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A Step Change in Real-time Near-bit Measurements from an Instrumented Downhole Drilling Motor Improves Directional Drilling Accuracy and Geo-steering Capability

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Abstract

Downhole drilling motors are the workhorse of our industry and are used on almost every well drilled globally. This makes an instrumented drilling motor the perfect tool for geosteering with near-bit inclination and formation-change-detection sensors. There have been a number of drilling motors and near-bit subs designed to provide near-bit inclination and gamma/azimuthal gamma measurements over the years. These designs provide the measurements but typically compromise drilling motor mechanical strength or directional response. This paper explains a new type of instrumented drilling motor with real-time continuous inclination and drilling dynamics.

The instrumented wired motors described in this paper have taken a completely different design approach. Using already-existing drilling-motor technology, the necessary sensors, electronics, wiring and short-hop technology have been transplanted into the centerline of the drilling motor without compromising mechanical strength. In addition, the design allows for fast turn-around service times in an existing drilling-motor workshop.

Directional drillers rely on measurement-while-drilling (MWD) real-time data to maintain the well-path on trajectory or within zone. MWD measurements are taken behind the drilling motor and are typically more than 50 feet behind the bit. Real-time near-bit inclination measurements allow for more accurate and precise directional drilling. The new instrumented drilling motor delivers real-time near-bit inclination just 5 feet behind the bit. In addition, near-bit vibration measurements can be used to identify formation changes. The new instrumented drilling motor can be used for geosteering using vibration measurements.

The instrumented wired motor has undergone extensive testing in West Texas to ensure the main components are reliable and can survive harsh drilling conditions. Testing was performed in three main phases; 1) through-wire communication, 2) dynamic inclination and vibration measurements; and 3) short-hop to MWD.

When all three phases of testing were complete the entire instrumented wired motor was deployed to deliver near-bit real-time inclination and drilling dynamics measurements to improve directional drilling. The near-bit inclination measurements allow the directional driller to respond to unpredictable directional changes such as formation push and formation tracking. This provides increased accuracy to keep the wellpath in the zone of interest, particularly in lateral wellbores. This paper will detail the innovative drilling motor design and results obtained during product validation.

Introduction

In unconventional horizontal drilling, it is important to place a wellbore in the most productive part of the reservoir. Geosteering aims to adjust the wellpath based on real-time geological and reservoir data for the optimal placement of the wellbore, rather than placing the wellpath according to a predetermined geometric plan. When MWD measurements are made 50-100 feet behind the drill bit, staying in the targeted geological position of the reservoir becomes difficult due to the spatial delayed response of the MWD measurement. To overcome this issue, a variety of specialized downhole tools have been developed over the years to make directional measurements and formation-evaluation measurements very close to the bit.