Azerbaijan University of Architecture and Construction
ISSN 2706-7726
Engineering Mechanics
Scientific and Technical Journal
E-mail: engineeringmechanics@azmiu.edu.az

March 2024	Issue 15	Volume 7	Number 1	Pages 33-38

RELEASE OF DRILLING BHA STUCKING IN THE WELL BARREL.

G.S. KHEYRABADI, S.A.MUSAVI

Abstract: In the economy of the oil and gas industry, along with an increase in oil and gas production, today the commissioning of wells that are idle for various reasons through workover is more profitable since it is much more efficient and less expensive than in comparison with the construction of new wells. Workover of an inactive oil and gas well can be implemented by using stationary and mobile drilling rigs. It is known that the efficiency of opening productive deposits, in terms of maintaining their reservoir properties, depends on the geological and physical characteristics of the deposit, the physical and chemical properties of reservoir fluids, the characteristics and indicators of the technology used at all stages of well construction (properties of drilling, cementing and special solutions , values and limits of change of bottomhole differential pressures along the wellbore during drilling and cementing, the degree of perfection of the hydraulic connection between the formations and the wellbore, etc.). In this regard, the purpose of the applied and developed technologies is to reduce or eliminate the negative impact of the main factors on the reservoir properties of productive formations and maintain the potential productivity of wells.

Key words: mobile drilling rigs, well pressure drop, breaking force, contact area, currying capacity

When drilling oil and gas wells, the maximum load on the drilling rig occurs in the case of the release of a drilling tool stuck under the action of a pressure drop.

The results of calculating the breaking force of a tool stuck under the action of a differential with various bottomhole layouts and brands of mobile drilling rigs showed that modern mobile drilling rigs make it possible to drill and repair oil and gas wells with a design depth of up to 5000 m.

Introduction.

Currently, drilling of oil and gas wells, their recovery and overhaul are mainly carried out by mobile units. This is due to the fact that the construction and dismantling of wellhead equipment takes a lot of money and time.

One of the complications that reduce the efficiency of putting wells successfully drilled to the design depth into operation is based on the results of its construction. Preservation of the natural permeability of productive formations in the technological processes of well construction, from initial opening to its workover, is still an urgent problem, despite the urgent need to solve this problem, since well productivity directly depends on it.

An analysis of the state of work in the field of maintaining the potential productivity of reservoirs shows that in most cases the currently used methods of drilling and pumping wells do not provide effective protection of oil and gas reservoirs from deterioration of their reservoir properties.

The change in the filtration characteristics of a productive formation during the construction, operation or repair of a well occurs within the area of the formation adjacent to the wellbore - the bottomhole formation zone (BFZ). It is known that a decrease in the filtration properties of the BFZ occurs due to the introduction of process fluids and mechanical impurities into the pore space of the filtrate during drilling, cementing, and perforation. Therefore, starting from the opening of a

productive formation by drilling and at all stages of construction, development and operation of wells, it is necessary to maintain or restore the natural permeability of the BFZ.
A change in the filtration properties near the well space is the cause of the manifestation of a pressure drop, which can contribute to the sticking of the drilling tool in the process of drilling. This phenomenon is one of the undesirable results that significantly reduces the efficiency of the wellbore construction.

Formulation of the problem.

It is known that in drilling overhauling and recovery process of oil and gas wells, sticking or jamming of the drilling tool on the surface of the well bore walls occurs (Fig. 1).
Therefore, when choosing a mobile installation, it is necessary to take into account the pace when capturing the column tubes in order to release it. Naturally, this load does not exceed the maximum allowable for the selected installation. During drilling and workover of wells, when drilling tool, release relevant in many cases this occurs under the action of a drop between hydrostatic and reservoir pressures under the following conditions (Fig. 1):

- the hydrostatic pressure of the drilling fluid exceeds the formation pressure by a certain amount; - the drill string is in contact with the wall of the well borehole; - the wellbore wall consists of highly permeable rocks; - the drill string for some reason remains without movement for more than 10-15 minutes.

Solution of the problem. Therefore, calculating the breakout force when gripping the drilling tool requiring differential pressure and determining its values with a high probability of being able to select the appropriate mobile drilling rig without complications.
These forces are determined by the following formula:

$$F = F_1 + \Delta PS\xi \tag{1}$$

where: F_1 - is the weight part of the drilling tool determined by the formula:

$$F_1 = Lq\left(1 - \frac{\gamma_H}{\gamma_M}\right) \tag{2}$$

γ_H - mud specific gravity;
γ_M - specific gravity of drill tube metal;
q - weight running meter of drill pipe, kg/m;
L- length of the free part of the drill string, m;
ΔP - differential pressure between the well and formation, kg/cm²;
S- area of the contact surface of the stuck part of the drilling tool, cm²;

