IADC/SPE-199571-MS

Dynamics Vibration Prediction and Comparison with Downhole Data Measurements in Unconventional Wells

Mohamed Mahjoub, Khac-Long Nguyen, and Stéphane Menand, DrillScan; Quang-Thinh Tran, Marie-Ange Andrianoely, Lionel Manin, and Régis Dufour, Univ Lyon, INSA-Lyon, CNRS UMR5259, LaMCoS; Matt Isbell, HessCorp

Abstract

During drilling operations, high drillstring vibrations may originate from various sources, namely, the bit-rock interaction, drillstring-wellbore contacts, stick-slip phenomena, fluid-structure interaction, and mass unbalances. Excessive vibrations may induce drilling equipment failures (fatigue, cracking, washouts, and ruptures), which can be costly and catastrophic. Therefore, it is crucial to accurately model the drillstring dynamics in order to help drilling engineers make better decisions and avoid harmful vibrational effects.

This paper proposes a numerical model developed in the time domain to estimate the drillstring lateral, axial, and torsional dynamics. It is based on the finite element method coupled with the Craig-Bampton reduction method (Craig and Bampton 1968) to reduce computation time. The drillstring-wellbore contact forces are automatically determined and may occur on both tool-joints and drill pipe bodies, and the drilling fluid is accounted for by its inertial and frictional effects.

The efficiency, accuracy, and predictive capacities of the model are assessed by comparing the computational results to downhole measurements for a case study of a non-conventional well. A good agreement for both lateral and torsional vibrations is obtained. The numerical results are used for a more detailed analysis on the lateral and torsional vibrations of the system. The evolution of lateral acceleration, from a forward to backward whirling tendency on the system, can then be assessed with the use of a spectral analysis.

The novelty of this dynamics model is that it can portray a realistic geometry of a drilling assembly in3D curved wells with the fluid presence and gives a complete study of the coupling phenomena between the axial, torsional, and lateral vibrations. The use of this novel dynamics model along with downhole data acquisition and wired pipe technology is one of the essential steps towards drilling automation to provide a better mitigation of drillstring vibrations.