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Detailed Dynamics Modeling Helps to Assess the Effect of Stabilizer Design on Drillstring Vibrations

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Abstract

Various stabilizer types are used in the industry, such as bladed stabilizers with straight or spiral blades, roller-reamers, and other emergent forms. Their designs are proved, via many in-field measurements, to have a significant impact on vibration levels. Although experimental data is extremely valuable to rank the available design options, testing the different stabilizers can be costly and sometimes risky. In addition, in-field conditions can be difficult to control making the comparisons between stabilizers even more complicated. Assessing the design impact using numerical simulations represents an interesting alternative to provide objective comparisons based on tests in a controlled environment.

When a stabilizer is rotating, the contact forces between its different blades and the wellbore are transient. A static approach like torque and drag or directional models is then insufficient to properly investigate the stabilizer's design characteristics. Therefore, a time-domain dynamics approach is adopted in this work. A detailed modeling of bladed stabilizers including the blade geometry (number of blades, spirality, and blade width) and friction characteristics are introduced in an existing time-domain model. These characteristics are used to compute the contact forces between the wellbore and each individual blade.

This numerical model is applied to quantify the effect of stabilizer design in terms of vibration, from straight blades to highly spiraled blades. First, a parametric study of blade design and wellbore inclination effects on stabilizer vibrations is presented by considering different stabilizers in straight well conditions. Simulations of an actual drill string configuration in an unconventional well is discussed. For vertical, curved, and horizontal sections, the acceleration levels, contact forces, and rotation speeds are investigated. These analyses can constitute guidelines about stabilizer design to minimize vibrations.

The novelty of this work is to introduce the geometry details of the stabilizers in the time-domain dynamics to differentiate designs in terms of likelihood to trigger vibrations.