HALLIBURTON

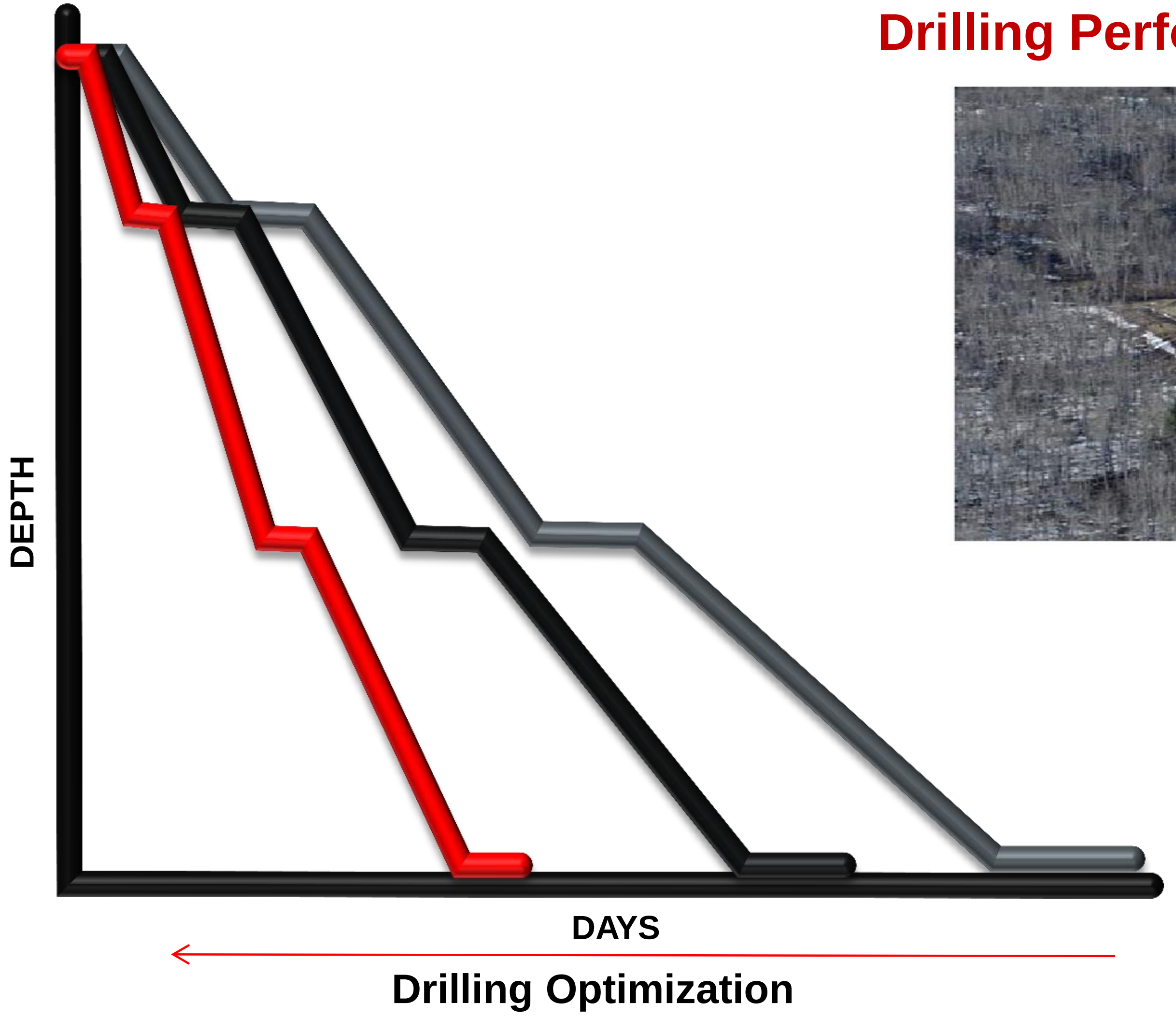
Unconventional Reservoirs

Efficiency and Execution Meet the Challenges of US Land Cementing

Agenda

- Displacement Practices for Horizontal Cementing
- Fluid Optimization
- Fluid Solutions
- Job Execution