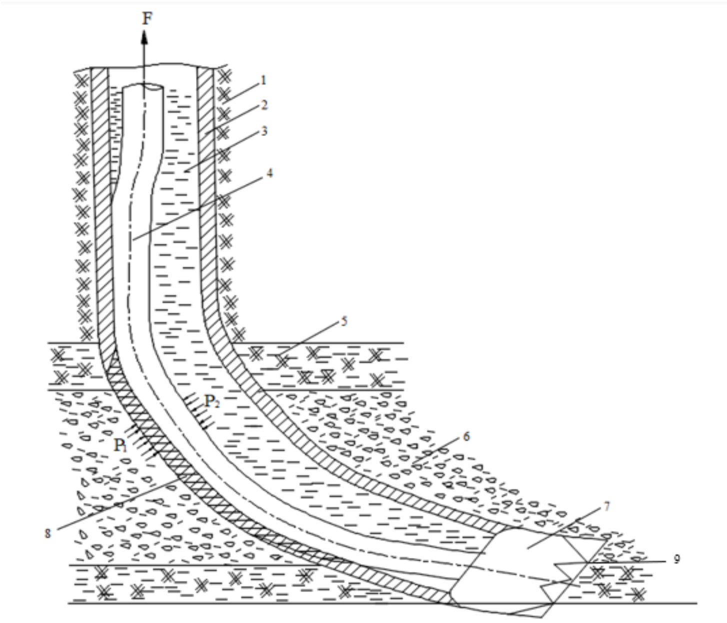

Figure 1. Scheme of sticking the BHA under the action of differential pressure:
1-wellbore; 2-clay cake; 3-drilling fluid; 4-drill string; 5-clay horizon; 6-sandy permeable horizon; 7-chisel; 8-contact surface of the stuck part of the BHA

ε- drag coefficient between metal and drilling fluid on the borehole wall. According to experimental data ε= 0,1.

According to studies [1,2,3,4], the pressure drop (oppressive pressure) is determined by the formula:

$$\Delta P = \frac{P_{r.c} - P_{p.l}}{1 + \frac{0.3\ D/K_f}{h/K_c}} \qquad (3)$$

where, $P_{r.c}$ – drilling mud hydrostatic pressure, kg/cm^2;

$P_{r.c} = \frac{N\ \gamma_H}{10}$

$P_{p.l}$- undisturbed formation pressure, kg/cm^2:

$$P_{p.l} = \frac{1{,}03\ H}{10}$$

H - depth of the permeable horizon, m:

D - wellbore diameter, mm:

H - mudcake thickness, mm;(Dedkov V.K. Yurikov N.K., 2014. Application of systematic analysis in enterprise management. *Reliability and quality of complex systems, 4(8): pp. 54-60.*)

K_f and K_c rock and mudcake permeability according to (Robotnov V.N., 1998. Mechanics of deformable solids. Nauka: *pp. 711.*, Sichuan Kunlun Petroleum Equipment Manufacturing Co., Ltd. https://www.kpem.com.cn (access: 10.12.2021); Sichuan Kunlun Petroleum Equipment Manufacturing Co., Ltd. https://www.kpem.com.cn (access: 10.12.2021)

$$K_f = 30\ ml \text{ and } K_c = 20\ ml$$

To determine the surface area of the contact of the stuck drill string with the borehole wall, we will use the calculation scheme shown in Fig 2. will be used.

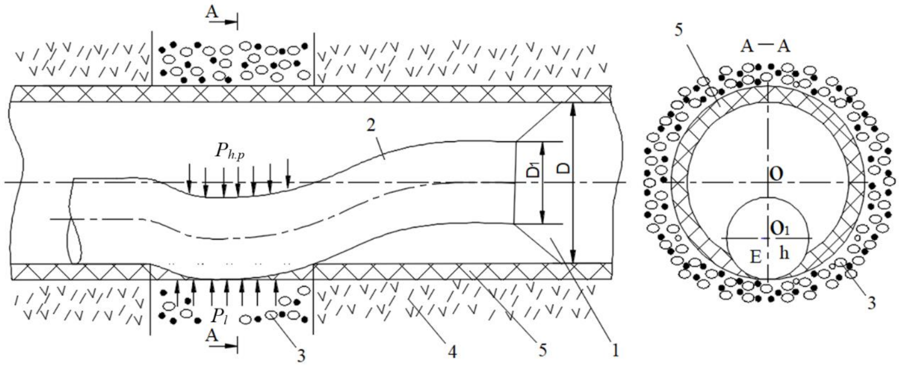

Figure 2. Calculation scheme for determining the contact surface of a stuck drill string with the borehole wall: 1 - drilling bit; 2-drill string; 3- highly permeable rocks; 4 - clay rocks; 5 - clay cake.

