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National Technical University "Dnipro Polytechnic"
Faculty of Natural Sciences and Technologies
(faculty)
Oil-and-Gas Engineering and Drilling Department
(full name)

EXPLANATORY NOTE

Qualification paper, degree bachelor
(bachelor, master)

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academic group 185-17-1 IC
(code)

specialty 185 Oil and Gas Engineering and Technology
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title Design of basic technological measures for the efficient development of oil deposits by thermal methods

Supervisors of	Name	Mark		Signature
		Rating	Institutional	
Qualification paper	Ihnatov, A.O.			
Sections:				
Technological	Ihnatov, A.O.			
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TASK
for the qualification paper, degree bachelor
(bachelor, master)

student Mahmoud Ayman Mahmoud Elsayed Hegazy **of academic group** 185-17-1 IC
(full name) (code)
specialty 185 Oil-and-Gas Engineering and Technology
specialization ____________________
according to the educational and professional programme "Oil and Gas Engineering and Technology"
title Design of basic technological measures for the efficient development of oil deposits by thermal methods
approved by the order of the rector of the National Technical University Dnipro Polytechnic dated 296-c (05/26/2021)

Section	Content	Deadline
Technologic	*Review, analysis, and clarification of current state of the development of heavy-oil deposits (deep levels, abnormal physicochemical properties).* *Basic theoretical and practical issues of the methods of oil recovery increase by injecting heat carriers into oil reservoirs and creating in-situ combustion; analytical studies of the integral characteristics of the influence of individual components on the efficiency of a process of thermal oil recovery increase relative to the properties of contacting phases and laboratory study of the model of interphase interaction for the process of thermal oil recovery increase.*	07/07/2021
Labour Protection	*Labour protection measures during the laboratory, stand-based, and industrial studies of the advanced methods of oil recovery increase as well as the basic safety requirements for brainwork rooms.*	07/16/2021

Task is issued ____________ Ihnatov A.O.
(signature) (name)
Date of issue 06/11/2021
Date of submission to the examination commission 07/20/2021

Accepted for execution ____________ Hegazy M.A.V.E.
(signature) (name)

ABSTRACT

Thesis project: 79 pages, 4 figures, 12 tables, 15 references.

The object of the study is drilling a well in terms of the Skorokhodovsky gas condensate field with the development of measures to improve the quality of drilling fluids.

The purpose of the study is to design a well at the Skorokhodovsky field.

Research tools are literature analysis and theoretical research.

The paper is compiled in accordance with the requirements of the guidelines. It contains information about the area of drilling, geological structure and characteristics of productive horizons. In the design part, the issues of well construction are resolved: the well structure has been designed, the equipment for the drilling rig, the rock cutting tool, the drilling and cementing technology have been selected. Measures have been developed to improve the quality of drilling fluids during preparation. Safety precautions are given when drilling wells. The issues of subsoil and environmental protection are highlighted. The estimate of well drilling has been substantiated.

PRODUCTION WELL, SKEW WALL, COMPLICATION, DRILLING FLUID PREPARATION.

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INTRODUCTION

Skorokhodovsky gas and oil field was discovered in 1973 by the Ministry of Geology of the Ukrainian SSR as a result of testing B-19 of the Visean stage in well 6 (interval 3602-3596 m).

In 1974, pilot production of the field began. Well No. 6 entered into gushing operation with a flow rate of 46 t/h of anhydrous oil.

In 1979, the Chernigovneftegazrozvedka trust of the Mingeo of the Ukrainian SSR calculated the oil, condensate and gas reserves of the Skorokhodovsky field. In the same year, the State Reserves Committee of the USSR approved the initial reserves of the field in the C1 category in the volume of: oil - 14473 thousand tons, condensate - 744 thousand tons, free gas - 1030 million m^3. At the same time, recoverable oil reserves of 6977 thousand tons, 421 thousand tons of condensate were approved.

In 1981, the deposit was brought into commercial development (MNP order No. 253 dated 05.05.1981.). In the same year, the Ukrgiproniinafta Institute drew up a technological scheme for the development of the field, in accordance with which the industrial development of the field is carried out.

In the period 1981-1989. 22 production wells were drilled and put into operation. The results of well drilling and industrial development have significantly changed the understanding of the geological structure and reserves of the field. According to an operational estimate, 1990. the reserves of the deposit are more than two times less than those calculated in 1979.

The rate of development of the field is lower than the design one due to a significant backlog of waterflooding of the main production facilities. In this regard, the field development indicators are also lower than the design ones.

For a reliable assessment of the hydrocarbon reserves of the field, a recalculation of reserves is required. To recalculate reserves and draw up a development project on their basis, it is necessary to clarify development indicators for the near future.

SECTION 1 GEOLOGICAL AND TECHNICAL CONDITIONS FOR CONDUCTING DRILLING WORKS

1.1 General information about the drilling area

Skorokhodovsky field (Table 1.1), like many other fields in the Dnieper-Donets depression, is distinguished by an extremely complex geological structure.

The Skorokhodovsky arch is a deep-lying brachyanticlinal, asymmetric fold with a steep southeastern fold (7-80) and relatively gentle (5-60); northwest and north wings.

There are 8 oil and gas deposits confined to Skorokhodovsky field. They are associated with reservoirs, developed to varying degrees in area and section, horizons V-15, V-16n, V-17, V-18, V-19, V-20, B - 26, T-1, and T-2.

Production wells No. 90, 91, 95 with an average depth 3750 m vertically (3792 m along the wellbore) are laid in accordance with the "Skorokhodovsky Field Development Scheme" for the purpose of exploiting productive horizons of the Visean stage (well No. 90 - horizon B-26 with further transfer to higher productive horizons B-20, B-19; well No. 91 - horizon B-26 with further transfer to the productive horizons B-19, B-16, well No. 95 - trial operation of the B-26 horizon and transfer (injection).

1.2 Horizon characteristics

Horizon V-15 is represented mainly by compacted rocks of limestone and dolomite. The porosity in the core varies from 5 to 18.6%, according to GDM data from 10 to 18.4%. Oil saturation varies from 70 to 96%, permeability reaches 1.47 μm^2.

Horizon B-16 is represented by alternating mudstone and limestone with layers of sandstone and coal. Its porosity is 17.8%, permeability is 1 μm^2, average oil saturation is 82%.

Horizon V-17 is represented by a massive sandstone layer, which is replaced in places in the roof and bottom parts by mudstone. Its porosity varies from 18.5% to 21.6%, permeability - (17-449) x 10-15 m^2, oil saturation - 82-93%.

Horizon B-18 is a mature sandstone layer. Open porosity varies within 15.00-20.8%, oil saturation - 74-92%, permeability - 0.017-1.449 μm^2.

Table 1.1 - Characteristics of the area of work

No. p / p	Name	Value (text, name, value)
1.	Area (deposit)	Skorokhodovsky
2.	Block (number or name)	
3.	Administrative location The state region district	 Ukraine Chernihiv Talalayivsky
4.	The year the area was introduced into drilling	1973
5.	The year of putting the area (field) into operation	1974
6.	Air temperature, degrees average annual the greatest summer greatest winter	 + 6 + 32 - 13
7.	Average annual precipitation, mm	660
8.	Maximum depth of soil freezing, m	0.90
9.	Duration of the heating period in a year, days	191
10.	Duration of the winter period in a year, days	101
11.	Azimuth of the prevailing wind direction, degree	315
12.	Highest wind speed, m / s	27

Horizon V-19 is widely developed in the section of the field and is characterized by high filtration and reservoir properties. Open porosity varies within 13.0-22.6%, oil saturation 74-94%, permeability - 0.01-1.47 μm^2.

Horizon V-20 is also characterized by high reservoir properties. Lithologically, the horizon is represented by sandstones and siltstones. Open porosity - 22.4%, permeability - 1.1 μm^2, gas saturation - 96%.

Horizon V-26 is characterized by a complex structure. It is composed of alternating gray and light gray sandstones and siltstones with interlayers of dark gray mudstone, less often limestones. The main parameters vary within the following limits: porosity - 11.8-19%, oil saturation - 63-94%.

The latest measurements of reservoir pressure during drilling and testing in the production string of wells No. 92, 203 show that the gradients of reservoir pressure in all productive horizons are below hydrostatic, at the level of 0.08-0.09 kgf/cm^2 per meter.

For a complete presentation of the lithological and stratigraphic characteristics of the open section, the following is planned: the selection of benchmarks for correlation, the study of the reservoir properties of productive horizons and determination of their depth, the selection of reservoir beds for testing, the study of natural radioactivity in the project well, and a complex of industrial and geographical studies. Sampling in volume of 55 m along the productive horizons V-16n, V-19, V-26 is planned as well.

To determine a clearer characteristic of productive horizons and their oil saturation, it is planned to conduct a study with a formation tester on pipes in middle-menilite sediments.

In order to study and clarify the stratigraphy, lithological and physical properties of productive formations, gas and water saturation of reservoir formations, physical and chemical properties, it is planned to carry out a set of laboratory studies.

Perforation of the production casing in the interval of occurrence of productive horizons is designed to be carried out with perforators of the PKS-80 type or a similar type.

1.3 Stratigraphy

Table 1.2 - Stratigraphic section of the well, occurrence elements and reservoir vugsity factor

Depth of occurrence, m		Stratigraphic department		Elements of bedding (falling) of layers along the bottom		Vug coefficient in the interval
From (up)	Before (down)	Name	Index	angle, deg.	azimuth, deg.	
0	390	Cenozoic	K_Z			1.07
390	965	Upper chalk	K_2			1.10
965	1135	Lower chalk	K_1			1.05
1135	1380	Upper Jurassic	J_3			1.10
1380	1510	Middle Jurassic	J_2			1.10
1510	1610	Upper Triassic	T_2			1.16
1610	2010	Lower Triassic sandy	T_{Epes}.			1.15
2010	2190	Lower Triassic sandy-clayey	$T_{p-g.}$			1.20
2190	2290	Lower Perm	P_1			1.12
2290	2560	Upper Carbon	S_Z			1.18
2560	2890	Moscovian tier	C_{2M}			1.34
2890	3190	Bashkirian stage	C_{2B}			1.30

3190	3350	Serpukhovian tier	C_{IS}			1.20
3350	3640	Upper Visean stage	C_{1Y2}			1.30
3640	3710	Lower Visean stage	C_{2Y1}			1.25
3710	3785	Tournaisian tier	C_{IT}			1.20

1.4 Lithology

Table 1.3 - Lithological characteristics of the well section

Stratigraphic Division Index	Interval, m		Rock		Standard description of the rock, full name, characteristic features (structure, texture, mineral composition, etc.)
	From (top)	Before (bottom)	Short name in the interval	in the interval	
1	2	3	4	5	6
K_Z	0	390	Loam Sand Clay Marl	5.0 65.0 25.0 5.0	yellow-brown, loess-like, soapy gray, greenish gray quartz; quartz-glauconite variegated red-brown, colorful with sand interlayers gray, greenish-gray sandy, glauconite
K_2	390	965	Chalk Sand Marl	70.0 5.0 25.0	white or gray, writing, soft greenish-gray, quartz-glauconite, uneven-grained with clay interlayers bluish and greenish gray, sandy, viscous
K_1	965	1135	Sand	fifty	greenish-gray, quartz-glauconite, fine-grained, clayey with interlayers of hard quartz, often solid,

1	2	3	4	5	6
					sandstones
			Clay	35.0	grayish, black and colorful, not calcareous
			Sandstone	15.0	colorful, often fused
J_3	1135	1380	Clay	70.0	colorful, carbonate, calcareous
			Sandstone	15.0	greenish gray, calcareous, fine-grained
			Limestone	15.0	siliceous with interlayers of shell rocks
J_2	1380	1510	Clay	70.0	gray and dark gray, calcareous, silty at the top, oily at the bottom
			Sandstone	30.0	fine-grained, clayey, slightly cemented
T	1510	2190	Clay	30.0	colorful, unevenly gritty, calcareous
			Sandstone	70.0	quartz, greenish-light gray, fine-grained, calcareous, slightly cemented
P_I	2190	2290	Anhydrite	5.0	light gray, dense, crystalline
			Dolomite	15.0	gray, fine-grained, dense
			Sandstone	40.0	gray, uneven-grained quartz and feldspar-quartz, with interlayers and lenses of small-gravel conglomerates
			Clay	10.0	variegated, argelite-like
			Limestone	30.0	dolomitized limestone
C_3	2290	2560	Sandstone	60.0	quartz and feldspar quartz, uneven-grained

1	2	3	4	5	6
			Argillite Siltstone Limestone	15.0 20.0 5.0	variegated, layered, dense gray, cemented gray, hidden crystalline, dolo- mitized
C_{2M}	2560	2890	Sandstone Argillite Limestone	60.0 30.0 10.0	quartz and feldspar-quartz, une- ven-grained, lush and medium- cemented mudstone-like clays, dark gray mudstone, sandy, dense gray, dark gray, clayey, strong, cryptocrystalline
C_{2B}	2890	3190	Argillite Siltstone Sandstone Limestone	55.0 15.0 20.0 10.0	dark gray, sandy, mica, dense gray, mica, pyrite, layered gray, quartz, fine-grained, mica gray, dark gray, crinoid
CIS	3190	3350	Argillite Siltstone Limestone	55.0 40.0 10.0	dark gray to black, irregularly silty, with interlayers of siltstone and limestone black, clayey, slightly low-cemented limestone gray, dark gray, micro granular, fractured, from microfauna re- mains
C1Y2	3350	3640	Argillite Limestone	30.0 20.0	dark gray, black, thin-layered, with fauna remains, with lime- stone interlayers dark gray, cryptocrystalline, dense, with numerous microfau-

1	2	3	4	5	6
					na remains, rarely organogenic, dense
			Sandstone	50.0	light gray, almost white, quartz, fine-grained, rarely medium-grained, silty
C1Y1	3640	3710	Limestone	50.0	dark gray, almost black, organogenic detrital, fossilized, dense
			Argillite	20.0	black, dark gray, dense
			Sandstone	30.0	light gray to white, medium-grained, strongly cemented
C1T	3710	3785	Sandstone	50.0	medium-grained, quartz
			Argillite	30.0	dark gray, mica, dense
			Limestone	20.0	dense cryptocrystalline

1.5 Tectonics

In the system of structures of the Talalayevske field, the Skorokhodovsky vault occupies the northwestern part. A characteristic feature of this fold is the absence of faults in its crest, although, according to seismic data, they have occurred repeatedly. But in none of the 30 drilled wells, no fractures were observed.

