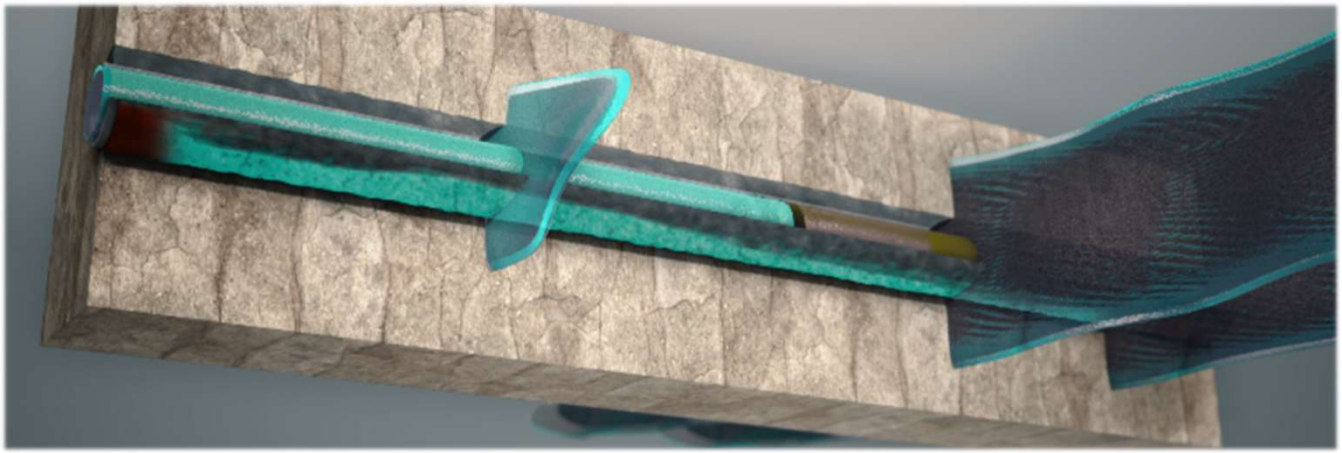
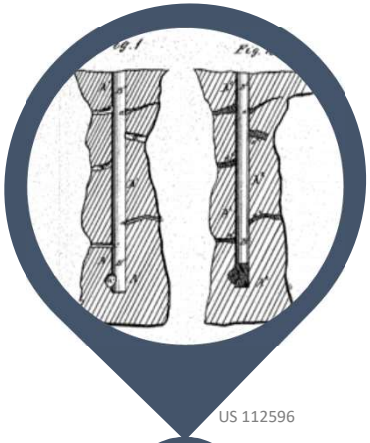
New cement system for effective zonal isolation in horizontal wellbores