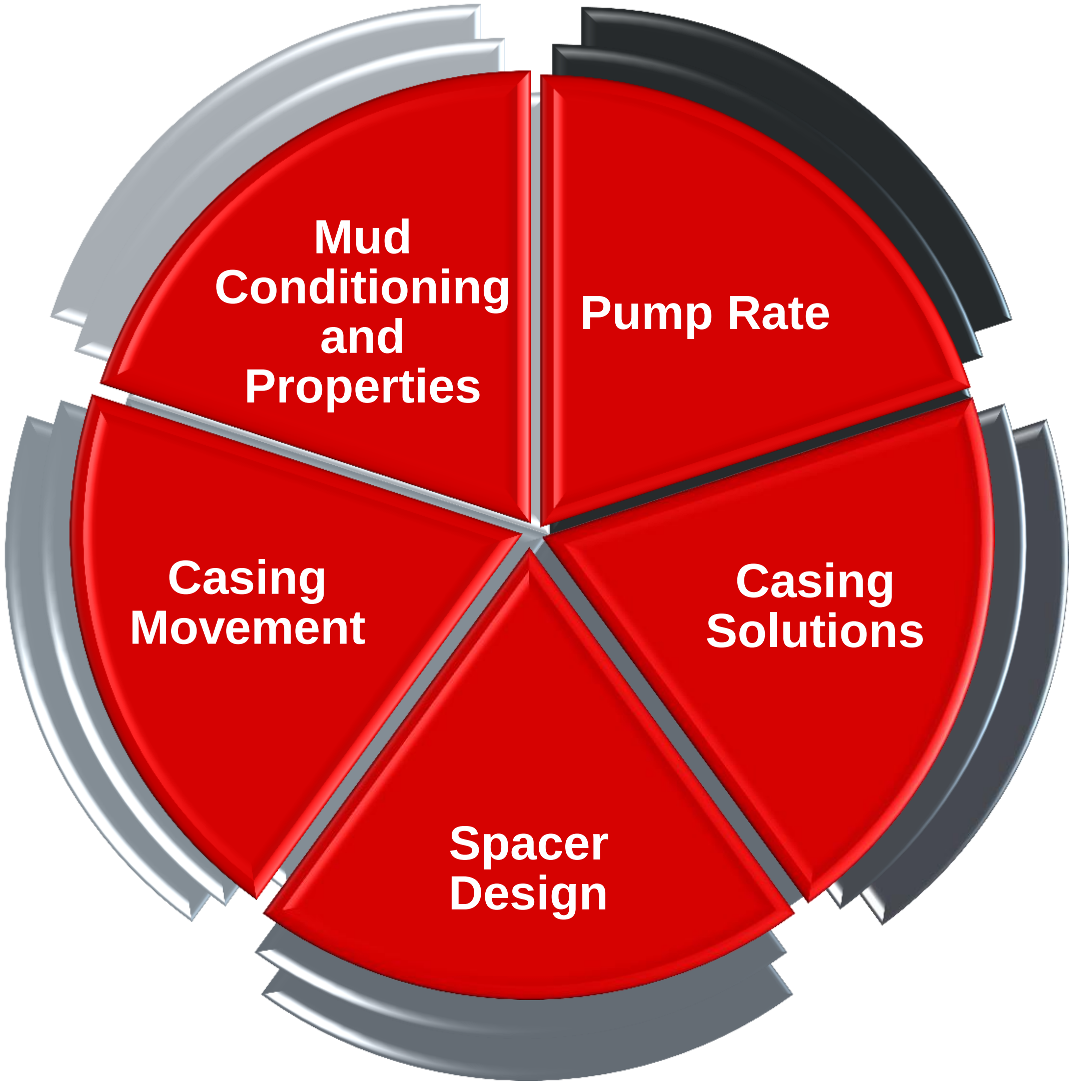
Drilling Performance



PAD Drilling Advantages:
- Less land used
- Fewer roads and pipelines
- Single processing facility
- Less urban & wildlife disturbance
- Less environmental foot print

- Delivery of highest value wellbore, in shortest time, & greatest financial return
- Requiring Cementing to be:
  - More Efficient
  - Less Risky
  - More Economical
- This also requires:
  - Higher laboratory utilization
  - More cement utilized / consumed
  - Higher equipment, bulk plant utilization

