Analytical and experimental backward whirl simulations for Rotary Steerable bottom hole assemblies

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Abstract
A unique analytical model has been developed to predict dynamic behaviour of the drilling assembly and gain a better understanding of the dominant factors that cause backward whirl. A full-scale test rig has been constructed that is capable of initiating and sustaining full rolling contact backward whirl, repeatedly, reliably and safely. Excellent correlation between these near real time analytical simulations and full-scale experimental results has been achieved giving confidence in using the model for serious predictive analysis of system response in real down-hole drilling conditions. This uniquely verified analytical model can be used for rapid iterative analysis to help generate and evaluate potential design improvements and whirl mitigation strategies.

These simulations have been focused on a latest generation point-the-bit rotary steerable system (Figure 1 shows the general arrangement of the steering system), but the principles can likely be applied to other rotary drilling assemblies.

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This return to rotary drilling has renewed industry interest in detrimental dynamic phenomena such as backward whirl (Stroud et al, 2011). Preventing these undesirable dynamics is crucial to drilling efficiency and it is widely recognised that the nature of BHA/borehole contact points plays a key role in preventing backward whirl. This investigation focuses on how roller reamer technology can be adapted for use as a key component in a rotary steering assembly to prevent borehole traction WITHOUT causing side-cutting and hole enlargement, and without adversely affecting system steerability. It describes how a custom design roller reamer can be used to replace a stabilizer as the fulcrum for a point-the-bit rotary steerable system (RSS).