SCAL10345A use in Bakken fracs provides immediate and long-term scale control

SITUATION

The Bakken's combination of high TDS (>250,000 mg/L), high calcium (>20,000 mg/L), high iron (>100 mg/L), and high temperatures (>250 °F) limits the amount of highly effective scale inhibitors.

The use of scale inhibitors in frac jobs in the Bakken is common practice, as operators seek to control scale formation due to mixing of incompatible brines and self-scaling brines. Application during the frac job can provide scale inhibitor residual returns to protect against scale formation during flowback and early well life when conditions prevent continuous or batch application of product. Control of scale formation can also help alleviate other issues, such as erosion corrosion, potentially extending pump run times.

CHALLENGE

Whether using solid or liquid scale inhibitors, some wells see premature failures due to scale during early well life. At times, scale inhibitor residual was detected, but the product was not effective. Other times scale inhibitor residuals declined rapidly as the product did not provide sustained returns.

While scale inhibitor application in frac jobs is common, a scale inhibitor that has a suitable adsorption/desorption profile in Bakken environments is essential for successful scale inhibition following a frac job.

Value

Long-term scale control with single wellhead applications

ACHIEVED WITH SCAL10345A TREATMENT PROGRAMS

NALCO Champion

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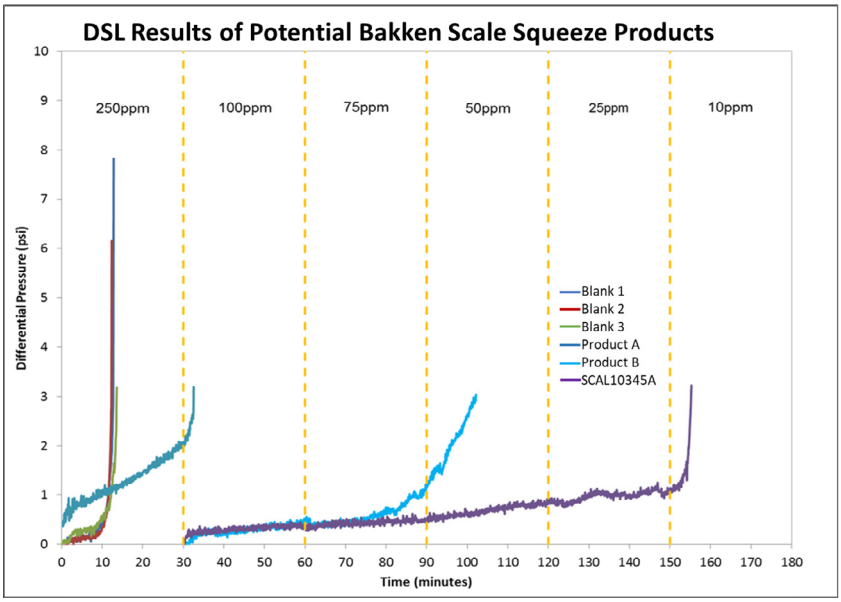


Dynamic Scale Loop (DSL) testing was conducted to determine the effectiveness of SCAL10345A under Bakken conditions in the presence of iron

SCAL10345A provides the following benefits:

- Highly effective against calcium carbonate in high calcium environments
  - As low as 10 ppm MED under Bakken conditions
  - Due to background phosphorous, minimum target MED is 15 ppm
- Brine compatibility
- Calcium and iron tolerance
- Thermal stability
- Adsorption and desorption with Bakken formations that allow for sustained residual returns

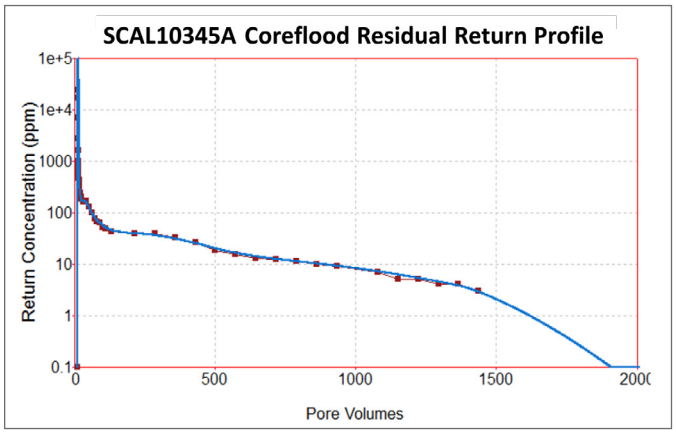
These capabilities have been documented in SPE paper SPE-184565-MS

INSIGHT

SCAL10345A has been proven to be the best-in-class scale inhibitor for calcium carbonate scale control in the Bakken, whether in continuous applications or in highly effective unconventional horizontal well scale squeezes.