The Skorokhodovsky vault does not have a pronounced strike. It has a triangular shape. However, such a fold shape is determined by the results of the manifestation of the salt diapirism of the Nyniv uplift. This is also emphasized by a noticeable decrease in the angles of incidence of rocks.

Thus, the Skorokhodovsky vault is a deep-lying, brachyanticlinal, asymmetric fold with a steep southeastern and relatively gentle northeastern and northern wings. Its northern wing is cut off by a limited gap. The presence of a discontinuous fault on the northern flank of the fold makes it possible to distinguish here two blocks, 1 - the central block and block 2 within which wells 90, 91, 95 were drilled. The Skorokhodovsky arch is also small in size. Along the top of the V-26 horizon, within the stratoisogypsum - 3550 m, its dimensions are 7.5 x 20 x 1.7 km, the amplitude is about 140 m.

1.6 Oil and gas water content (along the section of the well)

Table 1.4 - Oil content

Stratigraphic subdivision index	Interval, m		Collector type	Density, g / cm^3		Mobility	Sulfur content,%	Paraffin content, %	Free debit m3 / day	Dissolved gas parameters					
	from the top	to the bottom m		In reservoir conditions	after degassing					Gas factor, m3 / m3	Hydrogen sulfide content%	Carbon dioxide content%	Relative gas viscosity	Compression ratio	reservoir saturation pressure
C_{1Y2}	3420	3480	Pores	0.62	0.82	0.30	0.14	2.0	12	212		0.3	0.83	0.01	133
C_{1Y2}	3535	3550	Pores	0.61	0.81	0.30	0.15	1.5	23	212		0.3	0.83	0.01	133
C_{1Y2}	3555	3590	Pores	0.62	0.82	0.30	0.14	2.9	12	212		0.3	0.83	0.01	133
C_{1Y1}	3680	3705	Pores	0.71	0.85	0.25	0.20	4.0	25	133		0.5	0.90	0.03	174

Table 1.5 - Gas content

Stratigraphic subdivision index	Interval, m		Collector type	Condition (gas, condensate)	Hydrogen sulfide content,%	Carbon dioxide content, %	Gas density relative to air	Coef. gas compression in reservoir conditions	Free debit, m3 / ext	Density of gas condensate,g / cm3		Phase permeability, md
	From top	Before bottom								in reservoir conditions	at the wellhead	
C_{1Y1}	3595	3625	Pores	Gas condensate		0.18	0.95		30.000	0.48	0.70	

Table 1.6 - Water content

Stratigraphic subdivision index	Interval, m	Interval, m	Collector type	Density, g / cm3	Free debit, m3 / ext	Phase permeability, md	Chemical composition of water in mg-equivalent form						Min-eralization de-gree mg-eq / l	Sulin water type	Drinking
							Anions			cations					
	From top	From top					CL^-	SO^{-4}	NSO^{-3}	Na^+	Mg^{++}	Ca ++			
K_2	10	380	Pores	1.00	30	900.0	4	1	6	14	0	0	1	gkn	Yes
K_1	990	1120	Pores	1.00	50	850.0	15	4	five	25	1	1	2	gkn	Yes
J_2	1380	1610	Pores	1.02	100	300.0	212	6	9	221	1	4	4	sfn	Not
T_E	1610	2010	Pores	1.06	100	200.0	2455	17	1	2082	118	273	143	hlc	Not
S_Z	2300	2560	Pores	1.11	100	50.0	2761	19	2	2305	122	325	161	hlc	Not

Conclusions for the section

In the general part, the following is given: the geographical location, an overview of the previously conducted geological and geophysical studies and the geological characteristics of the area of work. The following is described: stratigraphy, tectonics andphysicochemical properties of formation fluids in a given area.

SECTION 2 WELL DESIGN.
SELECTION OF DRILLING EQUIPMENT AND TOOLS

2.1 Selection and substantiation of the drilling method

The selection of the most effective drilling method is due to the tasks that must be solved in the development or improvement of drilling technology in specific geological and technical conditions.

When drilling oil and gas wells, drilling methods have become widespread: rotary, hydraulic downhole motors and drilling with electric drills. The drilling of the project well will be carried out in a rotary way.

2.2. Well design

The well design is determined by the number of casing strings to be run, the depth of their installation, the diameter of the pipes used, the diameter of the bits that are used for drilling under each string, the height of the cement slurry rise in the annulus and the bottomhole design.

The well design depends on the depth of the productive strata, their productivity and reservoir properties, reservoir and pore pressures, as well as hydraulic fracturing pressure of permeable rocks, physical and mechanical properties and state of rocks.

The output data for the design of the well structure are:

- target horizon and well depth;
- the purpose of drilling and the purpose of the well;
- reservoir pressure and hydraulic fracturing pressure of rocks of stratigraphic horizons;
- forecasted oil and gas production rate;
- ways well completion and well operation;
- characteristics of rocks by hardness and abrasiveness.

When choosing a well design, the drilling time for each casing zone, the wear rate of the casing and intermediate string, as well as the geological knowledge of the drilling area are taken into account.

To select the number of casing strings and the depth of their lowering according to a certain value, the equivalent - gradients of reservoir pressures and hydraulic fracturing pressures of stratigraphic horizons (see Table 2.1.), We build a combined pressure graph.

Having built a graph, we determine the zones of compatible drilling conditions.

The compatibility of drilling conditions is understood as their ratio when the created parameters of the technological processes of drilling the underlying well interval will not cause complications in the drilled overlying interval, if the latter is not fixed with a casing.

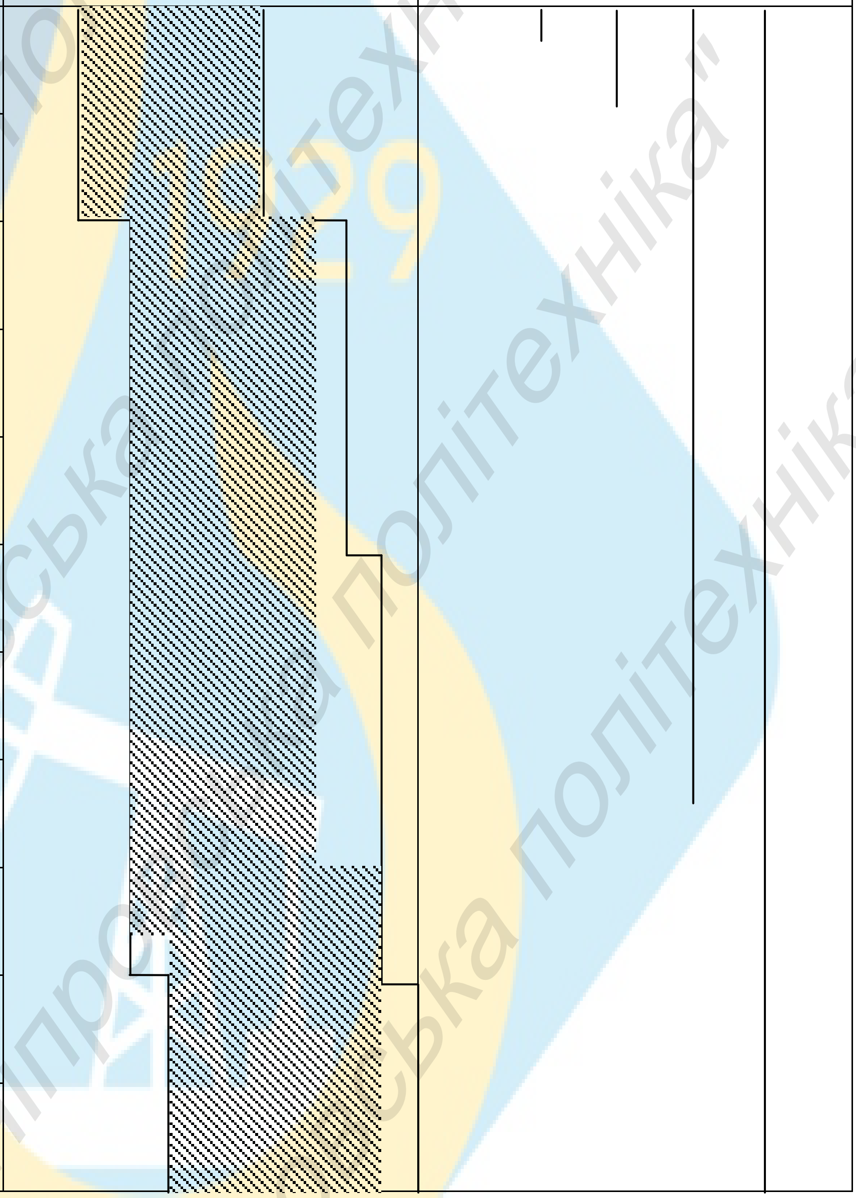
The diameters of the casing strings and bits are selected from the bottom to the top. The calculated values of the bit diameters are taken in accordance with GOST 20692-75, and for casing pipes in accordance with GOST 632-80.

When designing a well structure, first of all, the number of casing strings and the depth of their lowering are selected, proceeding from the prevention of incompatibility of drilling conditions for individual intervals of the wellbore. In this project, four casing strings are provided: under the direction, under the surface, intermediate and production casing. The depth of running the production string is determined by the location of the productive formations, methods of injection and well operation, as well as the design of the bottomhole. In our case, it is 3785 m, intermediate - 2300 m, the depth of the conductor is 400 m and the direction is 30 m.

The diameters of the casing strings and bits are selected from the bottom up, starting from the production string.

Table 2.1 - Combined pressure graph

Sole depth, m	Pressure gradient, MPa / m		Combined pressure graph	Well design
	Reservoir	Hydraulic fracturing		
300	0.01	0.012		
600	0.01	0.012		
900	0.0114	0.014		
1200	0.0108	0.013		
1500	0.0104	0.015		
1800	0.0105	0.015		
2100	0.0104	0.015		
2400	0.0108	0.016		
2700	0.0114	0.016		
3200	0.0116	0.017		
3875	0.014	0.018		



To establish the number of casing strings and the depth of their running, we build a combined graph of the change in the gradients of reservoir pressure and hydraulic fracturing pressure along the depth of the borehole. On its basis, we design the first rough design of a borehole. The final decision on the number of casing strings and the depth of their running is made after analyzing the geological and technical conditions of drilling, taking into account possible complications. Below is a combined pressure plot and projected well design.

1. In accordance with the initial data, the diameter of the production casing

d_{ek} = 146 mm.

2. Diameter of a drill bit for production casing

$$D_d^{ek} = d_m^{ek} + 2\delta, \quad (1)$$

Where $d_м^{ek}$- diameter of the production casing collar; for a given production casing d_d^{ek} = 166 mm;

δ - the size of the gap between the production casing collar and the wellbore wall, since the production casing diameter is equal to d_{ek} = 146 mm, then we take δ = 10 mm.

$$D_d^{ek} = 146 + 210 = 166 \text{ mm.}$$

In accordance with GOST, we accept for drill bits $D_д^{ek}$ = 215.5 mm.

3. Determine the inner diameter of the intermediate casing

$$d_{vn}^{pr} = D_d^{ek} + (6 \div 8), \quad (2)$$

$$d_{vn}^{pr} = 190.5 + 6 = 196.5 \text{ mm.}$$

We accept in accordance with GOST for casing pipes

d_n^{pr} = 219 mm; d_{vn}^{pr} = 210.1 mm; d_m^{pr} = 245 mm.

4. Determine the diameter of the bit for drilling under the intermediate string

$$D_d^{pr} = 245 + 2\ 20 = 285 \text{ mm.}$$

Accepted according to GOST for drill bits $D_д^{пр}$ = 295.3 mm.

