REDUCING TORQUE AND DRAG IN EXTENDED REACH WELLS

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Abstract - Drilling an extended reach well acquires precise engineering in drilling the deviated and horizontal section of the well as there are a lot of technical problems that can appear in these sections. The biggest issues that appear in the deviated and horizontal sections of the well are high values of friction factor that leads to high values of torque and drag, material wear of the joints, and inadequate cleaning of the well from cuttings. High values of torque moment and drag force represent a big problem when drilling directional wells, and in general affect the possibility of reaching the designed path of the well. One of the solutions to reduce torque and drag is to applicate lubricants in the drilling fluid to reduce the friction that appears when drill string is in contact with casing or borehole. Normally one method doesn't always solve the issue alone, so in conjunction with adding lubricants to water-based mud system, another solution is to add a protective ring on the tool joints/pipe body of the drill string that would be made from materials that could reduce friction and wear. Protective rings would be made from materials that have been used in the industry to produce various mechanical elements. In this paper lubricants will be tested in different concentrations to conclude the optimal concentration to be used in water-based drilling fluid and which material for the protective rings to be used for eventual practical use.

Keywords - Extended Reach Drilling, Friction Factor, Torque And Drag, Mechanical Wear, Lubricants, Protective Ring.

I. INTRODUCTION

In today's world the need for energy is growing, and by that the need for hydrocarbons is increasing and thus the oil and gas industry is forced to increase the production and at the same time to find new ways to produce oil and gas with minimizing the impact on the environment. One of the ways to access oil and gas reservoirs that were previously inaccessible or economically unprofitableis to drill an extended reach well.

Extended Reach Drilling (ERD) is one of advances in drilling technology that made the greatest impact on recovery factors and reservoir rates compared to other advances in technology. It is directional drilling characterized by very long horizontal sections and wells (Bou Hamdan, 2015).An extended reach well is defined as having a horizontal departure (HD) to true vertical depth (TVD) ratio (HD/TVD) of more than 2.0, or where the horizontal displacement is greater than 20,000 ft (6096 m)(Tveitdal, 2011; Bennetzen et al. 2010; Agbaji, 2009; Chen and Gao, 2018). The difference between a traditional deviated well and an extended reach well is given in Figure 1.

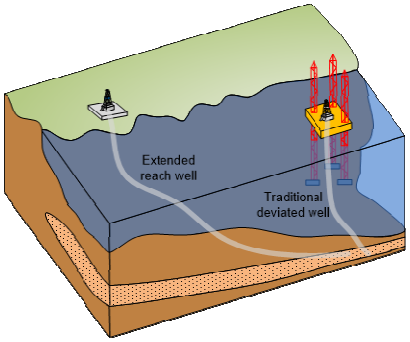


Figure 1.Difference between a traditional deviated well and an extended reach well

Most horizontal wells are drilled for one of the following reasons (Steiner, 1994; Bennetzen et al., 2010):

1. Development Of Fractured Reservoirs,
2. Development Of Reservoirs With Potential Problems Of Water And/Or Gas Coning,
3. Development Of Deposits With Production Deposits Of Small Thickness,
4. Connecting Several Isolated Reservoirs With Only One Well,
5. Reaching Several Reservoirs From One Location, And
6. Avoiding Drilling In Ecologically Sensitive Areas.

The aim/purpose of selecting Extended reach well instead of traditional deviated wells is one because it can reduce the total cycle time to production sales through utilization of existing infrastructure, extend the filed drainage radius of the reservoir, increase productions rates, access reservoirs that were previously inaccessible due to high development cost or environmentalconcern, technical and location constraints (Judzis et al., 1997).
Issues related to extended reach wells.

While drilling horizonal wells various technical issues can appear, especially while drilling the deviated and horizontal sections of the well. Most common problems are high values of friction which causes high torque and drag values, material wear of tool joints, inadequate cleaning of the sections in the well from cuttings which makes it impossible to reach previously selected point in the underground.

Research showed that reducing torque and drag forces can be accomplished by using several different methods, because using only one method does not

solve the issue related to high values of torque and drag forces. To reduce high values of torque and drag forces some of these methods should be engaged at the same time such as optimized well plan, bit selection, drill string design, use of rotary steerable system, use of modular motor, use of non-rotating drillpipe protectors, use of mud additives (lubricants) and proper hole cleaning (Çağlayan, 2014).

The most common and effective way to reduce torque and drag is to use lubricants in drilling mud system. While drilling such wells, most common used drilling muds or even drill-in fluid is a polymer mud with the addition of lubricants in it to reduce the friction factor and thus the torque and drag values.