Anatoly Medvedev, Schlumberger

October 16th SPE Westside Study Group meeting

Epigraph

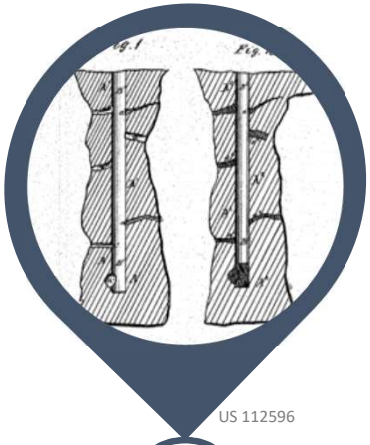


US 112596

1871

- US 112596, Drilling Oil Wells, J.K.Hill

Epigraph



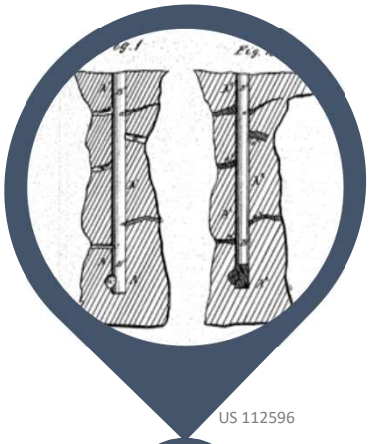
US 112596

1871

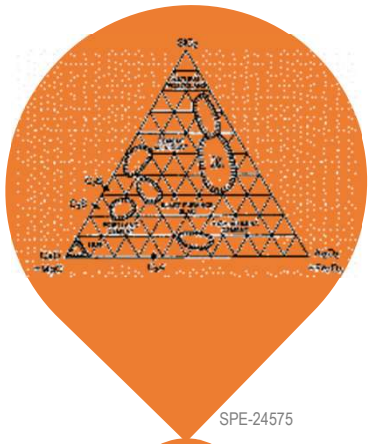
Future

- Ultimate goal: Controlled drilling fluid to cement conversion

Epigraph



US 112596



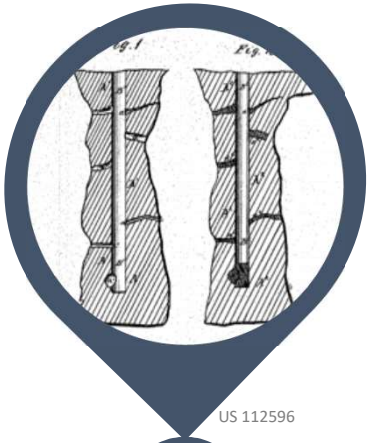
SPE-24575

1871 1969 Future

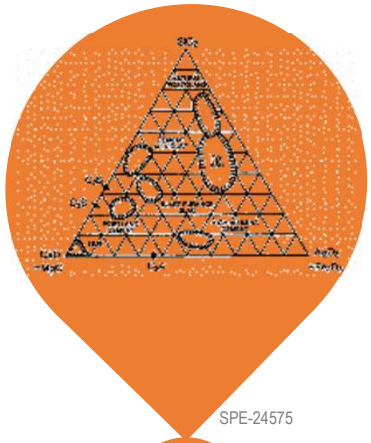
Mud-To-Cement (MTC) concept

- F. T. Jones, and D.C. Oliver. "A New Material to Cement Well Casing", The Oil and Gas Journal. October,1969
- K.M. Cowan, A.H. Hale, and J.J. Nahm, Shell Development Co. “Conversion of Drilling Fluids to Cements With Blast Furnace Slag: Performance Properties and Applications for Well Cementing”, SPE-24575, 1992

