



Advanced Completion Solutions for Multizone Water Injection in Soft Sand

WORLD'S FIRST 10,000-PSI TRIPLE-ZONE INTELLIGENT COMPLETION FOR WATER INJECTION

CASPIAN REGION

CHALLENGE

- » Multiple laminar sand packages requiring injection sweep
- » Limited interval access for sanding concerns
- » Water injection rate control to target zones

SOLUTION

Halliburton advanced completion systems, including:

- » HS-ICVs and ROC™ pressure and temperature gauges
- » ICV position sensors
- » Automated surface hydraulic system (SHS)

RESULT

- » Achieved control of all 14 zones while injecting at the required rates
- » Delivered world's first 10,000-psi three-zone water injection system
- » Maintained completion integrity without sand control measures

CHALLENGES

A major operator in the Caspian region required pressure support and sweep efficiency for enhanced recovery of a massive offshore oil field. Previous attempts at multizone, high-rate water injection in this soft sand field had mixed results with non-conformance injection profiles and loss of sand screen integrity, leading to sand infill and premature loss of zonal injectivity. Additional issues with interval control valve (ICV) reliability in early attempts, caused by control line damage and lack of custom automated topside control, also had to be addressed.

Effective remote control of the ICVs is required to successfully control injection conformance and to mitigate potential downhole sand control issues due to an interruption in water injection, without traditional sand control equipment as part of the completion. Automated control is required that closes one ICV or multiple ICVs during shutdowns that are performed because of topside equipment maintenance, well testing, emergencies, or loss of power.

SOLUTIONS

The Halliburton HS-ICV was chosen due to its custom flow trim, metal-to-metal (MTM) closure seal, enhanced control line protection for high-rate injection, and position sensor capability. Over the course of a year, the discrete flow trim choke was customized with the operator's reservoir goals in mind. Additionally, a comprehensive erosion study was completed that considered the operator's need to inject unfiltered water with a high solids content through the completion for the life of the well. The MTM closure seal is capable of 5,000-psi differential unloading, which is critical in a high-rate injection well for rapid startup after a shutdown sequence. Through 20 years of continuous improvement and lessons learned, the HS-ICV is equipped with enhanced control line protection for high-rate injection wells, which removes the control line from the turbulent flow path. The ICV position sensor gives the operator the ability to quantify injection rates into each zone, knowing the discrete custom flow trim position, flow coefficient, and pressure drop from the ROC™ pressure gauge.

A surface hydraulic system (SHS) was developed with extensive hazard and operability (HAZOP) assessment, hydraulic accumulators, and a battery backup system, as well as software that is designed to automatically close ICVs during shutdowns. This rapid shutdown of ICVs mitigated the need for standard sand control measures and decreased the risks of water hammer, sand infill, and zonal crossflow.



Injected up to
10,000
psi differential
pressure



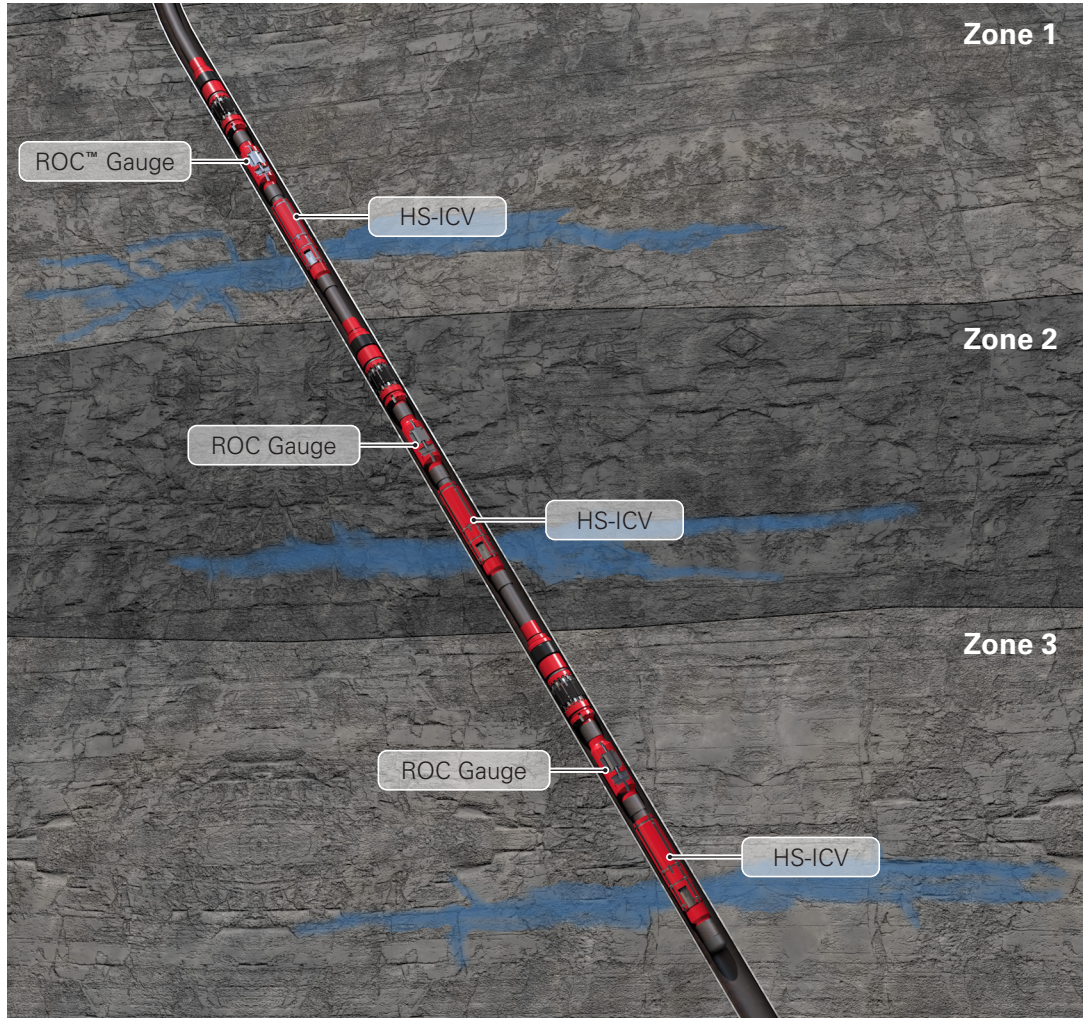
HS-ICV

The HS-ICV flow trim (choke) was customized to optimize the flow at each individual zone.

RESULTS

Halliburton installed an automated SHS that performed as designed for automatic ICV closure. This advanced completion solution is the world's first triple-zone, 10,000-psi water-injection intelligent completion, and the injection flow rates exceeded the operator's expectations.

Updated note: Total of 56 zones have been installed in 18 wells.



Three-zone intelligent completion for precise water injection throughout the completion

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