DEPLETED ZONE POSES HIGH RISK FOR SEVERE LOST CIRCULATION

After beginning a drilling campaign in a high-pressure, high-temperature (HPHT) field, Total E&P Borneo B.V. encountered a depleted zone at the top of the reservoir, followed by a rapid pressure ramp-up at the bottom of the reservoir. Geomechanics analysis determined that the depleted section would require mud weights up to 2.2 SG (18.4 lb/gal) to control pressures and maintain wellbore stability, but pressure depletion and the subsequent coupled-stress depletion response had decreased the fracture gradient in some sections of the reservoir. Analysis performed with the WellSET® lost circulation module in Baroid’s DFG™ modeling software estimated a rock fracture width of up to 800 µm. The risk of severe lost circulation was high and the operator included a contingency drilling liner in the well plan.

DUAL APPROACH PROVIDES OPTIMIZED FLUID AND LOST CIRCULATION TREATMENT

Baroid engineers used a dual approach to mitigate the high risk of lost circulation. The proposed ENVIROMUL™ HT invert emulsion fluid was engineered with a low plastic viscosity (PV < 55 cP) to aid in minimizing the equivalent circulating density (ECD) while drilling the depleted zone. To achieve the optimal PV, the Baroid team used a combination of micron-size barite and regular API barite to reduce inter-particle friction. Adding BaraMul™ IE-660 emulsifier helped modulate the emulsion droplet size and enhance oil-wetting to further decrease rheological properties without compromising the fluid’s carrying capacity and solids settlement.
Baroid personnel also designed a WellSET wellbore strengthening treatment to increase hoop stress and reduce the risk of lost circulation. The lost circulation material (LCM) package consisted of BARACARB® 150 and BARACARB 600 ground marble, as well as STEELSEAL® resilient graphitic carbon (see particle size distribution plot below). The LCM formulation was tested in the lab and demonstrated effective plugging of 500- and 1,000-µm slotted disks. The designed LCM package was monitored via a laser diffraction particle size analyzer while drilling to help Baroid personnel maintain particle size distribution within a target parameter.

In addition, Baroid installed a simple, low-cost LCM recovery system to reclaim the larger LCM while removing unwanted fines. The system was located in front of one shaker. Recovered LCM was redirected to the active system.

ENGINEERED DRILLING FLUID AND LCM PACKAGE DELIVER LOW ECD, ZERO LOSSES

TOTAL E&P Borneo B.V. started drilling the reservoir with 1.65 SG (13.8-lb/gal) ENVIROMUL HT fluid. When the density reached 1.84 SG (15.3 lb/gal), data from the pressure-while-drilling tool showed an average ECD of 1.97 SG (16.4-lb/gal) equivalent mud weight (EMW) – a low differential of 0.13 SG (1.1 lb/gal).

The operator successfully drilled to the target total depth ahead of plan with zero lost circulation incidents. In addition to saving rig time, the operator avoided the need to run the drilling liner that had originally been included in the well plan as a high probability contingency. Using the LCM recovery tool also contributed to lower drilling fluid costs and improved mud performance.

LCM particle size distribution – WellSET® wellbore strengthening formulation comprises three LCM types for effective particle size distribution

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