5. Determine the inner diameter of the conductor

$$d_{vn}^{k} = 295.3 + 6 = 301.3 \text{ mm.}$$

We accept in accordance with GOST for casing pipes

d_n^k = 324 mm; d_{vn}^k = 301.9 mm; d_m^k = 351 mm.

6. Determine the diameter of the drill bit for surface drilling

$$D_d^{pr} = 324 + 2\ 30 = 384 \text{ mm.}$$

Accepted according to GOST for drill bits D_d^{pr} = 393.7 mm.

Cementing of casing strings is carried out for the entire length of the string.

6. Determine the inner diameter of the direction

$$d_{vn}^{n} = 393.7 + 6 = 399.7 \text{ mm.}$$

We accept in accordance with GOST for casing pipes

$$d_{n}^{n} = 426 \text{ mm}; \ d_{vn}^{n} = 402.0 \text{ mm}; \ d_{m}^{n} = 453 \text{ mm.}$$

7. Determine the diameter of the drill bit for directional drilling

$$D_{d}^{n} = 453 + 2\ 30 = 503 \text{ mm.}$$

Accepted according to GOST for drill bits D_{d}^{n} = 508.0 mm.

The calculation results are summarized in the table.

Table 2.2 - Summary table of casing strings

Column name	Column lowering depth, m	Column diameter, mm	Bit diameter, mm	Cementing interval, m
Direction	30	426	508.0	0-30
Conductor	400	324	393.7	0-400
Intermediate column	2300	219	295.3	0-2300
Production casing	3785	146	215.9	0-3785

- 426 mm direction descends to a depth of 30 m in order to create a piping for circulation and prevent wellhead washout.

- A 324 mm conductor is lowered to a depth of 400 m in order to overlap unstable Cenozoic sediments and isolate upper aquifers in order to protect them from contamination with mud filtrate when drilling under an intermediate string. The conductor is cemented along its entire length.

- A 245 mm intermediate string is run down to a depth of 2300 m in order to cover unstable, absorbing Cretaceous, Jurassic, and Triassic deposits, as well as Permian deposits, during drilling of which coagulation of the drilling mud is possible. The column mouth is equipped with anti-blowout equipment. The string is run in one step, followed by cementing in order to ensure the tightness of the casing, as well as to guarantee a more worn running process and the quality of fastening.

- production casing 146 mm is lowered to a depth of 3785 m for the purpose of overlapping, testing and trial operation of the productive horizon

2.3 Drilling technique

2.3.1 Selection of rock cutting tools

Taking into account the physical and mechanical properties of rocks and the design of the well, we take the following rock-breaking tool.

For drilling in the interval of 0-30 m, we use the PM-508.0 mm bit.

For drilling in the interval of 30-400 m - roller cone bits III393.7 MCGV.

For drilling in the interval of 400-2300 m - roller cone bits III295.3 MCSV, III295.3 MS-GV, 295.3 SGV.

For drilling in the interval of 2300-2785 m - roller cone bits III215.9 SGV, III215.9 SZGAU and III215.9 SZ-GNU.

2.3.2 Drill string

1. The diameter of the drill collar is selected taking into account the diameter of the bit based on the following conditions

$$d_{\text{ubt}} = 0.75 \div 0.85 D_d; \quad (3)$$

2. The diameter of the drill pipes is selected from the ratio

$$d_{bt} = 0.7 \div 0.80 d_{\text{ubt}}, \quad (4)$$

Based on the proposed flow rate and dimensions of the pumping facilities, as well as taking into account the established practice of drilling operations in this area, we accept:

Interval

30-400 m

D_{ubt} = 203 mm; D_{bt} = 146 mm;

400-2300 m

D_{ubt} = 203 mm; D_{bt} = 146 mm;

2300 - 3785 m

D_{ubt} = 178 mm; D_{bt} = 127 mm;

The lifting height of the grouting slurry in the annulus is determined on the basis of the current instructional and methodological materials. The lifting height of the cement slurry behind all the columns should be made up to the wellhead [9].

2.3.3 Well flushing

Justification of the density of the flushing fluid

The density of the drilling fluid is selected according to the combined pressure graph and refined for each interval of compatible drilling conditions using the formula

$$\rho_{np} = \frac{\alpha P_{пл}}{gH}; \qquad (15)$$

Where R_{pl} - reservoir pressure in the well interval for which the ρ_{etc};

g - acceleration due to gravity, m/s^2;

H - depth of the top of the well interval, m;

α - standard coefficient, which, in accordance with the requirements of the rules for conducting drilling operations, determines the pressure reserve in the borehole above the reservoir one.

Density in the range of 30-400 m (since H <1200 then we take α = 1.12).

$$\rho_{np} = \frac{1,12 \cdot 70 \cdot 10000}{9,81 \cdot 400} = 1141 \text{ kg / m}^3.$$

We accept 1140 kg / m^3.

Density in the range of 400-2300 m (since H> 1500, we take α= 1.05).

$$\rho_{np} = \frac{1.05 \cdot 2300 \cdot 11600}{9.81 \cdot 2300} = 1161 \text{ kg / m}^3.$$

We accept 1160 kg / m^3.

Density in the range 2300-3785 m (since H> 1500 then we takeα= 1.05).

$$\rho_{np} = \frac{1.05 \cdot 3050 \cdot 10000}{9.81 \cdot 3785} = 1160 \text{ kg / m}^3.$$

We accept 1160 kg / m^3.

Drilling fluids perform functions that determine not only the success and speed of drilling, but also the commissioning of a well with maximum productivity. The main of these functions are:

– removal of cuttings from under the bit, transporting it along the annulus and ensuring its separation on the surface;

– keeping the sludge in suspension when the circulation of the solution is stopped;

– cooling the bit and facilitating the destruction of the rock in the bottomhole zone;

– creating pressure from the borehole wall to prevent water, oil and gas manifestations;

– providing physicochemical effects on the walls of the well, preventing their collapse;

– ensuring the preservation of the permeability of the productive formation during its opening;

– power transmission to the downhole hydraulic motor (when used), etc.

When drilling the projected well, the following drilling fluids will be used.

In the process of drilling, a clay mud with a density of 1.14 g/cm^3 treated with graphite and soda ash will be used under the conductor.

Clay mud parameters:

ρ = 1.14 g/cm^3,

T = 30 sec.,

B = 10 cm^3/30 min,

K = 1.5 mm

pH = 7.5

When drilling in the interval of 400-2300 m, losses, talus, landslides, coagulation, and the formation of cavities are possible. Therefore, it provides for the addition of kaphos, hypane, tyrsa, rubber crumb, soda ash and graphite to the clay solution:

Solution parameters:

ρ = 1.16 g / cm^3,

T = 35 sec,

B = 8 cm^3 / 30min,

CHC = 25/50 kgf / cm min,

K = 1.5 mm

pH = 8.5

When drilling in the interval of 2300-3750 m, coagulation of the mud, caverns, troughs, and sticks is also possible. It provides for the processing of KSSB, oil, AM-5, diesel fuel, sulfanol, graphite. Solution characteristics:

ρ = 1.14 g / cm^3,

T = 40 sec,

B = 5 cm^3 / 30min,

SNS = 30/50 mgf / cm min,

K = 1.5 mm

pH = 8.5

2.4 Drilling technology

2.4.1 Calculating the axial load on a bit

The value of the axial load on the bit Pdol, which should ensure the volumetric destruction of the bottomhole, taking into account the indicators of the mechanical properties of rocks and structural data on the contact area of the teeth of the bit with the bottomhole, is determined by the formula:

$$R_{dol.} = \alpha \cdot P_{sh} \cdot F_k, \quad (16)$$

where α - empirical coefficient that takes into account changes in bottomhole conditions for changes in hardness (α = 0.3 - 1.59);

P_{sh} - rock hardness according to L.A. Schreiner's method (by stamp); kg/mm^2.

Fk - contact area of the bit teeth with the bottomhole mm^2, determined by the formula of V.S. Fedorov:

$$F_k = (D_{dol.} \cdot \eta \cdot \delta) / 2, \text{ mm.} \quad (17)$$

where η - coefficient of overlapping teeth;

δ - coefficient of teeth blunting.

Thus, $R_{dol.} = \alpha \cdot P_{sh} \cdot D_{dol.} \cdot \eta \cdot \delta / 2$.

For wells with a diameter of 508 mm:

$R_{dol.} = 1 \cdot 150 \cdot 508 \cdot 1.21 \cdot 1/2 = 46101.5$ H = 4.61 t.

For a well with a diameter of 393.7 mm:

$R_{dol.} = 1 \cdot 550 \cdot 393.7 \cdot 1.21 \cdot 1/2 = 131003.5$ H = 13.1 t.

For wells with a diameter of 295.3 mm:

$R_{dol.} = 1.2 \cdot 400 \cdot 295.3 \cdot 1.14 \cdot 2/2 = 161588.4$ H = 16.16 t.

For a well with a diameter of 215.9 mm:

$R_{dol.} = 1.59 \cdot 400 \cdot 215.9 \cdot 1.4 \cdot 2/2 = 192237.69$ H = 19.22 t.

Let's compare the obtained values with the actual values of the load on the bit, which are calculated by the formula: $R_{dol.f.} = P1 + P2 + P3 + P4 + P5 + P6$,

where P1 is the weight of the bit, P2 is the weight of the adapter, P3 is the weight of the drill collar, P4 is the weight of the drill pipes, P5 is the weight of the kelly, P6 is the weight of the swivel.

For a well with a diameter of 393.7 mm:

$R_{dol.f.} = 150 + 15 + 4368 + 1864.5 + 2300 = 8697.5$ kg = 8.7 t.

For wells with a diameter of 295.3 mm:

$R_{dol.f.} = 150 + 15 + 2180 + 11484 + 1864.5 + 2300 = 37650$ kg = 37.65 tons.

For a well with a diameter of 215.9 mm:

$R_{dol.f.}$ = 150 + 15 + 29640 + 98890 + 1864.5 + 2300 = 132859.5 kg = 132.86 tons.

Since the actual WOBs exceed the design values, drilling will be performed at the design value with load compensation through the drilling rig winch.

2.4.2 Calculation of bit rotational speed

It is determined by the following formula:

$N = 60 \cdot v / \pi \cdot D_{dol.}$, (Rpm), (18)

where v is the average circumferential speed of rotation of the bit (V = 0.8 - 2.0).

For wells with a diameter of 508 mm:

N = 60 · 2 / 3.14 · 0.508 = 56.7 rpm, i.e. drilling will be carried out at 1 rotor speed.

For a well with a diameter of 393.7 mm:

N = 60 · 2 / 3.14 · 0.3937 = 77.07 rpm, i.e. drilling will be carried out at 1 rotor speed.

For wells with a diameter of 295.3 mm:

N = 60 · 2 / 3.14 · 0.2953 = 99.42 rpm, i.e. drilling will be carried out at 3 rotor speeds.

For a well with a diameter of 215.9 mm:

N = 60 · 1.5 / 3.14 · 0.2159 = 70 rpm, i.e. drilling will be carried out at 2 rotor speeds.

2.4.3 Calculation of the amount of flushing liquid

The technologically necessary amount of flushing fluid to ensure timely and uninterrupted removal of cuttings from the bottomhole along the annulus and cleaning the wellbore is found from the ratio:

$$Q = 0.785 \cdot (d^2_{dol.} - d^2_{out.b.tr.}) \cdot v_{out.}, \quad (19)$$

where $v_{out.}$ is the minimum permissible upward flow rate from the condition of high-quality cleaning and the wellbore (the smaller the diameter, the higher it is).

For a well with a diameter of 393.7 mm:

$Q = 0.785 \cdot (3.937^2 - 1.4^2) \cdot 4 = 62.52$ l / s.

The operation of 2 pumps UNB-600 will be carried out on 170 mm bushings with a capacity of 31.0 l / s.

For wells with a diameter of 295.3 mm:

$Q = 0.785 \cdot (2.953^2 - 1.4^2) \cdot 6 = 30.84$ l / s.

The UNB-600 pump will operate on 150 mm bushings with a capacity of 31.0 l / s.

For a well with a diameter of 215.9 mm:

$Q = 0.785 \cdot (2.159^2 - 1.27^2) \cdot 11 = 13.11$ l / s.

The UNB-600 pump will operate on 140 mm bushings with a capacity of 13.0 l / s.

2.5 Drilling equipment

2.5.1 Rig selection

We select the drilling rig according to the rated lifting capacity in accordance with the largest weight of the drill or casing string in the air.

Table 2.3 - Weight of drill and casing pipess

Indicators	Drill string	Intermediate column	Production casing
Column length	3785	2300	3785
Weight 1 m, N	235	736	411
Column weight, N	889475	1692800	1555635

Drilling rig drive type is selected depending on regional conditions. Taking into account the experience of work in this area, the drilling of the projected well will be carried out using a drive from an internal combustion engine.

To determine the largest string weight, we will compile a comparative table of the weight of the drill and casing strings.

Thus, the intermediate column has the maximum weight.

To drill a well, we choose the Uralmash 3D-76 drilling rig.

It is designed for drilling production and exploration wells for oil and gas with a nominal depth of 5000 m in a temperate climate, climatic version “U”, category I.