Epigraph



US 112596

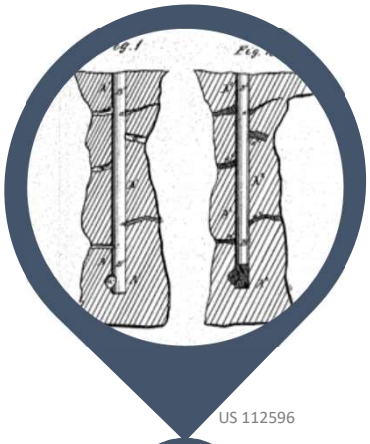


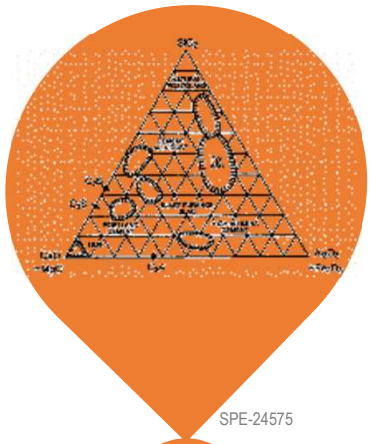
SPE-24575

1871 1969 2011 Future

- Change in market situation

Epigraph

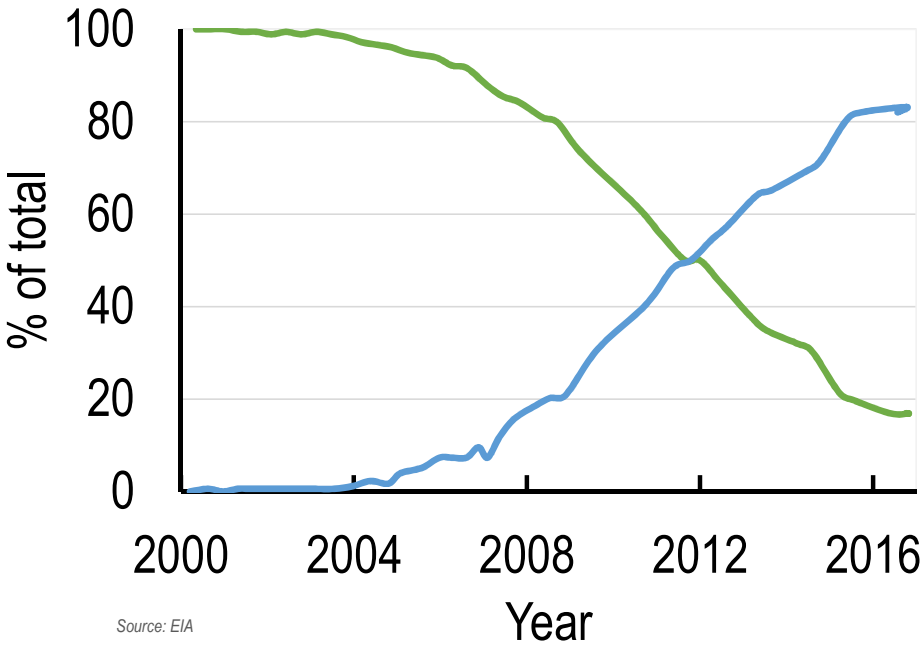

US 112596


SPE-24575

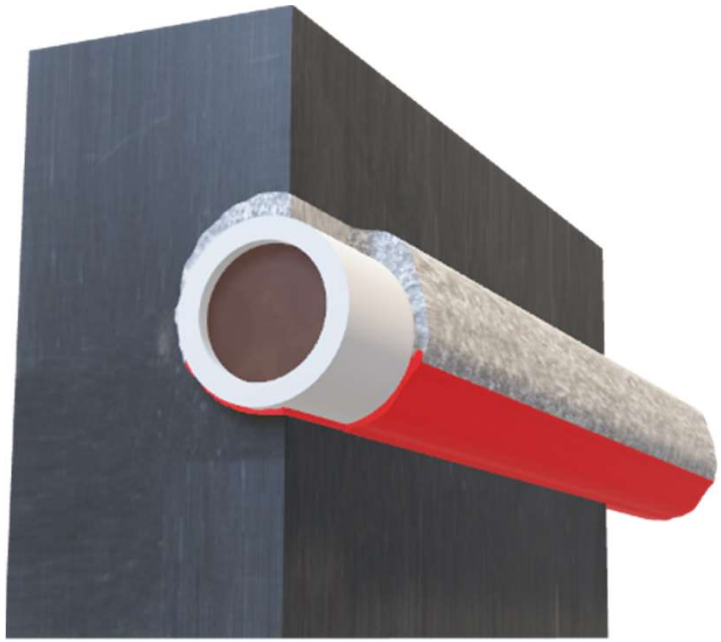
1871 1969 2011 2018 Future

- P. Kolchanov, D. Perroni, A. Medvedev, Y. Gao, R. Tercero, L. Todd, B. Lungwitz (Schlumberger), K.M. Cowan, W. Turner (Occidental Petroleum) “Effective Zonal Isolation in Horizontal Wells: Mitigating Negative Impact of Mud Channels”, SPE-191561-MS, 2018

