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ABSTRACT

of the dissertation for the degree of Doctor of Science

DEVELOPMENT OF HIGH EFFICIENT TECHNOLOGY TO PREVENT COMPLICATIONS IN THE “WELL-LAYER” SYSTEM IN DRILLING CONDITIONS

Specialty: 2523.01 - Well drilling technology

Field of science: Technical sciences

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GENERAL CHARACTERISTICS OF THE WORK

Relevance of the topic and degree of development. The successful development of the oil and gas industry in the country depends on the efficiency of geological exploration works for oil and gas exploration, which ensures the growth of hydrocarbon reserves. At the same time, in regions with complex geological conditions, poorly developed infrastructure, remoteness of material and technical bases, the increase in depths and drilling volumes during drilling for exploration and production leads to an increase in the duration of well construction and related costs.

Reducing the time required for the construction of wells and the development of new oil and gas fields depends primarily on the efficiency of drilling and well completion technologies. Mining experience over the past 15-20 years shows that there has been a significant decrease in the efficiency of drilling operations based on traditional drilling technologies. This phenomenon occurs due to the influence of anomalies existing in the rocks and layers that form productive layers located at great depths.

The accumulated scientific research work and drilling experience show that currently the research devoted to the search for successful solutions to the problems of reducing the construction period of wells, performing drilling operations without complications, increasing their efficiency and quality, and ensuring environmental safety are of particular economic importance and relevance.

The Republic of Azerbaijan is among the first in the world in the field of development of offshore fields. Currently, floating drilling rigs are used in drilling wells in the Azerbaijani sector of the Caspian Sea for the development of new oil fields in deep layers of water.

Oil extraction by creating artificial islands on the shelf of the Caspian Sea of Azerbaijan has long been known. Now complex technological complexes and hydrotechnical facilities have been created in the Caspian Sea.

Modern technical means to prevent oil-gas-water manifestations (fountains) during drilling of wells in complex conditions - underwater wellhead blocks, preventors, equipment for detecting oil-gas-water manifestations and issuing alarms - are not capable of ensuring the safety of work in themselves. There must be trained specialists who can prevent the fountain and safely use this equipment and floating drilling rigs. Previously, drills conducted with drilling crews were primarily focused on the quick and correct connection of subsea equipment, preventers, which in the current conditions is undoubtedly one of the initial and main stages of restoring balance in wells. However, this should be followed by operations that restore balance.

Currently, the basis of preparation for the elimination of oil-gas-water phenomena is the timely detection of its initial stage and the requirements for its elimination, as well as the correct and quick implementation of actions to close submersible equipment and preventers on semi-submersible drilling rigs during subsequent operations to restore balance in the well.

In the present work, the causes of the formation of oil-gas-water phenomena are studied, mainly during the equalization of wellhead and formation pressures on semi-submersible drilling rigs. New technical devices to prevent phenomena: preventer equipment for detecting oil-gas-water phenomena and underwater anti-fountain equipment and emergency signal transmission devices often do not ensure safe work.

In addition, the training of specialists in the elimination of phenomena is insufficient. One of the main prophylactic activities is technical safety control. Attention was also paid to these operations in the dissertation work.

Analysis of the known technical literature shows that the characteristics of drilling and construction of oil and gas wells in offshore conditions depend on the anchorage of floating drilling rigs, the limitations of the working platform and other reasons. In these technical literatures, safety requirements for floating drilling rigs and ships have not been analyzed at the proper level. Thus, the organization of work in the offshore zone does not meet modern requirements.

A review of the literature collected to date generally confirms that the analysis of complications that may occur during drilling, combating them and forecasting oil-gas-water manifestations are always relevant. This situation requires the creation of a system that integrates these issues.

Object of the study. Various types of complications in the "well-layer" system in offshore drilling.

Subject of the study. Methods and technologies for detecting, preventing and eliminating complications in offshore drilling.

Purpose of the study.

Increasing the quality and effectiveness of decisions on preventing complications and mainly oil-gas-water manifestations and accidents during drilling of offshore wells in anomalous geological conditions, and improving methods of combating them.

The main objectives of the research:

- analysis of the current state of traditional technologies for the construction of offshore wells;
- investigation of the causes of complications in drilling operations carried out in offshore conditions;
- study of the "cause-effect" relationships of phenomena occurring during drilling;
- methodology for assessing the wellbore, as well as the "well-layer" system conditions and related complications based on complex geophysical and geological-technological information;
- displacements of floating drilling rigs and vessels from the wellhead and support structures under the influence of external forces and their impact on technological processes;
- operational control of the wellbore condition and hydraulic conditions in the well;
- practical solution of technological problems of the quality and efficiency of well construction.