Dynamic Scale Loop (DSL) testing was conducted to determine the effectiveness of SCAL10345A under Bakken conditions in the presence of iron. Nalco Champion's testing indicated that SCAL10345A was the best performing product with a MED of 25 ppm under test conditions. Additional testing with a third-party found that SCAL10345A performed at 10 ppm under the third party's Bakken test conditions.

When qualifying scale inhibitors for scale squeezes, a coreflood test provides information on the ability of the product to adsorb and desorb from formation rock. Using Bakken core samples, Nalco Champion found SCAL10345A provided a very good adsorption/desorption profile, indicating long-term residual return. This has been confirmed with over 600 successful Bakken scale squeezes (to date), with realized returns shown on the next page. The coreflood test result also demonstrates the ability for SCAL10345A to provide long term residual return after frac jobs.



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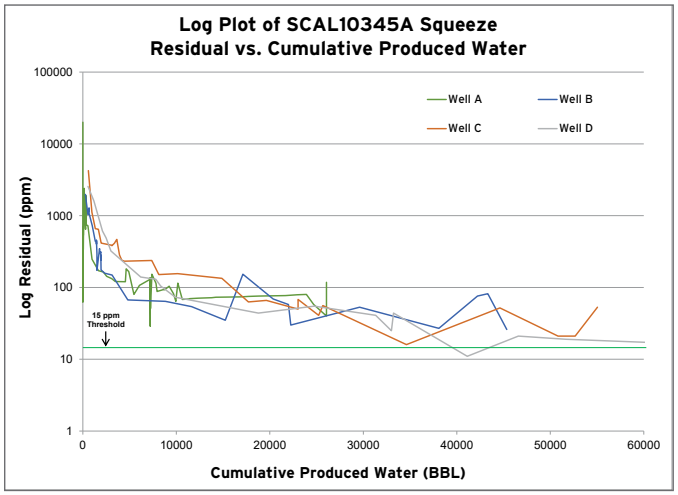


The squeezes were designed to protect a minimum of 60,000 BBL produced water.

Since the publication of these initial results, the squeezes have protected in excess of 60,000 BBL produced water.

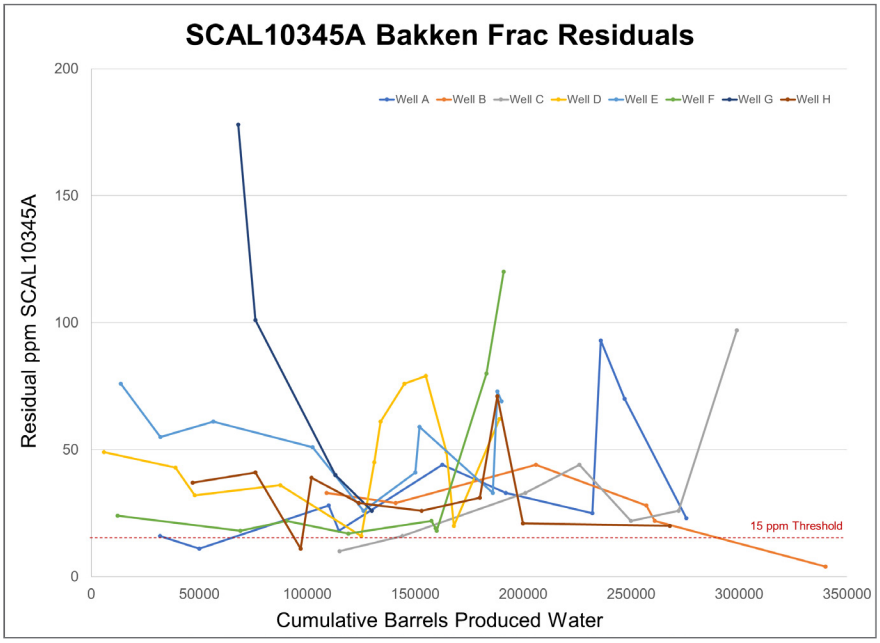
SOLUTION

SCAL10345A was tested with the operator's HVFR, slickwater, and crosslink systems and found it caused no issues. SCAL10345A was applied at 150 ppm throughout the entire frac job with no issues. This treatment method has provided SCAL10345A residual for 200,000 to 300,000 BBL produced water. Residuals were monitored to track product effectiveness and ensure the well was protected during flowback and early well life.

Nalco Champion's full lifecycle residual monitoring captures the full residual return, allowing for proactive treatment as frac residual reaches the MED threshold to avoid unnecessary well workovers due to scale.

RESULTS

The graph below shows realized SCAL10345A residual returns after application of SCAL10345A in frac jobs. These long-term returns have protected Bakken wells from scale formation during early well life. Coupled with scale squeezes later in well life, SCAL10345A provides Bakken operators the ability to control carbonate scale formation through the life of a Bakken well.



Frac returns - the dashed red line is the threshold for residual returns to be effective

Nalco Champion
Global Headquarters
11177 S. Stadium Dr.
Sugar Land, TX 77478
Telephone: +1-281-263-7000

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