SPE-210483-MS

How Motor Bend Affects Stick-Slip Vibrations: Modeling and Case Study

David Watt; Ngoc-Ha Dao; Mohamed Mahjoub; Stephane Menand; Mark Smith

Abstract

Contact friction along drill string is one of root causes of stick-slip vibrations, especially when drilling an unconventional well with a long lateral section. By using a downhole steerable motor in rotating mode, the motor bend can create important contact forces between the drill string and wellbore and consequently generate considerable frictional torques opposed to the drill string rotation. Therefore, for more accurate estimations of stick-slip behavior, these forces need to be considered in stick-slip modeling.

In this paper, a torsional vibration model based on a mass-spring system with multiple degrees-of-freedom is used to investigate the drill string stick-slip behavior. This stick-slip model includes the drill bit friction torque, contact friction along the drill string, and mud damping. The contact forces along drill string are determined using an advanced 3D drill string behavior model allowing to consider the motor bend effect. They are then integrated in the torsional equation of motion of the stick-slip model. A case study is carried out to show the consistency between the simulated results and field data.

Stick-slip is a highly damaging dysfunction that adversely effects all components of the drill string. In the case of this paper, the subject well experienced high stick-slip resulting in inefficient drilling and increased risk of equipment failure. Modelling of the drill string successfully replicated the stick-slip response observed at the rig site. Further modelling with consideration of the motor bend angle's effect successfully showed a reduction in stick-slip magnitude.

Considering the motor bend in the stick-slip model is the novelty of this work. This allows to determine more accurately the contact forces on the bottom-hole assembly (BHA), which directly influence the drill string stick-slip behavior. This work can provide a tool for the design of the BHA with a downhole steerable motor to mitigate stick-slip vibrations and lead to significant improvements of the bit performance and rate of penetration.

 DOI 10.2118/210483-MS