Preparing the Wellbore to Receive Cement

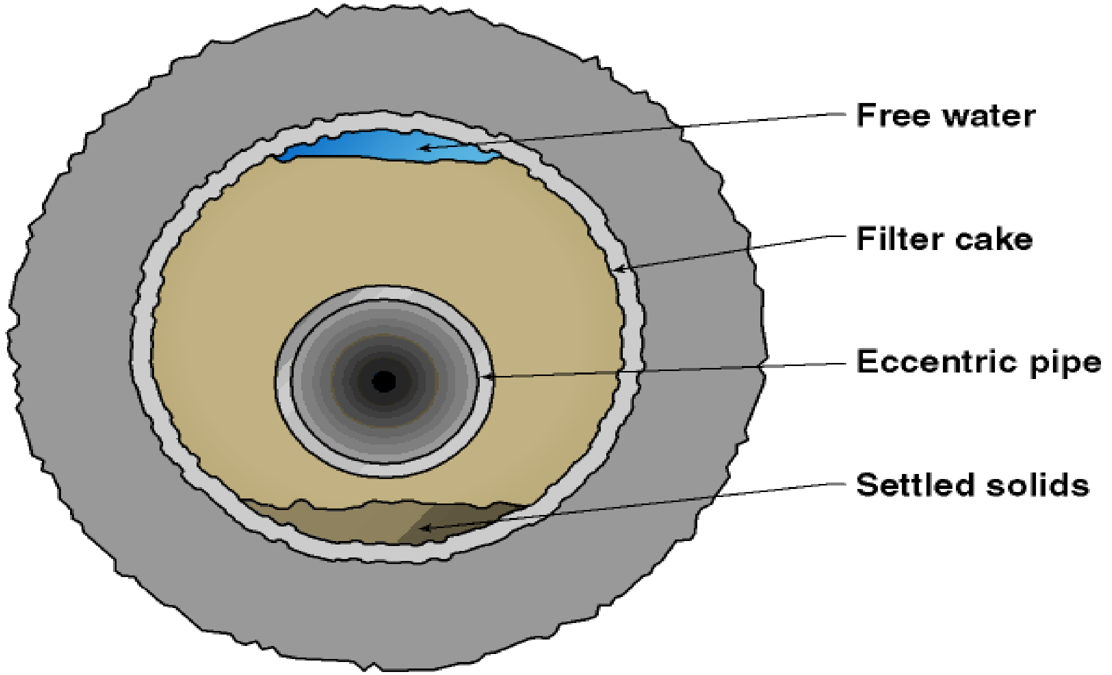


Fluid Optimization

Cement Slurry Stability

- Expose Slurry to actual job temperatures.
  - Thermal Thinning
  - Unplanned shutdowns

- Tests
  - Free Fluid
  - Fluid Loss
  - Dynamic Settling (On-Off-On TT)
  - API Sedimentation Test



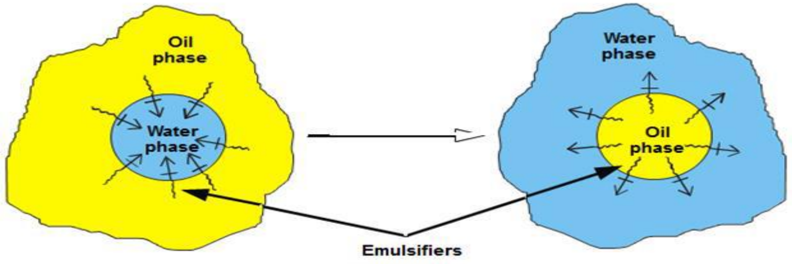
Dry Surfactant Spacer Design

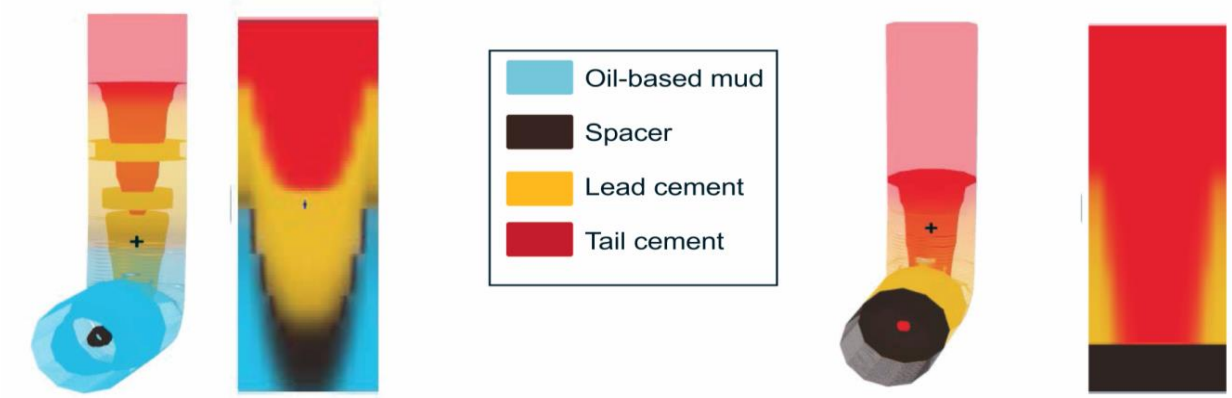
Challenge

Develop a spacer design that can be mixed on the fly to eliminate additional equipment on location, reduce time on location and reduce HSE risks

Solution

- Designed a tuned spacer design using dry surfactants that can be mixed on the fly
- Eliminated the need to pre mix spacer in a batch mixer thereby reducing our footprint on location, eliminating associated HSE risks, reducing job time, and reducing costs
- TergoVis (Scavenger) with surfactants



