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When Slick is Not Smooth: Bottom-Hole Assembly Selection and Its Impact on Wellbore Quality

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Abstract

Appropriate selection of a bottom-hole assembly (BHA) is critical to the success of a drilling operation. In US Land drilling, these assemblies are often selected using local heuristics rather than rigorous analysis. These heuristics are frequently derived from the incentives of the directional contractor as opposed to incentives for the operator. Large motor bends enable more rotation though the curve and reduce the possibility of tripping for build rates. Unstabilized motors are believed to aid sliding and tool face control. Both of these practices lead to drilling a more tortuous wellbore and may cause problems later in the well's life. This study quantifies the impact of these practices and proposes alternatives that can balance the needs of directional companies with the desire of operators for high-quality wellbores.

Over 60 conventional motor assemblies used to drill curves in the Eagle Ford and Permian were analyzed for directional performance using commercial drillstring analysis software. The sliding and rotary tendencies were modelled through the curve across a range of potential drilling conditions. Expected build-rate models were validated by comparison to the maximum achieved doglegs in the directional surveys. When available, additional validation was performed using motor yields calculated from slide sheets. The validated models were compared to the dogleg severity requirements for each assembly's respective well plan. Comparisons of slide ratios and slide/rotate tendencies of the BHAs were used to estimate the impact on wellbore quality using the tortuosity metric proposed by Jamieson (2019).

Typical well plans for both basins had curves of 10 degrees/100ft with no well plan greater than 12 degrees/100ft. Typical bottom hole assemblies were capable of >15 degrees/100ft under normal sliding conditions, with some assemblies capable of >20 degrees/100ft of build. Predicted build rates were validated by slide sheets and observed dogleg severities. Common characteristics among assemblies with excess capacity were high bend angles (>=2 degrees) and minimal stabilization. These slick assemblies also had a strong drop tendency in rotation at low inclinations. The combination of high-build rate with rotary drop greatly increases tortuosity, particularly in the early stages of well. A minority of the assemblies used a lower motor bend angle (<2 degrees) combined with multiple stabilizers. These assemblies had a more consistent directional capability throughout the curve and held angle in rotation. The success of these assemblies confirms that a higher quality wellbore with an improved BHA design is technically achievable.

As increasing attention is afforded to the topic of wellbore quality it is important to have methods available to technically achieve high-quality wellbores. In addition to the management of drilling practices, it is also important to have an appropriate BHA design that can enable those practices