An operator was planning to drill the first subsea high-pressure/high-temperature (HPHT) well in the North Sea for several years. The operator challenged Baroid to provide a fluid solution that would allow for drilling the 8 1/2-in reservoir section from 13,910 feet (4,240 meters) (cased depth) to 14,859 feet (4,529 meters) without exceeding a drilling window of 1.5 lb/gal, which would risk fracturing formation at the casing shoe. Projected mud weights were as high as 16.8 lb/gal to control the formation pore pressures. The bottomhole static temperature (BHST) of the well at total depth was anticipated to be at 305°F (152°C).

The relatively narrow mud weight window and high bottomhole temperature meant that proper fluid stability and attention to equivalent circulating density (ECD) control were critical for minimizing the risk of drilling-induced fractures and downhole lost circulation.

Baroid implemented its Technical Process, with extensive testing to customize a fluid solution for this challenge. Baroid proposed using the use of ENVIROMUL™ HT invert emulsion fluid (IEF) system based on its success on the HPHT Elgin-Franklin field in the North Sea. The fluid was specifically engineered to provide suitable rheology and gel strength profiles to work in a relatively narrow margin well section. Barite was utilized as the primary weighting agent due to the high mud weight requirement; BARACARB® bridging agent was used to mitigate any differential sticking while permeable sands were exposed. These were the key challenges that were planned for. However, throughout the drilling operation, there were numerous lengthy periods of downtime due to non-fluid-related issues compounded by bad weather. After the 10-inch casing was run and cemented, the well was displaced to the ENVIROMUL HT IEF system, circulated and conditioned for several hours, and then left static for several weeks (the longest single period being more than six weeks) while rig repairs were conducted. Upon tripping back to bottom with the drilling bottomhole assembly (BHA) and circulation of the fluid system, there were no weight fluctuations or other property deviations noted with the fluid.

ENVIROMUL™ HT Invert Emulsion Fluid System Enables Operator to Successfully Drill HPHT Well in North Sea

FLUID SYSTEM SAVES OPERATOR ALMOST USD 385,000

CENTRAL NORTH SEA, U.K. SECTOR

CHALLENGES

An operator was planning to drill the first subsea HPHT well in the North Sea in several years:

» The bottomhole static temperature (BHST) was anticipated to be at 305°F (152°C).
» A drilling window of 1.5 lb/gal made equivalent circulating density (ECD) control a critical factor for minimizing risks of drilling-induced fractures and downhole lost circulation.

SOLUTION

Baroid recommended the ENVIROMUL™ HT invert emulsion fluid system, along with the BARACARB® bridging agent, to mitigate the challenges of drilling in this HPHT well.

RESULTS

» ENVIROMUL HT fluid proved to be thermally stable at downhole conditions.
» Using the stable ENVIROMUL fluid, the operator was able to avoid chemical treatments and save at least one day of rig time, which equated to saving almost USD 385,000.

FLUID SYSTEM HELPS OPERATOR OVERCOME CHALLENGES OF DRILLING HPHT WELL

Baroid implemented its Technical Process, with extensive testing to customize a fluid solution for this challenge. Baroid proposed using the use of ENVIROMUL™ HT invert emulsion fluid (IEF) system based on its success on the HPHT Elgin-Franklin field in the North Sea. The fluid was specifically engineered to provide suitable rheology and gel strength profiles to work in a relatively narrow margin well section. Barite was utilized as the primary weighting agent due to the high mud weight requirement; BARACARB® bridging agent was used to mitigate any differential sticking while permeable sands were exposed. These were the key challenges that were planned for. However, throughout the drilling operation, there were numerous lengthy periods of downtime due to non-fluid-related issues compounded by bad weather. After the 10-inch casing was run and cemented, the well was displaced to the ENVIROMUL HT IEF system, circulated and conditioned for several hours, and then left static for several weeks (the longest single period being more than six weeks) while rig repairs were conducted. Upon tripping back to bottom with the drilling bottomhole assembly (BHA) and circulation of the fluid system, there were no weight fluctuations or other property deviations noted with the fluid.

DRILLING TIME SAVINGS

USD 385,000
(ONE DAY OF RIG TIME)
After the downtime, the well was successfully drilled to a total measured depth (MD) of 14,856 feet (4,528 meters) without any issues. The ENVIRONMENT HT IEF system remained in specification (aside from minor oil/water ratio adjustments required due to riser displacements) throughout the interval. While the fluid was not originally optimized for medium-term suspension, the laboratory qualification testing combined with proactive fluid engineering at the rigsite by the mud engineers ensured that the system was maintained in specification as planned for drilling the section. This resulted in the mud proving to be extremely robust, as it held up to these unplanned events without any issues.

**ECONOMIC VALUE CREATED**

Since the ENVIRONMENT HT fluid proved to be thermally stable, there was no need to circulate or condition fluid for extended periods of time to get the fluid back into specification, as might be the case if an unstable fluid had been used. Using the stable ENVIRONMENT fluid, the operator was able to avoid chemical treatments and save at least one day of rig time, which equated to saving approximately USD 384,930.

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**Operational Parameters with ENVIRONMENT™ HT IEF System**

<table>
<thead>
<tr>
<th>Property</th>
<th>Target Value</th>
<th>Value at t₀</th>
<th>Value at t₆.₆ weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud Weight</td>
<td>16.8 lb/gal</td>
<td>16.8 lb/gal</td>
<td>16.8 lb/gal</td>
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<tr>
<td>HPHT Fluid Loss @ 310°F (154°C)</td>
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<td>1.2</td>
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<tr>
<td>Yield Point</td>
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<td>23</td>
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<tr>
<td>Electrical Stability (ES)</td>
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<td>Oil/Water Ratio</td>
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<td>10-Sec/10-Min/30-Min Gels</td>
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<td>13/20/24</td>
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