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Advanced Mud Flow Monitoring System For Identification Of Open Fractures And Early Mud Losses Detection While Drilling

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ABSTRACT

An early well activity detection system based on a Coriolis-type mud flow meter was deployed for the first time by Cairn Oil & Gas in an HPHT Exploratory Well along the East Coast of India to obtain early well behavior signatures in real-time for safe drilling using synthetic oil base mud.

Exploratory wells drilled in high-pressure/high-temperatures and naturally fractured reservoirs are exposed to the risk of fluid influx and partial or total mud losses. The risk aggravates due to the narrow pressure window between formation and fracture pressures (Trip margin constrains), presence of natural open fractures, huge differential pressure due to compartmentalization and presence of any depleted reservoirs along with over pressured formations at virgin pressures.

In many instances, the onset of a series of alternate mud loss and fluid gain scenarios will critically constrain the well control options. This causes safety issues and significant loss of rig time. On the other hand, in case of tight reservoir conditions, absence of open natural fractures can lead to unproductive and thus uneconomic wells. Therefore, characterization of natural fractures is compulsory not only for productivity of the well, but also to ensure successful drillability of the well. The fracture detection from the Coriolis-type mud flow meter can be used as calibration points for other geophysical and petrophysical driven models.

The most commonly used techniques to detect the mud losses by monitoring the level of the mud pits with acoustic, floating sensors and/or using paddles set inside the flow line that measure the return mud flow rate. In contrast the advanced Coriolis mud flow meter works on the principle of converting mudflow out into an analog signal which represents the volume of mud.

Currently through real time advanced surface flow and delta flow curve we can distinguish between natural and induced fractures. In a natural fracture, initially the mud flows into the open fracture tends to concentrate mud solids within the fracture resulting in sudden increase in delta flow and decrease in flow out followed by a gradual decrease in mud losses because of damage in permeability due to fractures plugged with mud solids. In a matrix permeability loss case, due to porous formations or micro-fractured zones the mud losses gradually increase with penetration, and slowly decrease when the permeable zone finishes and plugging effects take place. In cavernous zones, mud losses start suddenly, at a high rate, with no return to the surface lines. But in the case of induced fractures, variations in some drilling parameters are recorded, allowing these losses to be distinguished from natural ones. Generally, the mud lost in the induced fractures is regained after a short period of time. The system is the direct and reliable source of Real-Time information on the presence of open fractures while drilling.

To conclude that the early detection of kick while drilling can avoid large damages and losses to Company’s valuable assets, personnel, well, and rig. In HTHP wells, where narrow pressure margins challenge the successful drilling Coriolis type flow monitoring system can add vital information in realtime drilling to achieve the well objectives and safeguard the men and machines. Identification of fractures enables early reservoir characterization and productive intervals identification. Conventional pedal sensor measures level of mud in flow line and can only detect major gains and losses qualitatively which are not reliable for fracture / loss and gain interpretation. In the absence of any petrophysical log data, information from mud flow analysis will remain the only source for identification of open fractures.