

BroadBand Sequence Service Enables Successful Fracturing of Openhole Section

Sequenced fracturing service enables remedial stimulation of 901-ft section in Bakken well with stuck casing

CHALLENGE

Stimulate 901-ft [275-m] openhole interval in completion with casing that had not reached the planned depth.

SOLUTION

Apply the BroadBand Sequence* fracturing service to enable efficient and effective temporary isolation of previously initiated fractures and induce stimulation of the entire interval of interest.

RESULTS

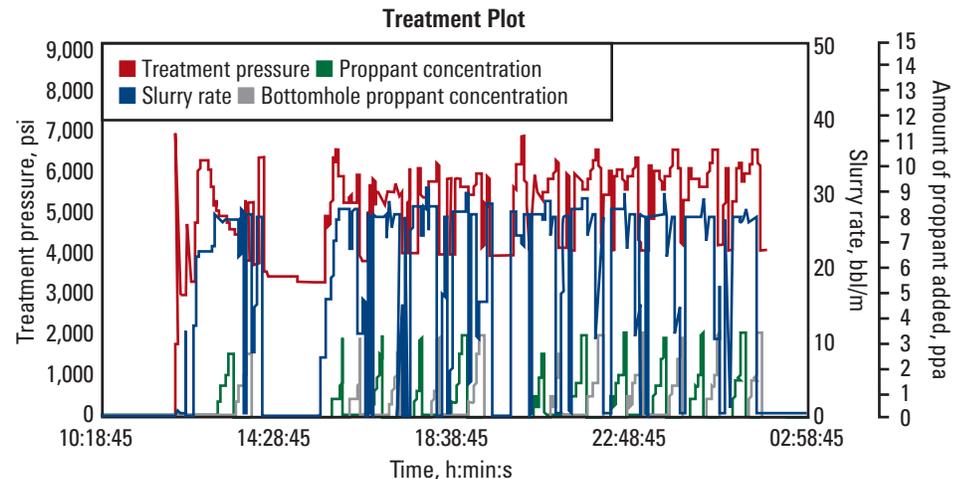
- Stimulated target interval with 11 stages and 10 BroadBand Sequence service treatments.
- Increased fracture initiation pressure consistently with total gain of 1,376 psi during the treatments.
- Flowed well with higher initial production rate and at a higher pressure than its direct offsets.



Openhole completions in the Williston basin

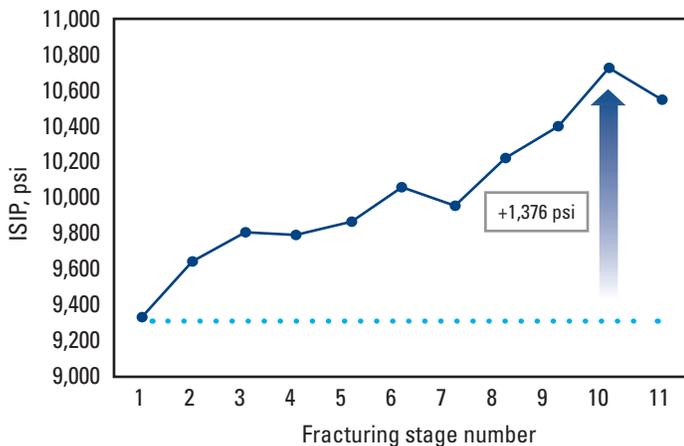
A large Bakken operator in the Williston basin with approximately 330,000 net acres in the play needed to stimulate a section of a well with stuck casing. New wells are completed to a TD in excess of 21,000 ft [6,400 m] with TVDs of 9,800–11,200 ft [2,987–3,414 m], fracture gradients in the range of 0.85–0.95 psi/ft, and a bottomhole temperature range of 220–250 degF [104–121 degC]. Typical horizontal completions use noncemented casing with the plug-and-perf technique.

