Bulging Resistance of Coke Drums using Staggered Seam Design

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Overview

• Shell bulging
• Types of bulges
• Vertical plate design
• Staggered seam design
• Analysis of staggered seam design
• Recent development
Shell Bulging

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

Courtesy of CB&I
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
Unconventional Shell Designs

• Vertical plate
• Staggered seam
Vertical Plate

- Publication: Feb 27, 2001
- US 6193848 B1
- CBI
Staggered Seam

- US 9884996
- International patents
Analysis of Staggered Seam Design

Cause of non-uniform growth:
• Weld-base strength ratio (10% and 50% used)
• Weld reinforcement (10% used)

Bulging simulation:
• Pressure (used in this analysis)
• Coke resistance (future)
Scope

- Conventional
- 3-leaf
- 4-leaf
Conventional Design
Radial Displacement

U, U1 ("ASSEMBLY__T-Datum csys-2")
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+1.521e+00
+1.493e+00
+1.466e+00
+1.439e+00
+1.412e+00
+1.364e+00
+1.357e+00
+1.330e+00
+1.302e+00
+1.275e+00
+1.248e+00
+1.221e+00
3-Leaf Staggered Seam Design
Radial Displacement
4-Leaf Staggered Seam Design
Radial Displacement
Results

Bulge simulation using pressure
Weld reinforcement 10%

Relative Bulging (%) vs Weld-Base Strength Ratio (%)
Conclusions

- Analysis confirmed that staggered seam design reduces bulging compared to conventional shell design.
- Using pressure loading, up to 27% bulging reduction is predicted.
- The four-leaf design results in a more significant bulging reduction than the three-leaf design.

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Recent Development

Licensed to Sumitomo Heavy Industries, Japan

Oct. 2020
Recap

- Shell bulging
- Types of bulges
- Vertical plate design
- Staggered seam design
- Analysis of staggered seam design
- Recent development: HES-Sumitomo agreement