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## THE CHOICE OF ROCK CUTTING TOOLS, THE MODE OF WORKING OUT AND THEIR DRIVE WHEN DRILLING WELLS WITH AN ELECTRIC DRILL AT THE GOTURDEPE FIELD

**Abstract:** The article discusses the analysis and recommendations on the choice of rock cutting tools, the mode of working and their drive, as well as the technology of drilling vertical and directional wells with an electric drill in the Western part of the oil and gas fields of Turkmenistan in order to increase the mechanical drilling speed and to successfully achieve the design depth. Materials of previously drilled wells, mining and geological characteristics of deposits, as well as operating instructions and rules for the operation of electric drills were used to analyze the selection of rock cutting tools, the working mode and their drive, as well as the technology of drilling vertical and directional wells with an electric drill. This paper provides a detailed analysis of the selection of rock cutting tools, the working mode and their drive, as well as the technology of drilling vertical and directional wells with an electric drill and provides recommendations on not allowing cable section breakdowns during drilling, as well as recommendations on choosing types of drill bits and operating instructions for different types of electric drills. This work can be used to perform the assigned tasks when drilling oil and gas wells with the aim of increasing the mechanical speed.

**Key words:** electric drilling, flushing units, central hole, bit, drilling mode, rotation speed, axial load, mechanical speed, axial backlash.

**Language:** English

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### Introduction

The correct choice of bits of the appropriate rock strength is the main necessary indicator in the drilling process to improve the mechanical and commercial drilling speeds of wells.

Based on the analysis of the drill bits for successful drilling by electric drilling at the Goturdepe field, we offer the following recommendations for choosing the optimal rock cutting tool and the mode of working and their drive:

a) The recommended standard sizes of electric drill bits are equipped with both central and lateral (hydraulic) flushing units. The central flushing holes are equipped with bits with diameters of 490; 393.7; 320 mm, and the side flushing holes are equipped with bits with diameters of 295.3; 269.9; 215.9 and 190.5 mm [1, 2]. In the table № 1, 2, 2.1, 2.2, 2.3, 2.4 and 3 are given the recommended sizes of bits for use in different sections of the Goturdepe field with an electric drill.

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**Table 1**

Drilling interval, m	Standard sizes and types of bits	Note
0 – 1000 Baku Tier	III 490 S-CV III 393.7 M-CV (M-GN) III 320 S-CV (S-GV)	Bits with diameters of 269.9 mm and 190.5 mm are used for drilling wells up to 1800 m deep in the western section of the Goturdepe square, in the eastern section of the area can be used for drilling exploration wells.
1000 – 2400 Baku tier, Acheron tier to the soles of “black clays”	III393,7 M-GW (M-CV) III295,3 M-GW (MS-GW) III269,9 M-GW (S-GNU) III215,9 M-GW-1 (M-GW-4) III190,5 S-GW-1 (S-GNU)	
2400 – 4000 Akchagylsky tier, red-colored thickness	III393,7 S-GV (S-CV) III295,3 MS-GV (S-GV) III215,9 M-GV-1 (MS-GV) ISM295,3 R-4	
4000 – 4600 The lower section of the red - colored thickness	III 295.3 S-GW (MS-GW) III 215.9 MS-GW (S-GW) ISM295,3 RG-4	
4600 – 5200 The lower section of the red - colored thickness	III215,9 S-GN (S-GV) III215,9 S-GNU III 190.5 S- GNU III 190.5 S-ZN	

In the technology of drilling with an electric drill, it is also provided for the use of M types with a sealed support;

b) drilling of wells with the above-mentioned bits is carried out using electric drills with gear inserts of type [3, 4]:

3290-12r (=3.15) - when drilling with Ø 490 and Ø 393.7 mm bits;

E240-8r (=3.0) - when drilling with bits Ø 320 and Ø 295.8 mm; .

