

First NOV 15K Multi-Entry Cemented MSF Deployed in a Tight HPHT Reservoir

Successful trial 15,000-psi cemented MSF installation with major Middle East Operator.

Background

A major Middle East operator approached NOV with an opportunity to develop a true 15,000-psi cemented MSF system for their tight, high-pressure, high-temperature (HPHT) gas field.

The operator was facing many challenges in deploying open hole MSF systems to setting depth in deep wells with long laterals targeting their tight HPHT reservoir. These deployment challenges resulted from multiple factors such as formation breakdown pressure, dogleg severity, and open hole wash-out.

These challenges have limited the number of stages the operator was previously able to deploy with open hole MSF systems, and – in some cases – forced switching to less preferable completions, thereby increasing cost and jeopardizing expected production.

For technical acceptance by the operator, a series of rigorous tests were performed. Following technical acceptance, a field trial was commissioned using the following criteria:

- Successful installation and deployment without mechanical failure.
- Perform well cementing operations without prematurely opening sleeves and with clear wiper plug bump on NOV landing collar.
- Complete frac operations with indication of successful zonal isolation across stages and 13,000+ psi differential pressure down hole across all stages, thereby ensuring proper activation of multi-port sleeves.



Case study facts

Location: Middle East

Product Specifications

- 15K i-Frac Flex CEM
- i-Seat
- BPS Maxx Toe Initiator
- Landing Collar/Wiper Dart

General Well Information

- Liner Size: 4.50-in. 15.1 ppf (114.3-mm 10.15 kg/m)
- Open Hole Size: 5.875-in. (148.23-mm)
- Well TVD: 14,167-ft (4,318 m)
- Well TD: 20,916 ft (6,375 m)
- Temperature: 306°F (152°C)
- Number of Stages: 10, Acid Frac
- Max. Surface Treating Pressure: 13,562 (94 MPa)
- Max. Bottom Hole Pressure: 19,037 psi (131 MPa)



Case Study

Solution

NOV developed the 15K i-Frac cemented (CEM) system using our industry-leading frac system as the starting point. Our extensive experience deploying both cemented and non-cemented MSF as well as our deep understanding of the region were critical in the product development process. Furthermore, our existing portfolio of i-Frac CEM ball-drop systems developed for various reservoir environments and customers proved crucial in rapidly designing and developing the 15K i-Frac CEM with Multi-Cluster design for 5.875-in open hole wells qualified to 15,000 psi at 350°F for this trial. The system was designed to have multiple entry points per stage to ensure full stimulation across each section to overcome the challenge presented by the tight formation. Additionally, the system enables more efficient frac operations with no WL and milling operations required and no downtime between stages.

Additional pressure cycle testing was conducted to simulate worst-case stimulation pressures. The 15K i-Frac CEM was tested to 15,000 psi differential pressure at 350°F. Then functionality testing was performed, including opening the frac sleeve to confirm Multi sleeve opening/activation.

The i-Seat also successfully passed an internal pressure test using 15,000 psi at 350°F, followed by ball-on-seat testing with non-dissolvable balls to ensure superior isolation between stages.

The BPS Maxx toe initiator utilizes a streamlined design with no moving parts and was selected due to well-known reliability. This technology is fully qualified for applications up to 400°F and can range in absolute opening pressures from 8,000 to 21,000 psi.

The Landing Collar is a simple and robust tool compatible with our NOV Superdart and is run above the shoe track of a cemented completion that includes a ratchet mechanism to lock the cement wiper dart in place once bumped. The Landing Collar and wiper dart have been pressure tested to 15,000 psi differential pressure.

Results

In July 2022, 10 stages with 3 entry points in every stage were deployed successfully to setting depth with no issues, the cementing operation was completed with clear indication of plug landing on landing collar and pressure integrity test was performed on the casing.

During deployment, the following challenges were eliminated with the i-Frac CEM System:

- Wash-out and DL severity, simple deployment with ability to rotate while running in hole to overcome any open hole ledges.
- Fewer lower completion components to be deployed in open hole.
- Simplify cementing operations with a specially designed single dart to wipe both drill pipe & liner casing.

The multistage stimulation with a maximum rate of 40.8 BPM and bottom hole pressure of 19,000 psi was performed in Nov 2022. Each stage was stimulated, and the ISIPs pre and post-fracturing indicated excellent isolation was achieved all while maximizing operators' efficiency in successfully completing Frac of 10 stages in less than 5 days.

Through the implementation of NOV i-Frac 15K CEM multi-port system the middle east operator was able to:

- Maximize stimulated lateral length, no stages were sacrificed due to deployment challenges or open hole condition.
- Guaranteed isolation between stages with cement.
- Allow continuous stimulation operation with no additional interventions or downtime between stages. No milling or perforation required.
- 15K Slim multi-port cemented frac sleeve design per stage maximized the chances of formation breakdown in a single stage — using single ball to open all sleeves — allowing the stimulation of all 10 stages without coiled tubing intervention in between.

For challenging HPHT completions, industry operators no longer need to compromise on performance. The latest NOV cemented frac system opens the door to target and stimulate reservoirs that were previously out of reach because of higher formation breakdown pressures.