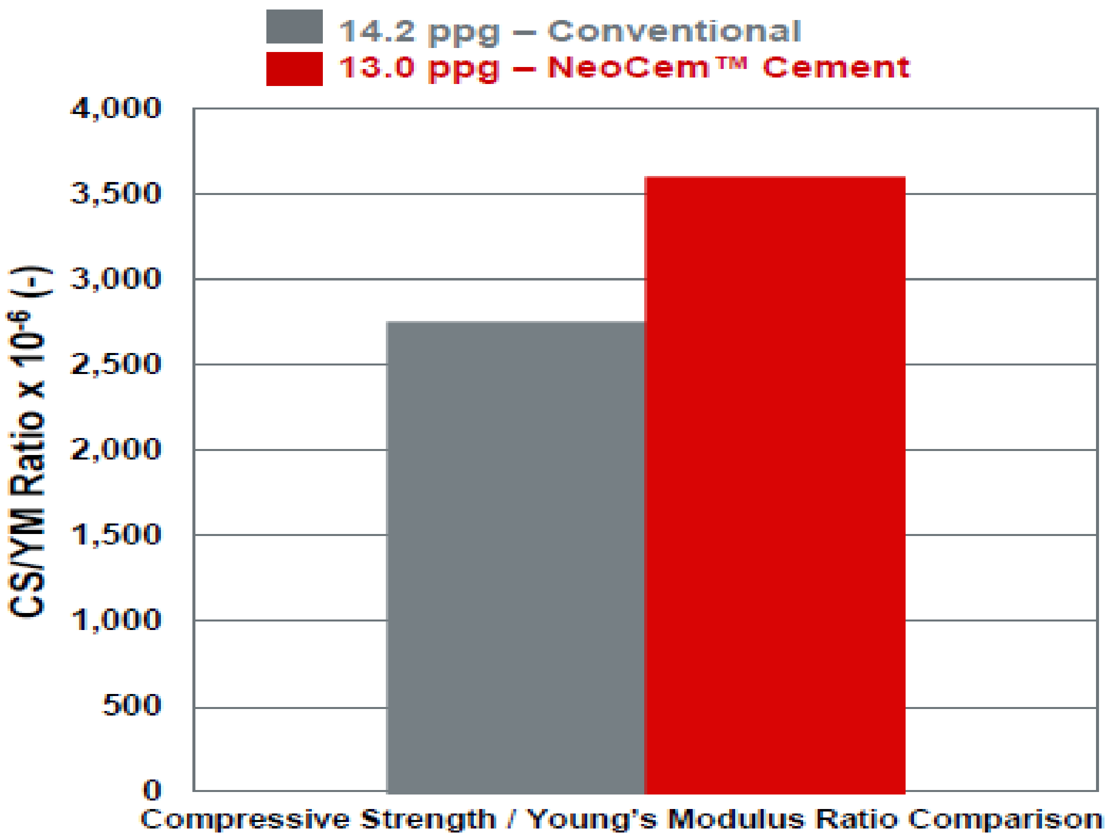


NeoCem™ Cement – Lighter Weight, Higher Performance

- Proprietary Blend
- Lighter Weight & Higher Performance
- Delivered Using Same Equipment, People and Processes

NeoCem™ Cement – Lighter Weight, Higher Performance

- Improved Mechanical Properties
- Enhanced Ductility
- Lower ECDs
- Improved Shear Bond
- Operationally Efficient
- Economical



