Wellsite Cementing Quality Control – A Necessary Practice for Cementing Success

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Cementing has been an important part of wellbore isolation and stability for decades. Cementing, though, if not implemented properly can also be costly, resulting in wrong densities, incorrect displacement, flowback, micro annulus, etc. However, these issues can be avoided with experienced quality control practices. This paper outlines a practical approach to cementing quality control to ensure that the operator has the best opportunity to achieve successful cement mixing and displacement. Case histories are presented to demonstrate the importance of these quality control practices.

Cement has been employed for over a century in a number of industries, primarily construction. As a result, cement sold into the oilfield has never been the priority that the petroleum industry would like it to be. To improve consistency the petroleum industry with assistance from the American Petroleum Institute (API) developed standard practices for cement classification and testing. These standards provide the framework for cement performance. However, the variance in properties of available oilfield cements puts a strain on predictable performance of field blends. Thus, the need for cementing quality control practices applied at the wellsite is more paramount than ever.

KEY WELLSITE CEMENTING QUALITY CONTROL PRACTICES:

- Review cementing proposal.
- Review lab reports on field cement blends.
- Verify calculations for wellbore fill capacity and displacement volume.
- Verify float equipment to be used.
- Confirm correct plugs are loaded in cement head and verify tattle-tail wire.
- Observe labeling of blends on cement bulk units and verify that they match proposal.
- Employ pressurized mud scales to check cement mixing densities frequently.
- Retain wet and dry cement samples for storage.
- Observe and verify displacement.
- Ensure plug is bumped and floats held; observe any flowback volume.
- Monitor returns throughout the job.
- Complete material balance.

Review cementing proposal: The pumping service company cementing proposal should contain information on well depths, bottom hole temperature, mud type, recommended cement blends, spacers, densities, wellbore capacity, casing capacity, volume calculations, sacks of cement and required additives.

Review lab reports on field cement blends: Laboratory reports should include water analysis and field blend data such as thickening time, fluid loss, and compressive strength. The thickening time should exceed pump time (e.g. mixing and displacement) by at least 2 hours. For testing purposes it is important to have laboratory weights and testing parameters (e.g. temperature, pressure, ramp rates).

Verify calculations for wellbore fill capacity and displacement volume: Repeat calculations to ensure that fill capacities are correct and that enough cement is on site to complete the job requirements for the operator.

Verify float equipment to be used: Include at a minimum float collars and shoes.

Confirm correct plugs are loaded in cement head and verify tattle-tail wire: Witness plug loading into the cement head and document tattle-tail wire in place. Tattle-tail should be longer than the cement head.

Observe labeling of blends on cement bulk units and verify that they match the job proposal: Note the labeling of bulk units for identification of lead cement, tail cement, and # sacks in each pod.

Employ pressurized mud scales to check cement mixing densities frequently: Using pressurized scales eliminates the influence of entrapped air that can alter density measurements.

Retain wet and dry cement samples for storage: Retention of wet cement confirms that cement was able to set. Keeping dry cement samples enables one to test the cement post-job in the event of a well problem. Wet and dry samples are stored for 6 months.

Observe and verify displacement: Count pumping unit displacement tub volumes to confirm cement displacement. Washers can help as a physical tally. Barrel counters should not be employed.

Ensure plug is bumped and floats held; observe any flowback volume: Landing a top plug confirms displacement accuracy and signals that the cement job is complete.

Monitor returns throughout the job: Returns indicate that the float equipment did not hold, possibly due to too much lost circulation material. For excessive returns it may be necessary to displace again if thickening time permits.

Complete material balance: Record wellsite inventory before the job and record remaining inventory after the job.

CASE HISTORY # 1

Glasscock County, TX
5 ½”, 20 lb Production Casing
MD 14,182 ft TVD 9,266 ft
BHST 191°F BHCT 177°F
Well circulated 3 hours (bottoms up 3.5 times)
Backup cement pump present

Water Temperature:	80 F
Water Analysis:	Yes
Water Volume:	1360 BBL (3 transports, 2 tanks)
Mud Density:	12.5 ppg
Spacer Density:	13.0 ppg
Lead Slurry Density:	12.5 ppg
Tail Slurry Density:	14.2 ppg
Spacer Volume:	80 BBL
Lead Slurry:	221 BBL, 650 sacks 50:50:10 + 0.25 lb/sk LCM + 0.5% Fluid Loss + 0.15% Free Fluid Control + 0.3% Retarder mixed at 12.5 ppg
Tail Slurry:	384 BBL, 1500 sacks 50:50:2 + 0.7% Dispersant + 0.2% Fluid Loss + 0.8% Gas Control + 0.45 % Free Fluid Control mixed at 14.2 ppg
Reported Thickening time, Lead:	6 hours, 59 minutes
Tested Thickening time, Lead:	not tested

Reported Thickening time, Tail:	4 hours, 35 minutes
Tested Thickening time, Tail:	9 hours, 35minutes to 70 Bc

Mixing rate:	5 BPM
Displacement rate:	7 BPM
Total displacement, planned:	309 BBL
Total displacement, actual:	315 BBL

Latch down plug loaded & dropped
Plug bumped; Floats held.

