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Custom-Designed TCP System Maximizes Productivity of 12 HPHT Development Wells with No Lost Time

Integrated perforation method increased production to levels that far exceeded expectations while ensuring data quality and HSE compliance

CHALLENGE

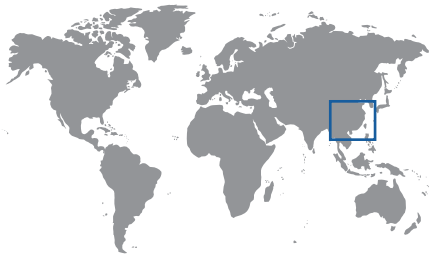
Increase production from 12 development wells in hostile HPHT reservoir while ensuring timely and efficient operations that promote safety.

SOLUTION

Deploy PowerJet Omega* deep-penetrating perforating shaped charges in a hydraulic-delay firing head and as modeled using SPAN Rock* stressed-rock perforating analysis, which validated production estimates and calculated the level of downhole shock inherent to wells with high hydrostatic pressure to further mitigate postperforation risks.

RESULTS

Successfully perforated all 12 HPHT wells—with total reservoir gas production exceeding the initial estimates—while remaining on schedule with no lost time or service-quality incidents.



Production campaign planned in challenging HPHT field

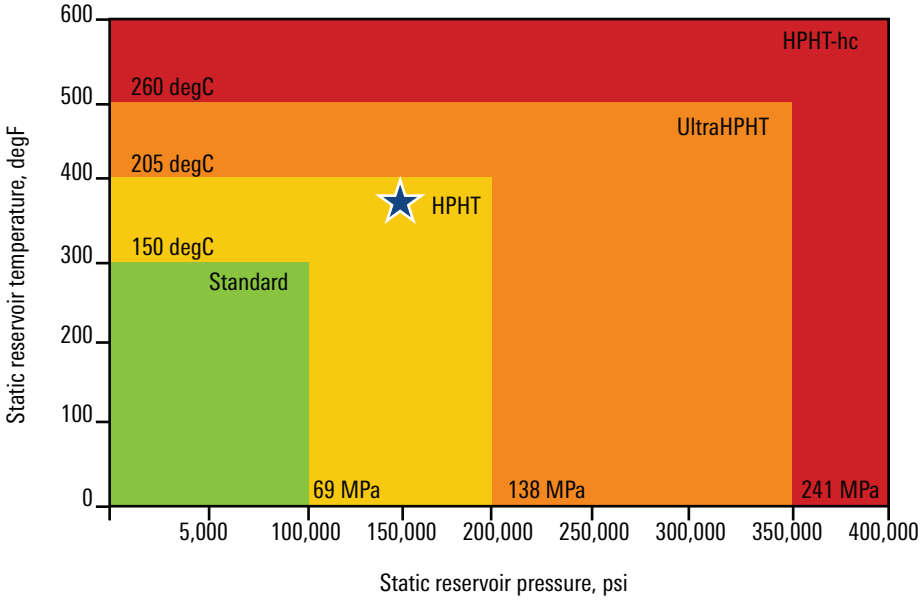
To increase production in a number of onshore vertical wells, an operator in China sought to perforate approximately 820 ft [250 m] of pay zone. Reservoir pressure exceeded 17,000 psi [117 MPa], and downhole temperature was greater than 350 degF [177 degC]. To prevent killing the wells after perforating, the operation required an overbalance of 800 psi [5.5 MPa], and the completion fluid was designed with a weight of 1.87 g/cm^3.

Optimized perforating system designed

Schlumberger designed a fit-for-purpose tubing-conveyed perforating (TCP) gun system that uses the latest developments in HPHT downhole tool design. The TCP job and string configuration provided a flexible, modular, and highly reliable perforating system that could ensure successful operations and improved production for the campaign.

An HPHT gun was loaded with HNS shaped charges, which were selected on the basis of the operation's downhole specifications. The HPHT hydraulic-delay firing (HDF) head was used as the primary firing system for the operation. Specially designed for HPHT operations, the HDF head incorporates Chemraz® seals with backup rings and uses an HPHT-rated sealed percussion detonator, providing reliability and efficiency in extreme conditions.

PowerJet Omega shaped charges, which provide 20% deeper tunnels on average compared with conventional charges, were chosen to increase the probability of perforating the 5-in casing and extending beyond the damaged zone based on the well and reservoir parameters.



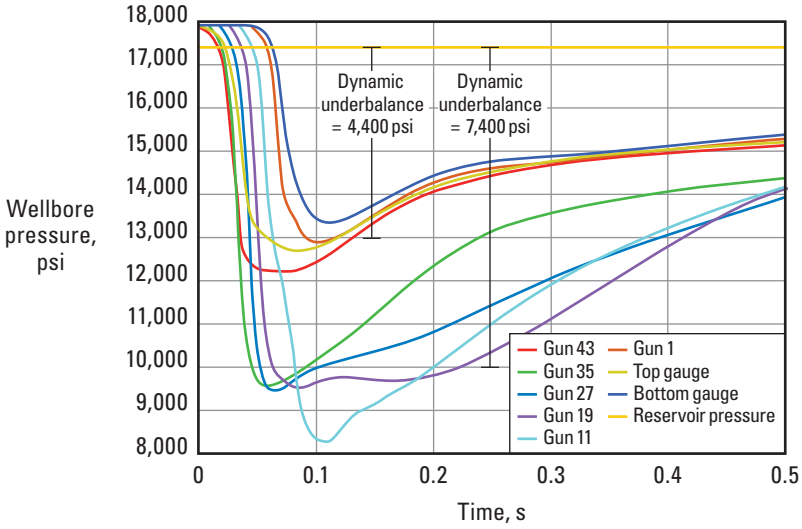
The perforated well (blue star) exhibited borderline-ultraHPHT conditions, which had an impact on the selection of perforating system technology.

Using PURE* clean perforations system software, Schlumberger engineers anticipated that a high dynamic underbalance (DUB) would be created when the guns fired because of the reservoir's naturally high pressure and the hydrostatic pressure of the wellbore fluid. The high DUB predicted with PURE system software was later verified with high-speed pressure data recorded in the actual job.

SPAN Rock stressed-rock perforating analysis considered the debris volume of the perforation tunnels in selecting the shaped charge and estimating the wells' productivity index. Downhole shock was also carefully considered to ensure minimal damage to downhole tools and equipment. Further analysis helped the operator decide to perform a shoot-and-pull operation without a retrievable packer.

Twelve HPHT perforating jobs efficiently performed with validated results

To date, the operator has run 12 HPHT perforating jobs without any lost time or service-quality issues, confirming the TCP configuration's ability to reliably and consistently perform under HPHT conditions. Final production rates increased beyond what the operator initially anticipated, also confirming the performance of PowerJet Omega charges under severe downhole conditions.



Dynamic drawdown pressure measured in the wellbore at the time the guns fired confirms that the dynamic underbalance considered in the gun system design ensured that perforation damage and debris were cleared from the perforation tunnels.

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