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PURE

Clean perforations system

APPLICATIONS

- Perforated completions in consolidated reservoirs with permeabilities >0.5 mD and pressures >1,200 psi

ADVANTAGES

- Increased well productivity and injectivity
- More effective acidizing and hydraulic fracturing treatments
- Reduced volumes of treatment fluids
- Minimal disruption of cement-sandface hydraulic bond
- Customized software to create and control dynamic underbalance for optimal results
- Large dynamic pressure differential from modest initial static underbalance or overbalance
- Higher effective shot density

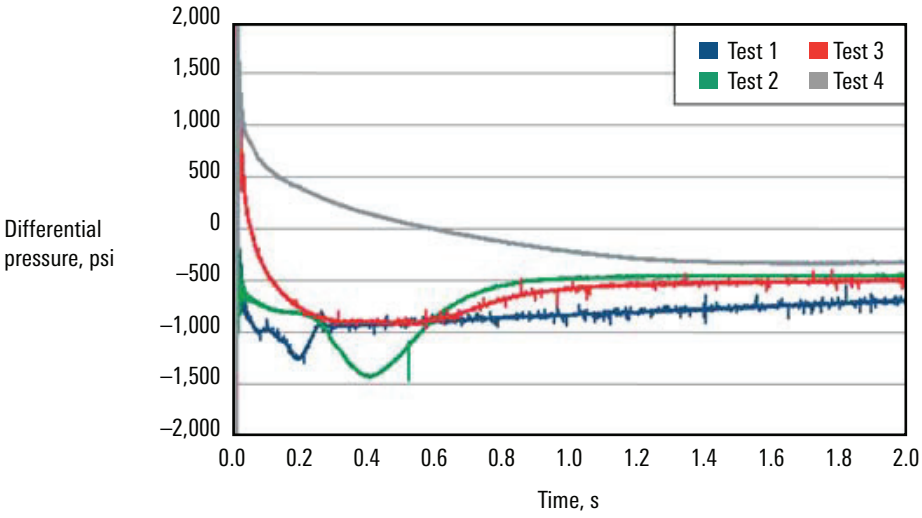
Dynamic underbalance increases productivity

The PURE* clean perforations system optimizes the dynamic underbalance, the transient underbalance produced just after the perforation cavity is created. Underbalanced perforating is the preferred method of removing perforation debris and crushed-zone damage, resulting in more-productive perforation tunnels. The required pressure differential between the reservoir and the wellbore (the required degree of underbalance) depends mainly on rock properties such as permeability and strength. Hard and tight rocks, for example, may need as much as 4,000 psi of underbalance.

The PURE system uses specialized hardware for job planning and productivity predicton to design a unique perforating system and completion process that will generate and control the optimal dynamic underbalance for a specific well, starting from a modest static pressure differential. By taking into account the properties of the reservoir, wellbore, and gun string, the system consistently minimizes or eliminates perforation damage and maximizes productivity.

Perforation cleanup is independent of initial underbalance

Conventional perforating relies on a large, static, initial underbalance that is established before the guns are fired and is based on estimated reservoir pressure. Experiments at the Schlumberger Productivity Enhancement Research Facility (PERF) in Rosharon, Texas, have shown that it is the maximum dynamic underbalance—not the initial underbalance—that governs perforation cleanup. In the tests, wellbore pressure was found to vary considerably during the half-second immediately after the charges were detonated.



Differential pressure (between the simulated wellbore pressure and the pore pressure) for tests 1 through 4 showed that the maximum dynamic underbalance varied from 400 to 1,300 psi.

