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Case Histories of Real Time Drilling Optimization Combining Drill String Modeling, Surface Measurements and Down-Hole Measurements

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Abstract

A novel, real time drilling optimization system is shown to improve drilling performance by increasing the rate of penetration (ROP) while extending the length of the bit run. Additionally the optimization system reduces the wear and tear on the drill string realizing additional cost savings by minimizing down-hole equipment failures. The result is lower total cost to drill the well.

The optimization system's new features include combining surface data with down-hole vibration data to get the available results in realtime. Additionally, the method uses mechanical specific energy to determine the drillability through stringers and fractures. While the average mechanical specific energy maybe minimized for a given set of surface parameters, the mechanical specific energy spikes whenever stringers, fractures or any other changes in the formation are encountered. The optimization program combines all of these features to determine the optimal parameter set points.

To date, seven wells have been drilled utilizing this optimization system. Significant cost reductions are achieved whenever the optimization recommendations are followed. The system combines analytical drill string modeling with real time drilling data. The real time drilling data includes surface data from the rig EDR system and down hole MWD data. The optimization system analyzes the data and then determines the optimized drilling set points based on the rate of penetration, mechanical specific energy, down hole vibration and data scatter. The system has the ability to identify and resolve drilling dysfunctions in real time, mitigating damage and avoiding unplanned trips.

In the planning stage, drill string modeling analyzes the proposed drill string to assess the structural integrity of the BHA, predicts the drilling tendencies to ensure the planned BHA is capable of developing the directional plan and identifies critical drilling speeds associated with excitation of the motor, bit and or drill string RPM. The modeling application also analyzes the drill string for torque and drag, stick slip and the planned hydraulics. During the

drilling process the model is continuously updated accounting for differences from plan. The system optimizes drilling performance in real time and offers solutions for mitigating drilling dysfunctions that could result in unplanned trips if not addressed in a timely manner.

Several examples are discussed in depth, which illustrate the efficacy and benefits of this new drilling optimization system.