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# Combining Downhole Axial and Surface Oscillation Tools, What Are the Consequences on Tool Face Control Performance?

Mohamed Mahjoub; Ngoc-Ha Dao; Khac-Long Nguyen; Stéphane Menand

## Abstract

When drilling in sliding mode, axial oscillation tools (AOT) and surface oscillation tools (SOT) are two possible solutions that are used in the industry to overcome the friction forces, especially in unconventional well trajectories with a long lateral section. The AOT is assembled in the drillstring and run in hole such that it is generally placed in the middle of the lateral section. It is actuated by the mud flow to produce high-frequency axial vibrations. As for the SOT, it is placed at surface and produces low-frequency torsional oscillations in the drillstring by alternating the rotation direction. For some challenging trajectories, the idea of combining both tools, where the SOT reduces the friction on the top part of the trajectory and the AOT deals with the bottom part, seems appealing. However, when coupling the two types of oscillations, one should be careful to the possible implications on tool face control performance.

In this paper, time-domain dynamics modeling is used to investigate the AOT and SOT behavior, whether they are employed separately or together. When simulated separately, the tools' influence zones can be identified, and their operating parameters can be tuned accordingly. When combining both tools, if their influence zones are overlapping, coupled axial and torsional oscillations occur and could have consequences on the tool face orientation (TFO). The observations obtained from simulations are confronted to data coming from a well drilled with both tools.

Numerical simulations show that the AOT helps the propagation of the torsional motion downhole, because it takes a part of the friction that opposes the torsional oscillations. If the SOT and AOT parameters are jointly well calibrated, then the steering from surface becomes faster, and the tool face control becomes more accurate. However, if the SOT's parameters are calibrated without regard to the AOT influence, then TFO variations could be obtained, indicating unstable tool face control leading to a tortuous well bore.

The use of time-domain modeling to jointly characterize the behavior of downhole axial and surface oscillation tools introduced in this work allows a better understanding of the coupling between the two tools. This work provides an opportunity to increase the extent of the lateral sections without impairing the wellbore quality.