NeoCem™ Cement – Lighter Weight, Higher Performance

- Pumped across all US Basins

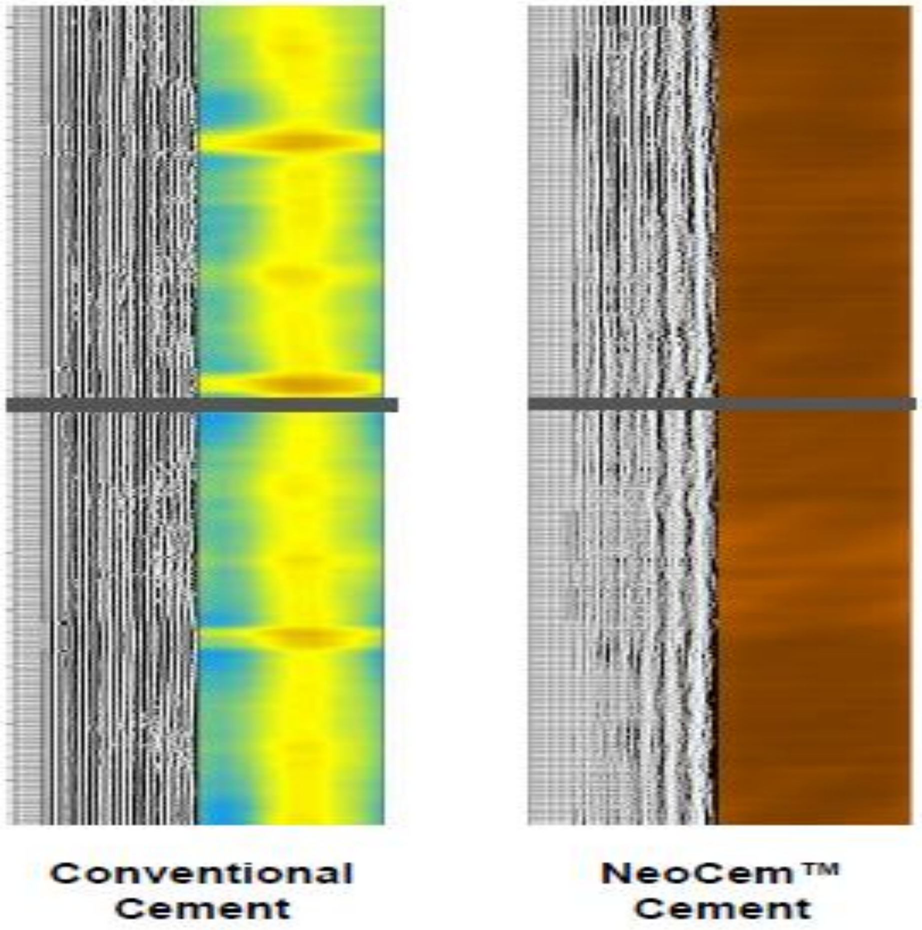
- ZERO NeoCem related COPQ

- 325 Deg BHST/BHCT
- 11.0 ppg -16.0 ppg

- Variable Density

- Latex NeoCem™
- Super CBL NeoCem™
- Acid Soluble NeoCem™
- Tuned Light NeoCem™

Bond Log Improvement



Driving Efficiencies and Solving Operational Challenges

Offline Cementing - Operational Steps

Rig on initial well

- Run casing to TD
- Circulate and condition the hole
- Land casing in the wellhead / hanger system
- Prepare wellhead to skid the rig

Rig moves to next well

- Configure the wellhead to accept a cement head
- Rig up of the return lines
- Rig up cementing lines from the pump to the wellhead
- Install plug container

Execution of the cement job

- Fill high pressure lines with fluid (including backside if applicable) and pressure test
- Pump spacer at a slower rate until pressure stabilizes
- Proceed with the conventional cementing

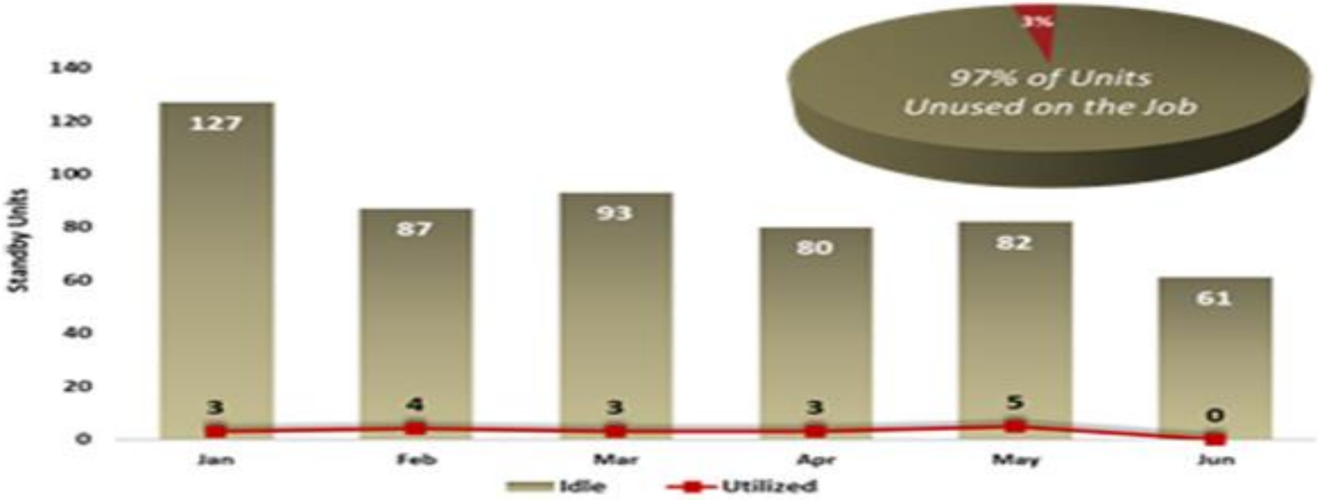
Production Job Efficiencies

Challenge

Reduce cementing costs for the operator and gain efficiencies on location

Solution

- Utilized NeoCem to simplify the job design and operations on location by pumping a single slurry
- Semi-permanently mounted standpipe to the V-door
- Eliminate the standby truck on location



