OVERVIEW

Managed pressure drilling (MPD) is all about keeping a well within the hydraulic window, between the pore pressure and fracture gradient. In order to properly manage the desired pressure downhole, keeping the pressure within that hydraulic window, MPD systems employ the following equation as the control algorithm:

\[
\text{Surface Pressure} = \text{ Desired Bottom Hole Pressure} - (\text{Hydrostatic Pressure} + \text{Friction} + \text{Surface Pressure Loss} + \text{Surge/Swab})
\]

The hydrostatic pressure of the well is based on corrections for the thermal effects on the fluids in the well. This is important in high-pressure/high-temperature (HPHT) and deepwater operations where the actual bottomhole densities will vary significantly due to heat transfer of the fluid.

Hydraulic simulators, such as the GB Setpoint™ advanced real-time hydraulic model, can apply corrections based on the temperatures reported on the daily mud report for the fluid being tested at the time. Often, the data being reported by the mud engineer is from either the flowline or suction pit, and the temperatures being reported are those from the source and not from the sample during the actual test. The sample mud has time to cool after it is drawn, and the temperature difference used in the simulator will greatly affect the thermal correction accuracy for hydrostatic calculations.
The rheological properties of the mud are utilized to understand the circulating friction, pressure drops, cuttings transport, and surge/swab effects while circulating or while tripping. In the industry today, the value used for hydraulic simulation is manually inputted from the data collected on a mud report. This report is generated either daily or at the end of a tower. The mud report is a spot check of the fluid system, and it reports the properties at that point in time.

The assumption for hydraulics simulators is that the mud is always homogeneous, but this is not true. Mud systems are constantly being treated, diluted, or weighted. Often, from one mud report to the next, the mud properties have changed enough to significantly affect the pressures within the well. Examples of the pressure variance have been greater than 100 psi, which, on some MPD wells, could be the difference between influxes or losses.

The BaraLogix™ Density and Rheology Unit (DRU) is a fully automated unit that measures the density and rheology of drilling fluids in real time. With this Halliburton unit, the GB Setpoint model can utilize the real-time data supplied by the BaraLogix unit and track each data point throughout a complete circulation of the wellbore.

OPERATIONS
The skid-mounted BaraLogix™ DRU, which is installed at the rigsite near the mud tanks, incorporates a self-generating nitrogen purge system and is ATEX Zone 1 and IECEx certified.

With the BaraLogix unit, fluid density is reported as frequently as every minute, with rheology measurements reported as frequently as every 15 minutes. During rheology testing, the fluid temperatures are brought to either a constant 120°F (49°C) or 140°F (60°C) per API standards for fluid testing. Measurements are brought into the GB Setpoint model to provide real-time analysis of fluid properties. The GB Setpoint model will track each input throughout the wellbore and based on the density input will calculate an effective density at the point of control.

The rheology data is also tracked for each individual sample and the GB Setpoint model calculates the circulating total friction, pressure losses, and surge/swab based on the result from each data point volume.

This patented technique improves control of the well by understanding what the theoretical hydraulic state of the well should actually be. Comparing the theoretical state to pressure-while-drilling (PWD) data then provides true early event detection. The BaraLogix system is the next step in completing a truly automated system for monitoring and managing the primary barrier system.

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com