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Drillbench Dynamic Well Control Provides Realistic Simulation of Kick Tolerance, Promotes Safer Operations

Operator optimizes coiled tubing operation in an ultraHPHT well using dynamic drilling simulation software, offshore Gulf of Mexico

CHALLENGE

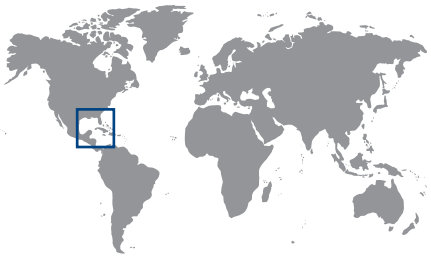
- Establish equipment kick tolerance for safer planned coiled tubing operation.

SOLUTION

- Simulate and evaluate the operation using Drillbench* dynamic drilling simulation software.

RESULTS

- Demonstrated smaller coiled tubing diameter as a better choice.
- Created larger wellbore clearance for more circulating mud volume.
- Determined larger choke opening in consideration of dissolved gas.



Assess surface equipment limitations to manage kick in HPHT well

In planning a wellbore cleanout procedure in an ultraHPHT well, the Schlumberger coiled tubing team raised safety concerns about kick tolerance and limitations of surface equipment to withstand high pressures while circulating out a potential influx. In ultraHPHT wells, an uncontrolled release of hydrocarbons can have serious consequences to life, assets, and the environment. In this well, wellbore conditions also provided considerable challenges due to small diameters, multiphase fluids, and various densities in the wellbore. Determination of the maximum influx allowable with the available equipment and the effect of coiled tubing size on the process of circulating out pressure was needed before moving forward with the planned coiled tubing operation.

Employ Drillbench dynamic drilling simulation software to evaluate well control risks

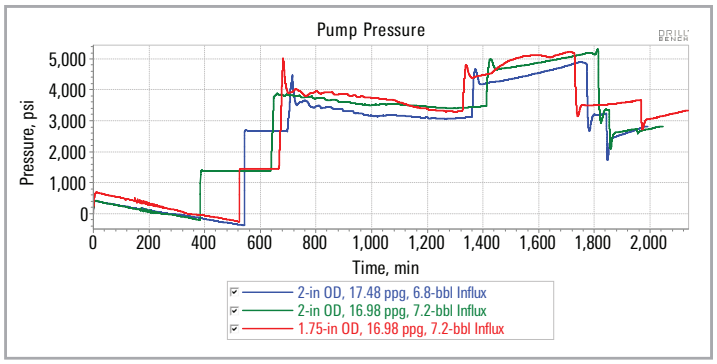
With unique transient and dynamic capabilities, the Drillbench dynamic drilling simulation software is the ideal technology to evaluate well control operations in HPHT and ultraHPHT wells, which can reach maximum bottomhole pressure and temperature of 26,000 psi and 420 degF, respectively. In contrast to the often-used spreadsheet calculations, which only provide a static solution at a particular depth and temperature, the Drillbench Dynamic Well Control module simulates complex transient conditions, including dissolution of gas in oil-base mud. The transient analysis tracks all the interactions of the influx fluids and their properties and shows changes in pressure and temperature along the wellbore as the influx is circulated up the hole during the well control process. This leaves little uncertainty as to what is happening and when it will happen, providing confirmation that an operation is achievable.

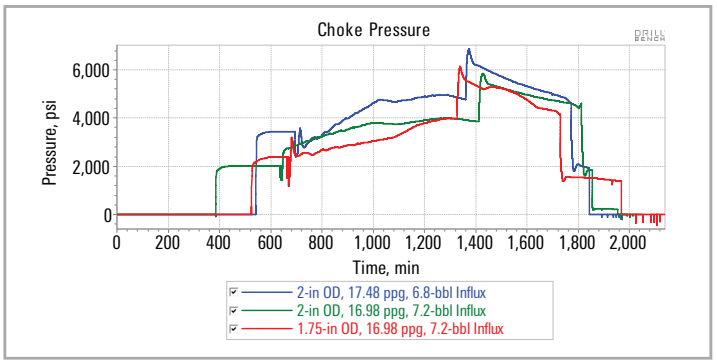
To evaluate the planned coiled tubing operation, sensitivity simulations of a range of parameters, such as coiled tubing diameter, mud densities, and influx size, were performed using the Drillbench Dynamic Well Control module. This provided the basis for a realistic evaluation of design limits and choice of operational procedures. Critical to an accurate simulation is an understanding of the rate of influx, which was difficult to predict because of the small diameters and heavy viscous mud that created high losses of pressure with any fluid movement in the annulus. Using the OLGA* dynamic multiphase flow simulator, the OLGA ROCX module established the influx rates for various drawdown rates, which were then plugged into the Drillbench Dynamic Well Control model to provide accurate simulations that assisted decisions as to the correct operational procedure to implement.

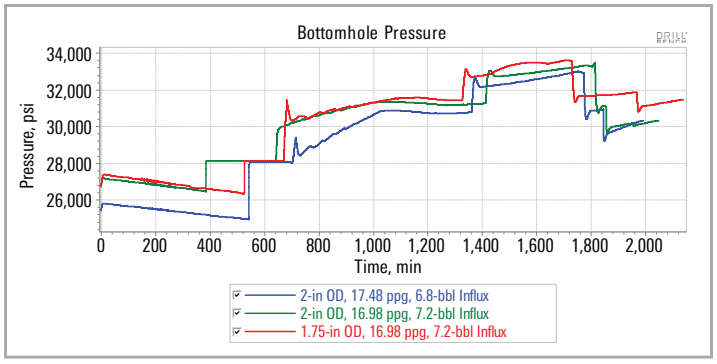
Demonstrated 1¾-in tubing outperforms 2-in tubing to pump out influx

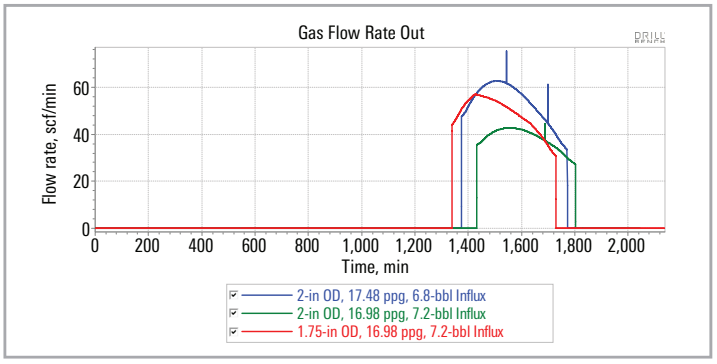
Analysis of results determined that 1¾-in coiled tubing with a 16.98-ppg hydrostatic wellbore gradient allowed an influx of 7.2 bbl that could be reliably circulated out. Simulations indicated that this tubing diameter had better pressure and flow characteristics than the 2-in coiled tubing for pumping out influxes because it offered larger clearances in the small-diameter wellbore and provided more mud for dissolving and holding gas, resulting in a slightly larger choke opening.

Simulations also identified that higher flow rates were possible during the initial circulation of the influx. Staging flow with reduced choke and lower rates also increased the speed of circulating the influx out of the well.









Iterative Drillbench software simulations test the sensitivity of various parameters.

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