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Mitigating and Understanding Stick-Slip in Unconventional Wells

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Abstract

Stick-slip is still present in most of the wells drilled today, especially in unconventional wells. Friction is an inevitable and important force along the long lateral section, but it contributes to many types of dysfunctions that lead to drilling inefficiency. Stick-slip is caused mainly by rotational friction induced along the drillstring, from the drill bit cutting the rock formation to the bottom hole assembly and drill pipe that contact the well bore. In the past, much attention has been given the cutting action of polycrystalline diamond compact (PDC) bits to explain and mitigate stick-slip, without much emphasis on the frictional torque. However, it is important to understand that the torque generated on the remaining drillstring accounts for most of the total torque at surface.

This paper presents a case study on an unconventional well where stick-slip modeling was used to explain and understand stick-slip vibrations with or without the presence of active control systems at surface. First, the stick-slip model, including a PDC bit law friction and accurate contact forces calculation along the drillstring and mud damping effect is fully described, with all necessary and field parameters needed. Then, it explains the process to reproduce and calibrate downhole and surface torque, using a sensitivity analysis showing the most important parameters that affect stick-slip results. The results reinforce the importance of drilling parameters, such as the weight on bit and associated torque on bit that define the bit aggressiveness and are key in controlling or mitigating stick-slip vibration. In addition, these results show the significance of string friction along the drill pipe. Next, the use of a downhole instrumented sub, along with wire drill pipe technology, enables a full comparison of the results of the model with downhole and surface data. Last, the affect of other parameters, such as friction coefficient and mud damping, are discussed.

With a better understanding of the initiation and translation of stick-slip from the bit up the hole to surface provided by this case study, engineers can be better informed when making decisions on factors such as drill pipe size and type, bit aggressiveness, and parameter changes in wells with severe stick-slip in unconventional wells application.

Introduction

Stick-slip, a self-sustained, low-frequency torsional vibration, has been largely studied in the past at different levels. In universities, research institutions focus has been mainly on understanding and modelling the