MINIMIZATION OF ATMOSPHERIC EMISSIONS IN THE HYDROCARBON PROCESSING INDUSTRY WITH HIGH EFFICIENCY PLATE-AND-SHELL HEAT EXCHANGERS

Texas Technology Showcase 2003
Outline

- Atmospheric Emissions from Use of Energy in the HPI
- Heat Integration
- Thermal Pinch
- PSHE as Best Equipment to Minimize the Pinch
- Case Story: Diesel Hydrotreater
- Case Story: Catalytic Reforming
- Case Story: Pygas Hydrotreater
- Summary

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Atmospheric Emissions from Use of Energy in the HPI

- Fired Heaters are Typically the Largest Consumers of Energy and the Largest Contributors to Atmospheric Emissions by Oil Refineries.

- Example of Utility Consumption at a Particular Diesel HDS Unit
  - Fired Heater 19 ¢ / bbl  6 lb. GHG / bbl
  - Compressor 6 ¢ / bbl (*)
  - Product Cooler 1 ¢ / bbl (*)

- Energy Consumption is Usually the Second or Third Largest Cost Center of a Refinery
  - First = Crude Oil Supply
  - Next is either Personnel or Energy
Atmospheric Emissions from Use of Energy in the HPI

Conclusion:

• Minimizing the Use of Fired Heaters is both:
  — Good for the Refinery’s Bottom Line Economics
  — An Excellent Method to Reduce Atmospheric Emissions.

• This Paper Suggests a Method and a Tool to REDUCE THE NEED FOR MANY FIRED HEATERS IN A REFINERY
Heat Integration

- Heating Side of HE
- Cooling Side of HE
- Fired Heater
- Reactor
- Cooler
- Feed In
- Product Out

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Thermal Pinch Inside the HE

Minimize Delta T at hot end to Minimize Charge Heater Duty

Heat Recovery is Limited By Thermal Pinch Inside the HE

Reactor Effluent Into the HE

Feed Out of the HE and to the Heater

Feed Into the HE

Effluent Out

°C

MM BTU / hr

Packinox

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PSHE as Best Equipment to Achieve Minimum Pinch

Barriers to Reducing the Pinch:

- The LMTD Diminishes Rapidly with the Pinch, and the Required Heat Transfer Surface Area Increases just as Fast
- The Tube Length Equivalent Increases Rapidly
- Complete Vaporization of the Feed is Needed
PSHE as Best Equipment to Achieve Minimum Pinch

Heat Transfer Through Very Large Corrugated Plates:

- Huge Surface Area in a Compact Design
- Very Long Tube Length Equivalent
- Corrugations Give High Turbulence to Help Complete Vaporization
PSHE as Best Equipment to Achieve Minimum Pinch

- Corrugated Surface Works as a Static Mixer
- Maintains high Turbulence and Promotes Two-phase Flow Distribution
- Allows Easy Superheating
PSHE as Best Equipment to Achieve Minimum Pinch

- Liquid Feed Injectors Allow Very Good Control of Liquid - Vapor Feed Distribution
- Allows Better Heat Transfer Inside the Plate Bundle
Plate-and-Shell HE as Best Equipment to Achieve Minimum Pinch

- The Protection of a Pressure Vessel Allows the Plate Bundle to Operate at High T and P

- Feed Outlet
  - Effluent Inlet

- Plate Bundle
  - Pressure Vessel
  - Effluent Outlet
  - Spray Bars for Liquid Feed
  - Recycle Gas inlet

PACKINOX

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Case Story: Diesel Hydrotreater

Two 65,000 bpd Units at Formosa Petrochemical

- Eliminated:
  - 75% of Heater Duty
  - 40% of Compressor HP
  - 40% of Cooler Duty

50,000 tons CO2 Equiv / year

- On line Since 12/2000

- Savings per Unit:
  - CAPEX > $5 Million
  - OPEX > $3 Million / yr

Charge Heater
Q (operating) = 5 MW
= 17 MM BTU/hr
Q (design) = 12 MW

Selected PFD with PACKINOX Exchangers

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Case Story: Diesel Hydrotreater

Two 65,000 bpd Units at Formosa Petrochemical

- Same Unit based on S&T:
  - Heater: 78 MM BTU/hr v. 17 MM BTU/hr
  - Compressor: 5000 hp v. 2950 hp
  - Cooler: 133 MM BTU/hr v. 78 MM BTU/hr
Case Story: Catalytic Reforming

More than 50 Units Retrofitted Around the World

- Two Reduction Samples in North America:
  - 59,000 tons CO2 Equiv. / yr on a 40,000 bpd Reformer
  - 16,500 tons / yr on a 26,000 bpd Reformer
Case Story: Pygas Hydrotreater (Mitsui, Japan)

- Unit with S&T before Revamp with PSHE
  - Heater 28 MM BTU/hr
- Operation Restricted by Limits on Air Pollution
Case Story: Pygas Hydrotreater (Mitsui, Japan)

- Eliminated: 100% of Heater Duty after Warm-Up
- On line since 1995
- Allows to Operate during Air Emissions Restriction

ZERO EMISSIONS!
Summary

High Efficiency Shell & Plate Heat Exchangers = $ +

Let's Make Texas as Green As We Can!