STRATCO®

Alkylation Technology Improvements

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DUPONT The miracles of science™

2007 Annual Meeting

Areas of Improvement

- **Net Effluent / Depropanizer Feed Treating**

  Reduce hydrocarbon inventory, improve separation and treating

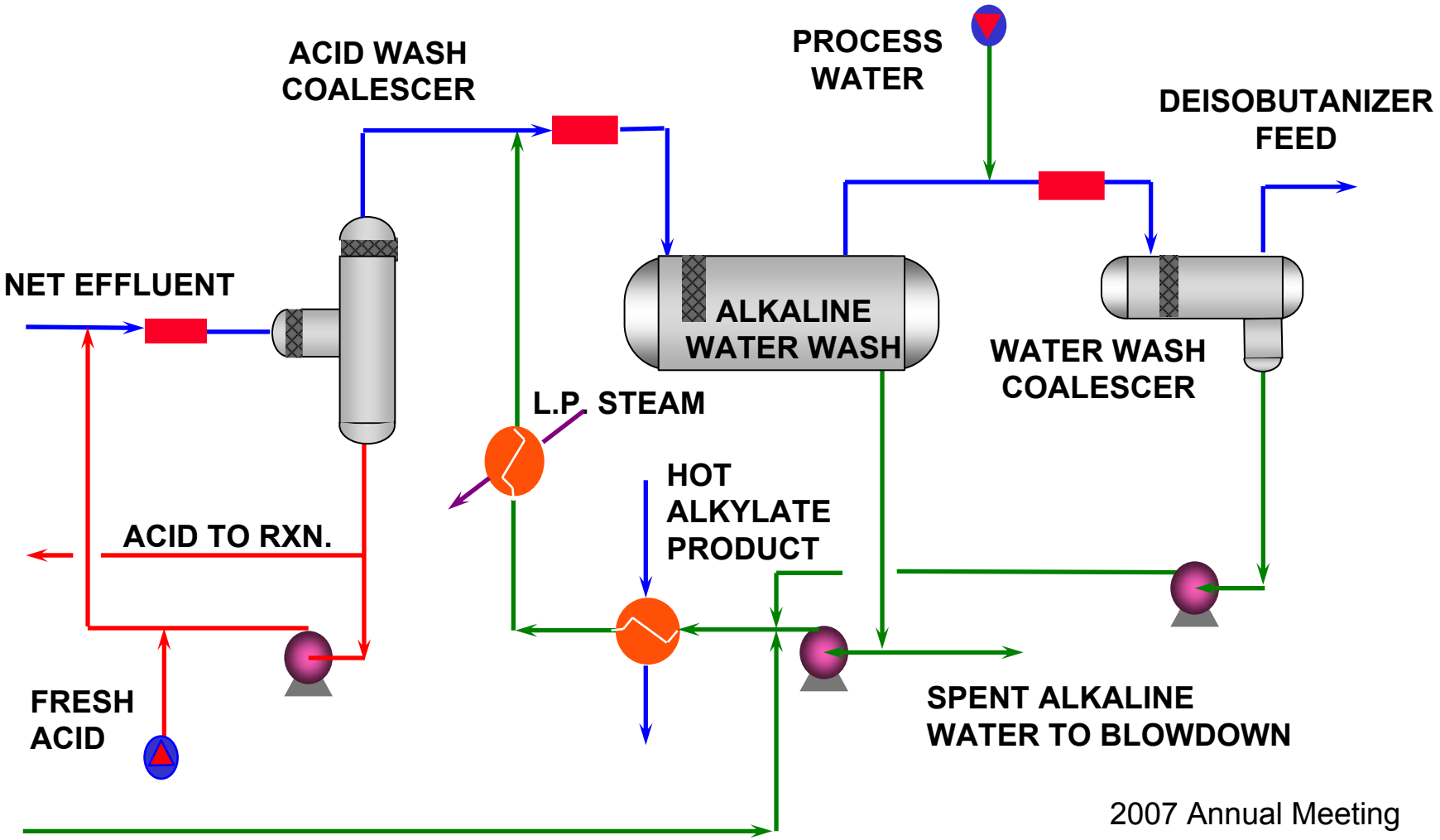
- **Reaction Zone**

  Reduce hydrocarbon and sulfuric acid inventory, improve reliability, operability and alkylate product quality

