Near-bit High Frequency Vibration Data Analysis For Twist-off Predictions

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Abstract

Objectives/Scope: The problem of drill string twist-off is a costly issue in the oil and gas drilling sector. Given the high expenses associated with repairing or replacing equipment, there is significant interest in predicting and preventing these incidents. This study aims to showcase how data gathered from high-frequency accelerometer located downhole can be utilized to forecast and avert drill string overloads that may lead to twist-off events.

Methods, Procedures, Process: To detect downhole tool dynamics, a specialized device is placed on the drill sub. The accelerometer records the x-, y-, and z-components of near-bit vibrations at a sampling rate of 1500 Hz with a dynamic range of ±200g. Current workflow is focused on the analysis of lateral components, which involves computing the lateral vibration index (LVI) as the root mean square (RMS) of the x- and y- vibration components. LVI spectrogram is generated using short-time Fourier transform. This spectrogram is then analyzed for any anomalies.

Results, Observations, Conclusions: Utilizing the proposed procedure, the lateral vibration index was used to calculate the amplitude spectrum with a two-second sliding window. Corresponding spectrograms were generated for three different drilling runs, one of which experienced a twist-off. Analysis of the near-bit vibration’s spectral composition reveals that for the normal drilling runs, the time-frequency distribution of energy exhibits a clear striped pattern in the low-frequency domain of the spectrum. However, the spectrogram for the drilling runs with twist-off contains several high-frequency anomalies. The latter first appear in the middle of the run and can serve as precursors. At the very moment of the twist-off where the recording ends, such an anomaly is also observed. The results of the proposed approach to the anomaly identification are in good agreement with those obtained by unsupervised machine learning techniques (based on an isolation forest).

Novel/Additive Information: This study suggests a method of utilizing high-frequency drilling dynamics data, specifically near-bit vibrations, to detect and forecast drill failures resulting from twist-offs. The approach involves analyzing the spectral composition of the lateral vibration components of the bit accelerations.