Coke Drum Improvements – Real World Reliability

Introduction

• Industry leading robust mechanical design.
• Coke drums are subject to cyclic loading through thermal cycling and interaction with insitu coke.
• Avoid premature bulging & shell cracks.
Coke Drum Improvements – Real World Reliability

• Achieving Excellent Coke Drum Longevity – Four Key Factors
  - Design / Specification
  - Fabrication
  - Inspection
  - Ongoing Operational / Mechanical life management

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• Design / Specification
  - Reduced number of circumferential welds
    • Taller shell courses
    • Vertical panel construction

Coke Drum Improvements – Real World Reliability

• Design / Specification
  - Coke Drum Customized plate specification
    • Higher Strength 1 Cr or 1 ¼ Cr plate
      - With Improved plate property requirements
    • Avoid 2 ¼ Cr or Vanadium enhanced steels
    • Higher clad shear bond strength
Coke Drum Improvements – Real World Reliability

• Design / Specification
  
  - Nozzle Design
    • Fully inspectable integrally reinforced nozzles.
    - Code figure UW 16.1f
    • Recognize and apply all real world loads to design.

Integrally Reinforced Nozzle
As per Figure UW-16.1f in ASME Section VIII Division I

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- Design / Specification
  - Two generally used types of skirt attachments
    - In-Line and Tangent Mount.
    - Finite element analysis based on real-world strain and thermal transients.
    - No skirt design is perfect.

- In-Line skirts
  - Satisfyingly straight forward computational solution.
  - Disadvantage in heat transfer to and from cone to skirt.
  - Special case forged ring design.
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• Design / Specification
  - Tangent Mount skirts
    • Issue of the ‘singularity’.
    • Rigorous fabrication.
    • Significantly better heat transfer to and from cone.
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• Fabrication
  - Rigorous qualification method for fabricators.
  - Very tight fabrication tolerances.
  - Fatigue resistant weld design.

• Inspection and Testing
  - Tighter than code Radiographic acceptance criteria.
  - UT in lieu of RT requirements.
  - Fabrication tolerance assurance.
Coke Drum Improvements – Real World Reliability

• Ongoing Operational / Mechanical fatigue management.
  - Strain Gages and Drum Skin TIs
  - Statistically Significant number of observations vs operation variables.
• Reach operational goals without undue fatigue accumulation.
• Make informed decisions on drum life management.
Coke Drum Improvements – Real World Reliability

- Overcoming Complications with side feed entry nozzles.
  - Flow channeling and heat maldistribution
    - Uneven coking, inefficient quenching.
    - Hot spots, blowouts.
  - Some cokers seem to ‘get by’ with single feed entry
  - Some cokers do not.
  - Key is to simulate bottom center up flow as much as practical.
Coke Drum Improvements – Real World Reliability

- Overcoming Complications with side feed entry nozzles.
  - Computational Fluid Dynamics (CFD).
  - Recommend upward swept dual flow.
  - Importance of feed piping configuration.
  - Piping design to support operations.