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Engineered Perforating System Boosts Productivity Across 6,200 ft in Offshore HPHT Gas Condensate Wells

Dynamic underbalance created by HPHT gun system and PowerJet Nova charges enables effective perforating and cleanup of ultralong intervals, North Sea

CHALLENGE

Reliably deploy and retrieve long gun assemblies on coiled tubing in hostile-condition live wells while maintaining multiple pressure barriers to perforate through drilling-induced damage.

SOLUTION

Customize an HPHT perforating gun system with rock-optimized PowerJet Nova* extradeep-penetrating shaped charges to bypass damage and create dynamic underbalance for effective perforation cleanup.

RESULTS

Increased productivity index and decreased skin value over an interval of 6,217 ft while ensuring HSE compliance.

Formation damage limits production in hostile environment

An operator producing in an HPHT gas condensate field in the North Sea wanted to optimize well deliverability via an engineered perforating strategy. Existing high-temperature shaped charge technologies, however, have historically been unreliable in adequately bypassing drilling-induced damage.

The ideal approach would achieve reservoir contact, perforate long intervals, sufficiently bypass formation damage, and improve productivity index (PI) while remaining within strict safety and barrier requirements and minimizing skin.

The operator collaborated with Schlumberger to develop and customize a solution that would meet the productivity objectives without compromising safety standards.

The PowerJet Nova HNS shaped charge is engineered to perform in stressed rock and HPHT environments.

Customized perforating system bypasses damage

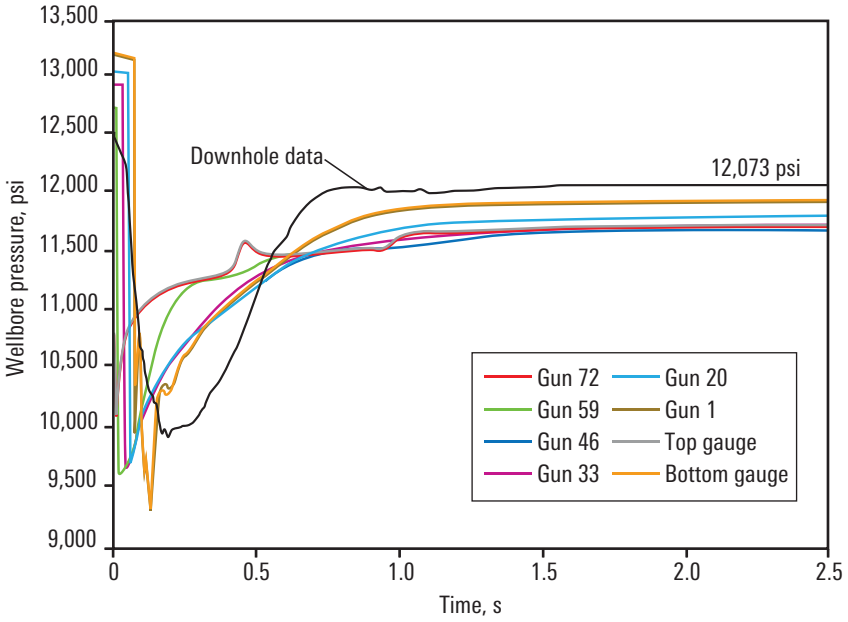
Focus was placed on enhancing penetration as well as optimizing wellbore dynamics by using underbalance to ensure clean perforations. SPAN* Rock stressed-rock perforating analysis was used to calculate setup pressures for optimal cleanup and to predict expected shock loads on the bottomhole assembly and coiled tubing.

Evaluating the results of SPAN Rock analysis also determined that PowerJet Nova HNS shaped charges would bypass the drilling damage. These high-temperature-rated charges improve penetration in stressed rock by 25% compared with previous-generation charges and provide up to 50% more formation contact.

High-speed pressure gauges positioned below the guns recovered downhole pressure data from each perforation run; results confirmed that SPAN Rock analysis accurately simulated the actual dynamic underbalance that was achieved at the perforations.

Extensive laboratory testing combined with offset field history demonstrated that perforating in a base oil would be least damaging to the formation while eliminating challenges associated with cleaning up alternative solids-laden fluids.

To remove the long gun strings from the live wells with a potential 6,000-psi surface pressure, two barriers were instituted. A lubricator valve, set above the subsurface safety valve, was successfully run on each well as the primary isolation barrier. A 5.125-in-ID CIRP* completion insertion and removal under pressure system, complete with remotely activated 15,000-psi hydraulic gate valves installed above the tree, would ensure successful gun retrieval should the downhole barrier be compromised and surface pressure was present.



Downhole gauges confirmed that the measured peak dynamic underbalance correlated with the pressure simulated prejob in SPAN Rock analysis. The rapid drop in pressure removed skin damage, creating cleaner perforating and improving the productivity index.

Skin minimized, productivity index surpassed

Five of the operator's wells were completed with a total of 6,217 ft [1,895 m] of perforating guns loaded with PowerJet Nova charges. The longest interval deployed on the high-strength coiled tubing was 1,649 ft [503 m].

Production data indicated that the PowerJet Nova charges bypassed the drilling-induced damage, and dynamic underbalance delivered clean perforations and low-skin completions, with the perforating strategy exceeding expectations.

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