The results of the calculation of stress separation of the gripping mechanism under the action of pressure drop on various layouts of the low-drill string and brands of mobile drilling rigs are presented on table 1.

Table 1.

The breaking force required to free the drill tool due to temperature drop and the brand of the mobile drilling rig

Well design	Drill tool layout	Solution density, g/cm^3	Peel thickness, mm	The length of the free part of the tool, m	Length of the stuck part of the tool, m	Force required to release the tool, kN	Rig brands	Manufacturer	Maximum load capacity, kN

<table>
<tr><td rowspan="3">Technical column d299 mm (2000-3000) m</td><td rowspan="3">Bit – Ø190 mm- УБТ-Ø146 mm (100m) Drilling Pipes – Ø114 mm (2000-3400 m) d127 mm (0-2000 m)</td><td rowspan="7">1,70</td><td rowspan="7">4,0</td><td rowspan="7">3400</td><td rowspan="7">5,0</td><td rowspan="3">1210</td><td>МБУ-180</td><td>КМЗ</td><td>1800</td></tr>
<tr><td>МБУ-180</td><td>000 idel neftmash</td><td>1800</td></tr>
<tr><td>МБУ-160 (PRI-700)</td><td>000 Lukoil kaliningradmorneft</td><td>1600</td></tr>
<tr><td rowspan="3">Technical column d324 mm (0-3000)</td><td rowspan="3">Bit – Ø295 mm- УБТ-Ø245 mm (100 m) Drilling Pipes – Ø127 mm (0-3400 m)</td><td rowspan="3">1350</td><td>МБУ-160</td><td>КМЗ</td><td>1600</td></tr>
<tr><td>Uralmash 3800/200 ДЗР-М</td><td>Uralmash</td><td>2000</td></tr>
<tr><td>ТД160 САА7</td><td>Generation</td><td>1800</td></tr>
<tr><td>Technical column d299 mm (0-3000)</td><td>Bit – Ø269 mm - УБТ-Ø178 mm (100м) Drilling Pipes – Ø127 mm (0-3400 m)</td><td>1110</td><td>ТД200 Сд АТ</td><td>Generation</td><td>2000</td></tr>
</table>

We accept that the drill string 2 lies on an elastic foundation (on the well wall) against the permeable horizon 3, which is affected by the force from the pressure difference (ΔP·S).

Under the action of pressure drop (ΔP), the drill string 2 in the middle of the grip zone deforms the mud cake throughout its thickness. As a result, a cone-shaped surface is formed between the gripping part of the drill string and the borehole wall. Due to the small value of the crust deformation, the surface area of the engagement of the gripping part of the drill string with the borehole wall can be determined by the under shown formula:

$$S = \frac{\pi b l}{2} \tag{4}$$

Where: b- width of contact between the body of the drill string and the borehole wall surface, cm;

l - length of the stuck part of the drilling tool, cm;

To determine the value of "b", the calculation scheme shown in Fig 2. is used:

According to (Robotnov V.N., 1998., Taha K.A. 2016) the borehole radius "R" and the radius of the stuck drill string "r" are expressed by the formulas:

$$R = \frac{b^2 + 4EC^2}{8EC} \quad (5)$$

$$r = \frac{b^2 + 4(EC+h)^2}{8(EC+h)} \quad (6)$$

b - the value of the contact width of the stuck part of the drill string with the borehole wall surface is determined by the formula

$$b = 2\sqrt{\frac{2Rrh}{R-r}} \quad (7)$$

Figure 3. Mobile drilling installation XJ1000

Thus, after combining formulas (1), 2), (3), (4) and (7), the tearing force to release the stuck drilling tool will be expressed by the formula:

$$F = Lq\left(1 - \frac{\gamma_H}{\gamma_M}\right) + \frac{0{,}2(P_{r.c} - P_{p.l})l}{1 + \frac{0.6\ R\ K_c}{h\ K_f}} \cdot \sqrt{\frac{2Rrh}{R-r}} \quad (8)$$

According to geophysical data, high-thickness high-permeability horizons, where the drilling tool jams under the action of a pressure drop of no more than 5 meters.

The table shows the results of calculating the breaking force of a tool stuck under the action of a pressure drop for various bottomhole layouts and brands of mobile drilling rigs, the lifting capacities of which make it possible to release the tool in case it is stuck from a pressure drop (fig. 3).

Results and conclusions. When drilling oil and gas wells, the maximum load on the drilling rig occurs in the case of the release of a drilling tool stuck under the action of a pressure drop.

The results of calculating the breaking force of a tool stuck under the action of a differential with various bottomhole layouts and brands of mobile drilling rigs showed that modern mobile drilling rigs make it possible to drill and repair oil and gas wells with a design depth of up to 5000 m.

In case of sticking of the drill string, its release without any complications is possible if the contact length with the rock is not more than 5 m.

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