High-Temperature Water-Based Fluid Proves Successful in Tight-Gas Field Development

MIDDLE EAST

OVERVIEW

Drilling any bore hole under high bottomhole temperature conditions, 300°F (150°C) or greater, presents a significant challenge. In addition to equipment sustaining these conditions over prolonged periods, the drilling fluid must also remain robustly in specification in order to maintain its well-control and hole-cleaning functions. In a great many land operations, water-based drilling fluids (WBDFs) are a requirement placing additional burdens on robust high-temperature designs. Conventional high-temperature polymers used in WBDFs can sustain moderate periods circulating and drilling at temperatures of 300°F (150°C) or more, but it is not uncommon for these systems to need extensive dilution with fresh drilling fluid and chemicals to maintain their function. A deteriorating high-temperature WBDF will lose viscosity – affecting solids suspension capacity, rate of penetration (ROP), and density, as well as filtration control capacity – resulting in overly thick filtercake and hole restrictions. The situation is made more acute if the fluid must remain static at bottomhole conditions for prolonged periods of several days due to logging runs or tool failures.

CHALLENGES

The customer in this case had drilled multiple offset production wells in its tight-gas field development in the Middle East. Bottomhole temperatures ranged from 300°F to 340°F (150°C to 170°C). Drilling conditions were manageable, but not optimal: high dilution rates to maintain fluid in specs, low ROPs, averaging 1.8 meters/hour (5.9 feet/hour), multiple bit runs and regular planned wiper trips. Moreover, after extended static periods, drilling fluid circulating up from the well needed to be segregated and reconditioned offline due to its deterioration at high temperature.

SOLUTION

Baroid customized its THERMA-DRIL™ high-performance (HP) HT WBDF, using select high-temperature polymers exhibiting excellent thermal stability up to 375°F (190°C). Fluid viscosity and high-pressure/high-temperature filtration control characteristics were very stable, only showing minor deterioration and barite sag after six days of exposure at static bottomhole conditions.

RESULTS

» Completed well 15.1 days ahead of AFE
» Delivered greater temperature stability, resulting in faster drilling, smoother drilling and tripping conditions, and fewer wiper trips
» Saved USD 136,000 on fluid costs, and USD 300,000 on rig time

The customer was targeting a 3,000-foot-long (1,000-meter-long) horizontal reservoir section for its next development well (a 30 percent increase relative to offset wells), and approached Baroid for a more robust and durable water-based drilling fluid solution.

SOLUTION

Baroid customized its THERMA-DRIL™ high-performance (HP) HT WBDF, using select high-temperature polymers to build a system that exhibited excellent thermal stability up to 375°F (190°C). Fluid viscosity and high-pressure/high-temperature filtration control characteristics were very stable, only showing minor deterioration and barite sag after six days of exposure at static bottomhole conditions.
In field applications, multiple benefits were observed with the new customized fluid. Significantly lower dilution rates and daily treatment schedules were needed to maintain the fluid in specification. THERMA-DRIL HP HT WBDF exhibited relatively low viscosity and high lubricity, helping to maintain low equivalent circulating density (ECD), improving pump rates and ROPs, and further reducing torque and drag. The system was also far more tolerant of CO₂ influxes without detrimental impacts on fluid properties.

Numerous operational benefits were also experienced due to the more durable fluid:

- Smooth drilling operations for the 8-3/8-inch section; fluid showed high thermal stability while drilling and tripping
- All bottom-up circulations showed fluid was in good condition with no sign of polymer deterioration or barite sag even after a six-day logging run
- No abnormal over-pull or drag was observed during tripping and logging operations, significantly reducing the need for wiper trips.

**ECONOMIC VALUE CREATED**

The customer enjoyed substantial economic gains from the introduction of the customized THERMA-DRIL™ HP HT WBDF. The well was completed 15.1 days ahead of the authorization of expenditures (AFE), where a significant factor behind this milestone achievement was the THERMA-DRIL HP HT WBDF, which delivered greater temperature stability, resulting in faster drilling, smoother drilling and tripping conditions, and fewer wiper trips.

Specifically, the customer gained:

- 1,060-meter (3,478-foot) horizontal reservoir section vs. 796 meters (2,612 feet) for the previous offset well (the longest well in the field, and was the second longest horizontal well in the area at the time.)
- USD 136,000 savings on fluid costs due to significantly reduced dilution rates arising from greater thermal stability
- USD 300,000 savings on rig time from fewer wiper trips for the 8-3/8-inch reservoir section, as the more stable THERMA-DRIL HP HT WBDF resulted in a thinner, slicker filter cake
- 50 percent improvement in ROP compared to offset in the horizontal section [2.7 meters/hour (8.9 feet/hour) vs. 1.8 meters/hour (5.9 feet/hour)].

**Fluid Performance and Cost Comparison**

| Well  | Days Drilling | Avg ROP (m/hr) | Footage, (m) | Total Volume (bbl) | Dilution Rate (bbl/m) | Total Fluid Cost, $ | Cost/m ($/m) | Cost/bbl ($/bbl) |
|-------|---------------|----------------|--------------|--------------------|-----------------------|-------------------|--------------|----------------|}
| First | 80            | 1.72           | 3,307        | 11,596             | 1.95                  | 1,513,271        | 457.60       | 130.50         |
| Second| 67            | 2.05           | 3,292        | 11,863             | 1.72                  | 1,376,750        | 418.21       | 116.05         |

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