Comments:
Total tail cement was 1700 sacks; actual job was 200 sacks less.
No laboratory data was made available at the wellsite by the pumping service company.
Laboratory test data was obtained post job from the pumping service company.
Cement mixing and displacement time: 3 hours, 18 minutes

CASE HISTORY # 2

Dimmit County, TX
5 ½", 20 lb Production Casing
MD 13,141'   TVD 7,604'
BHST 209°F   BHCT 199°F (based on temperature software)
Well circulated 2 hours
Backup cement pump present

Water Temperature:	72 F
Water Analysis:	Yes
Water Volume:	1002 BBL (2 tanks)

Mud Density:	11.4 ppg
Spacer Density:	12.6 ppg
Lead Slurry Density:	13.6 ppg
Tail Slurry Density:	16.4 ppg

Spacer Volume:	40 BBL
Lead Slurry:	196 BBL, 735 sacks 35:65:4 (Fly Ash: Class H: Bentonite) + 24 lb/sk Extender + 0.4% Retarder + 0.2% Defoamer mixed at 13.6 ppg
Tail Slurry:	371 BBL, 1944 sacks Class H + 0.3% Dispersant + 0.3% Fluid Loss + 0.1% Free Fluid Control + 0.4% Retarder + 0.2% Defoamer mixed at 16.4 ppg

Reported Thickening time, Lead:	7 hours, 23 minutes
Tested Thickening time, Lead:	8 hours, 39 minutes to 70 Bc

Reported Thickening time, Tail:	5 hours, 47 minutes
Tested Thickening time, Tail:	4 hours, 46 minutes to 70 Bc

Mixing rate:	5 BPM
Displacement rate:	5 BPM
Total displacement, planned:	289 BBL
Total displacement, actual:	289 BBL

Bottom and Top plugs loaded & dropped. Top plug bumped and floats held.

Comments:
Load sheet showed more cement at wellsite than actually present: 747 sacks Lead, 1945 sacks Tail
Cement mixing and displacement time: 3 hours, 32 minutes

COMMON OPERATIONAL ISSUES:

1) Unlabeled cement pods can result in Lead and Tail cements pumped in the wrong order.
2) Failure to observe loading cement wiper plugs can leave doubt about plug type and whether loaded.
3) Failure to observe release of cement wiper plugs can result in a "Wet Shoe" or over displacement.
4) Use of barrel counters instead of displacement tanks will lead to inaccurate displacement.
5) Excessive flowback when floats fail can contribute to the following:
    a. lower cement tops
    b. poor tail cement
    c. cemented toe sleeve
6) Failure to check densities during the job could result in poor quality cement and / or poor cement bond.

CONCLUSION:

Wellsite cement quality control can serve to prevent common operational issues and provide an independent detailed record of a cement job when reporting includes as follows:

- a detailed log of all events during the job
- verification of mud, spacer, and cement properties
- identification, labeling, and inventory of spacer and cement supply
- confirmation of water quality and storage volume
- loading and release of cement plugs (e.g. bottom plug, top plug, latch down plug)
- notation of rates and pressures
- material balance

NOMENCLATURE:

sk	sack(s)
ppg	pound per gallon
BBL	barrels
BPM	barrels per minute
MD	measured depth
TVD	true vertical depth
BHST	bottom hole static temperature
BHCT	bottom hole circulating temperature
LCM	lost circulation material
Bc	Bearden units of consistency

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Figure 1 – Use of Pressurized Mud Scale