In addition to adding lubricants to water-based mud system, another solution would be adding a protective ring on the tool joints/pipe body of the drill string that would be made from materials that could reduce friction and mechanical wear. So far, the industry uses a protective ring on the drill pipe body as shown in Figure 2 to reduce the mechanical wear.



Figure 2.Protective ring on the drill pipe body (www.maxwelloiltools.com)

According to earlier mentioned and based on the researched of recent work in this field, it was decided to go with polymer mud with weighting additivesin which lubricant was added in different concentrations, a minimum concentration of 2%, medium concentration of 4% and a highest concentration of 6% and the chosen materialsto test were polyoxymethylene (POM) and polyamide (PA6). The tests were conducted using an OFITE device for lubricity measurements (Lubricity tester) as shown in Figure 3 (left side) and the test blocks made from POM and PA6 that were specially manufactured so they would fit in the test block holder. Figure 3 (right side) shows the test blocks made from PA6, POM and metal.

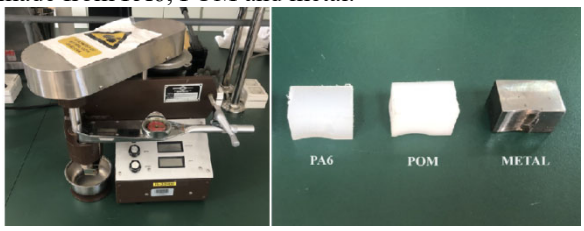


Figure 3. Lubricity tester on the leftside, and blocks made from PA6, POM and metal on the rightside.

Measurement of friction force is carried out when the device is brought to a rotation speed of the main shaft to 60 rpm, while at the same time locking the arm that holds the test block in test block holder and applying 17 Nm (150 lb-in) of force, so the two surfaces come in direct contact while motor is rotating. After 5 minutes the friction force value is recorded in lb.

The first test was performed using a polymer mud with weighting additives in which lubricant was added in concentration of 2%. The test was performed on a metal block and blocks made from POM and PA6 and results are presented graphically in Figure 4.

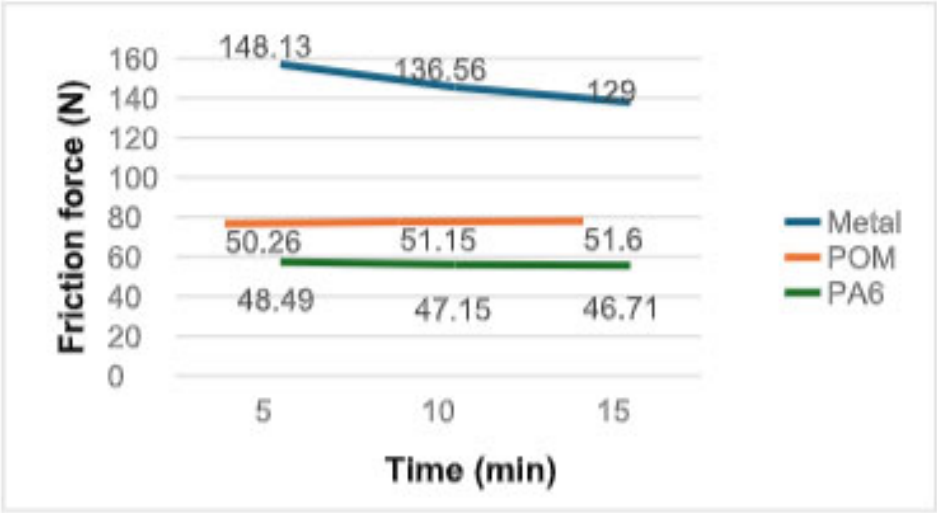


Figure 4. Values of friction forcereading while testing metal block and blocks made from POM and PA6 in a polymer mud system with weighting additives and lubricant in concentration of 2%.

Based on the data presented graphically in Figure 4friction force is decreasing for the metal block and block made from PA6 as test time passes by, while for the block made from POM the value of friction force slightly increases as test time progresses. After 15 minutes of testing the highest value of friction force is registered for metal block (129,00 N), followed by block made from POM (51,60 N) while the lowest value of friction force is registered for block made from PA6(46,71 N).

The next mud system that was tested was polymer mud with weighting additives in which lubricant was added in concentration of 4% and the results are graphically presented in Figure 5.