Specifications:

A type	Uralmash 3D-76
Drilling method	Rotary and turbine
Conditional drilling depth with a weight of 1m. drill string 30 kg m.	5000
Rigging	5x6
Permissible load on the hook during driving and well casing, kN	2250
Wire rope diameter, mm	32
Hook lifting speed when casing strings are walking and elimination of accidents, m / s	0.19
The speed of steady motion when lifting an unloaded elevator, m / s	1.58
Power on the drive (input) shaft of the lifting unit, kW	710
Passage diameter of the rotor table, mm	560
Power on the rotor drive shaft, kW	215
Permissible static load on the rotor table, kN	4000
The moment transmitted by the rotor table, kNm	50
Number of main mud pumps, pcs	2
Mud pump drive power, kW	600/530

The highest pressure at the pump outlet (in the manifold), MPa	25
Candle nominal length, m	34
Base height (drill floor elevation), m	6
Rotor table rotation frequency, s (rpm):	
minimal	0.33 (20)
maximum	3.87 (232)
Air pressure in the pneumatic system, MPa (kg / cm)	0.6 (6) - 0.8 (8)
Diesel generator set power (unlimited), kW	3 x 632
Kit masa, t, not more	170
Hook load from the weight of the drill string should not exceed 5 x 6 when rigged	1450 kN

Structure: On the tower-power base there is a drilling tower with elements of a traveling system, a rotor with pneumatic wedges, an AKB-3M2 drill key, and a winch with a hydrodynamic brake. The rotor is driven by a 2PR-50.8 double-row sleeve-roller chain from a drilling winch.

The power unit contains: a gearbox with cardan shafts, a power electric motor for the drive of the winch SDBO-6000 - 710 kW. and two electric compressors 4VU1-5 / 9, providing the drilling rig with compressed air (operating pressure of the pneumatic system is 8 kg / cm^2).

In the near-tower structure, two mud pumps are installed on the base, each of them has an individual electric drive, which is carried out by a V-belt transmission from an SMBO-6000-600 / 630 kW electric motor.

On a separate foundation there are AKSA ACQ 1130 diesel generator sets - 3 sets., 824 kW - each, Cummins diesel engines (USA), 956 kW each, Stamford (Great Britain) generators, designed to supply electric power to electric motors: (rotor drive and winches, drives for mud pumps UNB-600, compressors and other electrical equipment, as well as lighting.

Method of installation and transportation: modular, block, universal transport.

Circulation system TsS 3D-76M

Technical specifications:

1. Useful volume of drilling mud, m^3 160

2. Installed capacity of electrical equipment, kW 60

3. Climatic modification - U, product category 1 (at ambient temperatures from minus 45^o to plus 45^o) in accordance with GOST 15150

Product composition: intermediate block - 2 pcs., receiving block - 1 pc., end block - 1 pc., BHR block with base, switchgear block with cabinet
control, cable products and electrical equipment, lamps, control buttons, solution preparation unit and
chemicals BPR-2, a set of platforms for service with railings.

Method of installation and transportation.

The rig design provides for:

– large-block transportation of derrick-winch and hinged blocks on heavy trucks TPP-70 and T-60;

– transportation by medium blocks on trailers and platforms PP40Br with a lifting capacity of 40 tons;

– aggregate method of transportation by general transport [4].

2.5.2 Selecting a pumping unit

A mud pump for flushing a well in specific geological conditions is selected according to the technologically required amount of flushing fluid and the pressure developed at the same time to overcome pressure losses in the elements of the drilling system.

The amount of required flushing fluid when drilling under the production casing is 31.11 l/s. Let us now determine the pressure loss in the circulation system, knowing which it is possible to choose the most rational arrangement of the drilling tool, reasonably select mud pumps and make fuller use of their potential capabilities.

The head loss, kgf / cm^2, in the circulation system of the drilling rig during rotary drilling is determined by the formula:

$$P_{\Sigma} = P_m + P_{b.t.} + P_{k.p.} + P_d, \qquad (10)$$

where P_m - head loss during the movement of the drilling fluid in the surface pipelines from the pumping section to the drill pipe string, including the standpipe in the drill pipe, the drill hose, as well as the swivel and the leading pipe (pressure loss in the outer piping of the drilling - manifold);

$P_{b.t.}$ - head losses during the movement of drilling fluid in drill pipes and tool joints (pressure losses depend on the depth of the well);

$P_{k.p.}$ - loss of pressure when the drilling fluid moves in the annular space of the well (pressure loss depends on the depth of the well);

P_d - head losses during the movement of drilling fluid through the drilling holes of the drill bit;

P_m, P_d - do not depend on the depth of the well, and $P_{b.t.}$ and $R_{k.p.}$ increase with the depth of the well.

During the circulation of the cleaning agent, the head losses, kgf / cm^2, are different when pumping water and clay solution and depend on their properties and consumption.

$$P_m = 82{,}6 \cdot \lambda \cdot L_e \cdot \gamma \cdot Q^2 / d^5, \qquad (19)$$

where λ - dimensionless coefficient of hydraulic resistance when moving in pipes;

Q - drilling mud flow rate, l/s;

γ - specific gravity of the solution, g/cm^3;

d - inner diameter of drill pipes, cm;

L_e is the equivalent length of onshore pipelines, which is determined by the formula:

$$L_e = L_{\text{Н}} \cdot (d/d_{\text{Н}})^5 + Lc \cdot (d/d_c)^5 + Lsh \cdot (d/d_{sh})^5 + L_{в} \cdot (d/d_{в})^5 + L_{\text{в.тр}} \cdot (d/d_{v.tr})^5 + L_{e.f} \cdot (d/d_{e.f.})^5 \quad (20)$$

where $d_{\text{Н}}$, $L_{\text{Н}}$ - inner diameter and length of the injection line from the mud pumps to the riser;

d_c L_c - inner diameter and length of the riser with the drilling rig;

d_{sh} L_{sh} - inner diameter and length of the drill hose;

$d_{в}$ $L_{в}$ - inner diameter of the swivel barrel and its length;

$d_{e.f}$ $L_{e.f.}$ - diameter and equivalent length of the filter to be installed under the leading pipe;

$d_{v.tr.}$ $L_{v.tr.}$ - inner diameter and length of the leading pipe.

$$L_e = 30 \cdot (0.107/0.114)^5 = 78.4 + 15 \cdot (0.107/0.114)^5 + 15 \cdot (0.107/0.09)^5 + 2.5 \cdot (0.107/0.09)^5 + 15 \cdot (0.107/0.1)^5 + 2 \cdot (0.107/0.114)^5$$

$$P_M = 82.6 \cdot 0.026 \cdot 96.85 \cdot 1.2 \cdot (31.11)^2/(10.7)^5 = 1.72 kGf/cm^2$$

$$P_{b.t} = 82.6 \cdot \lambda \cdot \gamma \cdot Q^2 \cdot (l + l_e/l) \cdot L_b/d^5 \quad (21)$$

where L_b - length of the drill string, m;

le - equivalent length of the tool joints, m;

l - distance between the locks, m.

$$P_{b.t} = 82.6 \cdot 0.026 \cdot 2.03 \cdot (31.11)^2 \cdot (1 + 3.5/11) \cdot 3785/(10.7)^5 = 65.2 kGf/cm^2$$

$$P_{k.n.} = 82.6 \cdot \lambda_1 \cdot \gamma \cdot Q^2 \cdot L/[(D_c - d_H)^3 \cdot (D_c + d_H)^2], \quad (22)$$

where λ_1 is the coefficient of hydraulic resistance when the drilling fluid moves in the annular (annular) space; D_s - borehole (bit) diameter, cm; $d_{\text{Н}}$ - outer diameter of drill pipes, see.

The pressure loss from the tool joints in the annular space is small, therefore it is usually neglected.

$$P_{k.n.} = 82.6 \cdot 0.027 \cdot 2.03 \cdot 31.11^2 \cdot 3785/[(21.59 - 12.7)^3 \cdot (21.59 + 12.7)^2] = 8.13 kGf/cm^2.$$

The head loss, kgf / cm[2], in the bit depends on the configuration of the flushing holes, on the number and area of their cross-section, the consumption of the cleaning agent (drilling mud).

$$P_d = C \cdot \gamma \cdot Q^2, \qquad (23)$$

where C is the coefficient characterizing the head loss in the flushing holes of the bit, which can be calculated by the formula:

$$C = 0{,}51/(\mu^2 \cdot f_0^2), \qquad (24)$$

where μ is the flow coefficient,

f_0 is the total cross-sectional area of the flushing holes, cm^2.

$$C = 0.51/(0.65^2 \cdot 13.05^2\ ) = 7 \cdot 10^{-3}.$$

$$P_Д = 7 \cdot 10^{-3} \cdot 1.2 \cdot 31.11^2 = 8.13 kGf/cm^2.$$

Let's calculate the total head loss:

$$P_\Sigma = 1.72 + 65.2 + 9.32 + 8.13 = 84.37 kGf/cm^2.$$

Thus, the technologically necessary amount (flow rate) of flushing fluid to ensure timely and uninterrupted removal of cuttings from the bottomhole through the annulus and cleaning the wellbore, taking into account pressure losses, will be provided by the UNB-600 pump.

Description of mud pump UNB-600:

Mud pump UNB-600 (U86MA2) (Table 2.4) is designed to supply drilling fluid to the bottomhole when drilling wells up to 5000 m deep. to transfer the energy of the flow to the turbodrill and the associated bit. Water or clay solution with the presence of oil, alkali, soda and other components is used as a flushing fluid.

Two-piston drilling pump UNB-600 in terms of design is horizontal, crank, double-acting.

In the calculation of the main characteristics, it is assumed that the feed coefficient is 1, the efficiency is - 0.85.

Mud pump UNB-600 complies with GOST 6031 in basic parameters.

Table 2.4 - Technical characteristics of the UNB-600 mud pump:

Power, kWt	600
Number of double-acting pistons:	2
Frequency of double strokes maximum in min	65
Piston stroke length, mm	400
Type of gearing of the crank-slider mechanism	helical
Tooth inclination angle, degrees	9 ° 22'00 "
Valve box design	L-shaped double action
Connecting dimensions of the valve group in the valve box	# 9 API Spec 7K
Liquid pressure at the inlet, not less, MPa (kgf / cm^2)	0.1 (1)
Coolant supply system for piston rods	Under pressure from the aux-iliary centrifugal pump with electric drive
Coolant pressure, not less, MPa (kgf / cm^2)	0.15 (1.5)
Oil supply system to the friction units of the me-chanical part:	1.Gravity from collection trays
	2. Dipping in an oil bath
Overall dimensions, mm:	
length	5 100
width	3,000
height	4040
Gearbox housing	Cast
Weight, kg	25450

2.5.3 Rig selection and tackle system calculation

The tower is used for tripping operations and holding the drill string while drilling. Its choice is carried out according to the height H, m, and according to the carrying capacity Q.

Determine the height of the tower (H, m) by the formula:

$$H = k \cdot L_{sv.}, \quad (25)$$

where k is the coefficient that prevents the drill string from being pulled into the crown block when it is over-lifted (usually k = 1.2 - 1.5);

$L_{w.}$ - the length of the plug, depending on the depth of the well, m.

We accept k = 1.5; $L_{w.}$ = 28 m.

$$H = 1.5 \cdot 28 = 42m$$

Thus, the tower BMA-45 · 200-1 is quite suitable for the design work.

The lifting system of the installation is a chain hoist mechanism consisting of a crane block, a traveling (movable) block, a steel rope, which is a flexible connection between the drawworks and the mechanism for fixing the fixed end of the rope.

As the depth of the wells increases, the weight of the drill strings that have to be lowered and raised increases, and the maximum winding speed of the leading string of the wireline on the winch drum remains practically unchanged for drilling rigs of different classes. Therefore, for each installation, a traveling system is used with its own chain hoist ratio from 4 to 14. This is achieved by using various rigs.

We will calculate the rigging and select the wire rope.

Let us calculate the number of working branches using the formula:

$$m = Q_{cr}/P_l \cdot \eta_m, \quad (26)$$

where Q_{cr} - weight of the drill, N;

P_l - lifting capacity of the machine winch, N;

Hm - efficiency of the tackle system, equal to 0.8 - 0.9.

Since the drill string will have the greatest weight (169.28 t) when drilling under an intermediate string, we will calculate only for this string:

$m = 1692800/(50000 \cdot 9) = 3.7$ (take 4 branches).

The total number of rope branches with a symmetric system is:

$$m_0 = m + 2$$

$$m_0 = 4 + 2 = 6.$$

Therefore, a 5 x 6 rig will be used.

The length of the wire rope in the equipment Lo.c. depends on the number of strings m in it and the useful height of the tower hП.

$L_{o.c.} = (m + 2) \cdot h_p + l3$, where $l_3 = 30$ m is the length of the rope wound on the drum.

$L_{o.c.} = (6 + 2) \cdot 45 + 30 = 390.$

Then the weight of the rope $G_k = L_{o.c.} \cdot q_k$, where q_k is the weight of 1 m of the rope.

$G_k = 390 \cdot 33.8 = 13182$ N = 13.18 kN.

