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THE EFFECT OF FLUSHING ON THE MECHANICAL DRILLING SPEED

Annotation. A complete cleaning of the bottom of the well from fragments of destroyed rocks is carried out by a flushing liquid with a chisel. The amount and quality of the liquid supplied to the bottom of the well and the supply of drilling pumps depend on the cleaning of the bottom of the well. The article presents the calculated and actual data on the minimum supply of drilling pumps when drilling with various bits.

Keywords: flushing liquid, updraft, rock fragments, drilling, flow rate, flushing liquid, feed, well, lifting of drilling tools.

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ВЛИЯНИЕ ПРОМЫВКИ НА МЕХАНИЧЕСКУЮ СКОРОСТЬ БУРЕНИЯ

Аннотация. Полную очистку забоя скважины от обломков разрушенных горных пород долотом выполняет промывочная жидкость. От количества, качества подаваемой жидкости на забой скважины и подачи буровых насосов зависит очистка забоя скважины. В статье приведены расчётные и фактические данные минимальной подачи буровых насосов при бурении различными долотами.

Ключевые слова: промывочная жидкость, восходящий поток, обломки горных пород, бурения, расход, промывочная жидкость, подача, скважина, подъем бурильного инструмента.

During the construction of oil and gas wells, high mechanical drilling speed and bit penetration are crucial. Drillers who know the subtleties of technology pay special attention to the mechanical speed of drilling and sinking into the bit. Of course, the high performance of drilling bits depends on many factors, among which one of the main ones is the complete cleaning of the bottom of the well from fragments of rocks destroyed by the bit. In case of incomplete cleaning of the bottom of the well from the fragments of the drilled rock, the chisel will work on the surface of the fragments, repeatedly grinding them, which as a result, part of the chisel's resource is spent on grinding.

The complete cleaning of the bottom of the well from the fragments of destroyed rocks with a chisel is performed by flushing liquid, its quality and quantity supplied to the bottom of the well.

In [1,2] it is shown that the minimum velocity of the upward flow of the washing liquid Min required for complete cleaning of the bottom of the well from rock fragments destroyed by the chisel should be V_{min} = 0.9-1.2 m/s for drilling by rotary methods.

In [3,4] it is stated that in order to ensure complete cleaning of the bottom of the well from rock fragments destroyed by the chisel, the flow rate of the washing liquid during drilling should be within the range of Q = 0.05-0.067 l/s per/cm^2 of the bottom area. At the same time, a lower value refers to rotary, and a higher value refers to drilling with downhole motors.

At a known upstream velocity, the required minimum supply of flushing fluid to clean the bottom of the well from rock fragments destroyed by the chisel can be determined by the following formula:

$$Q_{min} = 0,785\ (D_{\mathrm{d}}^2 - d_{\mathrm{d.s.}}^2)\ V$$

where, D_{d} is the diameter of the bit, mm;

$d_{\mathrm{d.s.}}$ - is the outer diameter of the drill string, mm;

V - is the velocity of the upward flow in the annulus for the removal of sludge to the wellhead, m/s.

To compare with the actual supply of flushing liquid when drilling wells, the minimum supply was calculated when drilling with commonly used bits according to this formula:

1. When drilling with a 490 mm rotary bit:

$Q_{min} = 0,785\ (0,490^2 - 0,127^2)$ x 0,9 = 158,24 1/s;

2. When drilling with a 393.7 mm rotary bit:

$Q_{min} = 0,785\ (0,3937^2 - 0,127^2)\ x\ 0,9 = 98,1\ 1/s;$

3. When drilling with a 295.3 mm rotary bit:

$Q_{min} = 0,785\ (0,2953^2 - 0,127^2)\ x\ 0,9 = 50,2\ 1/s;$

4. When drilling with a 269.9 mm rotary bit:

$Q_{min} = 0,785$ (0,2699^2 - 0,127^2) x $0,9 = 40,1\ 1/s;$

5. When drilling with a 215.9 mm rotary bit:

$Q_{min} = 0,785\ (0,2159^2 - 0,127^2)\ x\ 0,9 = 21,54\ 1/s;$

6. When drilling with a 190.5 mm rotary bit:

$Q_{min} = 0,785\ (0,1905^2 - 0,114^2)\ x\ 0,9 = 16,5\ 1/s.$

When calculating the minimum supply of drilling fluid into the well, the mechanical drilling speed and the cavernosity coefficient are not taken into account. Because the cavernosity coefficient and the mechanical drilling speed have their own value for each interval, the lowest upstream velocity of V=0.9 l/s was used in the calculation.