An unexpected event took place during the setting of the casing in a horizontal completion in the Bakken formation with TD planned for 21,200 ft [6,462 m]. The 4½-in, 13.5-lbm P-110 casing being placed in the hole became stuck with the end of casing at 20,610 ft [6,282 m] not reaching TD. After several unsuccessful attempts to move the casing forward, the operator decided to consider options for the well stimulation phase. Initial alternatives included abandoning the toe section, leaving it unstimulated, or pumping a single fracturing treatment with the expectation that a large fraction of the interval would not be properly stimulated.

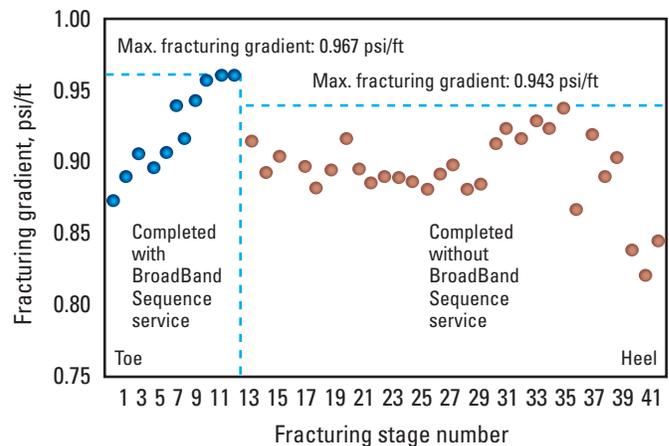


Treating plot for 11 fracturing stages featuring a composite pill pumped in between, followed by shut-in to measure instantaneous shut-in pressure (ISIP). The continued increase in average treatment pressure in subsequent fracturing treatments is indicative of sequential initiation of fractures in entry points with higher initiation pressure.

CASE STUDY: Sequenced fracturing service successfully stimulated openhole interval, Williston Basin



ISIP measurements showed progressive increase towards new rock with higher fracture initiation pressure with use of the BroadBand Sequence service.



The BroadBand Sequence service enabled stimulation of additional fracturing gradients (blue) that otherwise were not reached in other sections of the lateral where the service was not implemented (red).

Schlumberger partnered with the operator to efficiently stimulate their new completions and provide technology and solutions for the challenges of this basin that is a key growth area for global reserves.

Effective solution through sequenced fracturing

Faced with the undesirable prospects of either abandoning the toe section or leaving a significant interval of reservoir untreated, the operator chose instead to address the unexpected completion issues with aid of the BroadBand Sequence service. The deepest swell packer reached 20,287–20,299 ft [6,183–6,187 m], leaving a 901-ft [275-m] toe interval open for stimulation, most of which was not confined by the casing. This long openhole section was stimulated with 11 fracturing stages and 10 BroadBand Sequence service composite pills. The fracturing stages were pumped sequentially in 14 hours and without the use of mechanical aids such as bridge plugs or inflatable packers. The composite pills were pumped between fracturing stages to enable temporary isolation of previously stimulated entry points.

A shut-in was applied after placing each composite pill to monitor changes in the fracturing gradient. ISIP measurements captured at the end of each stage showed progressive increases. Once this interval was treated, a bridge plug was set at the end of the casing and the remainder of the well was completed as planned with the plug-and-perf technique.

More contact with the reservoir with outstanding completion efficiency

A total gain in ISIP of 1,376 psi with a maximum fracturing gradient of 0.967 psi/ft was recorded. Furthermore, the rest of the well was stimulated as per the original completion plan with 31 additional stages and without the use of the BroadBand Sequence service. The maximum fracturing gradient measured for the rest of the lateral was 0.943 psi/ft.

After finalizing all fracturing operations, the well was put in production using the same choke size as direct offset wells. The operator confirmed that the well treated with the BroadBand Sequence service had a higher initial production rate and flowed at a higher pressure than its direct offsets. Also, Broadband Sequence service materials were not observed during flowback at surface or during well cleanout operations. These results demonstrate the ability of the BroadBand Sequence service to stimulate high-stress openhole areas that otherwise would likely remain untreated with conventional fracturing techniques.

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