Let us determine the largest statistical load on the moving strings of the rope of the tackle system:

$P_{ts} = L \cdot q + l_{ubt} \cdot q_{ubt} + G_{ts}$, (27)

where L - length of the drill pipes, m;

q - weight of 1 m of drill pipes, N

l_{ubt} - collar length, m;

q_{ubt} - weight of 1 m of drill collar, N;

G_{tc} - weight of traveling block, rope and hook, N.

Let us calculate Gts:

$G_{tc} = G_{tb} + G_{rope} + G_{hook}$ (28)

$$G_{ts} = 67000 + 13182 + 35000 = 115182 \text{ N} = 115.18 \text{ kN}.$$

For drill string:

$L_{ot} = 3785$ m, $q_{ot} = 240$ N.

$P_{ts} = 3785 \cdot 240 + 115182 = 1023582 = 1023.58$ kN.

Static load on 1 string: $P = P_{tc} / m$, where m is the number of strings in the tackle system.

P = 1023.58 / 6 = 170.5 kN.

For a column with a diameter of 245 mm:

L_{ot} = 2300 m, q_{ot} = 736 N.

P_{ts} = 2300 · 736 + 115182 = 1807982 = 1807.98 kN.

Static load on 1 string: P = P_{tc} / m,

where m is the number of strings in the tackle system.

P = 1807.98 / 6 = 301.33 kN.

For a column with a diameter of 168 mm:

L = 3785 m, q = 411 N.

P_{ts} = 3785 · 411 + 115182 = 1670817 N = 1670.82 kN,

Static load per string: P = 1670.82 / 6 = 278.47 kN.

Taking into account the calculated static loads, we select a steel hoist rope of the right cross lay of the LK-RO type with a 6x38 + 1 m design with a diameter of 38 mm (according to GOST 16853-88) [4].

2.6 Well cementing

Initial data

When calculating the cementing of wells, the following is determined: 1) the amount of dry cement; 2) the amount of water for mixing the cement slurry; 3) the amount of displacement fluid; 4) possible maximum pressure by the end of cementing; 5) allowable cementing time; 6) the number of cementing units and cement mixing machines.

Let us calculate the single-stage cementing of each of the casing strings.

Table 2.5 - Initial data for cementing

	Conductor	Intermediate	Production casing
Descent depth (N, m)	400	2300	3785
Bit diameter (D, mm)	393.7	295.3	215.9
Outside diameter of casing pipes (d_1, mm)	324	245	146
Inner diameter of casing pipes (d_2, mm)	305.9	230.5	133
Lifting height of cement grout (N_c, m)	350	850	3160
Clay slurry density (ρ_p, kg / m^3)	1140	1160	1140
Density of cement grout (ρ_c, kg / m^3)	1860	1860	1860
Installation height of the stop ring from the bottom (h, m)	5	12	12

2.6.1 Calculation of the volume of cement grout

The volume of cement slurry to be injected into the well is determined by the formula:

$$V_c = (\pi / 4) \cdot [K_1 \cdot (D^2 - d_1^2) \cdot H_c + d_2^2 \cdot h],\ m^3 \qquad (28)$$

where K_1 is a coefficient that takes into account the increase in the volume of cement slurry consumed for filling caverns, cracks, and an increase in the well diameter against the calculated (nominal) one.

The value of the K_1 coefficient is determined from the caliper log for each specific well. Typically K_1 ranges from 1.1 to 2.5. In our case, we take K_1 = 1.15.

The direction and conductor will be cemented using pure Portland cement.

For better pumpability of the grouting mixture and in order to raise the cement slurry to the design height (to the wellhead), as well as in order to save Portland cement, the production casing in the interval 0 - 350 m will be cemented with a gel-cement slurry with a density of 1.42 g / cm^3 s using clay as a plasticizer. The ratio of clay to cement is 2:3; water-cement ratio m = 1.1. The interval 400 - 3785 m will be cemented with a solution of pure Portland cement with a density of 1.85 g / cm^3; water-cement ratio m = 0.5.

For a column with a diameter of 426 mm:

$V_c = 0.785 \cdot [1.15 \cdot (0.508^2 - 0.426^2) \cdot 30 + 0.399^2 \cdot 5] = 2.21\ m^3$

For a column with a diameter of 324 mm:

$V_c = 0.785 \cdot [1.15 \cdot (0.3937^2 - 0.324^2) \cdot 400 + 0.3059^2 \cdot 5] = 7.56\ m^3$

For a column with a diameter of 245 mm:

$V_c = 0.785 \cdot [1.15 \cdot (0.2953^2 - 0.245^2) \cdot 2300 + 0.2305^2 \cdot 20] = 13.63\ m^3$

For a column with a diameter of 146 mm:

Interval 400 - 2300 m:

$V_{g.ts.} = 0.785 \cdot [1.15 \cdot (0.2159^2 - 0.146^2) \cdot 2400 + 0.133^2 \cdot 20] = 71.77\ m^3$

Interval 2300 - 3785:

$V_c = 0.785 \cdot [1.15 \cdot (0.2159^2 - 0.146^2) \cdot 1485 + 0.133^2 \cdot 20] = 7.19\ m^3$

The total volume of cement slurry for the column: 71.77 + 7.19 = 78.96 m^3

2.6.2 Calculation of the amount of dry cement

The amount of dry cement for the preparation of cement slurry is determined from the expression:

$$Q_{ts} = \rho_{ts} \cdot V_{ts} \cdot 1 / (1 + m), \quad (21)$$

where m is the water-cement ratio;

ρ_{ts} - cement slurry density, kg / m^3, it can be calculated by the formula:

$$\rho_{ts} = [(1 + m) \cdot \rho_{c.ts.} \cdot \rho_w] / [\rho_w + m \cdot {}_{\rho s.c.}]. \quad (22)$$

where ρc.c. - density of dry cement, g / cm^3;

ρw is the density of water, g / cm^3.

ρ_{ts} = [(1 + 0.5) · 3.15. · 1] / [1 +0.5 · 3.15] = 1.85 g / cm^3.

For a column with a diameter of 324 mm:

Q_{ts} = 1420 · 7.56 · 1 / (1 + 0.5) = 8668.8 kg = 8.67 t,

For a column with a diameter of 245 mm:

Q_{ts} = 1420 · 13.63 · 1 / (1 + 0.5) = 12903.07 kg = 12.9 t,

For a column with a diameter of 146 mm:

Interval 0 - 2300 m:

The amount of gel-cement powder will be:

Q_{gc} = 1420 · 71.77 · 1 / (1 + 1.1) = 67942.27 kg = 67.94 tons (Cement powder: 40.76 tons, clay powder: 27.17 tons).

Interval 2300 - 3785 m:

Q_{ts} = 1850 · 7.19 · 1 / (1 + 0.5) = 8915.6 kg = 8.92 t,

The total volume of cement for the column: Qts = 67.94 + 8.67 = 76.86 tons.

The amount of dry cement that must be prepared, taking into account the losses during mixing of the cement slurry, will be calculated by the formula:

$$Q_{ts1} = K_2 \cdot Q_{ts}, \qquad (23)$$

where K_2 is a coefficient that takes into account ground losses during mixing of the cement slurry. If mixing is carried out without cement mixing machines, K_2 = 1.054-5-1.15, when using cement mixing machines, K_2 = 1.01. In our case, K_2 = 1.01.

For a column with a diameter of 324 mm:

Q_{ts1} = 1.01 · 1.91 = 1.93 t,

For a column with a diameter of 245 mm:

Q_{ts1} = 1.01 · 12.9 = 13.03 t,

For a column with a diameter of 146 mm:

Interval 400 - 2300 m:

Q_{ts1} = 1.01 · 67.94 = 68.62 t,

Interval 2300 - 3785 m:

Q_{ts1} = 1.01 · 8.92 = 9 t,

The total amount of dry cement, taking into account losses for the column:

$Q_{ts1} = 68.62 + 9 = 77.62$ t.

2.6.3 Calculation of the amount of water

The required amount of water for the preparation of a cement grout of 50% consistency is found from the expression:

$$V_w = 0.5 \cdot Qts, \quad (24)$$

For a column with a diameter of 324 mm:

$V_w = 0.5 \cdot 2.5 = 1.25\ m^3$.

For a column with a diameter of 245 mm:

$V_w = 0.5 \cdot 16.9 = 8.45\ m^3$.

For a column with a diameter of 146 mm:

$V_w = 1.1 \cdot 67.94 + 0.5 \cdot 8.92 = 79.19\ m^3$.

2.6.4 Calculation of the amount of displacement fluid

The required amount of displacement fluid (which is often used as drilling mud) is determined by the formula:

$$V_{pr} = \Delta \cdot \pi \cdot d_2^2 \cdot (H - h) / 4, \quad (25)$$

where Δ is the coefficient taking into account the compression of the clay solution (Δ = 1.03 - 1.05).

Substituting the values, we get:

For a column with a diameter of 324 mm:

$V_{pr} = 1.03 \cdot 3.14 \cdot 0.3059^2 \cdot (400 - 20) / 4 = 2.26\ m^3$.

For a column with a diameter of 245 mm:

$V_{pr} = 1.03 \cdot 3.14 \cdot 0.2305^2 \cdot (2300 - 20) / 4 = 35.65\ m^3$.

For a column with a diameter of 146 mm:

$V_{pr} = 1.03 \cdot 3.14 \cdot 0.133^2 \cdot (3785 - 20) / 4 = 44.90\ m^3$.

Very often in practice, the following empirical formula is used to quickly determine V_{pr}:

$$V_{pr} = D_н^2 \cdot H_1 / 2, \quad (26)$$

where $D_н$ is the nominal outer diameter of the string of pipes lowered into the well, in inches;

$D_н^2$ / 2 - the amount of displacement fluid required to fill 1 m of lowered pipes, l;

H_1 - installation depth of the stop ring, i.e. the depth of squeezing the cement slurry.

For the production casing:

$V_{pr} = 0.02 \cdot 3765/2 = 40113$ l $= 40.11$ m^3.

2.6.5 Calculation of injection pressure

The maximum pressure before seating the top plug on the thrust ring is determined from the equation:

$$P_{max} = P_1 + P_2, \quad (27)$$

where P_1 is the pressure required to overcome the resistance caught by the differences in the densities of the liquid in the pipes and the annulus;

P_2 is the pressure required to overcome hydraulic resistance.

$$P_1 = (1/105) \cdot [(H_c - h) \cdot (\rho_c - \rho_p)], \text{ MPa} \quad (28)$$

The value of P_2 is usually found using empirical formulas. The most common is the Shishchenko-Baklanov formula; for wells with a depth of more than 1500 m:

$$P_2 = 0.001 \cdot H + 1.6 \text{ MPa.} \quad (29)$$

For a column with a diameter of 324 mm:

$P_1 = (1/105) \cdot [(30 - 5) \cdot (1420 - 1100)] = 0.08$ MPa

$P_2 = 0.001 \cdot 30 + 1.6 = 1.63$ MPa.

$P_{max} = 0.08 + 1.62 = 1.7$ MPa.

For a column with a diameter of 245 mm:

$P_1 = (1/105) \cdot [(400 - 20) \cdot (1420 - 1100)] = 1.22$ MPa

$P_2 = 0.001 \cdot 400 + 1.6 = 2.00$ MPa.

Pmax = 1.22 + 2.00 = 3.22 MPa.

For a column with a diameter of 146 mm:

P_1 = (1/105) · [(1485 - 20) · (1420 - 1100) + 2300 · (1860 - 1200)] = 23.07 MPa.

P_2 = 0.001 · 3785 + 1.6 = 5.39 MPa.

P_{max} = 23.07 + 5.39 = 28.46 MPa.

2.6.6 Calculation of the number of cementing aggregates

The number of cementing units is determined based on the condition for obtaining the rate of lifting of the cement grout in the annular space at the casing shoe at the time of the start of squeezing (at least 15 m / s for the surface conductor and intermediate strings, frost less than 1.8 - 2.0 m / s for production strings); this condition follows from the assumption that an increase in the speed of movement of the cement grout in the annulus contributes to a more complete displacement of the clay slurry and its replacement with cement grout.

Often, the wellbore is curved, has local expansion, and the string is not strictly cemented in it. In such cases, it is advisable to displace the cement slurry from the column, maintaining a low rate of rise of the cement slurry in the annulus (ω = 0.1-0.4 m / s). The same should be done if the column is well centered, but it is impossible to create a turbulent flow of the cement slurry in the annulus. Since the squeezing almost always starts at the highest speed (as a rule, at IV), the number of aggregates from the condition of ensuring the speed (m v / s) of the cement slurry rise in the annulus is determined by the formula:

$$N_{ts.a} = [0.785 \cdot K1 \cdot (D^2 - d_1^2) \cdot \omega / Q_{IV}] + 1, \quad (30)$$

where Q_{IV} is the productivity of the cementing unit at IV speed, m^3 / s.

We select a cementing unit of the TsA-320M type with 127-mm cylinder bushings installed in its 9T pump (these bushings can be operated at pmax at the end of cementing). The maximum productivity is 0.9 m^3 / min at a pressure of 6.1 MPa.