The calculated and actual field data of the minimum supply of drilling pumps during drilling with various bits are shown in Table 1.

Table 1 shows that when drilling in the upper intervals of the 393.7 mm chisel, the supply of drilling mud into the well is significantly less and the lack of actual supply compared to the calculated one is:

for the Zhanubiy Kemachi field from - 48.1 l/s to -66.1 l/s;

for the Samantepa field from -56.1 l/s to - 63.1 l/s;

for the Surgil deposit, from -58.1 l/s to - 80.1 l/s.

Table 1

Calculated and actual data on the minimum supply of drilling pumps during rotary drilling to ensure complete cleaning of the bottom of the well

Drilling interval, m	Bit diameter, mm (well number)	Supply of flushing liquid for rotary drilling of wells		
		Calculated, l/s	Actual, l/s	Excess of calculated (+) or disadvantage (-), l/s,
1	2	3	4	5
Oil field South Kemachi (Bukh PI)				
0-429	393,7 (скв. 77)	98,1	50,0	-48,1
0-428	393,7 (скв. 121)	98,1	32,0	-66,1
0-402	393,7 (скв. 89)	98,1	40,0	-58,1
423-2000	295,3 (скв. 106)	50,2	36-40	-10,2+14,2
429-2196	269,9 (скв. 77)	40,1	38-40	-2,1+0,1
428-2215	269,9 (скв. 121)	40,1	35-40	-5,1+(4,9)
2214-2313	215,9 (скв. 105)	21,54	10	-11,54
2220-2332	190,5 (скв. 89)	16,5	10	-6,5
2215-2301	190,5 (скв. 121)	16,5	10-12	-4,5+6,5
Oil field Samantepa (Karaulbazar oil and Gas exploration expedition)				
0-256	393,7 (скв. 92)	98,1	35	-63,1
0-254	393,7 (скв. 97)	98,1	38	-60,1

0-255	393,7 (скв. 94)	98,1	40	-58,1
0-252	393,7 (скв. 102)	98,1	35	-63,1
0-177	393,7 (скв. 104)	98,1	10	-78,1
177-255	393,7 (скв. 104)	98,1	42	-56,1
256-1900	269,9 (скв. 92)	40,1	28-38	-2,1+12,1
254-2348	269,9 (скв. 93)	40,1	32-42	-8,1+(+1,9)
255-1943	269,9(скв. 94)	40,1	30-40	+0,1+10,1
252-1903	269,9 (скв. 102)	40,1	28-35	-5,1+12,1
255-1960	269,9 (скв. 104)	40,1	28-38	-2,1+12,1
1900-2353	190,5 (скв. 92)	16,5	20,0	+3,5
2348-2480	190 (скв. 93)	16,5	18	-1,5
1943-2337	190,5 (скв. 94)	16,5	28-30	+11,5+13,5
1903-2367	190,5 (скв. 102)	16,5	18	+1,5
1960-2348	190,5 (скв. 104)	16,5	20-22	+3,5+5,5
Oil field Surgil (Ustyurt UBR)				
35-405	393,7	98,1	27	-71,1
35-403	393,7	98,1	30	-68,1
32-403	393,7	98,1	40	-58,1
0-406	393,7	98,1	18	-80,1
32-401	393,7	98,1	28-40	-58,1+70,1
405-1502	269,9	40,1	21-45	+4,9+(-19,1)
403-1503	269,9	40,1	20	-20,1
403-1502	269,9	40,1	35-40	-0,1+12,1
406-1502	269,9	40,1	18-19	-21,1+22,1
401-1502	269,9	40,1	22	-18,1
1502-2865	190,5	16,5	21	+4,5
1503-2850	190,5	16,5	18	+1,5
1502-1781	190,5	16,5	35-40	+18,5+23,5
1781-2952	190,5	16,5	23	+6,5
1502-2950	190,5	16,5	18-23	+1,5+6,5
1502-2950	190,5	16,5	22-28	+5,5+11,5