E215-8r (=3.0) - when drilling with bits about Ø 269.9 mm;

E190-8r (=3.0) - when drilling with bits Ø 244.5 and Ø 215.9 mm;

E185-8r (=2.92) - when drilling with bits about Ø 215.9 mm;

E164-8r (=3.13) - when drilling with bits about Ø 190.5 mm.

c) the drilling regime parameters are established based on the analysis of field materials for working off bits and drilling modes for the Goturdepe area [5, 6];

d) the program of the drill bits for the well with the indication of the operating parameters of the drilling process is given in the table 2. The installed axial loads on the bit during the voyage must be maintained constant. The constancy of the rotational speeds is ensured by the technical characteristics of the electric drills used;

e) when working with the deflector, the axial load on the bit does not decrease against the values set in Tables 2.1.-2.4, because the STE telemetry system provides continuous and accurate monitoring of the effect of the angle of twisting of the drill string on the position of the deflector at any technically permissible axial loads;

f) during the drilling process, the driller is obliged to maintain the established drilling modes and the operation of the electric drill, guided by the readings of control measuring devices, including kilowattmeters, power indicators on the bit, ammeters, voltmeters. The main devices that should be used to monitor the operation of the bit are the hydraulic weight indicator of the drill string and the wattmeter. According to the ammeter, only the maximum permissible (by heating the engine) value of the total current consumed by the electric drill is controlled [7, 8];

g) if there is no increase in power during drilling, consumed by an electric drill, in accordance with an increase in the axial load, or there is a zero indication of the power indicator in the presence of a load on the bit according to the weight indicator, this indicates the "hanging" of the drill string due to its "sticking" to the wall of the well or the expansion of the lower compressed part [9,10, 11].

In directional wells, in particular at large zenith angles, the phenomenon of "hanging" is very common. In these conditions, it is especially important to monitor the operation of the bits according to the power indicator;

h) to prevent the drill string from "hanging", it is recommended to rotate it during drilling with a rotor at a speed of 5-30 rpm. Turns and detachments of the column from the bottom-hole can also be used as a measure to eliminate the resulting "hanging";

i) in order to avoid jamming of the bit, the electric drill must be turned on before reaching the bottom-hole. The bottom-hole should be approached smoothly with washing and elaboration;

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k) drilling should begin with the bit running in at an axial load of 2-5 tc, for 3-5 minutes, with its gradual bringing to the optimum value within 5-10 minutes;

l) the moment of lifting the bit is determined by two signs: a decrease in the mechanical drilling speed and an increase in power on the electric drill, recorded by the readings of the power indicator and meters with frequent peaks. The first sign indicates the wear of the bit armament, and the second one indicates the wear of the support. The presence of these signs is a signal of the need for an immediate cessation of the longest drilling of the well and the lifting of the bit. A 2-3-fold decrease in mechanical speed can be used to make a decision about lifting the bit, if it is observed relative to the lowest value of the mechanical speed of penetration at the beginning of chiseling. It should be taken into account that the drilling speed of clay layers is a multiple of times less than permeable layers (reservoirs) [12, 13, 14];

m) as an additional feature, according to which it is possible to control and set the operating time at the face, is the axial backlash of the support. The value of the latter should not exceed 4-5 mm for bits about 215.9 mm and 5-6 mm for bits about 295.3 mm.;

n) the sudden termination of the penetration with a simultaneous reduction to zero of the power on the bit while the electric drill is running indicates the termination of the kinematic connection between the electric drill motor and the bit due to the breakdown of the splined coupling couplings, shafts or the destruction of the gear transmission of the gearbox insert [15,16];

o) when drilling wells with bits of the ISM-FT type, it must be taken into account that they contribute to a more intensive set of curvature than three-roller bits;

p) core sampling should be carried out in accordance with the "Instructions on the technology of drilling oil and gas wells with electric drills".

**Table 2. Standard sizes of the bits used and drilling modes on the Goturdepe area (Eastern section, exploration wells, design depth of 5200 m).**