Market changes

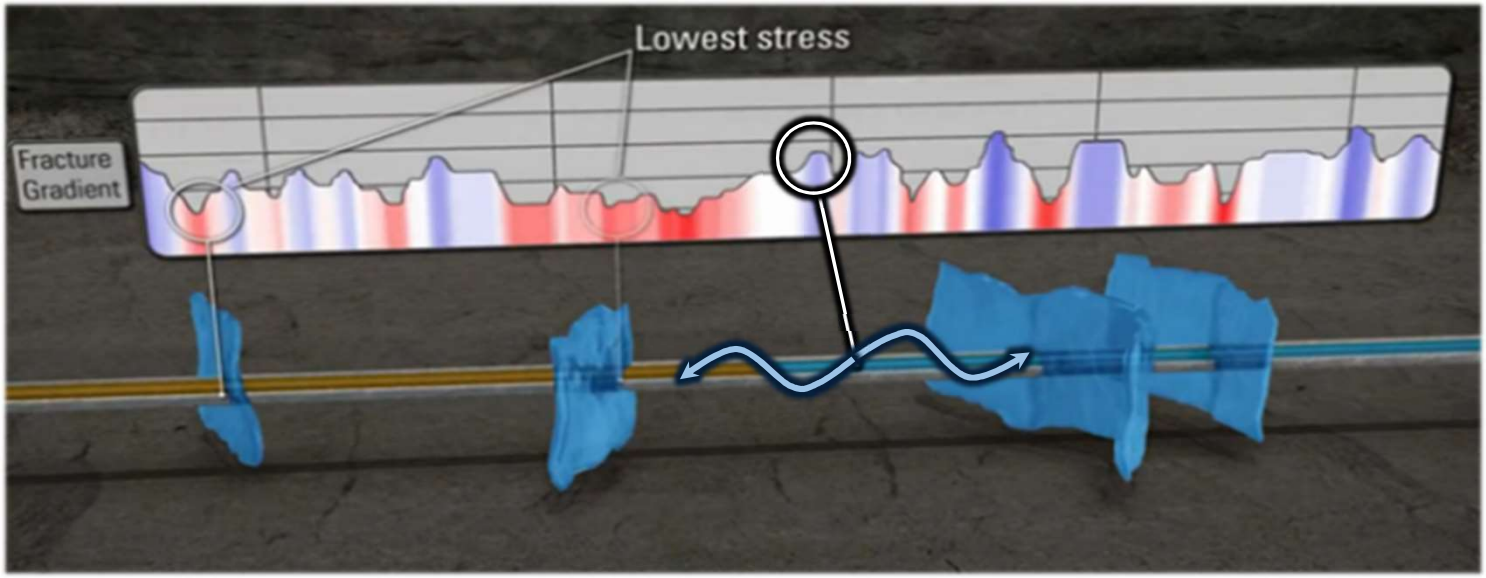


Source: EIA



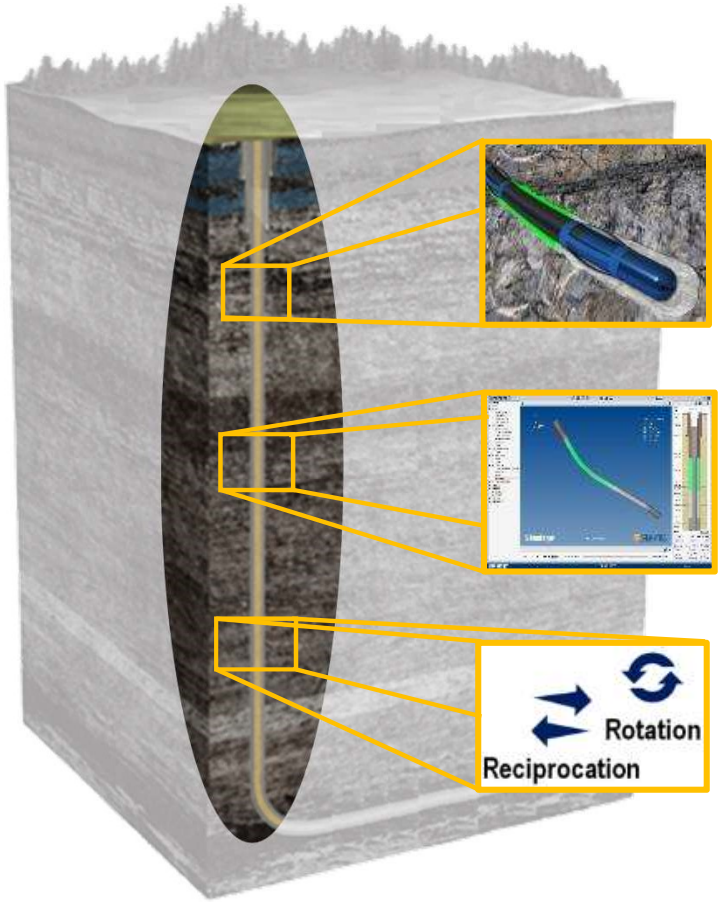
- Increase in horizontal drilling
- High eccentricity affects mud removal

Effect of cement on completion quality



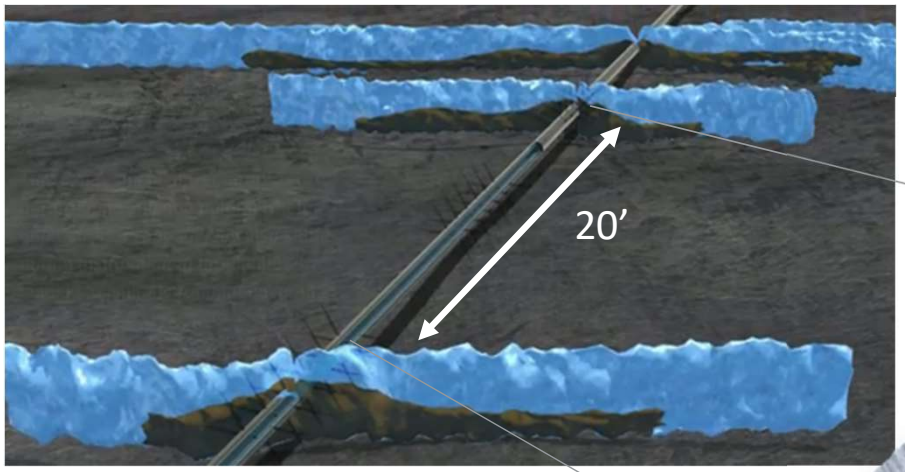
- Cement maximizes control of fracture initiation point
- Cement prevents fluid communication between intervals

Industry best practices



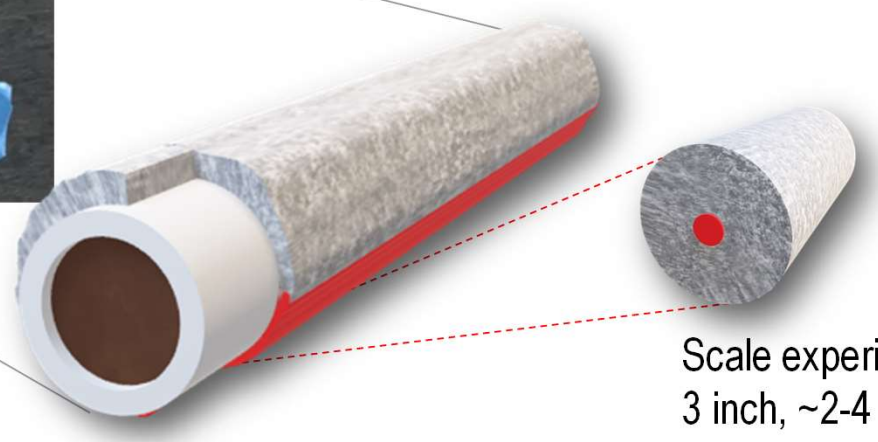
- SPE-173365 (Chevron) Selection of perforation clusters location based on cement quality
- SPE-181684 (Schlumberger) Fracture initiation process
- SPE-172937 (BP) Cement placement is critical for fracturing
- URTeC-2691375 (Schlumberger) Refracturing candidate selection
- JPSE 139, 254-263 (Texas A&M, Berkeley Lab) Incomplete cementing may cause shear failure
  - *Other literature is available because this is an area of increasing concern.*

