<tr>
<td>Downcomer Froth Backup, %</td>
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<td>43%</td>
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<tr>
<td>Tray Pressure Drop, mmHg</td>
<td>5.21</td>
<td>5.04</td>
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</table>
Conclusions

- Old ideas can lead to significant progress in new applications.

- A 27% increase in tray efficiency was realized through the use of the “push valves” and increased flow path length.

- Run length has increased significantly. In the past CIP had to be applied every few months - this tower now has operated since April with no increase in pressure drop.