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Drilling Without WOB, Dream or Reality ? An Effective Field Test by Total Angola.

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Abstract

Recent developments in PDC bit modelling and single cutter analysis have enabled to design a new generation of cutting structures - based on the optimization of a specific interactive cutting mode - that generates, by the mere drilling action of the cutters, an axial force oriented in the drilling direction : a negative weight on bit.

This paper presents the application of this new PDC bit design and shows that WOB can be significantly reduced in a wide range of formations. A monobloc 8"1/2 PDC bit was designed, tested in laboratory, and self penetration was clearly achieved in field conditions.

A full PDC bit design methodology using a new PDC cutters geometry optimized for a maximum thrust effect, along with specific manufacturing procedures for high-level precision in cutter positioning, were developed for this specific new bit generation.

Laboratory tests showed that it was possible to drill without WOB at a high rate of penetration and with a small increase in specific energy. Preliminary field tests in cement demonstrated that self penetration - drilling with the neutral point just above the bit - was possible with specific surface control, and a first operational application was conducted by Total E&P Angola.

This new bit technology has the potential to increase bit performance, specifically in operating conditions where power is available but WOB is limited due to friction, buckling or reduced vertical depth. The ability to drill with reduced WOB - or even without any WOB - should extend the potential of existing drilling technologies such as Extended Reach Drilling, Coiled Tubing or Steerable Motor in sliding mode and reduce axial vibration, thus increasing the MTBF of downhole tools.

Introduction

WOB limitations

It is commonly accepted that torque and weight must be transmitted to the bit in order to drill. While torque, with the development of downhole motors, is almost always available at bit in all types of wells, it is well known that some well configurations lead to poor weight transmission.

Directional corrections in sliding mode

When performing a trajectory correction with a downhole motor in oriented mode, the weight transfer is reduced due to increased friction as the drillstring is not in rotation. Power is still available down the hole but cannot be fully exploited as the bit fails to penetrate the formation. The ability to drill with a reduced requirement in WOB should have a strong impact on performance since a ratio of 50% sliding is common during the build-up phasis, with the reduction ranging from 5 to 2 of the ROP (Fig.1).

Extended Reach Drilling

With the development of directional drilling, long horizontal departures are becoming more and more classical in well design. It enables to reach very distant targets from the slot and to develop important horizontal drainage architectures. However, this development reaches a limit¹ as the friction increases : at some point the WOB can no longer be transmitted to the bit. In such cases, the ability to drill a longer section with the remaining WOB can extend the potential for horizontal departure as well as the footage of productive drain in the payzone.

Vertical drilling

Some applications require the ability to drill a vertical well with a very high level of precision. To achieve such results, it is important to limit the buckling tendency of the BHA since it forces the system out of verticality. The ability to reduce the need for WOB or to develop self-penetrating bits helps reducing the buckling effect.

Coiled tubing

In the case of coiled tubing, the system is not heavy and rigid enough to transmit sufficient WOB without buckling. To achieve adequate performances, one must play on RPM rather than penetration rate per revolution. With the ability to