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Stiff String Casing Design: Tortuosity and Centralisation

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Abstract

The forces and stresses along casing strings are modeled using a stiff string torque and drag model. The effect of wellbore tortuosity and centralization are quantified in preplanning phase in addition to the effect of 3D orientated casing wear. A realistic case study is presented to show the resulting effect on axial, burst, collapse and Von Mises equivalent (VME) safety factor as well as VME body and connection design envelopes.

While running a tubular downhole, a smooth wellbore is normally assumed when performing a torque and drag calculation. In reality, the inherent tortuosity of the wellbore which is caused by the drilling process can cause significant local doglegs. When applying a soft-string torque and drag model, the stiffness, radial clearance and high frequency surveys needed to fully model local doglegs are rarely modeled. The stiff string torque and drag and buckling model can model these effects, as well as the addition of rigid and flexible centralisers. This study involves the comparison of different casing design load cases, under different centralizer programs and tortuosity taking into account a 3D orientated casing wear.

The results show that there can be significant differences in overall axial stress depending on the centraliser program and tortuosity used. The soft string model doesn't directly account for bending stress, normally this is estimated using a Bending Stress Magnification Factor (BSMF). In contract the stiff string model can directly calculate the additional bending stress. This additional stress can be particularly prevalent while RIH casing with centralisers and high tortuosity. The reduction in American Petroleum Institute (API) and VME stress envelope is also quantified using a 3D orientated casing wear model. A better understanding of axial stress state reduces risk of well integrity issues.

This paper will show the benefits of using a stiff string model, considering additional contact points, bending stress as well as the benefits of modelling tortuosity and centralizer program early in the design process. During extended reach drilling (ERD) and high-pressure, high temperature (HPHT) wells, this information can be critical when correctly assessing the axial stress state.