For a column with a diameter of 324 mm:

$n_{c.a} = [0.785 \cdot 1.2 \cdot (0.3937^2 - 0.324^2) \cdot 1.5 / 60] + 1 = 2$ units.

Taking into account the established practice of drilling operations in this area, we accept $n_{c.a.} = 1$ unit.

For a column with a diameter of 245 mm:

$n_{c.a} = [0.785 \cdot 1.2 \cdot (0.2953^2 - 0.245^2) \cdot 1.5 / 60] + 1 = 3$ units.

Taking into account the experience of work in this area, we accept 2 units.

For a column with a diameter of 146 mm:

$n_{c.a} = [0.785 \cdot 1.2 \cdot (0.2159^2 - 0.146^2) \cdot 2 / (0.9 / 60)] + 1 = 5$ units.

Taking into account the established practice of drilling operations in this area, we take $n_{c.a} = 5$ units TsA-320M.

2.6.7 Calculation of cementing performance

Cementing productivity (duration of the cementing process in minutes) can be determined by the formula:

$$t_{ts} = [(V_1 / Q_{tsa}) + ((V_{ts} + V_{pr} - V_1) / Q_m)] + t_{sp.} \quad (31)$$

where $V_1 = V_{pr} - \Delta V$, ΔV is taken equal to 1 - 2 m^3;

Q_{tsa} - total productivity of cementing units, m^3 / min;

Q_m - productivity of cementing units, at which the most complete displacement of the drilling fluid by cement is achieved, m3 / min.

$$Q_m = 0.785 \cdot (D^2 - d1^2) \cdot K1 \cdot \omega, \quad (32)$$

t_{sp} - time spent during cementing for auxiliary operations, mm (t_{sp} + 10 - 15 min.)

For a column with a diameter of 324 mm:

$Q_m = 0.785 \cdot (0.3937^2 - 0.324^2) \cdot 1.2 \cdot 1.5 = 0.07$ m^3 / s = 4.2 m^3 / min.

$t_c = [(0.76 / 0.9 \cdot 1) + ((2.21+ 2.26 - 0.76) / 4.2)] + 15 = 16.68$ min.

For a column with a diameter of 245 mm:

$Q_m = 0.785 \cdot (0.2953^2 - 0.245^2) \cdot 1.2 \cdot 1.5 = 0.04$ m^3 / s = 2.4 m^3 / min.

$t_c = [(19.12 / 0.9 \cdot 2) + ((13.63+ 35.65 - 19.12) / 2.4)] + 15 = 31.92$ min.

For a column with a diameter of 146 mm:

$Q_m = 0.785 \cdot (0.2159^2 - 0.146^2) \cdot 1.2 \cdot 1.5 = 0.048\ m^3 / s = 2.88\ m^3 / min.$

$t_c = [(45.27 / 0.9 \times 10) + ((78.96 + 44.90 - 45.27) / 2.88)] + 15 = 57.43$ min.

Duration of cementing should not exceed 75% of the time of the onset of setting of the cement slurry. Then the permissible cementing time is:

$t_{add} = 0.75 \cdot t_{n.schv.} = 0.75 \cdot 120 = 90$ min.

Thus, the selected number of cementing units and the calculations performed satisfy the conditions for cementing the casing strings [10].

2.6.8 Calculation of the number of cement mixing machines

Based on the condition of providing cement mortar for all operating CA-320 M units,

$n_{tscm} = n_{tsa} \cdot Q_{tsa} / Q_{tscm}$ (33)

where Q_{tsa} is the average productivity of one operating unit when pumping cement slurry into the column, m^3 / min;

Q_{tscm} - average productivity of one cement mixing machine 2SMN-20, m^3 / min.

Based on the conditions for placing the cement powder delivered to the drilling rig in the bins of mixing machines:

$n_{tscm} = Q_{ts1} / q_{tsb}$, (34)

where Q_{ts1} is the weight amount of dry cement delivered to the drilling site, taking into account the estimated losses, t;

q_{tsb} - the weight amount of cement placed in the hopper of one cement mixing machine

For a column with a diameter of 324 mm:

$n_{ccm} = 1 \cdot 0.9 / 1 = 0.9 = 1$ machine.

$n_{tscm} = 1.93 / 20 = 0.1 = 1$ machine 2SMN-20.

For a column with a diameter of 245 mm:

$n_{ccm} = 2 \cdot 0.9 / 1 = 1.8 = 2$ machines.

$n_{tscm} = 13.03 / 20 = 0.65 = 1$ machine 2SMN-20.

We accept 1 cement mixing machine 2SMN-20.

For a column with a diameter of 146 mm:

n_{tscm} = 10 · 0.9 / 1 = 9 machines.

n_{tscm} = 77.62 / 20 = 4 machines 2SMN-20.

We accept 4 cement mixing machines 2SMN-20

2.6.9 Cementing equipment

Cementing aggregates

Cementing units are designed:

– for preparation, pumping and pumping of grouting (or other) solutions into wells;

– for carrying out various types of well flushing through lowered pipe strings;

– for treatment of the bottomhole zone of wells, injection of isotope solutions, hydrosand-jet perforation and other technological operations in wells;

– for pumping various liquids or solutions from tanks of wells and reservoirs;

– for hydraulic pressure testing of casing pipes and strings, as well as various equipment.

The most widespread in the field practice of oil and gas regions of the country are cementing units TsA-320M and ZTSA-400A.

When cementing the project well, the cementing units TsA-320M will be used.

Technological characteristics of the cementing unit TsA-320M:

Mounting base …………………………………………. KrAZ-257 vehicle chassis

Cement pump:

type ………………………………………………………………. ……… .9T

hydraulic power, hp ……………………………………………………125

piston stroke, mm …………………………………………………….. …… .250

maximum pressure, kgf / cm^2 ………………………………………..………320

maximum flow rate, l /s ……………………………………………………23

drive …………………… .. …….. from the engine of the KrAZ-257 vehicle

water supply pump:

type ………………………………………………………………….…….1B

plunger diameter, mm ………………………………… .. …… ..125

plunger stroke, mm ……………………………………………… ..… ..170

flow rate, l / s ………………………………………………………… ..… 13

pressure, kgf / cm2 …………………………………………………. ..… .15

drive ………………………………………… ..…. from the GAZ-51A engine

measuring tank capacity, m ………………………………. .. ………… ..6,4

cement tank capacity, m ………………………………………………….0.25

diameter of intake pipelines, mm ……………………….. ……………100

diameter of discharge pipelines, mm ……………… .. ……………………50

total length of the dismountable pipeline, m …………………… .. …… 22

Total weight of the unit, t ……………………………………………………17.5

Cement mixing machines

Cement mixing machines and units are designed for transportation of dry grouting materials (clay powders) and mechanized preparation of grouting (clay) solutions.

In field practice, cement mixing machines 2SMN-20, SMP-20, SM-10, SM-4M and units 1AS-20, 2AS-20, ZAS-30 are used.

In this case, cement mixing machines 2SMN-20 will be used.

Technical characteristics of the machine 2SMN-20:

Mounting base ……………………………………….KrAZ-257 vehicle chassis

Transport capacity, t ………………………………………………8 - 10

Hopper volume, m …………………………………………..……..….14.5

Hopper capacity (for cement), t ……………………..…………….20

Method of obtaining a solution ………..……… mechanical-hydraulic

Productivity in m / min during cooking:

Cement mortar ……………………………………………..… 0.6 - 1.2

Cement-bentonite mortar ……………………………………0.5 - 1.0

Clay mortar ………………………………………..…………1.0 - 2.0

Mixing fluid pressure, kgf / cm^2 …………………………………8 - 20

Total weight of the unloaded machine, t …………………… ……… 13.8

Method of loading into the bunker ……………………… ... by auger loader

The density of the grouting slurry is regulated by changing the amount of water supplied to the mixer using a device with a set of nozzles and a tap on the bypass line, as well as the amount of dry cement supplied by changing the rotation speed of the motor shaft and two parallel loading augers located in the bottom of the 2SMN-20 hopper [2].

According to the above, a geological and technical project was completed (Fig.3.2).

Conclusions for the section

The well will be drilled by a drilling rig Uralmash-3D-76 in four drilling intervals: direction - 426 mm in diameter, conductor - 324 mm in diameter, intermediate string - 245 mm in diameter and for production casing 168/146 mm in diameter, using mud. The drilling process is monitored by the GTI station. Cementing of the well will be carried out using cement mixing machines 2SMN-20, cementing units and a blending tank. Control of the process will be provided by the SKTs-2M cementing control station.

SECTION 3 LABOUR PROTECTION

3.1 Training and instruction of workers

The quality of vocational training and education of workers in safe working methods is one of the most important factors in reducing the level of injuries at work.

The training of new skilled workers for the oil and gas industry is carried out both in the production and technical schools (PTS) for vocational education, and directly at the enterprises and organizations of the industry.

Industrial and technical training directly at enterprises and organizations, the oil and gas industry is conducted in three directions:

- training of new workers, the initial qualification level of the corresponding profession (specialty);
- retraining of workers who are released in connection with mechanization, reorganization of production and transfer to other work;
- consistent improvement of the production and technical qualifications of workers and their economic education.

When training workers and raising their qualifications, educational and methodological councils, which are created at enterprises and organizations for the implementation of educational and methodological work, play an important role. The structure of the educational and methodological council includes advanced workers, chiefs and engineers and technical workers of workshops and departments, heads of the labor and wages department, shop and other organizers of industrial and technical training, the director of the training center, representatives of trade union and other public organizations of the enterprise, heads of day and evening vocational and other educational institutions. The composition of the educational and methodological council is approved by an order for the enterprise, while the chief engineer of the enterprise or his deputy is appointed as the chairman of the council.

Educational and methodological councils discuss training programs, visual aids developed at the enterprise regarding the conditions of this production, issues related to the organization and conduct of training to improve the qualifications of personnel at the enterprise.

The members of the council monitor the state of theoretical knowledge and industrial training, consider the forms and methods of providing practical assistance in improving the technical and general educational knowledge of workers directly in brigades.

Workers and engineers and technicians learn safe working methods at the enterprises of the ministries in accordance with the provisions that are in force in their system DST 12.0.004-79. This training is carried out at all enterprises and for all employees, regardless of the nature and degree of hazard of production, as well as: work experience and qualifications of workers in a given profession or position.

Workers who perform work with increased danger (personnel who maintain steam cauldrons and cranes, as well as: electrician, welder and others) undergo special training. Compulsory training in labor protection is provided for both workers and employees who are not officials, and for administrative and technical workers - officials.

T of workers raining consists of the following stages:

- introductory briefing (when applying for a job);
- targeted training in labor protection in special courses or at the enterprise;
- on-the-job briefing;
- checking knowledge and admission to independent work;
- re-instruction;
- one-time briefing when changing the watch.

During the introductory briefing, the applicant is introduced to the internal labor regulations, the specific features of this production, the basic requirements of industrial sanitation, safety and fire protection at the facility. This briefing is carried out by employees of the labor protection service, but specialists from the relevant services are also involved on special issues.

All workers are required to undergo targeted training in labor protection at a training center (point) or by an individual method from an experienced skilled worker.

After targeted training of the employee, as well as for all those sent, transferred to temporary or permanent work from one department to another (and in all cases when the employee is provided with a new job for him), instructions are required: at the workplace with a practical demonstration of safe techniques and methods labor. This briefing is carried out by the direct supervisor of the work individually with each employee.

After the introductory briefing, targeted training and instruction at the workplace, before admitting the employee to independent work, his knowledge of labor protection is checked by the commission assigned for this structural unit by order of the enterprise. The chairman of the commission is the technical head of the unit responsible for safety. In addition to assessing knowledge, the commission gives a general conclusion about the possibilities of admission to independent work.

Every year workers and employees undergo a periodic examination of their knowledge of labor protection.

Workers engaged in work with increased danger, the list of which is determined by the head of the enterprise, are re-instructed once every 3 months. The exception is made by workers, for whom, due to the specific features of the work performed, special rules establish other terms. All other workers, regardless of qualifications and length of service, re-instruction: must be held at least once every 6 months.

When changing the technological process, introducing new types of equipment and mechanisms, as well as when introducing new rules or instructions on safety and industrial sanitation, an extraordinary briefing of workers and employees is carried out, followed by verification of their knowledge. Extraordinary briefing; can be carried out by order of the heads of the enterprise and at the request of the control bodies in cases of insufficient knowledge of labor protection instructions or their gross violations.

If, during the check, the worker showed unsatisfactory knowledge of labor protection, then he is not allowed to work independently, but is sent for additional studies and is rechecked within a two-week period.

If minor technological changes have taken place at the workplace that do not require re-briefing, then when the shift is changed, the workers undergo a one-time briefing. Special instruction is also provided; before receiving an assignment to perform particularly hazardous work.

For administrative and technical workers also; introductory instruction is provided; when they are hired. Such instruction; is necessary in order to familiarize employees with the working environment, the organization of labor protection work at a given enterprise, with the duties and responsibilities for the state of labor protection, as well as with guidance materials on labor protection issues.