Research methods

The issues raised in the dissertation are determined by the use of mathematical methods (grapho-analytical method, application of computer technology) based on the analysis, systematization and processing of actual mining data, and the use of theoretical and practical data.

At the same time, the dissertation work widely used a mutual comparative analysis of theoretical and practical data.

The main provisions put forward for defense:

• a new methodology for regulating the pressure control in the well-layer system during the drowning (ramming) of the well due to tectonic and technogenic activity;

• an improved methodology for assessing emergency conditions and risks during well drilling;

• new technological approaches to prevent destructive forces arising in the watershed belt and underwater equipment from the influence of external forces arising during drilling with floating rigs at sea;

• a practically significant technology for preventing oil-gas-water manifestations during the separation of a semi-submersible floating drilling rig from the wellhead in case of an accident;

• justification of a new well structure aimed at increasing the quality and technical and economic parameters of wells drilled in deep sea layers in complex geological conditions.

Scientific novelty of the research:

• a systematic methodology for preventing oil-gas-water manifestations in wells based on a complex of geophysical and geological-technological studies has been created, which has resulted in the creation of an approximate diagram of the methodology, as well as a design scheme of a well structure for drilling in the Caspian Sea area based on mining data and experience;

• the mechanism of the formation of baric conditions in the well layer system during drilling and the scientific and practical regularities of their relationship with complications have been determined, which has resulted in the establishment of an algorithm for the analysis of complications and the model for taking measures (the sequence of model implementation) and the theoretical and practical significance of studying the phenomenon of gas separation leading to an increase in pressure in the well;

• a new method for determining the density of the solution that prevents the occurrence of oil-gas-water manifestation and hydraulic fracturing during well drilling has been developed and its effectiveness has been substantiated, whereby research is primarily aimed at developing and improving the scientific basis for regulating the main components of drilling fluids, as well as substantiating their scope of application;

• new technical and technological principles for increasing the stability of the water separator belt on floating drilling rigs have been developed and scientific and technical bases have been developed, whereby schemes of the algorithm for the direction of forces falling on the semi-submersible floating drilling rig and the anchor chains (in some installations, their ropes to the seabed-soil (soil)) have been given;

• a system of technological measures and proposals for improving the technical and economic indicators of drilling offshore wells was created and a significant increase in the final indicators was achieved, thereby demonstrating the feasibility of conducting drilling operations based on the results of the algorithm of the model (mathematical expectation of random variables) for assessing the impact of complications occurring in wells drilled in the Caspian Sea on the overall drilling progress;

• the scientific foundations of the elimination of gas manifestations and open fountains from a semi-submersible floating drilling rig were shown and the corresponding technologies were developed, thereby building a block diagram of the algorithm for carrying out measures to eliminate oil-gas-water manifestations during drilling using experience and mining materials;

• the technological feasibility of identifying technogenic anomalies observed during drilling from floating drilling rigs and eliminating them was determined;

• A new technological approach has been proposed to maintain the formation pressure in the wellbore in equilibrium during drilling from floating rigs, and its feasibility for application in mining conditions has been determined.

Theoretical and practical significance of the research:

• recommendations received as a result of the analysis of mining data, proposals aimed at preventing complications during drilling from modern floating drilling rigs were developed;

• accurate selection of the density of the solution was proposed in terms of preventing the occurrence of wells in the well and hydraulic fracturing in the formation during drilling from floating drilling rigs;

• a complex of system technologies was developed and applied to field practice to increase the quality and efficiency of drilling operations, improve the operational characteristics of wells in various geological and technical conditions, which is shown by the following:

• the results of the industrial application of the developed complex of technologies were aimed at increasing the efficiency and productivity of drilling wells in Azerbaijan, reducing the time required for their commissioning and ecology;

• scientific and methodological approaches and system solutions were developed to improve the technical and economic indicators of drilling by reducing accident risks, costs and increasing the drilling speed for comprehensive improvement of technological processes for the construction of wells in offshore conditions;

• the results of the work will allow for operational prediction of the properties of rocks and natural hydrodynamic systems, the use of geophysical and geological-technological research systems in drilling for the protection of the environment and subsoil, to improve the hydraulic conditions of drilling operations, to regulate the technical condition and hydrodynamic conditions of the well, and to protect the collector properties of productive layers.

Personal contribution of the author. The formulation of the main ideas and tasks in the dissertation work, the identification, systematization and generalization of research objects and directions were carried out with the direct participation of the author.