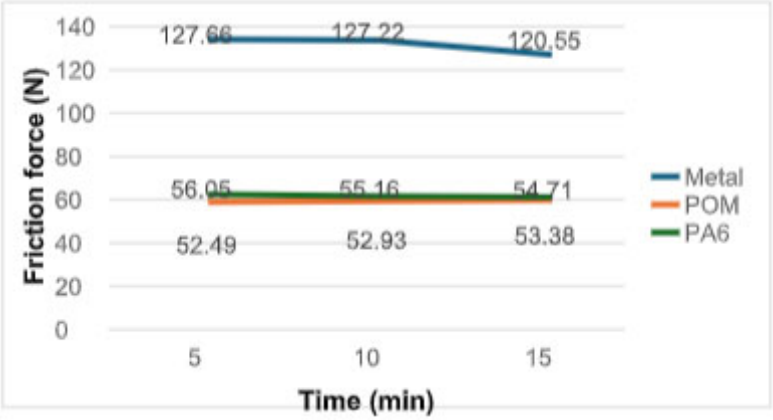


Figure 5. Values of friction forcereading while testing metal block and blocks made from POM and PA6 in a polymer mud system with weighting additives and lubricant in concentration of 4%.

Based on the data presented graphically in Figure 5friction forceis decreasing for the metal block and block made from PA6 as test time passes by, while for the block made from POM the value of friction force slightly increases as test time progresses. After 15 minutes of testing the highest value of friction forceis registered for metal block (120,55 N) while the lowest value of friction forceis registered for blocks made from POM (53,38 N) and PA6 (53,38 N).

The final mud system to test is polymer mud with weighting additives in which lubricants was added in concentration of 6% and the results are graphically presented in Figure6.

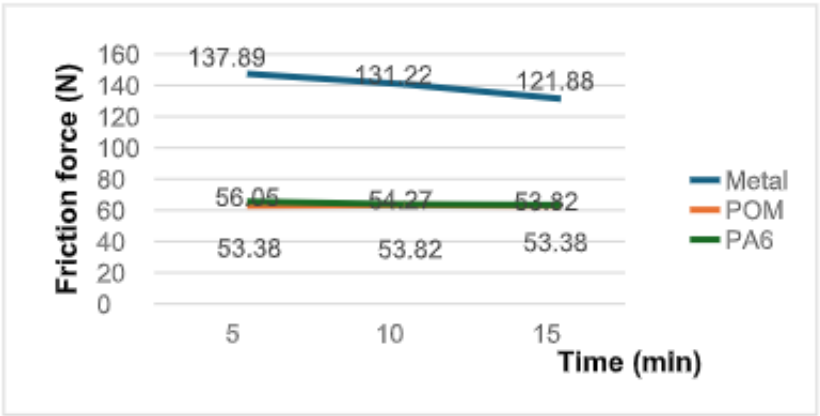


Figure 6. Values of friction force reading while testing metal block and blocks made from POM and PA6 in a polymer mud system with weighting additives and lubricant in concentration of 6%

Based on the data presented graphically in Figure 6friction forceis decreasing for the metal block and block made from PA6 as test time passes by, while for the block made from POM the value of friction forcedoes not change. After 15 minutes of testing the highest value of friction forceis registered for metal block (121,88 N) while the lowest value of friction forceis registered for blocks made from POM (53,38 N) and PA6 (53, 82 N).

Comparing the three tested mud systems, it can be seen that the values of friction forcefor blocks made from POM and PA6 in polymer mud with weighting additives and lubricant in different concentrations of 2%, 4% and 6% slightly changes while comparing the metal block the highest value of friction forceis in polymer mud with weighting additives in which lubricant was added in concentration of 2% and it decreases with increasing the lubricant concentration to 4% but with further increasing the lubricant

concentration to 6% the value of friction forcedoes not changesignificantly.

CONCLUSION

The most common issue when drilling deviated and horizontal section of an extended reach well is high values of friction that cause high values of torque and drag which in the end makes it impossible to reach the designed depth. One of the solutions to reduce these high values is to use lubricants in the drilling fluid with the combination of protective sliding ring that aremade from POM or PA6.

The presented results in this paper show that values of friction force for POM and PA6 in polymer mud system with weighting additive in which lubricant was added in different concentration of 2%, 4% and 6% aremuch lower than for the metal block. From the obtained results it can be seen, that increasing the lubricant concentration more than 4% does not change the value of friction force. The main purpose of the protective sliding ring is to decrease the mechanical wear of tool pipe joint and at the same time to decrease the friction between the two surfaces in contact. The next step would be to test the mechanical wear of these materials of which the protective sliding ring would be made from. Also, testing the chemical effect of the mud system on the blocks made from PA6 and POM should be made as next step.

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