Furnace Erosion Presentation

- Furnace Process Design
- Furnace Cleaning Methods
- Furnace Erosion and Lessons Learned
- Furnace Outlet Thermowell Location and Lessons Learned

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Types Of Coker Furnaces

- Single Fired
- Doubled Fired
- Triple Fired
Common Factors For All Furnace Designs:

– Typical Outlet Temperatures 850-950 F.
– Large Fuel Gas Consumers
– Coke Fouling Impacts Performance and Efficiency
– Coke Fouling Requires Periodic Cleaning
– Today’s Market Conditions Require Cokers To Feed Heavier, High Metal, High Sulfur Feeds To Be Profitable
– Erosion affects Safety, Reliability, and Profitability
Furnace Designs

• Mule Ears
  • A) Reliable Design - Erosion Resistant
  • B) Cause High DP Across Furnace
  • C) Subject To Leaking
  • D) Easy To Access Furnace Tubes

• U-Bends
  • A) Less Erosion Resistant
  • B) Lower DP Across Furnace
  • C) Do Not Leak
  • D) Cannot Access Furnace Tubes
Current Methods To Remove Coke

• On-Line Cleaning:
  » A) Spalling With Condensate Injection
  » B) Spalling With Steam Injection

  » Advantage- Minimum Feed Interruption
  » Advantage- Increases Time Between Decokes
  » Disadvantage- Increased Erosion
Current Methods To Remove Coke

• Off-Line Cleaning
  » A) Steam/ Air Decoke
  » B) Pigging
  » C) Steel Shot Circulation

  » Advantage - Less Erosion
  » Disadvantage - Usually Requires Outside Contractors
  » Disadvantage - Loss of Feed Throughput During Procedure
Typical Single-Fired Coker Furnace

Feed

Steam/Condensate

To Coke Drums
During feeding, coke is being laid down on tube walls which insulates them, decreasing heat transfer.
During Spalling or Decoking, coke is removed.

Note the concentrated impact area.
Note the bulged area of the header box
Coke that breaks loose from the tube walls during spalls/decokes can accelerate to velocities of 200-500 ft/per second before impacting the ends of the tubes due to the tube lengths in furnaces.
Note pocket created by localized erosion.

Flow

Upstream Side
Downstream End Of U-Bend
Theory Behind “Flatback” Design

Green Area Denotes “Protective” Liquid Layer That Absorbs Impacts
Thermowell location is in the high velocity zone.

Elbow is known site of high erosion rates.
Relocating the TW takes it out of the high velocity zone.

Hardfaced or stellited elbow
Furnace Outlet Elbows

Typical Outlet Elbow

Stellite Hardfaced Interior
Summary

• Furnace Tube Lifespan:
  • A) Erosion Monitoring
  • B) Creep/ End Of Life Analysis

• U-Bend Design
  • A) Type U-Bends
  • B) Erosion Monitoring

• Outlet Thermowell Location
  • A) Hardfacing
  • B) Relocate to Low Velocity Area
  • C) Erosion Monitoring/ Inspection

• Outlet Piping/ Elbows
  • A) Hardfacing
  • B) Metallurgy Research/ Review
  • C) Erosion Monitoring/ Inspection
Conclusions

• In normal furnace operation there is always a certain amount of erosion taking place.
• Spalling/ Decoking Procedures accelerate the erosion processes in the furnace due to the coke on the tube walls being stripped from the tube walls and those coke particles impacting areas downstream.
• Modifying your Spalling or Decoking procedures to reduce velocities can help to slow erosion process.
• Opportunity inspections with non-destructive monitoring techniques such as UT and X-ray can determine erosion rate if baseline thicknesses were taken at beginning of service life.
• Improving furnace design can help control and minimize the erosion rates.