CSI TECHNOLOGIES
A SUPERIOR ENERGY SERVICES COMPANY

CEMENT SPACER DESIGN AND TESTING

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DEVELOPMENT DRIVEN. FIELD FOCUSED.

Agenda

- Basics of Spacer Design
- Surfactant Selection
- Spacer Effects on Cement
- Quality Control

The Makings of a Spacer

- Water
- Weighting Agent
- Viscosifier
- Surfactant Package (if needed)

Weighting Agents

- Spacer density should be greater than downhole mud weight and less than lead cement density.
- Typically barite.
- Alternatives:
  - Calcium Carbonate or Hematite

Viscosifiers

- Suspend solids, create stable non-settling fluid.
  - Important to test in actual well conditions.
- Two theories on spacer rheology:
  - Spacer should have uniform flow in eccentric annulus. Shear stress is not largely affected by shear rate.
  - Spacer rheology should be greater than downhole mud rheology and less than lead cement rheology.
  - Important in horizontals.

Surfactants

- Spacer may contain more than surfactant.
- Primary purpose is to water-wet casing and formation so that cement can bond properly.
- Selection by trial and error.
  - Screening test.

Surfactant Selection

- Three tests to base your decision on:
  - Reverse Emulsion Test
  - Rotor Test
  - Casing Coupon Test

Reverse Emulsion Test

- What it tells you: how much spacer is needed to turn an oil-external emulsion into a water-external emulsion.

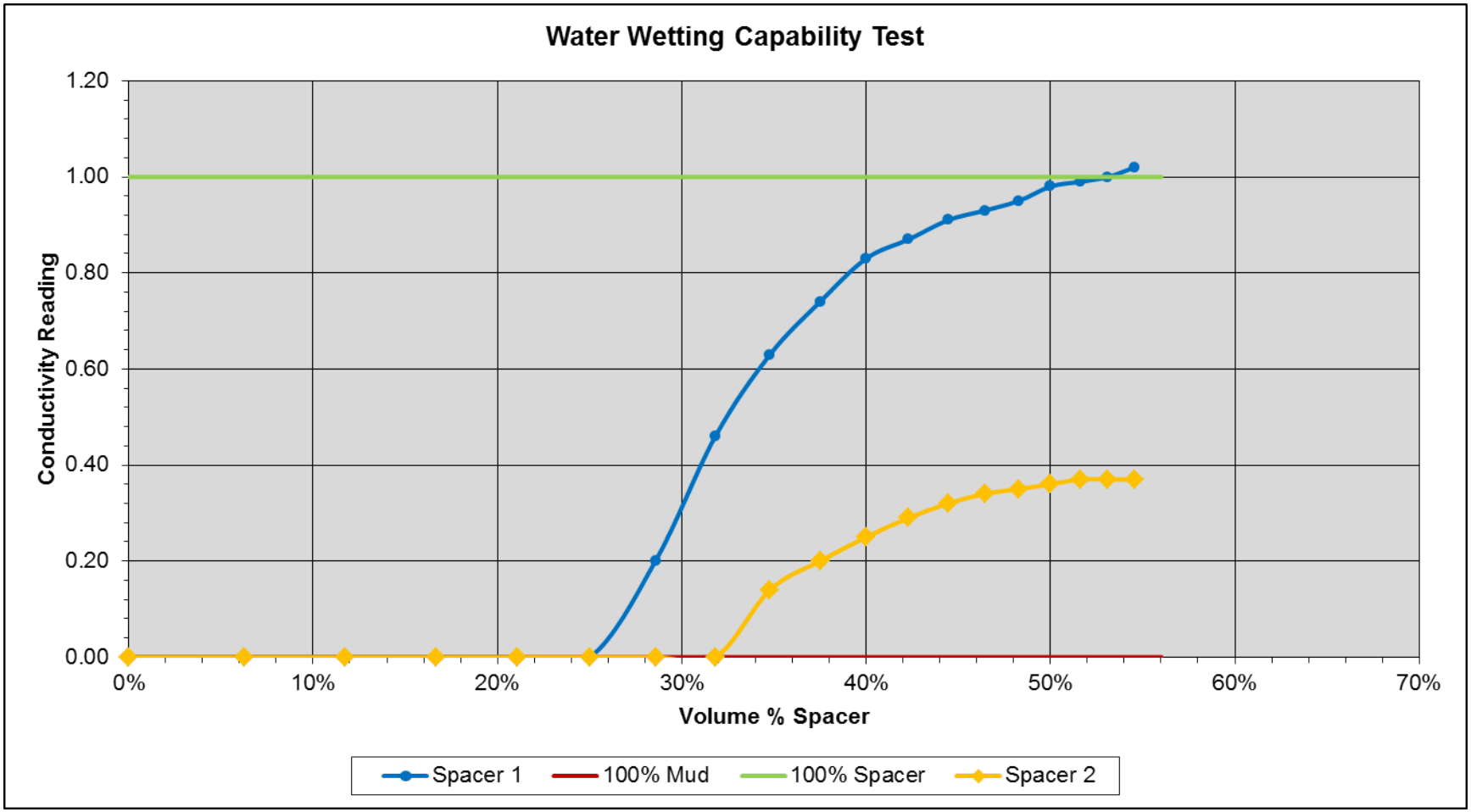
- Why it matters: OBM and SBM must have their emulsions flipped to water-external in order to fully remove the mud.

Reverse Emulsion Test

- How to do it: Pass an electric current through a mud sample. With OBM and SBM, the conductivity will be zero or very low. Titrate in spacer and monitor the conductivity versus spacer volume.

Reverse Emulsion Test

Reverse Emulsion Test



Rotor / Grid Test

- What it tells you: how effective a spacer is at eroding a mud filter cake.

- Why it matters: in order to achieve good cement to formation bond, the mud filter cake must first be removed

Rotor / Grid Test

- How to do it: Using a specialized rotor on a standard atmospheric rheometer, spin the mesh rotor in mud at 100 rpm for a set duration. Remove the rotor and weigh it. Mix the spacer, and spin the mud-laden rotor in spacer, checking weight every 5 minutes.

Casing Coupon Test

- What it tells you: how effective a spacer is for water-wetting a casing

- Why it matters: in order to achieve good cement to casing bond, the casing must be water wet.

Casing Coupon Test

- How to do it: Take a casing coupon and coat it in mud, wipe it down to leave a mud film. Attach it to the side of a rheometer fitted with a modified rotor and spin it for a set duration. Using a goniometer, measure the angle of a water droplet on both the spacer-washed side and mud film side. Compare these angles to values of untreated casing and Teflon tape.

Compatibility Testing

Current Rheology Compatabilities suggested by API	
Mud:Spacer	Spacer:Cement
0:100	0:100
5:95	5:95
25:75	25:75
50:50	50:50
72:25	72:25
95:5	95:5
100:0	25:50:25

Additional Compatibility Testing

- Spacer contaminated thickening time
  - Spacers with surfactant tend to retard.
  - Spacers without surfactant at HTHP can accelerate.
- Spacer contaminated compressive strength

Additional Compatibility Testing

- Spacer contaminated thickening time
  - Spacers with surfactant tend to retard.
    - Add a second spacer without surfactant to act as a buffer.
  - Spacers without surfactant at HTHP can accelerate.
    - Add retarder to the spacer if needed
- Spacer contaminated compressive strength

On-site QC

- Measure density and surface rheology on location prior to pumping.
  - Adjust weighing agent and viscosifier as needed to obtain similar properties to those tested in the lab.

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THANK YOU

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