STRATCO®
Alkylation Technology Improvements

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Alkylation Business Development Engineer
Areas of Improvement

- **Net Effluent / Depropanizer Feed Treating**
  Reduce hydrocarbon inventory, improve separation and treating

- **Reaction Zone**
  Reduce hydrocarbon and sulfuric acid inventory, improve reliability, operability and alkylation product quality
Net Effluent / DEP Feed Treating Improvements

• Static Mixers
  – New process design includes static mixers in each hydrocarbon treating step

• Coalescing Media
  – New process design includes media in all treating vessels
  – Eliminates the electrostatic precipitator and large vessels needed for gravity settling
  – Previous design 30 minutes of residence time, with coalescing media ~3 fold volume decrease
Net Effluent Treating

NET EFFLUENT

ACID TO RXN.

FRESH ACID

ACID WASH COALESCECR

L.P. STEAM

ALKALINE WATER WASH

HOT ALKYLATE PRODUCT

SPENT ALKALINE WATER TO BLOWDOWN

PROCESS WATER

WATER WASH COALESCECR

DEISOBUTANIZER FEED

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Depropanizer/Propane Purge Treating

- DEPROPANIZER FEED
- PROCESS WATER
- CAUSTIC WASH
- WATER WASH COALESCE
- FRESH CAUSTIC
- TO NET EFFLUENT TREATING
- TO DEPROPANIZER/BATTERY LIMITS

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Reaction Zone Improvements

• Acid Settlers
• Contactor™ Reactor Repairs/Upgrades
• Tube Insert Technology
• ¾” Tube Bundles
Acid Settlers

• Previous design: Internal “H” distributor, large vessels, 12’ x 50’ or 15’ x 70’

• New Design: Coalescing media, smaller vessels 8’ x 32’, 10’ x 40’, or 12’ x 40’

• Volume decrease ~ 2.7 to 3.5 fold
Contactor™ Reactor Repairs/Upgrades

- Hydraulic Head Repair
- Feed Nozzles
- Mechanical Seal Improvements
- Metallurgy Upgrades (Impeller, Impeller Cap, Wear Ring, Shell Transition Cone, Spider Assembly, Hydraulic Head)
Contactor™ Reactor

A - Contactor Reactor Shell
B - Tube Bundle Assembly
C - Hydraulic Head Assembly
D - Motor, Turbine/Driver

Coolant
In
Emulsion
To Settler

Circulation
Tube

Spider
Feed Nozzles

Impeller

HC

Acid

Coolant
Out

Coolant
In

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Tube Inserts

Issue:
Poor Distribution

- Effluent enters at bottom
- Partial Phase Separation in Channel Inlet
- Non-Uniform Distribution

Two-Phase Effluent Refrigerant Inlet

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Indications and Problems of Poor Distribution

• Lower than expected calculated overall heat transfer coefficient

• Corrosion/Erosion of selective tubes due to lack of cooling

• Tubes may run dry and therefore no vaporization to provide cooling

• Result is reduction of overall available surface area for heat transfer
Opportunity for Improvement

TO FEED/EFFLUENT EXCHANGERS

SPENT ACID

FRESH ACID

OLEFIN AND ISOBUTANE

ACID SETTLERS

CONTACTOR REACTORS

SUCTION TRAP

FLASH DRUM

REFRIGERANT RECYCLE

Pressure Drop Available Over PCV

FROM REFRIGERATION SECTION

TO REFRIGERATION SECTION

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Approach

- Transfer pressure drop from PCV to tube sheet by use of tube inserts
- Inlet to tubes is now single phase providing more uniform flow distribution
- Flashing occurs over the tube inserts
What Do They Look Like?
Tube Insert Performance

- 20-30% average increase in Heat Transfer Coefficient (U)
- Lower reactor temperature 2-3°F
- Lower corrosion rates
- Lower acid consumption
- Increased feed rate
## Tube Insert Installations

<table>
<thead>
<tr>
<th>Location</th>
<th>Sets of Inserts/# Contactors</th>
<th>Installation Date</th>
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<td>4/8</td>
<td>Winter 2001</td>
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<td>Refinery #2 Hess Port Reading</td>
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<td>Refinery #3 HOVENS A</td>
<td>6/6</td>
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<tr>
<td>Refinery #6 North America</td>
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<td>Winter 2004</td>
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¾” Tube Bundle

- Historical standard is the 1” bundle
- 1” OD, 10,070 ft² / 613 tubes
- ¾” OD, 13,630 ft² / 1,101 tubes
- 12 installed ¾” tube bundles
¾” Tube Bundle Performance

- Case 1
- Replaced 9,800 ft² with 13,630 ft²
- No additional modifications
- Olefin feed rate increase ~14-15% increase @ constant reaction Temperature
- Reaction temperature decrease of 4.6°F at constant olefin feed rate
¾” Tube Bundle Performance

- Case 2
- Replaced 8,500 ft² with 12,130 ft²
- Replaced 9,800 ft² with 13,630 ft²
- New feed nozzles, rebuilt heads
- Olefin feed rate increase ~10% increase @ constant reaction Temperature
Combined ¾” Tube Bundle and Tube Insert Performance

- One current installation – 42” Contactor™ Reactor
- Replaced 4,160 ft² with 5,978 ft² with Tube Inserts
- Rebuilt head/impeller
- Reaction temperature decrease of 15°F at the constant olefin feed rate
In Summary

• DuPont is continually looking to improve the STRATCO® Alkylation Technology
• Reducing hydrocarbon and sulfuric acid inventories
• Increasing Contactor™ Reactor throughput and/or alkylate product quality (Tube Inserts, ¾” Tube Bundle, Contactor™ Reactor maintenance)