Laboratory testing approach



Distance between stages: > 20 ft

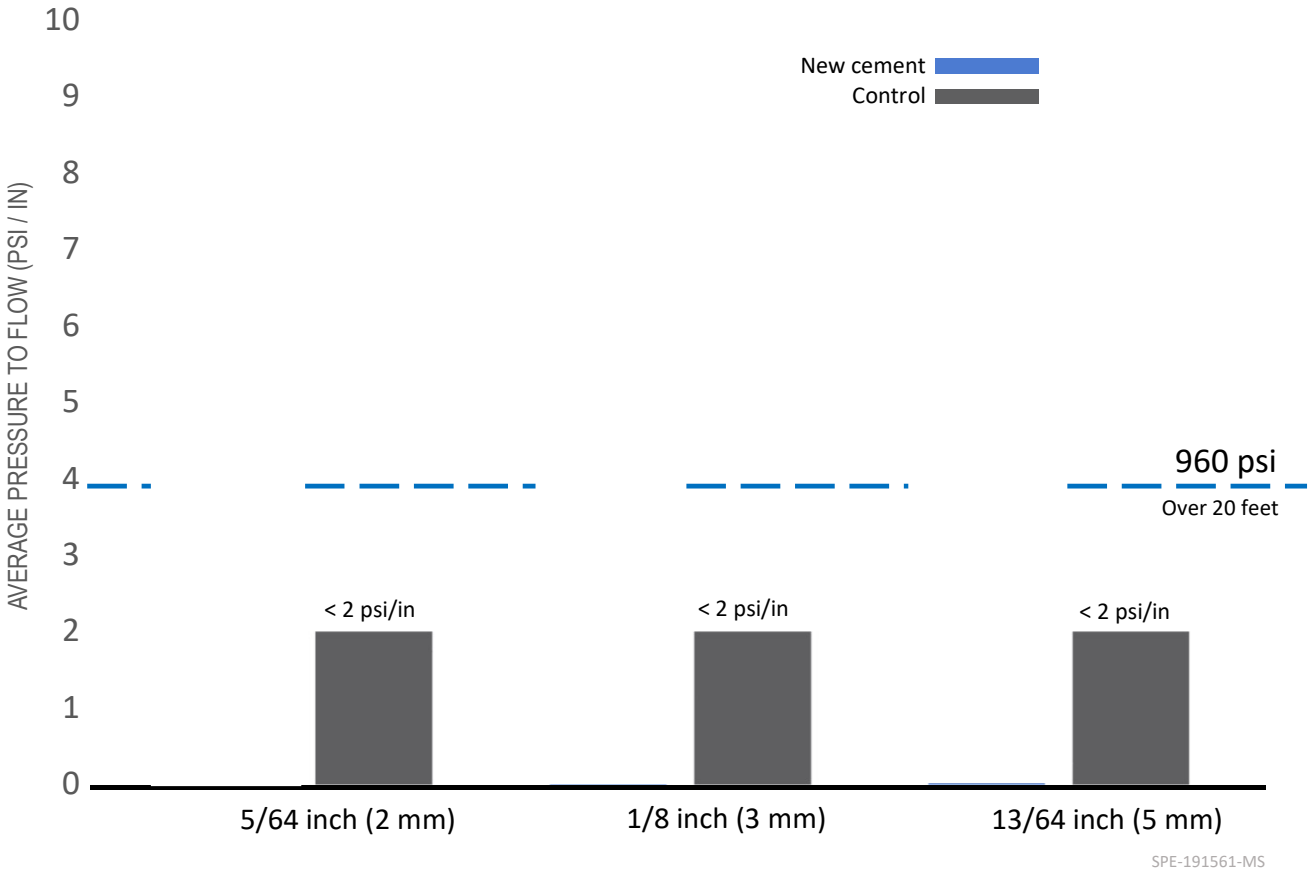
Average pressure difference: 500-1000 psi