Periodically, once every three years, or more often, if it is foreseen by special rules, managers and administrative and technical workers of enterprises and organizations undergo an examination of their knowledge of labor protection according to the profiles of their official duties. At the same time, these same employees are obliged to pass an extraordinary test of knowledge in the following cases:

1) when new labor protection rules are enacted or supplemented or changed;

2) when introducing new types of equipment and mechanisms, introducing (new industries or technological processes in the amount of new requirements for these types of equipment;

3) when appointing for the first time to work as a person of technical control or when transferring to another position that requires additional knowledge of labor protection;

4) in cases of an unsatisfactory state of safety at the facilities;

5) at the request of higher organizations, state control bodies and technical labor inspections of the trade union, in case of insufficient knowledge of the rules, norms, instructions on labor protection.

In each specific case, the scope and timing of an extraordinary check are established by order of the heads of the enterprise or a higher organization.

An educational and methodological center for training and systematic improvement of the level of knowledge in the field of labor protection is the labor protection office, which is created at enterprises and organizations with an accounting number of employees of 100 people or more. For individual enterprises, the objects of work on which are of a temporary nature (for example, at a drilling rig, a construction site etc.), mobile offices (corners) of labor security are created, mounted in mobile trailers (buses, vans).

Occupational safety offices will be equipped according to typical designs tailored to the specifics of each industry. So, for example, for the gas industry enterprises at the Department of Labor Protection at the Grozny Oil Institute, a typical project for equipping an occupational safety cabinet with programmed training has been developed, and VostNIITB is a typical project for a mobile labor protection cabinet.

One of the directions for improving the process of industrial training is the issue of labor protection - the use of modern technical means, as well as means and methods of programmed learning.

Currently, at oil and gas enterprises, devices of the Cobra type (educational, monitoring the safety of work) are widely used for programmed learning and knowledge testing. The methodological basis for their application is the development of the departments “Labour Protection” of the State Tax Inspection and MING as well as VostNIITB and VNIITB.

The use of means and methods of programmed learning in the process of self-training and knowledge testing contributes to the improvement of the system of industrial training in labour protection, increasing the level of knowledge, rigor and objectivity of knowledge testing.

3.2 Preparing the rig for drilling

The analysis of drilling accidents suggests that most of them occur as a result of the use of inappropriate working practices.

In order to reduce injuries, a high qualification of workers is required, their knowledge of the technical features of well drilling, the purpose, design and operating rules of equipment and mechanisms, correct and safe work practices, as well as; high level of technical supervision.

Improvement of labor organization, mechanization of heavy and labor-intensive work, rationalization of technological processes, implementation of new types of equipment, mechanisms and tools the main directions for increasing labor productivity and creating a healthy and safe working environment at drilling rigs.

When drilling oil and gas wells, a significant number of accidents occur during the operation of equipment. Correct installation and timely maintenance of it create conditions for further safe work. Therefore, before putting into operation only the mounted drilling rig, it is necessary to check its equipment with safety devices and devices, elements of small mechanization, control and measuring instruments and spare tanks.

Before starting drilling, the driller must have the following documents:

1. Well placement certificate.
2. Geological and technical outfit.
3. Approved layout of drilling and power equipment.
4. Passport for a drilling rig, drilling and power equipment, hoist line, drill pipes, instrumentation.
5. The act of pressure testing of the injection line of mud pumps.
6. The act of checking the condition and compliance with the standards of grounding resistance of electrical equipment, starting devices.
7. Test report for the travel block lifting limiter under the crane block.
8. The derrick fastening and cementing certificate.

9. Tower test certificate.

All members of the drilling crew must be familiar with these documents.

Preparation of a drilling rig for drilling consists of the following activities: checking of all fastening parts on the drilling rig and drilling equipment, re-equipment of the tackle system, borehole drilling, centering the tower with a rotor, cementing the equipment, creating directions.

The well construction cycle includes the following main types of work:

- preparatory and construction works;
- drilling and fastening;
- tide test;
- dismantling of equipment.

The safe performance of these stages of work is ensured by compulsory compliance with the safety rules given in the current instructions and other regulatory documents for each type of work.

Each of the above documents contains safety rules for a specific type of work that is performed during the well construction process.

The most dangerous types of work are envisaged to be carried out under the guidance of a person who has the right to carry them out, sufficient work experience, knows well the spinning wheels of such work and the labor protection requirements when performing them.

At the same time, the most dangerous are works on installation, dismantling of the tower and equipment on it and moving it to another well in a vertical position, as well as: installation: (dismantling) of large and heavy drilling equipment using lifting mechanisms.

Installation, dismantling: and transportation of the tower and drilling equipment must be carried out in accordance with the requirements of the manufacturer's instructions, the approved layout of the drilling equipment and foundations, as well as: labor protection. The drilling base and live equipment are connected to the ground loop using metal bars, and the tower is equipped with a lightning rod. Before drilling the well, it is necessary to hold a start-up conference to familiarize with the working project with the participation of the entire drilling crew and the main UBR specialists.

3.3 Safety measures when performing work

The most dangerous types of work during the stage “Drilling and casing the well” are round-trip operations, collection and disassembly of the BHA, pulling the drill collar into the drilling rig and throwing it out onto bridges, work on replacing large-sized equipment that has failed, operation of drilling pumps, liquidation intensive gas showings, gas emissions and fountains, cargo handling and others.

When performing tripping operations, the most dangerous are accidents associated with the tightening of the traveling block under the crown block with the next break of the wireline, the fall of the tackle system into the drilling, and possibly the fall of the derrick. To prevent this type of accidents, work on lowering and lifting the drill string and casing should be carried out only if there is a working anti-tensioner of the traveling block under the crown block and a working brake system of the winch.

According to the operating conditions, the drilling tower belongs to the objects that require special attention, since they are susceptible to significant variable loads from zero to permissible, which necessitates increased control over its operation.

According to paragraphs. 3.2.1 - 3.2.3 “Safety rules in the oil and gas industry” and amendments to them, adopted in February 1984 p., In order to prevent dangerous operation, the drilling rig, crown block, crown block frame, undercrown block beams are subject to inspection at least once every two months by a mechanic and a drilling foreman, as well as, at least once a year, a thorough inspection by a special team to inspect the drilling rigs; in the manner prescribed by the approved methodology. After 7 calendar years, the rig must be inspected by a special commission with the participation of the chief specialists of drilling and rig-assembly organizations and, if there is a conclusion about its suitability for further operation, it must be tested for carrying capacity. If the test results are positive, the commission sets the term for further operation of the tower, but not more than 5 years.

In the future, in an exceptional manner, the operation of the tower can be extended for another 3 years, but only after its complete disassembly with revision of all units and elements, rejection and replacement of some of them unsuitable for further operation, assembly and subsequent testing.

In all cases of operation of the tower for more than 7 years, it should be annually inspected by a commission with the participation of chief specialists, drawing up an act on its technical condition and a conclusion on the suitability of the tower for further operation. In addition, the tower status is checked:

- before running the casing;
- before the start and after the end of fishing operations, which require the stuck pipe string to be pacing;
- after a strong wind at a speed of 15 m / s for an open area and 21 m / s - for a forest and in a hollow;
- after the end of the installation.

The introduction of lubricating additives and chemicals into the drilling mud is provided through the mud cleaning system in accordance with safety rules and instructions for their safe use, and the maintenance personnel must be provided with personal protective equipment in advance, based on the type of chemicals that are used.

When working with drilling tongs, which are used for screwing and unscrewing drill pipes, the presence of people in the range of these tongs is not allowed, which will eliminate the possibility of injury to the maintenance personnel.

To prevent rupture of the injection and auxiliary service lines during the circulation and pumping of drilling mud and chemicals, mud pumps and pumps for household needs are equipped with safety devices.

Intensive gas shows, gas emissions and fountains are the most dangerous types of complications and accidents. Prevention of gas seepage and gas fountains in compliance with the "Temporary instruction for the prevention of gas and oil water seepage, emissions and open flowing during well drilling", approved by AT "Ukrgazprom" in 2.09.98 is provided by:

- selection of an appropriate well design;
- selection of casing strings of appropriate strength;
- selection of the density of the drilling fluid, which ensures the implementation of the required hydrostatic pressure in the well, exceeding the formation pressure;
- wellhead sealing with blowout preventer equipment;
- availability of reserve drilling mud with a volume of at least one well volume;
- availability of a drilling crew trained in practical actions to prevent and eliminate gas and gas outbursts.

Operation of pressure vessels must be carried out in accordance with the requirements of the “Rules for the installation and safe operation of pressure vessels”.

Operation of electrical equipment, power and lighting lines must be carried out in accordance with the requirements of the “Rules for the safe operation of electrical installations of consumers” DNAP 0.00-1.21-98 and clause 10.1.3 “Safety rules in the oil and gas industry”.

Repair work that is carried out in the process of drilling a well using an electric welding machine must be carried out by persons who have permission and work experience in compliance with the rules and instructions for labor protection in accordance with the approved list.

According to the Rules for the Development of Gas and Gas Condensate Fields, well development is envisaged to be carried out only with the appropriate pressure Christmas tree installed at the wellhead and piping the flow manifold of the well, which makes it possible to carry out the necessary sampling, measurement of pressure and temperature.

Fountain fittings should be fixed and pressurized to the pressure allowed for pressurizing the production casing, and the discharge manifolds should be pressurized to 1.5 times the pressure expected at the wellhead.

The most dangerous types of work during well testing are perforation work, when unauthorized shots are possible, as well as possible gas showings when perforating productive horizons. In order to prevent gas emissions during perforation, blowout equipment is installed at the wellhead, and perforation work is planned to be carried out in accordance with the safety requirements specified in section. 12 “Safety Rules”. All work on well testing is planned to be carried out under the supervision of a responsible engineer and technical worker in compliance with the requirements of Section 4.10. “Safety rules in the oil and gas industry”. When conducting research in a well, the measurable line is supposed to be fixed on at least two supports, one of which is installed at the end of the DVKT line. Near the Christmas tree and near the DVKT, to replace the diaphragms, it is planned to install sites of a stationary or mobile type.

Before replacing diaphragms, the tested line must be vented to atmospheric pressure. Ignition of the gas that comes out of the flow lines is provided with the help of a rocket launcher, and at low flow rates of a long-burning hearth, which is bred before opening the valve.

When working with a lubricator at a height, it is planned to install a platform with a flooring made of metal sheets that exclude the possibility of sliding or boards with a thickness of at least 4 cm, a handrail with a height of 125 cm with longitudinal strips located at a distance of 40 cm from the bottom from one and a side height not less than 15 cm, which adheres tightly to the flooring. Well survey work should be carried out in accordance with the “Instructions for the Integrated Study of Gas and Gas Condensate Reservoirs and Wells”.

Drilling of a well using the existing technology is carried out around the clock, and therefore it becomes necessary to provide the workplaces of the drilling crew and other facilities with appropriate lighting.

During the construction of the well, it is envisaged to use personal protective equipment and overalls for workers of the drilling and rig crews. The list of personal protective equipment and overalls that meet the requirements of the current DST and TU.

The drilling crew must be provided with a set of labor protection instructions in force at the enterprise in accordance with the approved list, as well as) plans for the elimination of possible accidents and practical actions in case of oil and gas shows and open fountains.

3.4 Industrial hygiene

The process of drilling a well is accompanied by noise and vibration levels that can reach from 80 to 100 dB at permissible levels according to SDS 33.6.037-99 - 80 dB. The main sources of noise on the rig are: drawworks, rotor, mud pumps, DVZ, electric motors, vibrating screens and other mechanisms. Since the noise level may have certain deviations from the permissible according to DSN 33.6.037-99, the maintenance personnel are expected to provide protective equipment in accordance with DST 12.1.028-80.

Permissible values of vibration parameters: vibration acceleration frequency (dB), vibration displacement amplitude (max 10 ~), total time to vibration (XV) must meet GOCT 12.1.012-90, and methods and means of protection - GOST 26568-85. Monitoring of noise and vibration levels is envisaged to be carried out periodically during certification of workplaces with VSHV-OOZM2 devices.

The control of noise and vibration levels is carried out by the labor protection service of the enterprise or by specialized organizations that have the appropriate permission, under contracts with the drilling organization.

In accordance with the requirements of the Occupational Safety Standards System (Occupational Safety Standards System), incoming inspection of equipment, instruments and tools is provided for their compliance with GOSTs and TUs before the start of installation and drilling operations, as well as the availability of passports for all equipment, instruments and tools.

It is planned to plan the drilling site with a slope towards earthen barns, and under the derrick, aggregate and pumping blocks - the construction of sewage trays in order to remove atmospheric precipitation and drilling wastewater.

The well is planned to be drilled by a drilling team of 36 people. Due to the continuous cycle of well construction, the robot of the drilling crew is carried out around the clock, in shifts. The maximum number of people on the rig is 13 people.

Delivery of the drilling crew to the drilling site is envisaged by the shift motor transport in 8 hours. In accordance with SNiP 2.09.04.87 table. 6, the construction of the well refers to groups 1, 2c and 2d of production processes, in connection with which it is planned to install carriage houses on the drilling site, in which the premises are located:

- for the driller (with permanent radio communication);
- for the rest of the members of the drilling crew;
- for work and leisure of specialists who have arrived on a business trip;
- power supply unit;
- dressing room with wardrobes, one compartment for 1 chol.;
- for drying workwear;
- shower room for 1 mesh;
- washbasin for 2 taps.