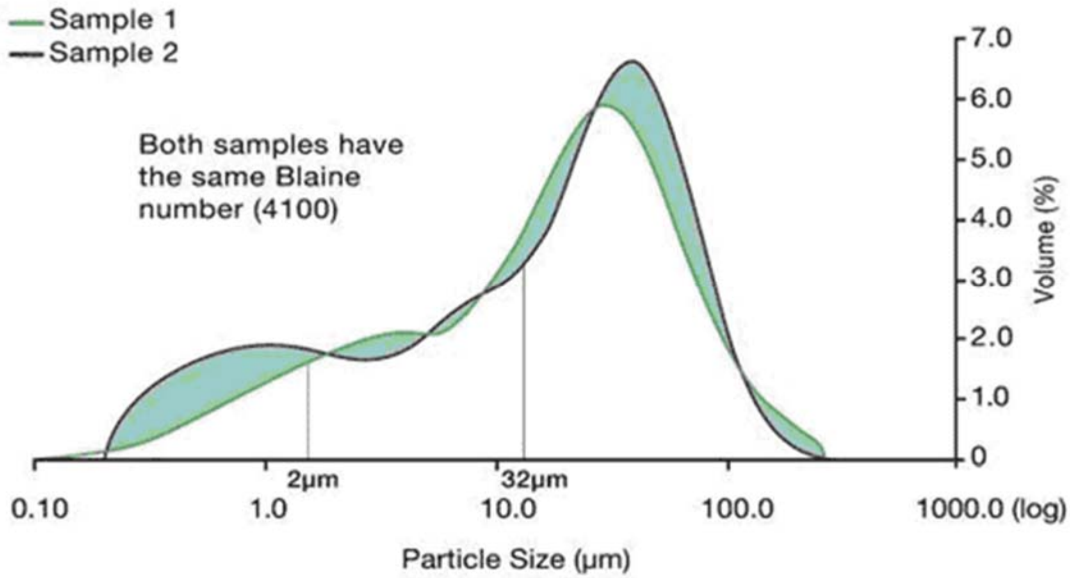

Figure 2 – Particle size differences impact cement consistency and performance

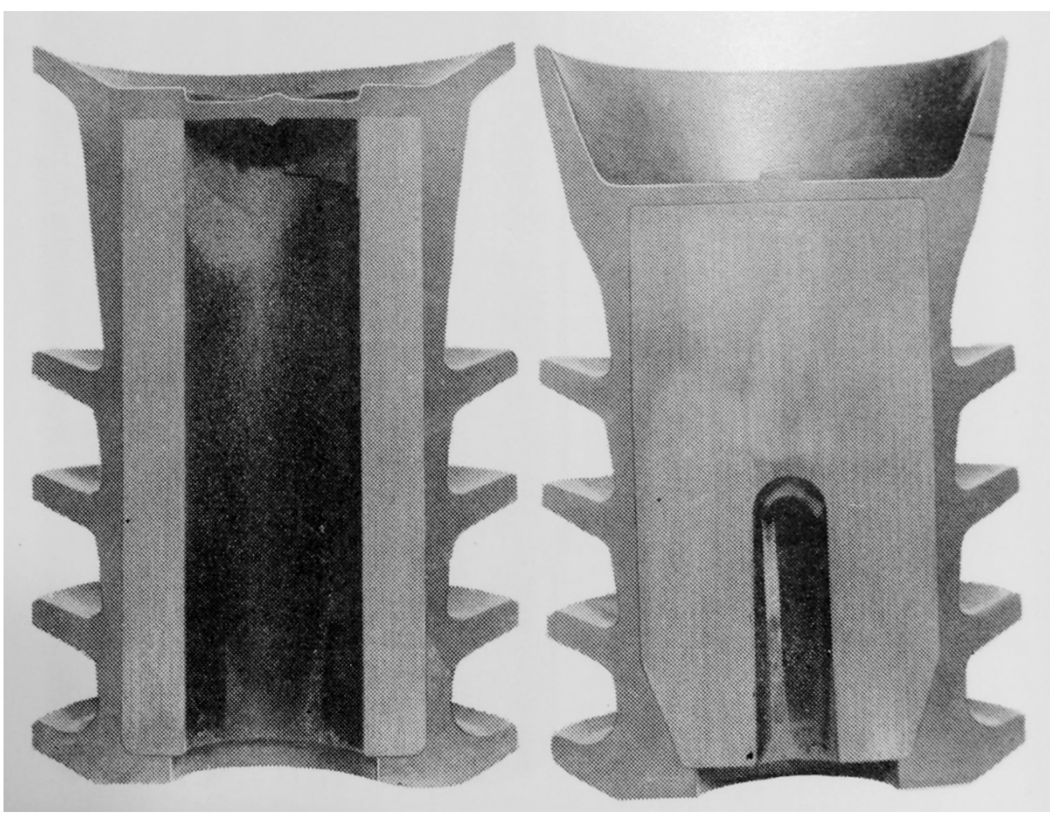

Figure 3 – Bottom (left) and Top (right) cement plugs used in well cementing