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Characterization of Drilltring During Drilling Operation

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Investigating drillstring (DS) buckling behavior is of interest to oil and gas industries. Friction force has a significant influence on DS buckling initiation and transition. In this study the effects of adding Nano-Sepiolite (NSP) to the water-based drilling fluid (WBDFs) on the friction between the DS and wellbore wall were investigated. The DS sinusoidal and helical buckling, DS lock-up condition and the axial force transfer were experimentally investigated. The WBDFs lubricity, coefficient of friction (COF) between the DS and the casing, and the stability of the rheological properties of the NSP modified WBDFs containing 1- 5 wt.% NSP was tested in high temperature and high pressure (HTHP) environment utilizing the in-house built experimental setup.

Keywords: buckling, friction force, drilling, drillstring failure, nano-modified drilling fluids

1. Introduction

During drilling operation, when a compressive force is applied on a DS, a sinusoidal buckling mode is created and moves into a helical buckling as compressive force increases as shown in Figure 1. This leads to a gradually increasing in friction resistance and contact forces between the DS and the casing and results in reducing axial forces transfer to the drilling bit and eventually to a lock-up situation beyond which the drilling bit does not go further and ultimately leads to DS failure.

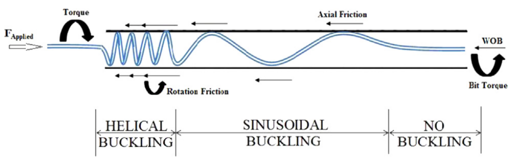

Figure 1: Schematic of DS buckling in horizontal section

Drilling process competence greatly depends on the capability of the drilling fluids (DF) to perform specific tasks without which the process cannot progress. Advanced lubricants are designed and added to the DFs to reduce the friction force in deep drilling where DFs deteriorate due to HTHP environment [1].

2. Methods

To reduce friction between the DS and wellbore wall, various concentrations of NSP were developed and used as lubricants in the WBDFs. An in-house experimental setup (Figure 2) that imitates a wellbore being drilled in the presence of circulating DF were developed and utilized to examine the performance of the NSP-modified WBDFs at normal and HTHP environments. Figure 3 shows images from the inside of the drilling setup. The figure shows a buckled DS due to contact with the casing. Details about designing and constructing of the drilling setup as well as testing procedure will be provided later.

Figure 2: Drilling performance setup

Figure 3: Drillstring buckling in NSP-WBDFs

3. Results and Discussion

Figure 4 shows buckling and lockup behavior of the DS (loading and unloading) in water, air, and NSP modified WBDFs (mud). It also shows the axial force transfer (AFT) as a function of applied force. Results show that when applied force was between 0 and 1300 N there was no buckling. Curves start shifting away from the tangent line nearly at 1300 N which indicates that sinusoidal buckling is initiated. At 2800 N NSP modified mud starts shifting away from the sinusoidal line which indicates that helical buckling is initiated. AFT in Air and water curves started shifting sooner that in Mud. The gap between the applied and AFT curves increased with increasing the applied force which indicates that additional length of the rod was entered the helical configuration so higher friction forces were introduced. When the top force was increased further until it reached about 4300 N, lower curves start shifting away from the helical buckling line forming a horizontal line which indicates a lock up condition was reached.

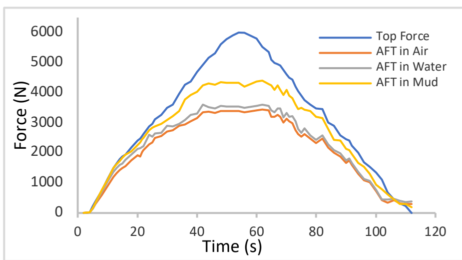

Figure 4: buckling and lockup behavior of DS

4. References

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