

North Sea Operator Doubles Injection Rate After Efficient Diversion Stimulation of Long, Ultralow-Temperature Interval

OpenPath Sequence service diverts acid to uniformly stimulate a long interval, enabling return to injection after rapid diverter dissolution

To uniformly stimulate a long interval in a North Sea injection well, an operator used efficient technology that diverts acid stimulation fluid and then dissolves rapidly, even in an ultralow-temperature reservoir.

Improve injectivity in a long, low-temperature well

To restore the performance of an injection well through a chalk reservoir with average bottomhole temperature near 70 degF [21 degC], the operator needed an economical means of ensuring complete stimulation of the long (500-ft), heterogeneous interval with the smallest possible volume of acid.

Divert treatments from high-permeability rock

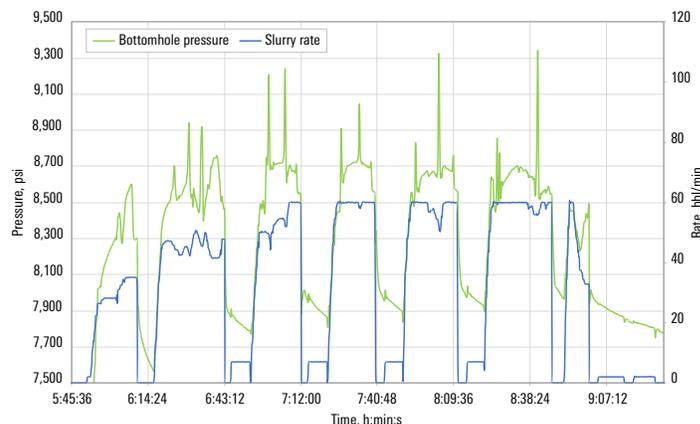
Diverters such as rock salt and nitrogen foam have long been used to divert stimulation fluids from high-permeability reservoir segments for more uniform coverage of long intervals. For the North Sea wells, rock salt dissolved too quickly, resulting in little or no pressure response indicating diversion. Diversion with nitrogen foam was inconsistent and required specialized equipment that limited its application. A third alternative, a low-temperature polylactic acid (PLA) diverter, is not optimal for these conditions because it dissolves slowly at lower temperatures.

Ensure diverter dissolution at low temperatures

OpenPath Sequence* diversion stimulation service integrates modeling, near-wellbore diversion, and a fluid system to suit reservoir conditions, type of completion, and treatment requirements. The diversion system uses composite pills engineered to address specific challenges—including ultralow bottomhole temperatures that prevent complete dissolution of conventional diverters.

Stimulate a 200% improvement in injectivity

Delivered from the *Island Centurion* stimulation vessel, the stimulation treatment comprised 1,800 bbl of low-pH crosslinked gel and 1,300 bbl of 28% HCl pumped over five cycles with four pills of the ultralow-temperature diverter. Each diverter pill generated sustained bottomhole pressure increase and diversion pressure spikes of 300 to 700 psi.



Engineers designed the OpenPath Sequence service with five cycles and four pills of the ultralow-temperature diverter, which generated pressure spikes indicating diversion.

Before stimulation, the first target well's water injection rate was 5,000 bbl/d. After stimulation, the well was brought online with an initial water injection rate of 15,000 bbl/d, which stabilized at 11,500 bbl/d. The treatment was calculated to have improved relative stimulation efficiency[†] by more than 200% as compared with six earlier treatments using rock salt. The efficiency of the ultralow-temperature diverter indicated that its more complete diversion enabled the acid stimulation fluid to reach more of the perforated interval. No specialized equipment was required, and the well was returned to injection rapidly after treatment.

Technical details

Additional details of the case are presented in OTC paper 31246.

[†] Relative stimulation efficiency is a measure of the volume of acid pumped per foot of perforated interval per barrel of injection or production improvement.