The Different Types and Causes of Coke Drum Bulging

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History of Shell Bulging

- Major problem for decades.
- Despite design improvements, still a problem - perhaps more severe today.

Courtesy of CB&I
Bulging Study Background

• Database of one hundred and eighty four laser scans from coke drums in North America, South America, Europe, and Asia:
  – Carbon steel, Carbon-½ Moly, and 1, 1¼, and 2 ¼ Chrome
  – Age: new to 48 years.
  – Diameter: 19.7 to 32 feet.
  – Tangent-to-tangent length: 50.5 to 102 feet.
  – Minimum shell thickness: 0.45 to 1.54 inches.
  – Maximum shell thickness: 0.84 to 1.89 inches.

• Laser scans originally used for assessing bulging severity using the Plastic Strain Index (PSI)™.
Bulging Types

• Uniform
  – Seam Bulging
  – Bottom Growth
  – Tapered Growth
  – Outage Growth
  – Mid-height Growth
  – Band Bulging
  – Helical Bulging
  – Accordion Bulging

• Local

Weil and Rapasky (1958)
The constrained balloon
Classical Seam Bulging
Bottom Growth

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**Radius (in)**

800 700 600 500 400 300 200 100 0

Height (in)

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**Radius (in)**

900 800 700 600 500 400 300 200 100 0

Height (in)

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**Radius (in)**

900 800 700 600 500 400 300 200 100 0

Height (in)
Outage Growth
Mid-height Growth

[Graphs showing mid-height growth with radius and height on the axes.]
Band Bulging
Helical Bulging
Accordion Bulging
Local Bulges
Causes

• Fabrication / design:
  – Local PWHT
  – Material / section mismatch

• Operation:
  – Coke stiffness
  – Thermal Gradients:
    • Axial
    • Circumferential
    • Local
Recap

• Bulges are not all the same
• Examined large database of laser scans
• Introduced distinct types of bulges
• Examined underlying causes rooted in design, fabrication, and operation