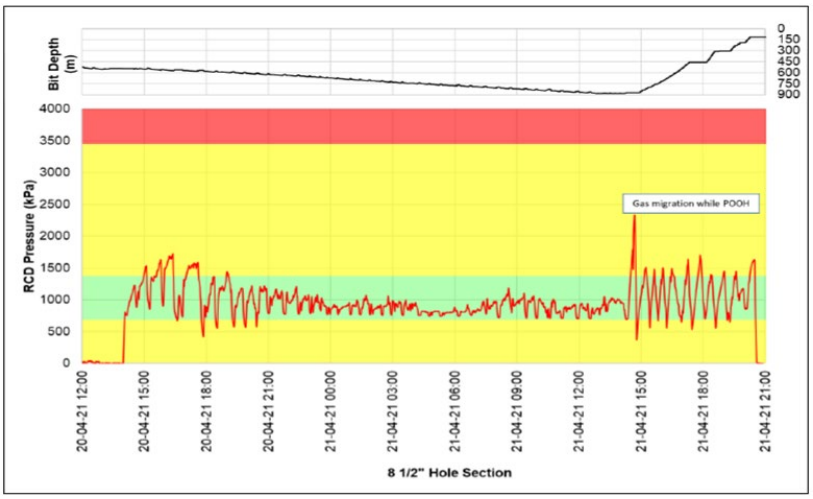
Nitrogen Cap Drilling, MPD Techniques

Slashed Conventional Water Usage in Half, Conserved 54,000+ Barrels in First Application



RCD pressure management for the 8 1/2-in. hole section in Well #1 shows mitigated gas migration during stripping out through the RCD.

Objectives

- Reduce the loss of wellsite water into a reservoir that causes delay in oil production in active and surrounding wells.
- Minimize the number of Well Process Safety incidents produced by the Natih gas cap flow and improper well dynamic fill.

Our Approach

- Weatherford experts studied the offset well data and suggested that drilling the Natih formation with an 8 1/2-in. and a 6 1/8-in. hole was a candidate for nitrogen cap drilling (NCD) a variation of the managed pressure drilling (MPD) technique taking advantage of the fracture presence.
- NCD is a closed-loop drilling system with no returns to the surface that establishes a pressure communication between the surface and the top of the annulus liquid. This serves as a safety improvement to the drilling operations because the loss of the hydrostatic column is detected and the resultant well gas flow does not reach the rig floor.
- The customer also decided to run the 7-in. liner in NCD mode due to the safety improvement and further reduction of fluid loss into the formation when compared with conventional completion operations.
- Unlike conventional drilling, NCD converts the traditional open-loop drilling process into a closed-loop drilling system with the installation of a rotating control device (RCD) on top of the annular blowout preventer (BOP) and establishing a nitrogen cap in the annulus.

LOCATION
Oman

WELL TYPE
Oil producer

HOLE SIZE AND ANGLE
8-1/2 in., 90°
6-1/8 in., 90°

CASING SIZE AND TYPE
9-5/8 in., #40

LINER SIZE AND TYPE
7 in., #23

PRESSURE
342 psi (2,355 kpa)

MEASURED DEPTH
8-1/2 in. hole section
1,624 to 2,897 ft (495 to 883 m)
NCD established at 1,817 ft (554 m)

6-1/8 in. hole section
2,897 to 4,094 ft (883 to 1,248 m)
NCD established at 3,523 ft (1,074 m)

PRODUCTS/SERVICES
- SafeShield® model 7100 rotating control device
- Membrane nitrogen production unit
- Compression equipment

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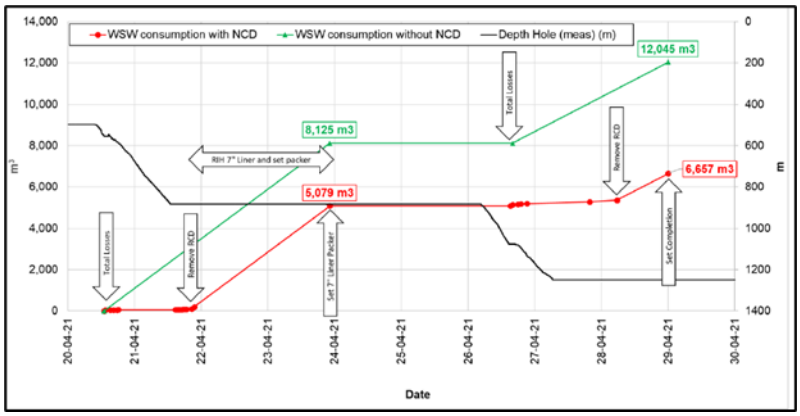
Our Approach (continued)

- NCD allowed pneumatic pressure communication via a pressurized nitrogen column on top of the annulus liquid (heavy annulus mud (HAM),) balancing the formation pressure with a positive wellhead pressure to understand well behavior and monitor gas migration.
- A positive injectivity test confirmed the applicability of the NCD technique to take the drilling fluid and cuttings back into the formation.
- Drilling commenced on two trial wells with wellsite water injected down the drillstring and HAM injected intermittently in the annulus from the back side of the RCD based on the annulus surface pressure changes due to gas migration.
- Tripping out of the hole was accomplished using NCD to keep the well balanced and monitored and avoiding gas migration to surface. However, running, setting, and cementing the 7-in. liner was done conventionally due to incompatibilities of the liner running drillstring and the RCD.

Value to Customer

- A total of 2,362 ft (720 m) was drilled successfully without interruption, saving 54,067 bbl (8,596 m^3) of water.
- The saved wellsite water volume represents 50% of the total volume the customer would have used if these two wells had been drilled using conventional methods (Natih Dynamic Fill).
- By using NCD technology on the trial wells, no Well Process Safety incidents were experienced. Since NCD reduced the time the dynamic fill procedure was used, the customer realized that using NCD in future wells would minimize the likelihood of Well Process Safety incidents which are inherent to the conventional dynamic fill procedure.



Water consumption comparison if drilled with Natih Dynamic Fill (green) and actual consumption with NCD (red) in Well #1.

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