According to SN-245-71 p. 6.2, the drilling crew and boiler station are supposed to be provided with imported drinking water with specially equipped vehicles that meet the requirements of GOST 2874-82 from a source for which there is a sanitary and epidemiological station permit.

Drinking water consumption per person per day add up to 25 liters of jail and 11 liters of hot (addition 3 SNiP 2.04.01-85). The average demand for drinking water per day is 0.3-0.5 m3. Potable water storage areas must meet the requirements of Ch. 13.7 “Safety rules in the NGDP”.

According to GOST 41-00 032 626-00-007, special waterproof pits or tanks are to be constructed for household wastewater, in which the wastewater is neutralized and transported to the nearest local treatment plant. It is planned to store solid household waste in closed metal containers and, as they accumulate, take it to the landfill. According to SNiP 2.09.04-87, as well as; SNiP 2.04.01-85 at a distance of 75 m from the working area, carriage houses and outside the sanitary protection zones of a water well, it is planned to build a toilet at two distances with a size of at least 1.6x1.2 m with a waterproof concreted cesspool with a volume of at least 13 household waste ... (The volume of the cesspool is taken from the calculation of the simultaneous maximum number of people at the drilling rig, 13 people, but the frequency of cleaning the hole is 1 time / year).

Meals for the members of the drilling crew are provided with the help of a boiler station for 9-12 seats, which meets the requirements of SNiP 2.09.04-87.

Heating of the wagon houses is provided by water heating from the boiler room, mounted on the drilling rig. It is envisaged to build a pipeline with a diameter of 51 mm from the boiler room to the carriage houses, and on the branches of 32 and 25 mm.

It is planned to provide the drilling room with a first aid kit with a set of medicines and instruments and dressing materials for providing first aid to victims, as well as medical stretchers.

Communication with the management of the drilling organization and the personnel on duty is provided by means of a radio station.

3.5 Fire safety

When drilling a well, it is necessary to adhere to the requirements of the “Fire Safety Rules in the Gas Industry”.

At the drilling site, it is necessary to provide external water supply for fire extinguishing in accordance with the “Protocol of the technical meeting on the issues of external water supply of drilling sites for drilling units” Ukrburgaz “or fire extinguishing” dated 06.07.2000 and a typical scheme of “External water supply for drilling units” Ukrburgaz “for fire fighting”.

The scheme provides for the installation of fire hydrants on the branches of the water supply from the water storage tank in the pumping room, the tower-power unit, the drilling mud cleaning and degassing unit, near the residential wagon houses, as well as a tap installed between the water well and the water supply tank for connecting the fire department driveway technology.

In case of emergencies, in accordance with the "Instructions for the organization and safe conduct of work to eliminate open oil and gas gushers at the wells of AT "Ukrgazprom" approved on 05/04/1998, it is envisaged to build outside the drilling site, perpendicular to the axis of the prevailing wind direction, two earthen pits for accumulation of water in them for the needs of liquidating the fountain. Taking into account the maximum flow rates of wells at the fields of DC Ukrgazvydobuvannya, the volume of earthen pits should be at least 5000 m3.

The drilling crew in this case operates according to the plan of the LIKVO VGPC. Section 18 indicates the distance to the nearest natural body of water and its approximate volume.

The placement of wagon houses for housing and amenity needs, storage, production and auxiliary premises, access roads and sites for the placement of special equipment must be performed in accordance with the requirements of the Fire Safety Rules, and the drilling rig is provided with primary fire extinguishing means.

The arrangement of residential wagon houses is provided separately from one another or in pairs to the end to each other. In the latter case, the exits from them should be located in opposite directions.

At a distance of 15 m from the wellhead, it is planned to build a site 12 m wide to accommodate fire fighting equipment in case of extinguishing a fire of gas and oil fountains.

Oil and PMM, which are used in the construction of a well, are fire hazardous. In order to prevent their ignition, appropriate metal containers are provided, which are equipped with level gauges and breathing tubes installed on the concreted sites, the area around which is heaped with an earthen embankment 1 m high.

It is planned to install a tank for storing oil for technological needs at the PMM site. Installation of a tank for oil on gutters is prohibited.

When oil is introduced into the drilling fluid and oil baths are installed, it is necessary to adhere to the requirements of the "Fire safety rules in the gas industry" clause 9.1.13.-9.1.20.

The construction of an overhead power line is provided in such a way that a wire break does not create a fire hazard.

The placement of containers with PMM and oil is envisaged at a distance of at least 20 m from the premises of the power and pumping units and other buildings and structures, and the fuel pipeline is planned to be equipped with a shut-off valve, which is installed at a distance of 5 m from the wall of the machine room.

It is planned to equip the discharge pipes of the engines with spark arrestors, and discharge the discharge gases at a distance of at least 15 m from the wellhead when laying the discharge pipeline horizontally and 1.5 m from the roof ridge of the room - when laying it vertically. In places where exhaust pipes pass through a wall or roof that can burn, it is planned to leave a gap between the pipes and the structure of the room at least 15 cm, and wrap the pipe in these places with non-combustible material.

The electrical distribution board of the drilling mud cleaning and degassing unit is planned to be installed in an intensively ventilated place outside the degasser installation block, and ventilation windows are also provided in the roof and cladding of the block walls.

Illumination of the unit for cleaning and degassing drilling mud and preventers is provided with explosion-proof lamps.

Conclusions for the section

The work provides all the necessary life safety measures.

SECTION 5 SUBSOIL AND ENVIRONMENTAL PROTECTION

In accordance with the fundamentals of subsoil legislation, the basics of water legislation and the water code, the current regulation on Gosgortechnadzor, to strengthen nature protection and improve the use of natural resources, prospecting and exploration, drilling and development of oil fields should be carried out with full and strict observance of measures for the protection of subsoil and the environment.

The main requirements for the protection of subsoil for the prospecting and exploration of oil fields are state control over the rational use and protection of subsoil, (as well as the establishment of the procedure for its implementation), compliance with the standards approved in the established manner, regulating the conditions of subsoil, atmospheric air, lands, forests, water

Subsoil protection provides for the implementation of a set of measures aimed at preventing oil losses in the subsoil due to poor quality of wells, violations of the technology of oil deposits and well operation, leading to premature watering or degassing of reservoirs, fluid flow between productive and adjacent horizons, destruction of oil-containing rocks, casing and cement behind it.

Environmental protection envisages measures aimed at ensuring the safety of settlements, rational use of land and water, prevention of pollution of surface and ground waters, the air basin, preservation of forests, nature reserves.

The main requirements for environmental protection during the operation of wells are the selection of downhole and surface equipment and the establishment of optimal modes of its operation.

In fulfillment of the specified requirements for the protection of subsoil and the environment during the drilling of project wells, measures must be taken to ensure:

a) prevention of open flowing, decanter formation, absorption of drilling fluid, collapse of the walls of wells and interstratal flows of oil, water and gases in the process of wiring, development and their further operation;

b) reliable isolation in wells of oil-bearing, gas-bearing and water-bearing strata throughout the section;

c) tightness of all technical and casing strings, lowered into the well, their high-quality cementing;

d) prevention of deterioration of reservoir properties of productive strata, preservation of their natural state during opening, consolidation and development.

Perforation and torpedoing of wells must be carried out in strict compliance with the current instructions. After the completion of drilling the well and perforating the string, to prevent a decrease in permeability and the bottomhole zone due to prolonged exposure to water or mud, the well should be developed in the shortest possible time.

If there is a danger of interstratal flows of oil, gas and water, it is not allowed to take measures to intensify the inflows of oil and gas.

When testing wells, development products should be collected in closed containers.

The transportation of auxiliary materials and solutions injected into the oil reservoir should be carried out in closed containers or containers, excluding their leakage.

If oil spills on the surface of the earth or enters a water body as a result of an oil and gas outburst, open flowing of a well or a pipeline accident, it is necessary to inform the authorities exercising state control over the state of water bodies, no later than 3 hours from the moment of detection, stop taking surface and groundwater for drinking water supply and take measures to prevent further spread of pollution.

Oil spilled from the surface of the object must be localized, collected by technical means and methods that are harmless to the inhabitants of water bodies and do not have a harmful effect on the conditions of sanitary water supply, and sent to oil treatment plants or treatment facilities.

On a contaminated plot of land, the collection or neutralization of pollution should be carried out, followed by land reclamation in accordance with GOST 17.5.3.04-83. If the embankment and waterproofing of the sections are violated, they must be restored.

A significant plot of land is temporarily taken away for the construction of a well. After the completion of drilling and testing of the well, most of the land is to be returned to the land user in a reclaimed form. Therefore, by the beginning of construction and installation work, it is necessary to remove the working layer and store it on a separate site, and after the end of drilling, use the removed working layer to restore the fertility of this area.

The main sources of environmental pollution during drilling are flushing fluid and reagents that are used to regulate properties; particles of rocks or blowouts from the well of formation fluids and drilling mud during gas showings; when mastering and testing; remnants of grouting solutions.

Minimizing environmental pollution while drilling is possible only through complex problem solving. To do this, it is necessary to use metal or concrete vats to provide flushing fluids, reagents, oil and petroleum products, and to collect and temporarily store all cuttings, reservoir and drilling wastewater (BSW), earthen pits with a sufficiently high and reliable embankment, which cannot be destroyed by storm water. The bottom and walls of earthen barns must have good waterproofing so that liquids and chemicals that are stored cannot penetrate into groundwater horizons and natural water bodies. Drainage ditches are to be built around the rig to remove DWW and spilled drilling fluid into a sump.

During drilling operations, a large amount of wastewater is generated. It is recommended that they be cleaned and reused.

Combustible gases that are released during degassing of the drilling fluid or during the development, testing of the well are burned in a special torch, which is installed no closer than 100 m from the well.

If the gas contains H_2S, then simply burning it is not enough, since when H_2S is burned, sulfur oxides that are heavier than the air are formed and form a very toxic sulfuric acid with moisture. Therefore, H_2S and other highly toxic components of formation fluids must be neutralized while in the well or in the cleaning system of the drilling rig.

After completing the drilling of the well, the area to be reclaimed must be freed from drilling mud and cuttings that remained in the vats.

To prevent the penetration of drilling waste and well testing waste, household wastewater, and contaminated rainwater from the drilling site into the soil, a system for the accumulation and storage of drilling waste is organized, which includes:

- the formation, through appropriate planning, of technological sites, their waterproofing and the installation of trays for transporting wastewater to the collection point;
- construction of storage pits, which provide separate collection of drilling waste and well test products by type. It is envisaged to clean drilling wastewater from suspended and oil mixtures to the concentration of substances dissolved in them within the permissible limits in accordance with the "Hygienic standards of the Ministry of Health Healthy Me" 1003-72 and discharge to the area after agreement with the authorities of the sanitary and epidemiological service.

Purified BSV must meet the following requirements:

- pH - 5-9
- mech mixtures - up to 30 mg / l
- content of oil products - up to 50 mg / l.

BSV cleaning is carried out by the method of chemical coagulation using coagulant aluminum sulfate Al_2. A 19% aqueous coagulant solution is prepared at the drilling rig in advance in a 25m3 tank. Mixing of the solution is carried out using a TsA-320M unit, or with compressed air. Treatment of contaminated water is carried out using the pump of the TsA-320M unit by spraying the solution onto the surface of the liquid in the barn. The settling time of the coagulated particles is 12-24 hours, and the compaction time is up to 36 hours. After that, it is necessary to move all the illuminated liquid to the area adjacent to the drilling site with the unit.

The degree of purification for the main contaminating components is equal to:

- on suspended substances - 96%;

- by chemical oxygen demand - 90%;
- for oil and oil products up to 95%.

Conclusions for the section

The measures are represented to prevent accidents and complications as well as to protect mineral resources and the environment.

CONCLUSIONS

In this work, drilling and casing of a production well with a depth of 3785 m at Skorokhodivsky oil and gas field with the development of measures to prevent violations of the integrity of the walls of the well.

In the general part, the following is given: the geographical location, an overview of previously conducted geological and geophysical studies and the geological characteristics of the area of work. The following is described: stratigraphy, tectonics andphysicochemical properties of formation fluids in a given area.

The well will be drilled by a drilling rig Uralmash-3D-76 in four drilling intervals: direction - 426 mm in diameter, conductor - 324 mm in diameter, intermediate string - 245 mm in diameter and for production casing 168/146 mm in diameter, using mud. The drilling process is monitored by the GTI station. Cementing of the well will be carried out using cement mixing machines 2SMN-20, cementing units and a blending tank. Control of the process will be provided by the SKTs-2M cementing control station.

The work provides all the necessary life safety measures. It also considers measures to prevent accidents and complications as well as to protect mineral resources and the environment.

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APPENDIX A

List of the qualification paper materials

No.	Format	Designation	Names	Number of pages	Note
1					
2			Documentation		
3					
4	A4	OGEB.21.05.PZ	Explains the note	79	
5					
6			Demonstration material	1	
7					
8			Graphical material	1	