



# Statoil: Kvitebjørn 2007–2013

Managed pressure drilling  
and completion



**Five reservoir sections have been drilled and completed using cesium/potassium formate brine in the Kvitebjørn field since 2007. The reservoir sections were drilled using managed-pressure-drilling (MPD) technology with a specially designed drilling fluid.**

Kvitebjørn is a HPHT gas/condensate field under development in block 34/11, located in the south-eastern part of the Tampen Spur area in the North Sea. The field, which is east of Gullfaks and north of Huldra in block 30/2, is in 190 metres of water. The reservoir lies at approximately 4,000 metres depth and is classified as high temperature, 155°C (311°F) and high pressure, 81 MPa (11,700 psi).

Prior to introducing the MPD drilling technique, nine wells had been drilled and seven completed with cesium/potassium formate fluids in the Kvitebjørn field. The gas/condensate production started after the second well had been drilled and completed. On the last conventionally drilled well, 140–170 bar (2,030–2,466 psi) of depletion was encountered and massive losses were experienced. Drilling was suspended before reaching total depth due to the well control situation created by these mud losses.

The reduced fracture gradient in the reservoir sands as a result of pore pressure depletion was the root cause of Kvitebjørn's challenges for the remaining five wells.

MPD was employed to mitigate the problem. This is a technique that uses reduced mud weight and surface controlled back-pressure to manipulate the downhole pressure profile. MPD offered the solution for the remaining wells, but had little precedence in the HPHT environment. In order for MPD to be successful in an HPHT environment, accurate automated choke control was required to compensate for bottomhole pressure (BHP) variations that arise from temperature changes, drill pipe rotation, swab/surge, and several other phenomena known to create significant BHP variations in HPHT wells. To enable MPD to be used in the Kvitebjørn HPHT reservoir, a range of synergistic technologies were required, including a drilling fluid designed to improve the fracture gradient.

A 'designer mud' based on low-equivalent-circulating-density (ECD) cesium/potassium formate brine was found to be the best solution for improving the fracture gradient.

A 'designer mud' was introduced in collaboration with M-I Swaco based on low ECDs cesium/potassium formate brine from Sinomine Specialty Fluids with a controlled particle size distribution blend of calcium carbonate and graphite. The density of this mud ranged from 1.79 to 1.83 g/cm<sup>3</sup> (14.9 to 15.2 lb/gal).

All wells drilled in MPD mode were completed in overbalance with 1.91 to 2.12 g/cm<sup>3</sup> (15.9 to 17.7 lb/gal) cesium/potassium formate completion fluid.

## Conclusions

- Managed pressure drilling has successfully been used to drill five reservoir sections in the depleted Kvitebjørn reservoir
- A 'designer fluid' based on low ECD cesium/potassium formate brine with a controlled particle size distribution blend of calcium carbonate and graphite was the best solution to strengthen unstable wellbores in depleted reservoir sections
- All wells were completed in overbalance with a cesium/potassium formate completion fluid

## Literature

*Syltøy, S., Eide, S. E., Torvund, S., Berg, P. C., Larsen, T., Fjeldberg, H., Bjørkevoll, K. S., McCaskill, J., Prebensen, O. I. and Low, E.: Highly Advanced Multitechnical MPD Concept Extends Achievable HPHT Targets in the North Sea, SPE 114484, January 2008.*