Connection Flow Monitor Software (CFM)
Automated Mud Flow Characterization for Early Detection of Kicks and Wellbore Breathing

In any oil and gas drilling operation, the onset of a fluid influx (kick) or wellbore breathing (ballooning) results in serious safety concerns and significant costs to the operator. Early detection of changing conditions reduces safety risks, minimizes costs associated with unplanned events and prevents wellbore damage caused by controlling a fluid influx or reacting to wellbore breathing.

Sperry Drilling services’ Connection Flow Monitor (CFM) software characterizes the return flow rates and volumes of the drilling fluid to identify the difference between an influx and wellbore breathing. CFM provides the early detection of changing conditions and triggers alarms to alert the engineer. Connection Flow Monitor trend analysis provides the engineer with the necessary information to interpret the difference between a normal flow return profile, a kick and wellbore breathing. This interpretation ensures that the appropriate action is taken as the incorrect diagnosis will lead to a significantly larger influx or lost circulation.

**Connection Flow Monitor Software Benefits**
- Detect kicks and wellbore breathing early enough to mitigate the harmful effects
- Reduce safety risks associated with well control events
- Reduce costs associated with unplanned events
- Minimize wellbore damage

**Connection Flow Monitor Software Features**
- Performs automated monitoring and trend analysis of multiple measurements including pit volume, pit volume rate of change, pressure and flow rate
- Performs trend comparisons from the same start point - pumps-off, with alarms to alert the user to changes
- Uses historical data from previous wells or bit runs for trend analysis
- Can be operated at the rig site and in real-time centers

**Danger of Misdiagnosis**
Kick and wellbore breathing are two phenomena that – if confused and treated wrongly - can lead to significant mud losses and lost circulation.

A kick at a connection is identified by a higher return flow rate and volume than normal. The high flow rate caused by a kick will not diminish in the same way as the flow rate caused by wellbore breathing.

Wellbore breathing during connections or pumps-off cycles is also identified by higher than normal return flow rate and volume. Because of that wellbore breathing can initially be misinterpreted as a kick.
However, the initial increase in the flow rate caused by wellbore breathing will eventually subside. During circulation, the equivalent circulating density is high enough to open fractures and push mud into the formation. When the pumps are turned off, the pressure decreases below the fracture closure pressure and mud lost into the fractures is squeezed out back into the annulus. This return of lost fluid causes a greater rate of mud return than normal, eventually stopping when the fractures close.

A kick is controlled by increasing mud weight above the pore pressure; wellbore breathing is controlled by mud weight reduction. The consequence of misdiagnosis, where wellbore breathing is diagnosed as a kick, leads to an increase in the mud weight which results in greater mud losses and lost circulation.

**Flow Rate Monitoring**

Surface flow rate monitoring is the traditional method for early kick detection. This method relies on flow meters or acoustic devices to measure in and out flow rate and monitor for any changes. However, many flow rate measurement devices in use today have limited accuracy. Rig motion adds further inaccuracy to flow rate interpretation leading to significant delays in identifying a kick or wellbore breathing.

Drilling fluid volume in the rig’s surface flow lines is dependent on the flow rate of the mud pumps. The higher the flow rate - the greater the volume of mud in the surface lines. Therefore, the flow rate used prior to a connection determines the volume and rate of mud flow return to the pits. If flow rates differ between connections, the mud return characteristics will change, often considerably. Characterizing flow return and flow rate is key to developing a full understanding of the flow return behavior from the well during a connection.

The CFM software establishes reference baselines and monitors the behavior of a well during each connection from the instant the mud pumps are shut down. Automated measurements of pit volume total (PVT), pit volume rate of return, flow rate and pressure are performed. Using multi-measurement trend analysis, the CFM software fingerprints a normal connection profile eliminating the uncertainty of traditional kick and wellbore breathing detection methods. Deviations from a normal trend, either from wellbore breathing or a kick will be quickly identified.

As pumps-off flow equalization is dependent on pumps-on flow rate, the CFM software allows the user to save trend data from multiple flow rates and use these for real-time comparison.

Historical connection trends from offset wells or previous bit runs can be used as a reference for real-time trend comparisons to determine the severity of a problem, such as wellbore breathing.

As part of Sperry Drilling services' InSite system, the CFM software is able to receive data either directly from sensors or via industry-standard WITS or WITSML data transfer protocols. This integration allows the CFM software to be run either at the rig site or in a remote operations Center. Real-time data is available in the InSite® system and on the web via the InSite® Anywhere service.

For more information, contact us at sperry@halliburton.com