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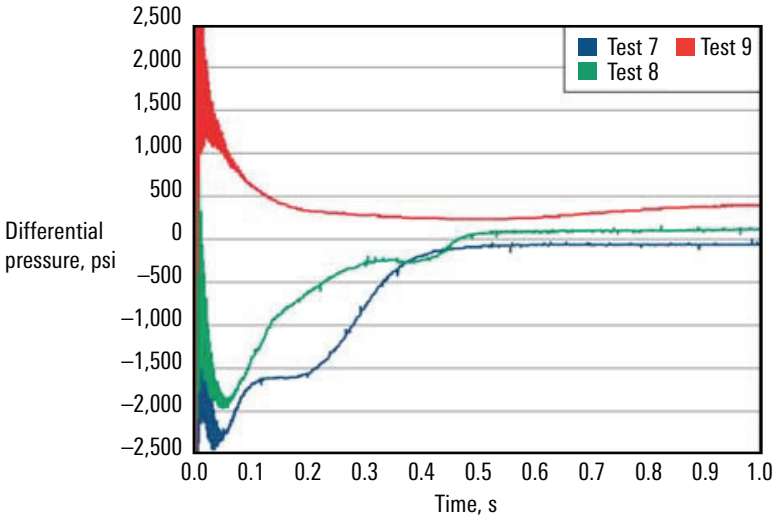
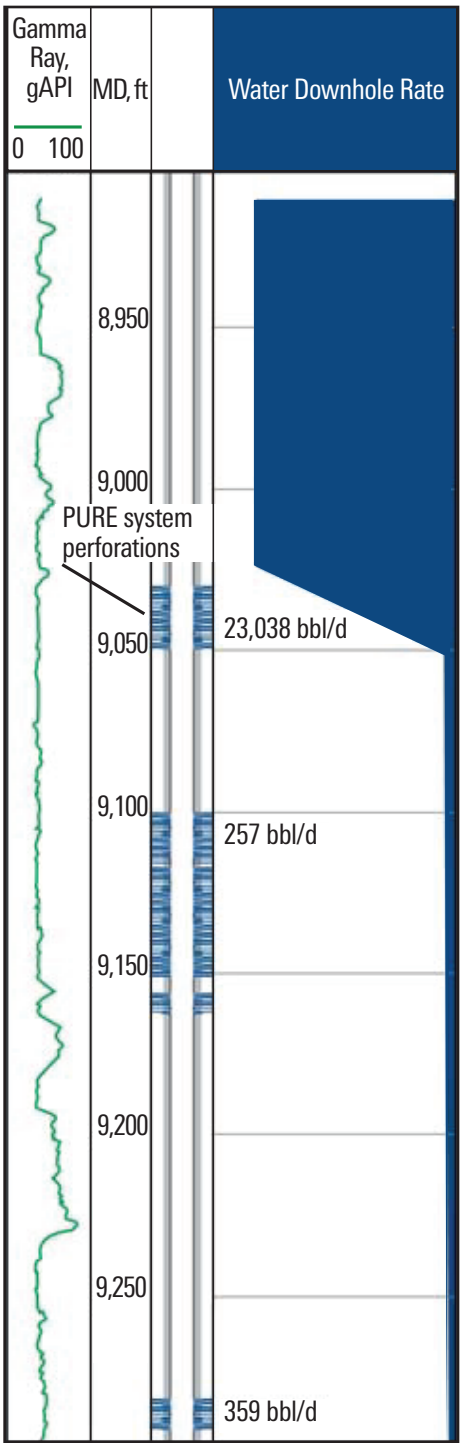


Tests 7 through 9 showed a range of –300 to 2,400 psi for the maximum dynamic underbalance.

Customized design produces successful outcome

Careful control of wellbore dynamics is critical to the success of the perforated completion. The PERF experiments conclusively showed that previously neglected variations in wellbore parameters have a profound effect on completion performance. Significant improvement can be achieved by accounting for the completion geometry, fluids, and perforating hardware in the perforating job design. Because of this degree of customization, the PURE system has been successfully used in hard- and soft-rock formations, oil and gas reservoirs, sandstones, and carbonates.



A 20-ft section of PURE system perforations in an Alaskan North Slope well increased the injection rate nearly 500%, from 194 to 1,152 bbl/d/ft.

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