Interval	Stratigraphy	Type bit	Type electric drill	Axial load, kN
1. 0-700	Baku Tier	Sh490 M-CV (Sh490 S-CV)	3290-12=3,15	100-120
2. 700-2800	Baku tier + Absheron- akchagyl + red-colored thickness	Sh393,7 M-CV Sh393,7 S-CV ISM 392 RG	E290-12r = 3,15150-180	150 - 280
3. 2000-2300	"Black clays"	Sh393,7 M-CV	E290-12r = 3,15150-180	160-180
4. 2800-4600	Red - colored thickness	Sh295,3 MS-GV	E240-12r	180-240
5. 4600-5200	Red - colored thickness	Sh215.9 S-GW Sh 215.9 S-GN	3185-8r=9 3185-8r=2,92	200-220 180-200

continuation of table 2

Interval	Stratigraphy	Type bit	Power consumed by the bit, kW	Rotation speed, rpm	Note
1. 0-700	Baku Tier	Sh490 M-CV (Sh490 S-CV)	250-310	455 (145)	When using bits of the ISM-RG type, it is necessary to strengthen control over the deepening of wells in order to prevent the curvature of the hole
2. 700-2800	Baku tier + Absheron- akchagyl+ red-colored thickness	Sh393,7 M-CV Sh393,7 S-CV ISM 392 RG	200 – 270	145 (445)	
3. 2000-2300	"Black clays"	Sh393,7 M-CV	200-270	145	
4. 2800-4600	Red - colored thickness	Sh295,3 MS-GV	190-220	230	
5. 4600-5200	Red - colored thickness	Sh215.9 S-GW Sh215.9 S-GN	120-140 120-140	75 (75)240	

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**Table №2.1. Standard sizes of the bits used and drilling modes on the Goturdepe area (Eastern section, production wells, design depth of 4250 m).**

Interval	Stratigraphy	Type bit	Type electric drill	Axial load, kN
1. 0-100	Baku Tier	Sh490 S-CV	3290-12	100
2. 100-1500	Baku tier + Absheron	Sh393,7 M-CV	3290-12	150 - 200
3. 1500-3500	Absheron-akchagyl+ red-colored thickness	Sh295,3 MS-GV Sh295,3 S-GV	E240-8r= 3	200-240
4. 2000-2300	“Black clays”	Sh295,3 MSGV Sh295,3 S-GV	E240-8r= 3	200-240
5. 3500-4250	Red - colored thickness	Sh215.9 M-GW Sh215.9 S-GN	E240-8r=2,92	180-220 180-200

continuation of table 2.1

Interval	Stratigraphy	Type bit	Power consumed by the bit, kW	Rotation speed, rpm	Note
1. 0-100	Baku Tier	Sh490 S-CV	250-310	455	Drilling modes for directional wells are the same as for vertical wells.
2. 100-1500	Baku tier + Absheron	Sh393,7 M-CV	200 – 270	455 (145)	
3. 1500-3500	Absheron-akchagyl+ red-colored thickness	Sh295,3 MSGV Sh295,3 S-GV	190-220	230	
4. 2000-2300	“Black clays”	Sh295,3 MSGV Sh295,3 S-GV	200-220	230	
5. 3500-4250	Red - colored thickness	Sh215.9 M-GW Sh215.9 S-GN	120-140 120-140	240	

**Table 2.2. Standard sizes of the bits used and drilling modes on the Goturdepe area (Eastern section, production wells, design depth of 2700 m).**

Interval	Stratigraphy	Type bit	Type electric drill	Axial load, kN
1. 0-30	Baku Tier	Sh393,7 M-CV	3290-12	120
2. 30-800	Baku tier + Absheron	Sh295,3 M-GN	E240-8r	100-120
3. 800-2700	Absheron-akchagyl+ red-colored thickness	Sh215,9 M-GV-1	3185-8r =3	120 - 200

Continuation of table 2.2

Interval	Stratigraphy	Type bit	Power consumed by the bit, kW	Rotation speed, rpm	Note
1. 0-30	Baku Tier	Sh393,7 M-CV	270	455	

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2. 30-800	Baku tier + Absheron	Sh295,3 M-GN	220	230	Drilling modes for directional wells are the same as for vertical wells.
3. 800-2700	Absheron-akchagyl+ red-colored thickness	Sh215,9 M-GV-1	110	240	

**Table 2.3. Standard sizes of the bits used and drilling modes on the Goturdepe area (Western section, production wells, design depth of 3800 m).**

Interval	Stratigraphy	Type bit	Type electric drill	Axial load, kN
1. 0-800	Baku tier + Absheron	Sh393,7 M-CV	3290-12	120
2. 800-3200	Absheron-akchagyl+ red-colored thickness	Sh295,3 M-GW	3240-8r=3	150 - 240
3. 1300-1500	“Black clays”	Sh295,3 MS-GV	3240-8r=3	160-180
4. 3200-3800	Red - colored thickness	Sh215,9 S-GW	3185-8r	180-220