The reason for the insufficient supply of drilling fluid to completely clean the bottom of the well from the fragments of drilled rock is most likely due to the instability of rocks in the upper intervals and the danger of their collapse, shedding, erosion, etc. Therefore, when drilling in the upper intervals with a 393.7 mm chisel, in order to avoid scree, landslides, washouts, etc., a special drilling mode may be applied that limits the supply of drilling fluid, as well as the load on the chisel and mechanical speed. In the fields under consideration, according to the table, there is also insufficient supply of drilling mud to the bottom of the well to completely clean it from rock fragments when drilling with 295.3 mm and 269.9 mm chisels, although the borehole could be drilled under optimal conditions.

When drilling with bits of 215.9 mm and 190.5 mm through the productive formation at the South Kemachi field, there is also an insufficient supply of drilling mud for complete cleaning of the bottom of the well from rock fragments. This is due to the low pressure of the productive reservoir and the risk of catastrophic absorption. However, when drilling with a 190.5 mm bit at the Samantepa and Surgil fields, the supply of drilling mud exceeds the minimum required by +1,5-+13,5 1/ s and on + 1,5-1-23,5 1/ s accordingly.

The actual field data indicate that in order to completely clean the bottom of the well from the fragments of the drilled rock, it is necessary to drill wells at a certain rate of upward flow of the washing liquid in the range of 0.9-1.0 m/s in the annulus during rotary drilling. In the absence of the required upstream velocity of the flushing liquid, complete cleaning of the bottom of the well from the fragments of the drilled rock does not occur. As a result, the chisel works on the surface of crushed rocks, grinds them repeatedly and part of the chisel's resource is spent uselessly. When drilling in soft rocks in the upper intervals, and especially in clays, the removal of sludge is not completely ensured and the chisel, working in clays, winds the oil seal, the bit balls jam, the penetration reaches a minimum due to the oil seal, as well as due to the sludge located in the borehole.

When lifting the drilling tool, the chisel and the bolt go like a piston. The chisel pulls out all the sludge above the chisel. In drilling practice, the entire trough system was completely filled with sludge, after lifting the drilling tool during drilling in the upper intervals in soft clay rocks, with insufficient supply of washing liquid.

When drilling through a productive reservoir with a bit of 190.5 and 215.9 mm, the danger is associated with catastrophic absorption of drilling fluid and, subsequently, the manifestation of gas. Therefore, based on the experience of well construction, the following conclusions can be drawn:

1. The upper intervals of the section during well drilling are mainly represented by loose, crumbling, crumbling and clay rocks.

When drilling loose, crumbling, crumbling rocks, a drilling regime is required that limits the load on the bit, the number of rotations of the rotor, the supply of flushing liquid and the discharge of drilling mud. When drilling in clay rocks, the supply of flushing liquid is required to completely clean the bottom of the well in order to avoid winding clays on the chisel and weighted drill pipe.

2. In the middle intervals from under the conductor to the productive formation, an optimal drilling mode can be applied, which allows the maximum possible supply of drilling fluid into the well and ensures complete cleaning of the bottom of the well from fragments of drilled rock, the load on the bit and the number of rotations of the rotor to obtain a high mechanical drilling speed.

3. When drilling through a productive formation, a special regime is required that preserves the original reservoir properties of rocks as much as possible, representing a productive formation and preventing catastrophic absorption with subsequent gas occurrence.

4. In the middle intervals, the low supply of the drilling pump is due to a misunderstanding of the drillers about cleaning the bottom of the well from the fragments of drilled rocks.

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