Operator Requested Standby Equipment Utilization

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Commander Full Bore Top Drive Cement Head

- Features and Benefits
  - Wireless remote control capable
  - Optional Lower Safety Valve
  - Optional 3rd Chamber
  - 3” Manual Ball Drop Port
- Before We Execute
  - Casing Adapter
    - » Casing Size
    - » Casing Thread Type

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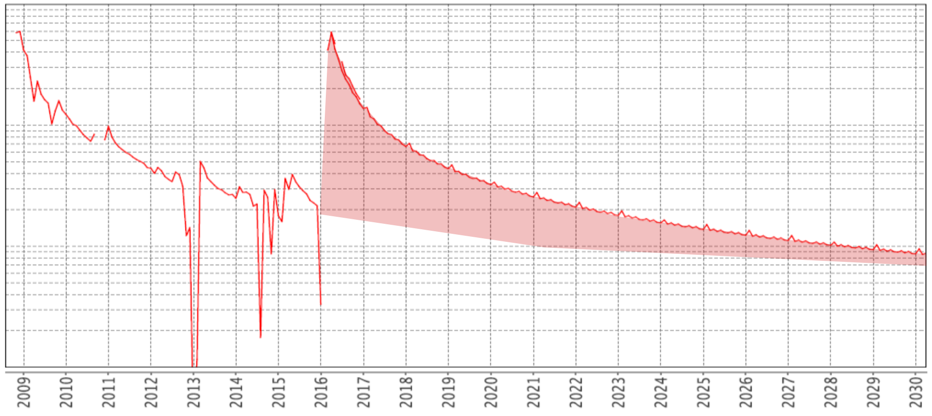
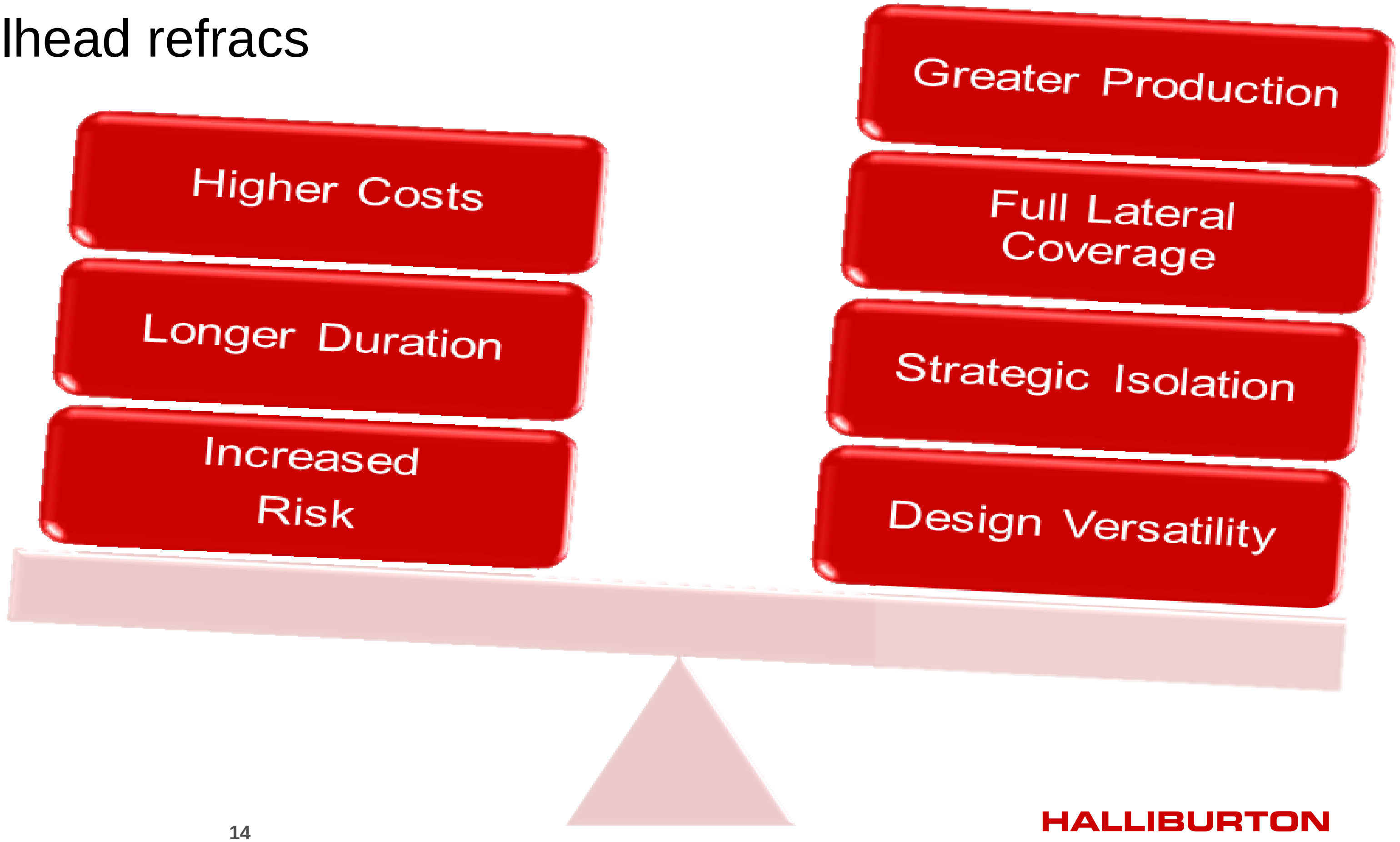
Casing-in-Casing Refracs