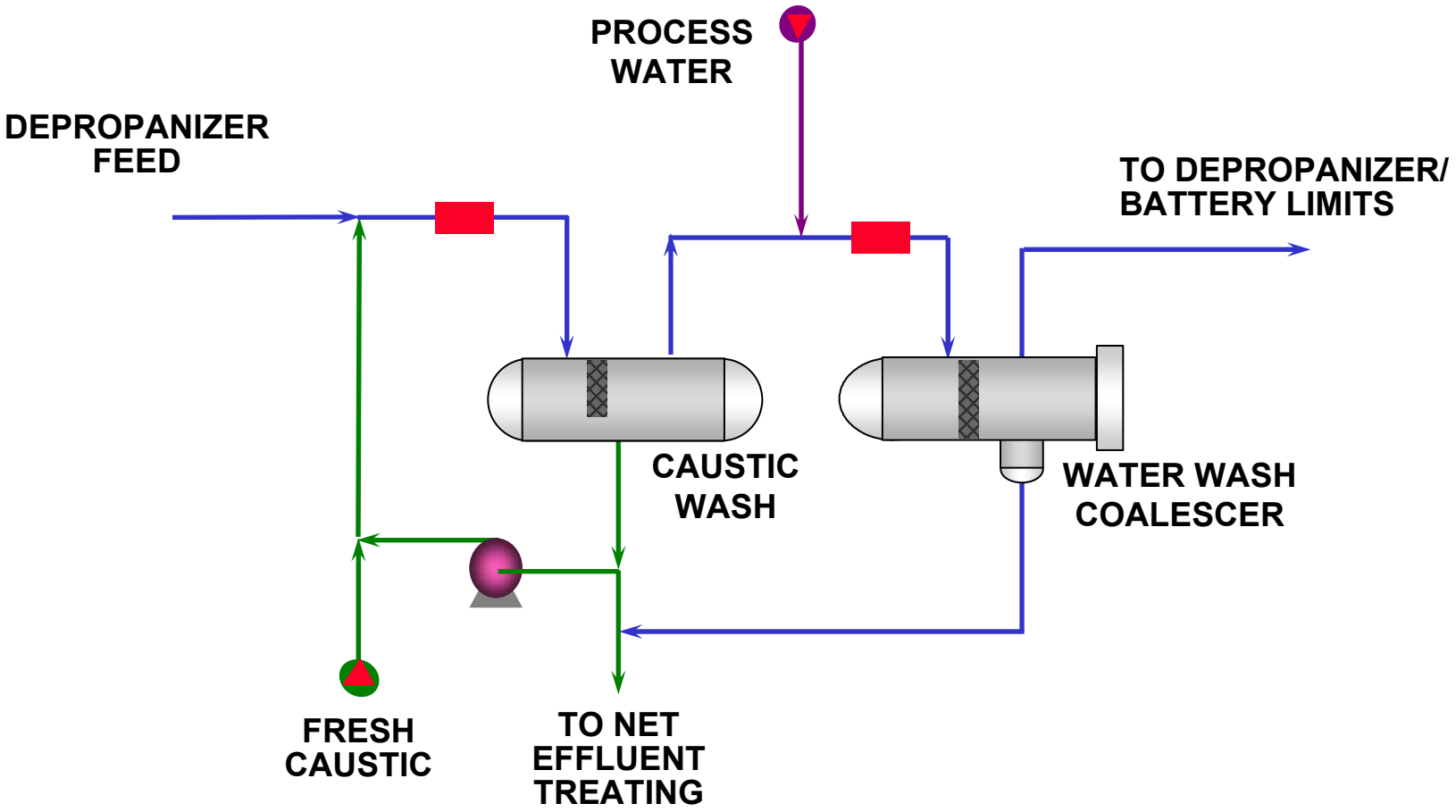
Net Effluent / DEP Feed Treating Improvements

