

BroadBand Sequence Service Stimulates Wells with 50% Less Diverter Material, Bakken Shale

High-pressure injector technology and large-particle diverter pills improve operational efficiency in wide fractures and reduce job time

CHALLENGE

Reduce stimulation time and diverter volumes without detrimental effect on productivity.

SOLUTION

Optimize the BroadBand Sequence* fracturing service design with diversion pills comprising larger particles, and deliver concentrated pills with a high-pressure injector.

RESULTS

- Reduced diverter volumes by 50%.
- Enabled real-time mixing of diversion pills while pumping, thereby improving operational efficiency.
- Reduced time to achieve 1,500 psi [10 MPa] diversion pressure by 70%.



Openhole diversion challenges traditional pills

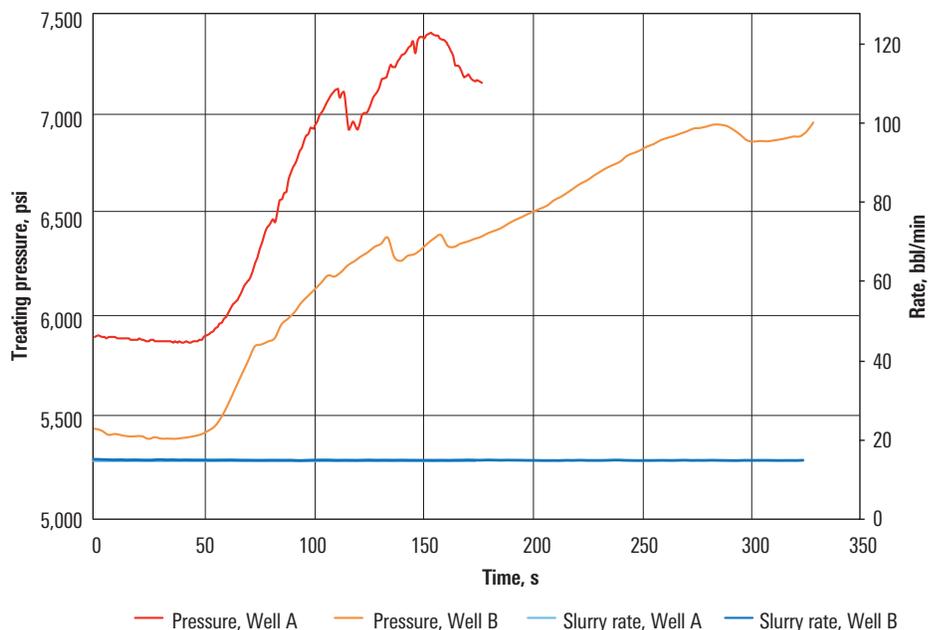
An operator in the Bakken Shale typically completes wells with uncemented liners and swell packers. The wells are stimulated in plug-and-perf operations with average interval lengths of 300 ft [91 m] containing three to four perforation clusters each.

The challenge of optimally stimulating such wells is that fracture initiation is not controlled by perforations, and fracture widths can be quite large. As a result, treatments based on traditional multimode diverter pills are challenged to fully block the fractures and divert fluids. In one example well, each stimulation stage required 40 lbm [18 kg] or more of diverter material and waiting times as long as 5 minutes to determine whether the diversion was successful.

Injected large particles bridge fractures rapidly

For the next well, Schlumberger proposed a BroadBand Sequence service design based on new diverter pills using larger particles mixed with fibers and smaller particles, delivered in a high-pressure injector. The large particles were designed to block a fracture or perforation and the smaller particles to reduce the remaining permeability and create temporary isolation. Fibers ensure the integrity of the blend from surface to near-wellbore and enhance bridging.

The high-pressure injector system is installed downstream of a high-pressure pump to rapidly deliver a concentrated pill to the perforations for quicker pressure response and more consistent diversion results. The system also eliminated the dedicated equipment previously used to mix and pump the pill, reducing equipment on location.



The diversion pill with larger particles injected into Well A achieved diversion pressure 70% faster (93 s) compared with a conventional pill delivered using a conventional delivery system into Well B (282 s).

Rapid, efficient diversion with less material

The service design with large-particle pills was used in a newly drilled openhole well with a swell packer completion. The 10,900-ft [3,322-m] well had 58 intervals with three to four perforation clusters per interval and a bottomhole static temperature of 220 degF [121 degC]. The objective was to execute 58 hybrid stages at 60 to 65 bbl/min [9.5 to 10.3 m³/min] with diversion pills injected between proppant stages and squeezed into perforations while pumping at 20 bbl/min [3.2 m³/min].

The new stimulation design diverted fluid from the wide fractures more efficiently compared with prior designs using conventional diversion systems. On average, the new design achieved 43% higher diversion pressure per pound of diverter pumped. As a result, the designs reduced diverter volumes by at least 50% compared with designs based on conventional diverters: A total of 57 pills were deployed in the campaign, achieving diversion (1,500-psi [10-MPa] pressure) with only 5 to 20 lbm [2 to 9 kg] of diverter material compared with an average of 40 lbm [18 kg] required for conventional diverter pills diluted for conventional delivery.

In addition to dropping the volume of diverter material required, the injection system reduced the waiting time to confirm diversion by as much as 70%. The operator was satisfied with the reliable diversion, operational efficiency, and simplified quality control.

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