- Production
  - ~76% of original test rates
  - 2X to 4X improvement over bullhead refracs
- Operations
  - 30 – 50 BPM
  - Slickwater/Hybrid





Casing in Casing Cement Designs for Refracs

- Challenges
  - HPHT Environment
  - Tight Annular Clearance
  - Fluid Loss to Existing Perforations

- Cement Properties
  - Tight Fluid loss control
  - Low Rheological properties
  - Thermally Stable
  - Corrosion Resistance
  - Enhanced Mechanical properties

Casing in Casing Cement Designs for Refracs

- 14.5ppg ShaleCem™

Tight Fluid Loss

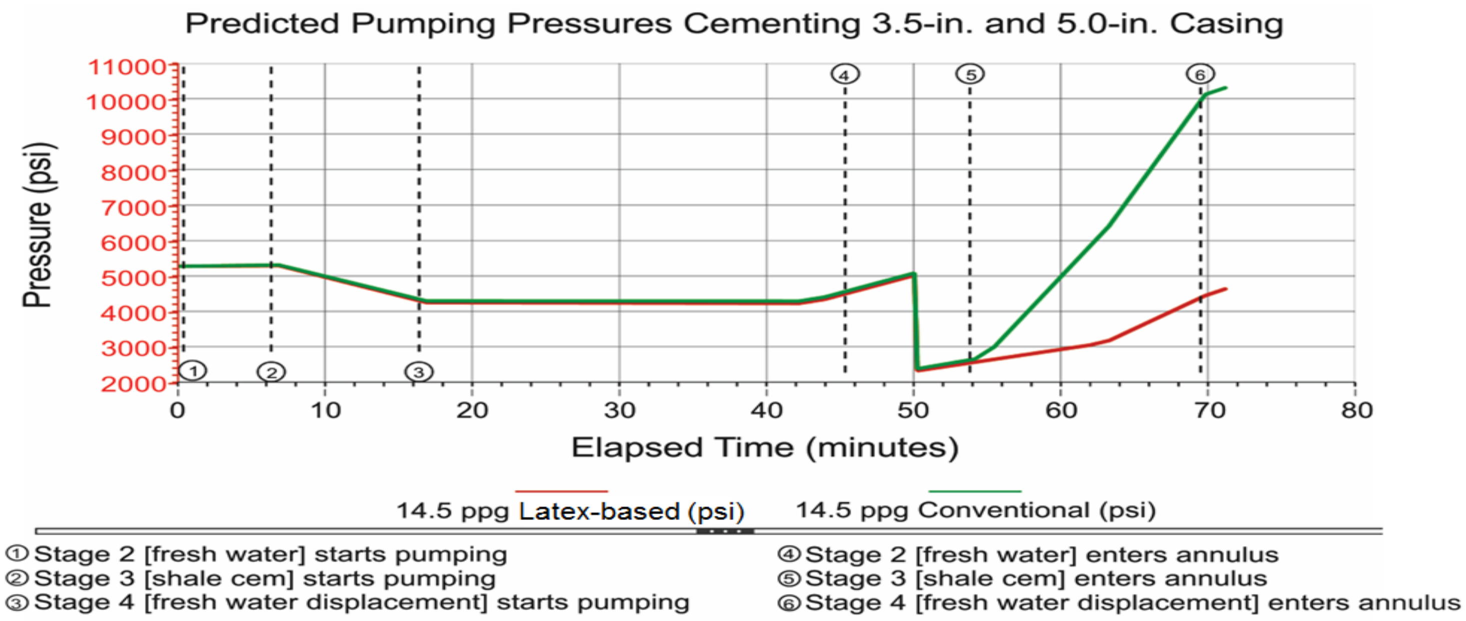
Temp	API Stirred Fluid Loss
300°	18 cc/ 30 min