Scale experiment:
3 inch, ~2-4 *psi/in*

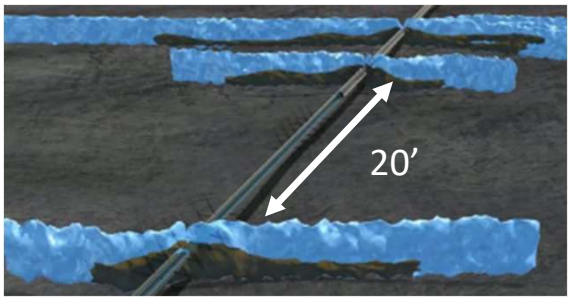
- Mud channel laboratory model with well-controlled parameters

Laboratory validation example



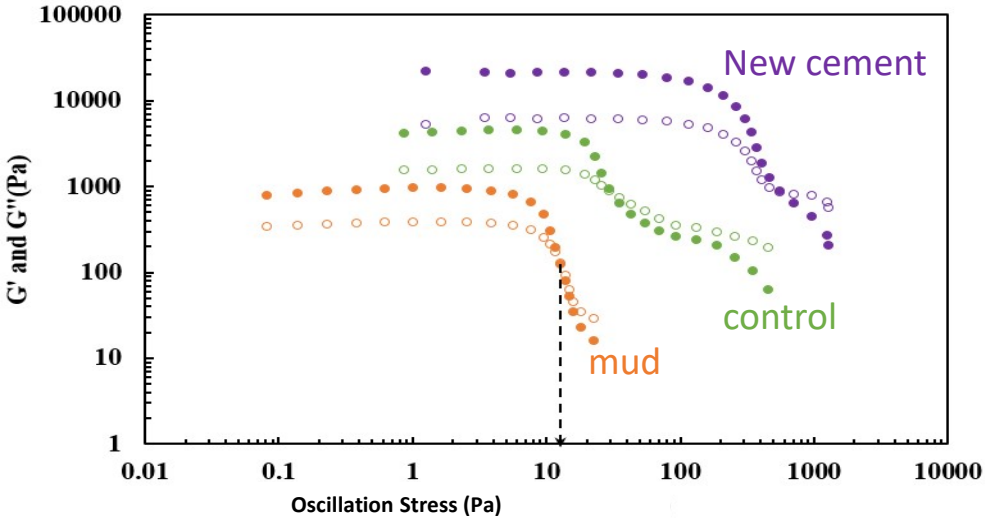
SPE-191561-MS

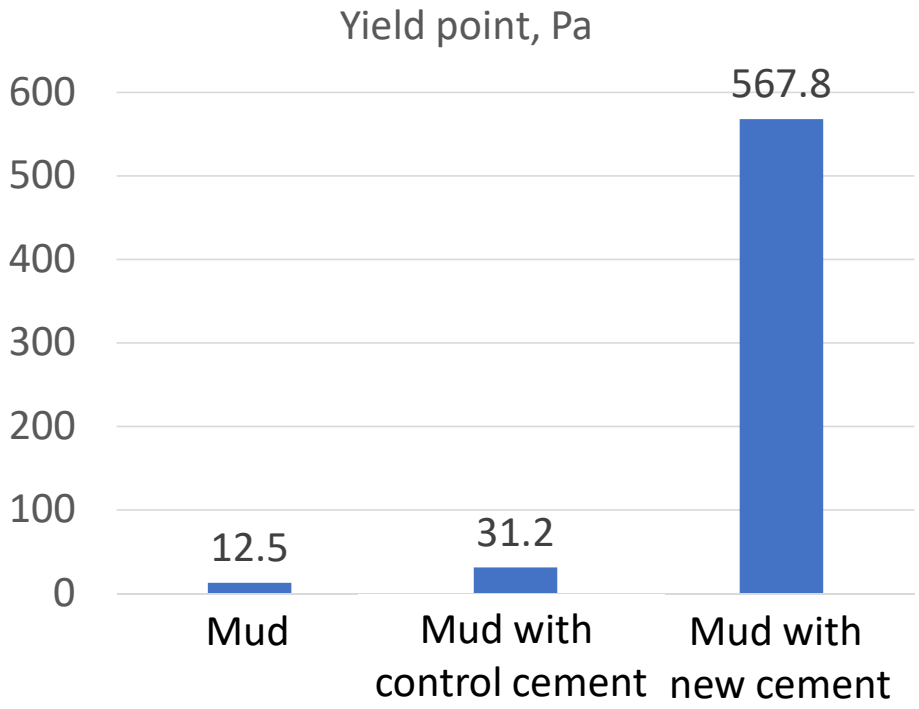
*13 lbm/galUS diesel-based mud



Mud resists flow under stimulation pressures

Drilling fluid rheology

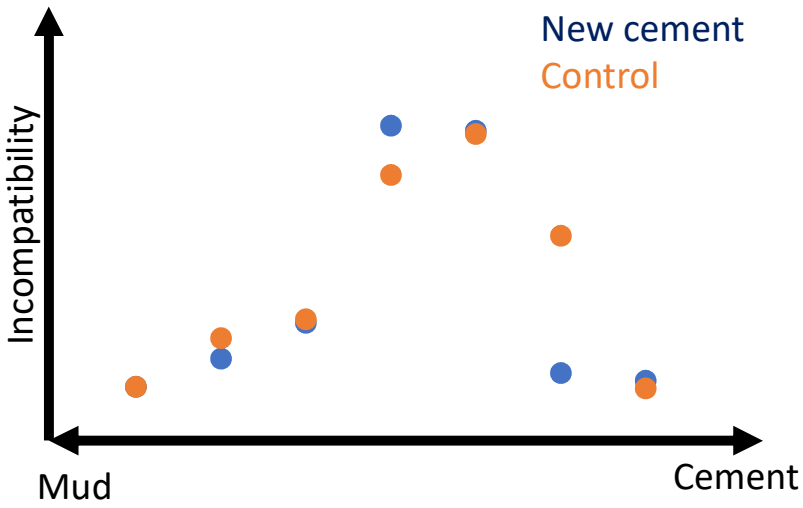


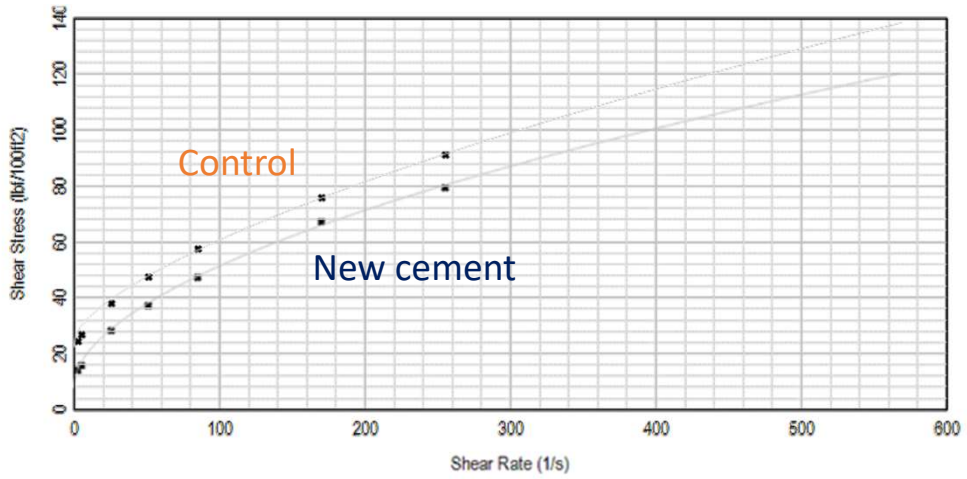


- Significant increase in yield point after 3 days


Fulcrum
Conventional
TRACEABLE®

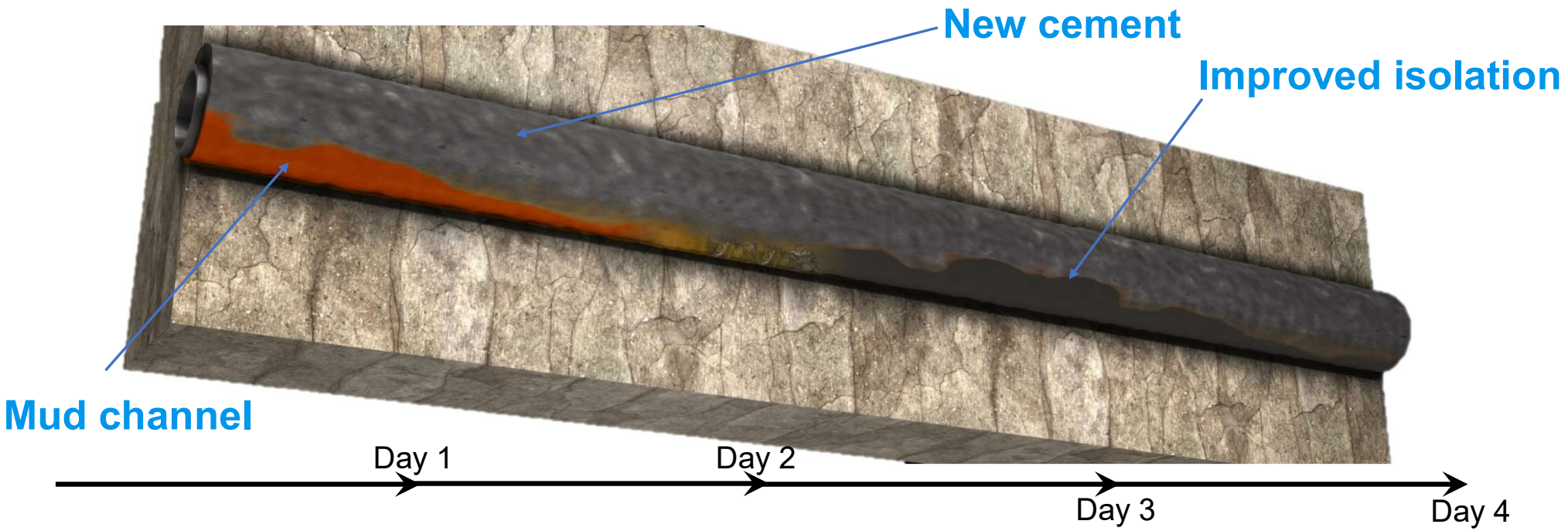
No effect on cement properties





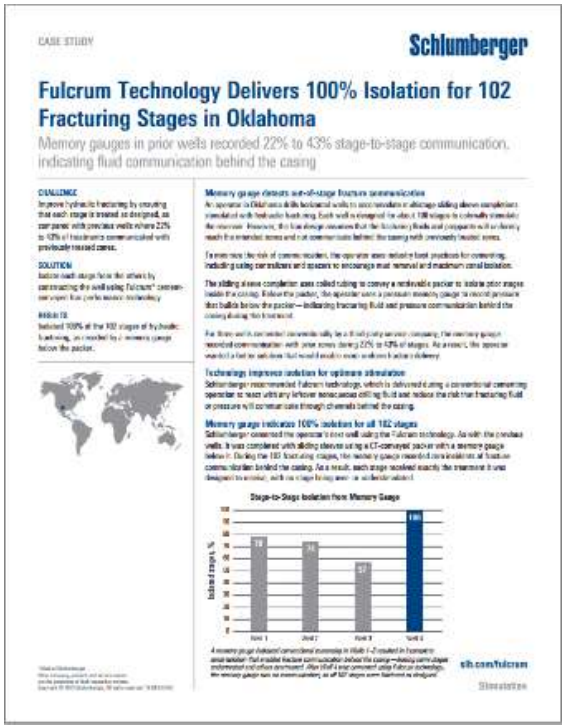
- No effect on cement rheology, mud compatibility, or mechanical properties

