Efficiency of Inhibitive Mud Application in Horizontal Wells

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Abstract. Currently, we have been witnessing the increasing number of problems in drilling caused by certain challenges in drilling through depleted reservoirs, complicated geological settings, and fast-growing technology of extended reach drilling. One of the methods used to solve the problems is casing-while-drilling. The authors have been studying the difficulties occurring while using this method with a special focus on the issue of torque increase while rotating a casing string at an excessive speed. The paper presents calculations of the torque taking into account the friction coefficient. As an effective solution to reduce the torque a new centralizer has been designed in the laboratory of the Department of Oil and Gas Well Drilling of Almetyevsk State Oil Institute. While performing casing drilling operations a new centralizer with roller balls attached makes it possible for rolling friction to be replaced with sliding friction and, thus, prevent thread stripping.

1. Introduction
Economic development of unconventional reservoirs necessitated the development of leading edge horizontal drilling and well completion techniques. Currently, there is a increasing tendency in the world to have production systems with horizontal sections in the producing reservoir. One of the priorities in stimulation of oil production from the Romashkinskoye field in the Ural-Volga region is also associated with drilling wells with horizontal ends. PJSC TATNEFT increased the number of horizontal wells with horizontal tailing-in in the period from 2001 to 2016 has increased 4 times (figure 1) [1] Horizontal wells are getting longer and longer, require more stimulation stages, must be optimized (not just efficient and economical) and environmental concerns cannot be ignored as well.

2. Overview of the Project
The largest Tatarstan reserves being drilled are located in the Pashyiski horizon of the Romashkinskoye oil field, which contains about 84.5% of the recoverable oil reserves [2]. An important task in the construction of directional wells with a horizontal end is to ensure that sloughing of the borehole wall does not occur, and maintain its stability. The main factors determining the destruction process of the walls composed of clay deposits are shown in figure 2. [3] In the areas drilled by PJSC Tatneft, there are trouble zones because of the layers difficult to drill through and reach the productive horizon. They are mostly confined to the Kynovsky horizons, the thick sequences of plastic clays. Hydration of clay rocks in the Kynovsky argillites leads to the problems like sloughing and caving.
Figure 1. Horizontal well drilling dynamics, PJSC TATNEFT.

Therefore, close attention should be paid to the properties of the drilling mud used, and to the fact that its functional task is to minimize the destabilizing effect by reducing hydration of clay rock which involves due consideration of pressure control issues.

Figure 2. Factors determining the process of borehole wall destruction.

The article presents the study of 56 directional wells with a horizontal completion drilled into the Devonian deposits: 35 drilled by NGDU Aznakaevskneft, 14 drilled by NGDU Jalilneft, 7 by NGDU Leninogorskneft; they all are structural divisions of TATNEFT Group.

From 2013 through 2017, enterprises of the TATNEFT Group of Companies applied the following types of mud compositions designed with respect to the specific drilling fluid requirements, or regulations, to be used in the Russian oil and gas fields: UniDrill (in 26 wells), Mud Max (18 wells), PremiumGel (11 wells). In our previously published papers we discussed the main properties of the compositions enlisted and gave a detailed description of the inhibition process [4-13].

In field conditions, the time spent on solving such problems and complications as caving, sloughing, sections squeezing, and key seating, can be evaluated as an indicator of the deformation process slowdown in the borehole [14]. Complications occur because of incompatible drilling
conditions while drilling directional hole with horizontal completion in the intervals of clayey sediments accompanied with an obvious and abnormally high reservoir pressure [15, 16].

Since drilling horizontal wells in the Pashian horizons involves passing through formation sections composed of the sloughy Kynov clays and borehole inclination more than 65°, the study carried out to evaluate the amount of the problems and the time spent to prevent them has a significant impact on making recommendations for successful drilling [17, 18].

The study revealed that there were problems recorded in all 11 wells drilled using PremiumGel sodium bentonite drilling fluid. Mud Max inhibited salt drilling mud was used in drilling of 19 wells and there were problems in 68% of them though 32% were straight-ahead drillings with no troubles. UniDrill was used to drill 26 wells, 54% were trouble free though drilling problems were encountered in 46% of them.

For this purpose, the correlation between the time spent on solving the problems occurring while drilling and the type of the drilling mud used has been made (figure 3).

Figure 3. Time spent on solving the problems occurring while drilling versus the type of the drilling mud used.

Taking into account the number of difficult wells and a temporary indicator for jobs to avoid or eliminate the well problem, made it possible to distinguish the following trends:

– per-well problem average while using PremiumGel was 9.1% and, in addition, the time to eliminate adverse effects was twice as much compared to other fluids used;
– per-well problem average when Mud Max was used just accounted for 5.4% and the shortest time to eliminate adverse effects;
– per-well problem average using UniDrill was 3.8%, the time to eliminate adverse effects compared to Mud Max slightly exceeded.

The key features of customized drilling services include high deviation angles to enter the Kynovsky horizons [19, 20]. In the course of the study we have considered two ranges according to zenithal angles (60°-70° and 70°-80°), and have found the averaged time for fighting adverse effects and eliminating the problems per one well with respect to azimuthal angle for drilling through the Kynovsky horizon (figure 4).

Mud Max added to the wellbore to facilitate the drilling process is more effective in the zones with drilling inclination in the range from 70° to 80° because the time to solve the problems is reduced by 29% compared to penetration at 60° to 70°. With the same number of wells in the areas from 60°-70° up to 70°-80° the total time needed to eliminate troubles reduced 3 times in comparison with cases when Premium Gel fluid was used.
Figure 4. Time needed to solve problems versus deviation angle when drilling the Kynovsky horizon.

Premium Gel was used in smaller number of wells and it took the maximum time to solve well problems. When angle was 70° to 80° the time spent on solving the problems was five times as much (compared to Mud Max and UniDrill). When the hole inclination was 60°-70° and Premium Gel was used, the average time made 10.1 h/well; and for borehole inclination of 70 to 80° it increased 2.67 times as much. It was UniDrill that showed the minimum time recorded needed for eliminating problems occurring while drilling in the Kynovsky horizons. Practical experience of drilling has proved that additional increase of concentration by 25% improve Mud Max inhibitive drilling mud properties and results in drilling with no troubles at all. However, this solution leads to drilling fluid cost increase by 10 to 15% and, accordingly, the cost of horizontal drilling increased as well.

3. Conclusion

The results of the study carried out by the authors contribute to effective and successful horizontal drilling in the Devonian deposits and provide the opportunity to use the proper highly inhibitive drilling fluids, i.e. Mud Max and UniDrill. Despite the increase in the cost of drilling fluid used, the final cost of well construction will be significantly lower due to reduction of problems and emergencies accidents compared to drilling with non-inhibitive muds, and we also should keep in mind that the cost of horizontal wells usually decreases rapidly through time.

4. References

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