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Effects of Drill Mud and Drive Torque Sinusoidal Excitation on Drillstrings Lateral and Torsional StickSlip Vibrations

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Oil and gas drilling companies spend around 20$ billion annually from which 15% is attributed to material and productive time losses. The most prevalent drilling problems are caused by the Bottom-Hole-Assembly failure which includes drill string and drill bit damage or fatigue failure. During normal operation, to achieve penetration that cannot be met by the drilling motor power section, the bit torque generates an increased reactive torque that acts in the opposite direction of the driving rotation. This sudden increase in reactive torque is transmitted through the drill string as torsional 'stick-slip' vibration, which is often regarded as one of the most damaging modes of vibration. Due to cyclical rotation acceleration and deceleration of the bit, Bottom-Hole-Assembly, or drill string, this phenomenon produces accumulation and release of energy stored as several turns of twist in the rotor. While downhole vibrations are difficult to prevent and cannot be totally eradicated, implementing of corrective methods may be highly efficient for drilling optimization. In the present work, the effect of drill mud on drilling dynamics is studied, then, a sinusoidal excitation is added to the drive torque and resulting impact on downhole equipment is presented. A laboratory scale arrangement consisting of a flexible rotor and a stator is used, and attention is paid to whirling and stick-slip motions of the drill string. The results are provided in the form of responses in the time and frequency domains. A non-linear coupled dynamic model of a rotor enclosed within a stator and subjected to non- linear mud film force is developed. Comparisons with simulations data are also included. The work is one of the first studies carried out on the influence of adding a sinusoidal excitation to the driving torque with the use of drill mud on drill-string whirling motions in a laboratory environment.

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