Compressive Strength

Temp	500 psi	24 Hr
300°	6:16	1504 psi

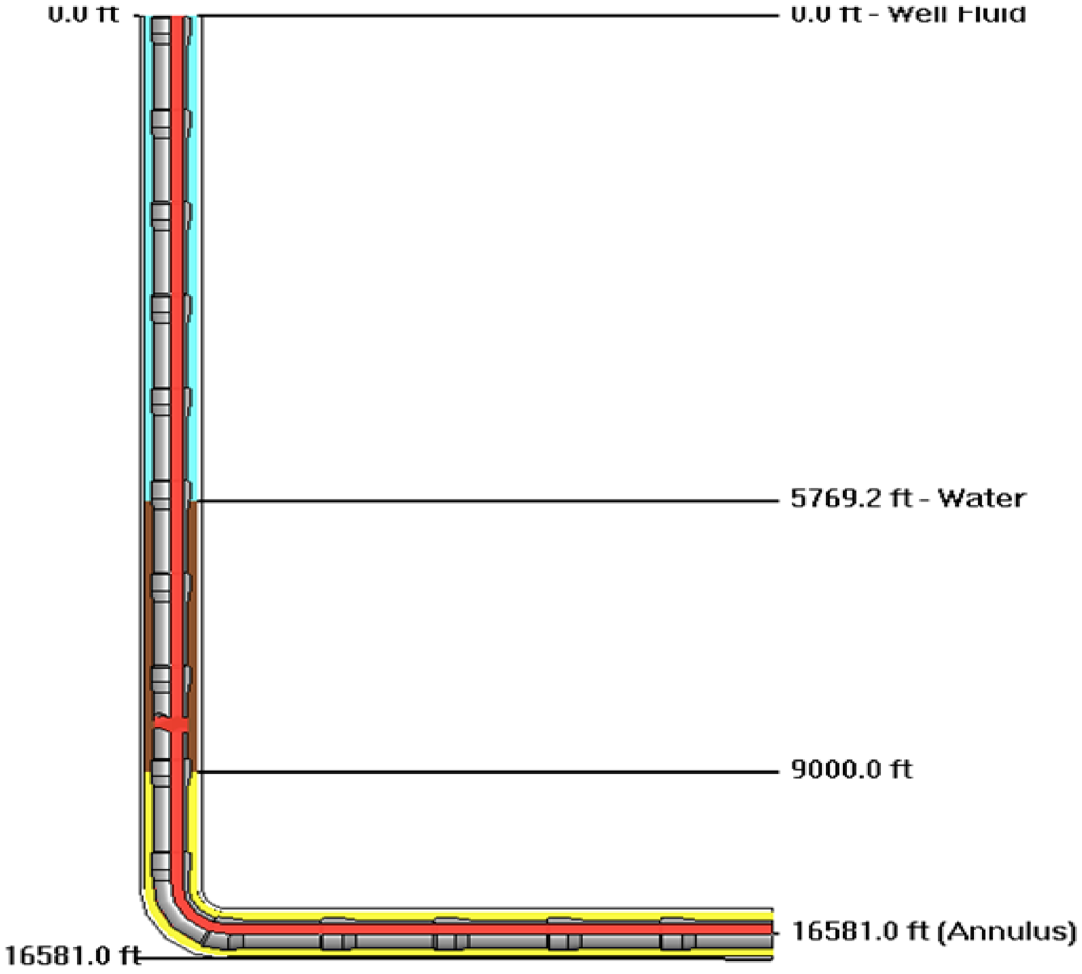
Low Rheological Properties

Temp	300	200	100	60	30	6	3
80°	46	32	20	13	8	4	2
130°	22	16	8	6	4	2	2
190°	22	16	8	6	4	2	2



Cemented Casing in Casing for Refracs

- Over 80 Jobs cemented since 2016
- Successful implementation in multiple assets for 12 different operators
- 250°-360° BHCT
- Utilized several different well configurations and techniques



Conclusion - Answering the Right Questions

- ✓ Can my thread type handle the torque needed for rotation?
- ✓ **Can I get my casing to bottom with the current centralizer program?**
- ✓ Does the geometry of the well limit my ECD management?
- ✓ What is my stimulation method?
- ✓ Are my drilling and cementing fluids rheologically enhanced?
- ✓ **Can my cement withstand the pressure cycling of the well?**
- ✓ **Are my fluids thermally stable and compatible?**
- ✓ Am I using the correct plug system for wiping efficiency and fluid separation?
- ✓ **Are my mud properties optimized for cementing?**
- ✓ Can the pump rate be maximized for mud displacement?

THANK YOU