USING POLYMER CENTRALIZERS TO REDUCE THE FRICTION FACTOR IN HORIZONTAL DRILLING

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Horizontal drilling is becoming standard practice. The cumulative footage of horizontal wells has already exceeded that of vertical and directional wells. To increase production, operators extend the length of the borehole's horizontal section, which in turn leads to a complicated well trajectory. Experience shows that this results in higher operational risks. One such possible complication is that casing strings may fail to reach the planned depth.

Analysis of the causes revealed an increased friction coefficient (0.4–0.5) between the casing string and the borehole walls. This problem may be effectively solved by using polymer turbolizer centralizers (hereinafter referred to as "turbolizers"). The complex composite polymer material used to produce turbolizers has a very low friction coefficient, making it much easier to run the casing to the target depth in particularly difficult open-hole conditions, especially in wells with long horizontal intervals. Using polymer turborlizers, design engineers can model longer horizontal and subhorizontal wells, extending the length of the productive interval while reducing operational risks at the design and implementation stages.

Design engineers at Naberezhnye Chelny Pipe Plant (NChTZ LLC) have developed an optimized turbolizer geometry to effectively centralize the casing in the well and create turbulence in the fluid flowing around the casing and behind the casing during RIH and cementing operations. The resulting turbulence substantially facilitates drilling fluid displacement and replacement by cement slurry in the zone around the turborlizer centralizers, particularly across cavernous borehole intervals. Besides, when running a turbolizer, neither oxidation nor channeling occur, thus ensuring a better cementing quality.

The turbolizer's design was developed to minimize formation drag and provide the lowest possible hydraulic resistance during fluid circulation due to the optimally selected wall thickness and a larger flow-through area compared with thick-walled turbolizer designs. A spherical contact patch and custom-designed blade shape reduce the risk of getting stuck in the most challenging sections while running the string. Turbolizers are made of an innovative frost-resistant composite material, which reduces the risk of their damage during transport and installation, even at low ambient temperatures.

Fig. 1.

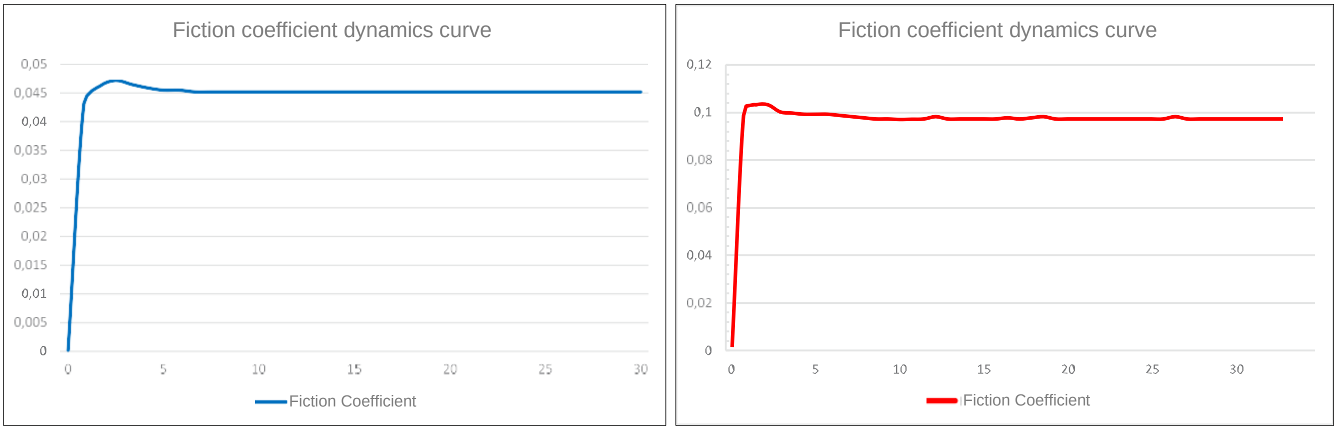
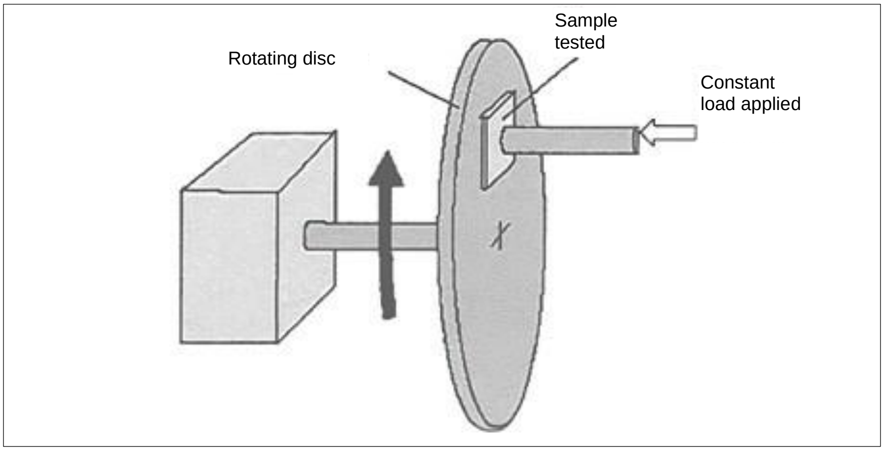


Fig. 2



The operating principle of turbolizers is based on their blades obstructing the upward flow of fluid in the annular space in such a way that swirling is created around the casing string, directed toward the borehole walls. As a result, the absolute velocity of the fluid filaments is increased, the effective Reynolds number (Re*) is higher, and multiple vortex initiation sites are created. Thus, the flow becomes more turbulent in general, even at subcritical Reynolds numbers. This, in turn, enhances cementing quality since a mud film is washed away from the casing surface and the structure of the drilling mud in caverns and keyseats is destroyed, enabling better displacement of the drilling mud and its replacement with the cement slurry. Higher turbulence in the cement slurry flow during cementing enhances the quality of the cement job by ensuring better cement distribution behind the casing.

The performance of the newly developed polymer centralizer design was evaluated in the course of tribological tests run in accordance with the API TR 10TR5 2008 standard to measure material friction and wear using the "pin-on-disk" method. The tests were performed on a tribometer (pin-on-disk machine), which consists of a rotating disk, on which a sample product is placed and secured by applying an axial load *(Figure 2)*. To simulate downhole conditions, the rotating disk surface was made of non-polished steel, simulating the surface of a casing string. The number of disk revolutions depended on the rotation time required to achieve the target footage of H=4,300 m.

The tribological tests showed that after running the specified distance of 4,300 m, a dry friction coefficient was 0.1. The wet friction coefficient measurement yielded a value of 0.045, which is 10 times lower than observed when using metal centralizers *(see Figure 1).*

In addition, tests were performed to find the degree of the turbolizer material deformation under radial and axial loads. The test gave the following results:

- The recorded radial deformations under load were within 1 mm, ensuring reliable casing standoff.

- The material deformation caused by the applied axial load did not exceed 0.5 mm.

- The turbolizer's locking rings, secured to the casing string with 4 set screws, can withstand axial load with minimal displacement of up to 2 mm, provided the tightening torque for the set screws on the ring is at least 30 N·m.

Due to a combination of advanced materials and state-of-the-art technologies, the turbolizers resist deformation, ensuring a good casing standoff and reducing the risks of occurrence of leaks behind casing. Thus, these turbolizers are suitable for applications in unstable formations, under high dogleg severity, and at high inclination angles. Along with risk reduction, they enable trouble-free running of casing strings or liners to the planned depth, even in the most challenging conditions.

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