Design Verification, Optimization and Validation of Ultra-HPHT Completion and Production Tools

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Agenda

• Introduction
• Completion Packer Design Overview
• Packer Seal Design Verification and Optimization
• Material Characterization
• Test validation
• Conclusion
Introduction: Completion Systems
Packer Overview
HPHT Designation Defined By Reservoir Temperature and Pressure
Ultra-HPHT Technical Challenges

- Seal /Polymer
  - Significant challenges at the ultra temperatures (> 450F)
  - Seal Research
  - Metal to Metal

- Metallurgy
  - Availability on Nickel Alloys
  - NACE above 450 F

- Imperfect As-Rolled Casing
  - Ovality, eccentricity, ID 3-Lobes Variances, etc.
Ultra-HPHT Technical Challenges

Geometric Imperfection

The Tested As-Rolled Casing and its Rough ID Surface
Completion Packer  Design Overview

Test Packer
Completion Packer Design Overview

Design Objectives:

- Seal as-rolled casing with ID range 4.592” - 4.895”.
- 20,000 psi at 470F pressure below.
- 17,000 psi at 470F pressure above.
- Water media
- Test to envelope points at 470F with a cool down.
Design Verification and Optimization

Flowchart of New Seal Development

Design Verification Load Cases:
- Extrusion barrier deployment
- Maximum ID casing at 300° F
- Maximum ID casing at 470° F
- Minimum ID casing at 300 ° F
- Minimum ID casing at 470 ° F
Design Verification and Optimization (2-D)
Design Verification and Optimization (3-D)
Material Characterization

FFKM – Uniaxial Compression at 500°F

Elastic-Plastic Engineering Stress-Strain Curve at 500°F
Design Validation

Performance Envelope

- Point #1: 20,000, -150,000
- Point #2: 0, 100,000
- Point #3: 17,000, 175,000
- Point #4: 17,000, -300,000
- Point #5: 20,000, -150,000

Tension vs. Axial Load (lb) vs. Pressure (psi)
Conclusion

- MSC.MARC is an indispensable design verification and optimization tool that substantially reduces development time and test iterations.

- Test facilities that are able to test up to 700° F and 30,000 psi are keys to future ultra-HPHT product development success.

- Polymer material and metallurgy advances provide a solid foundation for delving further into ultra-HPHT territory.
A NEW ERA BEGINS.

Questions?