- 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



Depropanizer/Propane Purge Treating



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

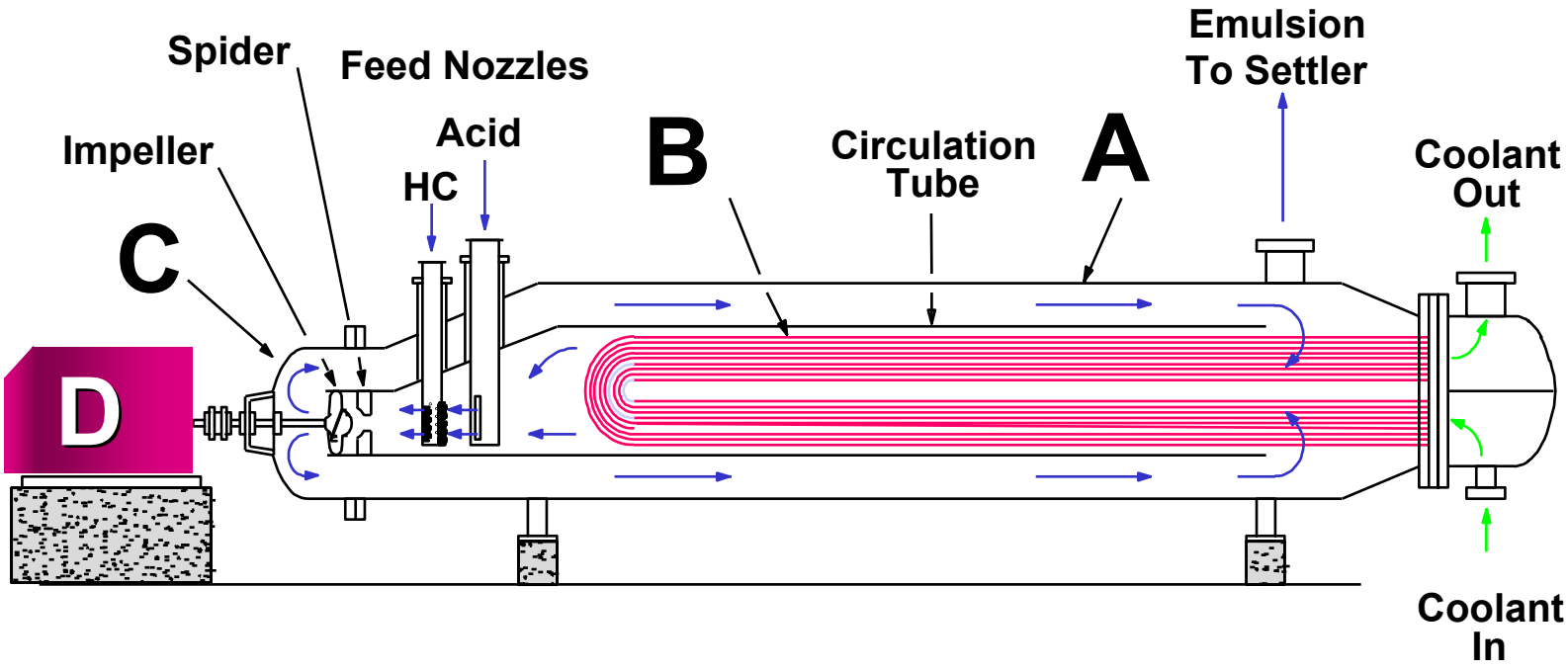
NPRA

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

Contactor™ Reactor

NPRA

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

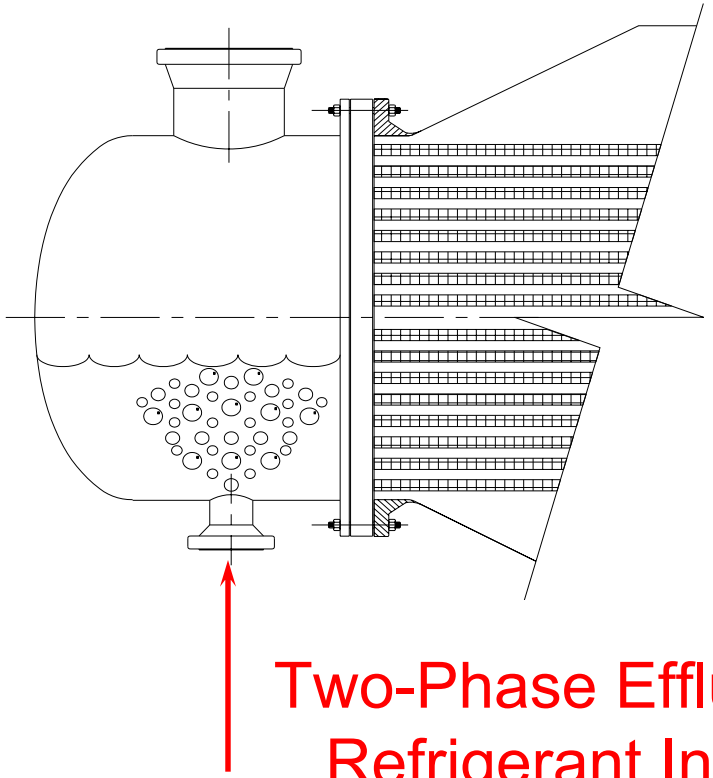


Tube Inserts

Issue:

Poor Distribution

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



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

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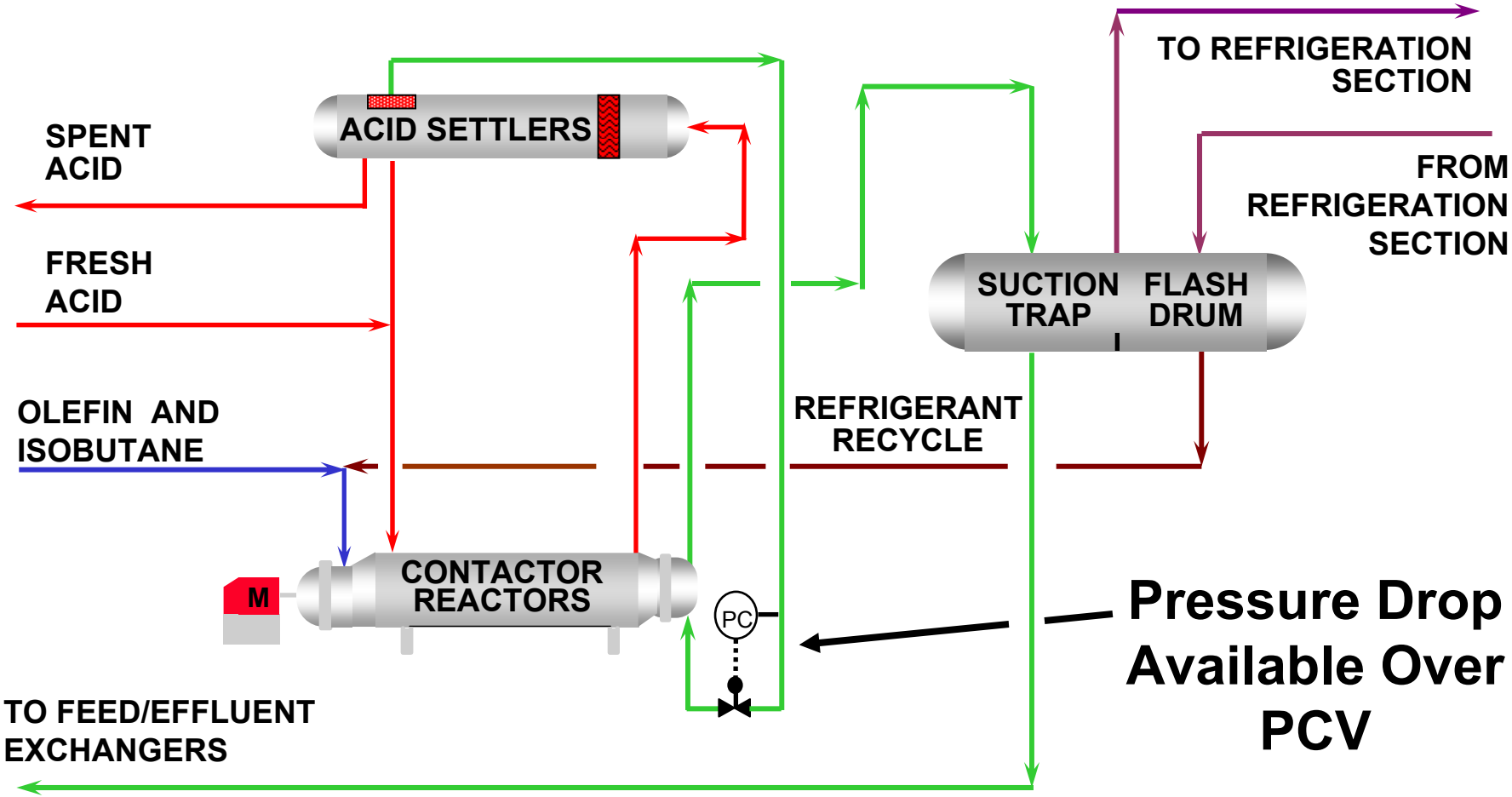