Continuation of table 2.3

Interval	Stratigraphy	Type bit	Power consumed by the bit, kW	Rotation speed, rpm	Note
1. 0-800	Baku tier + Absheron	Sh393,7 M-CV	270	455	Drilling modes for directional wells are the same as for vertical wells.
2. 800-3200	Absheron-akchagyl+ red-colored thickness	Sh295,3 M-GW	220	230	
3. 1300-1500	“Black clays”	Sh295,3 MS-GV	220	230	
4. 3200-3800	Red - colored thickness	Sh215,9 S-GW	110	240	

**Table 2.4. Standard sizes of the bits used and drilling modes on the Goturdepe square (Western section, operational directional wells, design depth of 1700 m).**

Interval	Stratigraphy	Type bit	Type electric drill	Axial load, kN
1. 0-30	Baku Tier	Sh393,7 M-CV	3290-12	80-120
2. 600-1500	Absheron + 2 packs of "black clays" + akchagil	Sh295,3 M-GN	E240-8r=3	120-180
3. 1500-1700	Upper red - colored thickness	Sh215,9 M-GV-1	3185-8r=3	120 - 220

Continuation of table 2.4

Interval	Stratigraphy	Type bit	Power consumed by the bit, kW	Rotation speed, rpm	Note
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1. 0-30	Baku Tier	Sh393,7 M-CV	250-310	455	Drilling modes for directional wells are the same as for vertical wells.
2. 30-800	Absheron + 2 packs of "black clays" + akchagil	Sh295,3 M-GN	270	230	
3. 800-2700	Upper red - colored thickness	Sh215,9 M-GV-1	110	220	

**Table 3. Lithological and stratigraphic characteristics of the geological section of the Goturdepe deposit**

Stratigraphy					Lithology
group	system	department	tier		
			The western section of the square	The eastern section of the square	
Kainazoi–Neogene–Pliocene			Baku 0-600m Absheron 600-1600m Akchagyl 1600-1635m Red-colored thickness 16350-4000m	Baku 0-900m Absheron 900-2400m Akchagyl 240-2600m Red - colored thickness 2600-5200m	Baku tier: alternation of slightly compacted sands and clays. Absheron tier: alternation of weakly compacted sands and clays and siltstones. Akchagyl tier: sandstone, dense clays, siltstones. Red-colored stratum: alternation of sandstones with dense clays "black clays" occur in the western section in the range of 1300 – 1500 m, in the eastern section in the range of 1900 - 2200 m.

**Drilling muds and well flushing**

a) The type of drilling mud, its parameters and chemical treatment must comply with the approved regulations for drilling muds [17,18];

b) To prevent the swelling of the rubber of the current supply cable sections used and the premature loss of its mechanical properties, the oil content in the drilling mud should not exceed 105 °C (by weight of the volume of the solution) [19, 20, 21];

c) well flushing is designed from the provision condition:

- the velocity of the upward flow of drilling mud in the annular space in the range of 0.4 - 1.00 m /s;

- specific flow rate of the washing liquid - 0.035 - 0.062 p/sec per 1 cm<sup>2</sup> [22];

- the hydromonitor effect of flushing the bottom of the well with pressure drops in the bit of no more than 6.0 MPa;

d) the specific hydraulic power on the bit must be kept at least 0.3 kv [23,24].

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<b>Impact Factor:</b>	<b>ISRA (India) = 6.317</b>	<b>SIS (USA) = 0.912</b>	<b>ICV (Poland) = 6.630</b>
	<b>ISI (Dubai, UAE) = 1.582</b>	<b>PIHII (Russia) = 3.939</b>	<b>PIF (India) = 1.940</b>
	<b>GIF (Australia) = 0.564</b>	<b>ESJI (KZ) = 8.771</b>	<b>IBI (India) = 4.260</b>
	<b>JIF = 1.500</b>	<b>SJIF (Morocco) = 7.184</b>	<b>OAJI (USA) = 0.350</b>

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