Isolation mechanism



- Turn remaining mud channels into a thick paste: channel mud rheology increase
- New approach in well cementing

Field cases



CASE STUDY

Schlumberger

Fulcrum Technology Delivers 100% Isolation for 102 Fracturing Stages in Oklahoma

Memory gauges in prior wells recorded 22% to 43% stage-to-stage communication, indicating fluid communication behind the casing

CHALLENGE

SOLUTION

RESULTS

Memory gauge detects out-of-stage fracture communication

Technology improves isolation for optimum stimulation

Memory gauge indicates 100% isolation for all 102 stages

Stage-to-Stage Isolation from Memory Gauge

slb.com/fulcrum

Stimulation

CASE STUDY

Schlumberger

Fulcrum Technology Improves Cement Bond Index by 55% in Horizontal Wells, Permian Basin

Cement-conveyed frac performance technology efficiently mitigates hole-cleaning challenges by altering mud mobility—without special equipment or cement designs

CHALLENGE

SOLUTION

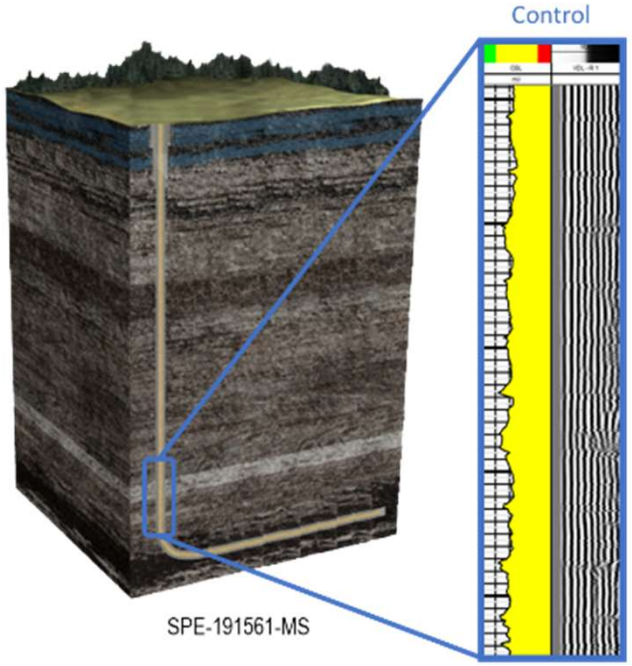
RESULTS

Cement system alters fluid mobility in mud channels

Logs indicate bond index improvement and minimized channeling

Additional details of the work are described in SPE-191561.

Cementing



Conclusions

- New approach in stage isolation
- First cement-to-fracturing technology
- Compatible with almost all cements and nonaqueous drilling fluids
- Next step in controlled drilling fluid – cement system