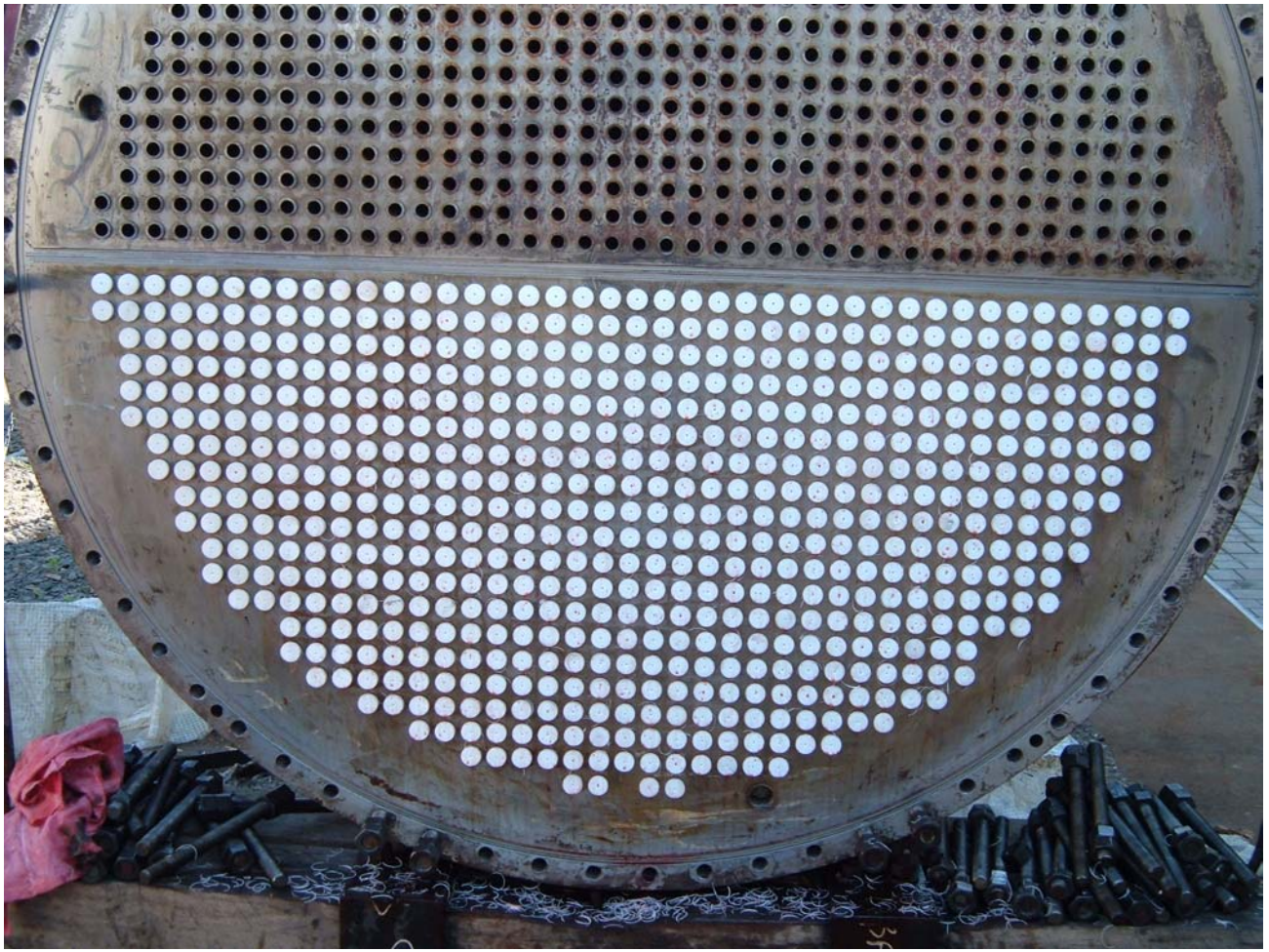
Pressure Drop Available Over PCV

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?

NPRA



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

	Location	Sets of Inserts/# Contactors	Installation Date
Refinery #1	North America	4/8	Winter 2001
Refinery #2	Hess Port Reading	2/2	Spring 2003
Refinery #3	HOVENSA	6/6	Fall 2003
Refinery #4	North America	6/6	Winter 2003
Refinery #5	North America	3/3	Winter 2004
Refinery #6	North America	8/10	Winter 2004

Tube Insert Installations

	Location	Sets of Inserts/# Contactors	Installation Date
Refinery #7	North America	2/12	Winter 2005
Refinery #8	Europe	3/3	Summer 2006
Refinery #9	North America	2/4	Winter 2006
Refinery #10	Europe	2/2	Spring 2007
Refinery #11	North America	2/2	Spring 2007
Refinery #12	North America	2/2	Spring 2007

¾” Tube Bundle

- Historical standard is the 1” bundle
- 1” OD, 10,070 ft^2 / 613 tubes
- ¾” OD, 13,630 ft^2 / 1,101 tubes
- 12 installed ¾” tube bundles

¾” Tube Bundle Performance

- Case 1
- Replaced 9,800 ft^2 with 13,630 ft^2
- 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 ft^2 with 12,130 ft^2
- Replaced 9,800 ft^2 with 13,630 ft^2
- 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 ft^2 with 5,978 ft^2 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)