Approbation of the main results:

• In the annual report of the Department of "Drilling of Oil and Gas Wells" (now "Petroleum Engineering") of the Azerbaijan State Oil Academy (now Azerbaijan State Oil and Industry University) (Baku, 2013-2017);

• At the IV International Scientific and Practical Conference "Khazarneftgazyataq -2000", Baku, 2000;

• Heydar Aliyev and Azerbaijan Education-2013 Republican Science Conference, Baku, 2013;

• Azerbaijan Technical University, Heydar Aliyev and Azerbaijan Education, Republican Science Conference, International Science Conference on Non-Newtonian Systems in the Oil and Gas Sector, Baku, May 7-8, 2013;

• International Scientific Conference "OIL-GAS, OIL REFINING AND PETROCHEMISTRY" dedicated to the 90th anniversary of the Azerbaijan National Petroleum Corporation, Baku, 2010;

• VI International Scientific and Practical Conference "Actual Problems of Science of the XXI Century" in Moscow, Moscow, 30.01.2016;

• XI International Correspondence Conference "Development of Science of the XXI Century" in Kharkov, 14.03.2016;

• International Scientific, Technological and Management Conference in San Diego, California, USA, December, 2016;

• Materials of the VII World Scientific and Practical Conference in Russia, Krasnodar, March 31, 2023;

• Reported at the International Scientific Conference "Energy Locomotive of the Turkic World" dedicated to the 100th anniversary of Heydar Aliyev at ASOIU, October 25-26, 2023.

Published works.

45 scientific works were published on the materials of the dissertation, including 7 articles (Web of Sciense and Scopus), 2 patents, 11 conference materials, 2 monographs, 5 reference books and 8 textbooks.

Name of the organization where the dissertation was performed

The dissertation was performed at the Department of "Petroleum Engineering" of the Azerbaijan State Oil and Industry University.

Structure and volume of the dissertation:

The dissertation consists of an introduction, 5 chapters, conclusions and proposals, a list of 221 used literature, 96 figures, 75 tables and 494 pages with 436 059 characters, including appendices.

The author expresses his deep gratitude and appreciation to the corresponding members of ANAS, Professor Galib Efendiyev, for their constant support and recommendations in the implementation of the dissertation work, for constantly monitoring and monitoring the

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SUMMARY OF THE WORK

The introduction defines the relevance of the research, the purpose of the dissertation work and the main problems of the research, the methods of their solution, the scientific innovations and the practical value of the work, the structure and the scope of the work are justified. The dissertation work consists of five chapters. In the dissertation work, based on mining data and technical literature, the following were analyzed: types of floating drilling rigs and the organization of drilling service; the role of floating drilling rigs in the rapid development of offshore drilling; types of semi-submersible and self-elevating floating drilling rigs, drilling vessels; the causes of the formation of oil-gas-water manifestations and methods of combating them, systems for organizing drilling service; the state of modern drilling technology is analyzed.

The introduction of the type of floating drilling vessel in the elimination of oil-gas-water manifestations is also justified here.

Chapter 1 of the dissertation work considers the issues of assessing the effectiveness of drilling wells from floating drilling rigs using existing drilling technologies in various geological conditions, theoretical and mining data at the technical-technological level, scientific and technical literature, which are the fund works of the "Neftegazelmitedzatlayiha" Institute, the Russian Oil and Gas Institute, patents and documents in the USA, Germany and other leading countries in 2011-2020. All of this is mainly relevant to the topic of the dissertation, which is related to the complications arising in the "well-layer" system under study.

An analysis of the known technical literature shows that the characteristics of drilling oil and gas wells in offshore conditions and their construction depend on the anchoring of floating drilling rigs, the limitations of the working platform and other reasons. In these technical literatures, safety requirements for floating drilling rigs and ships are analyzed at the appropriate level. However, the organization of work in the offshore zone does not meet modern requirements.

In the present work, the causes of oil-gas-water phenomena are studied, mainly during the equalization of wellhead and formation pressures on semi-submersible floating drilling rigs. New technical devices to prevent phenomena: preventer equipment, equipment for determining oil-gas-water phenomena and devices for transmitting emergency signals often do not ensure safe work.

In addition, the training of specialists in eliminating phenomena is insufficient. One of the main prophylactic works is technical safety control. Attention was also paid to these operations in the dissertation work.

A review of the literature collected to date generally confirms that the analysis of complications that may occur during drilling, combating them and forecasting various complications are always relevant. This situation requires the creation of a system that includes these issues.

Main methodological principles and objectives of the study.

Currently, the oil industry of Azerbaijan is developing rapidly. Oil and gas production is increasing, new oil-producing regions are being developed and exploited, oil fields are being developed, metal consumption of installations and devices for oil extraction, accumulation and preparation is increasing, the length of fields and main pipelines for oil transportation is increasing. Along with this, environmental problems arise: the need to improve the technology of exploitation of fields with increased wastewater, drilling waste, oil-gas-water manifestations, hydrogen sulfide-containing products. The issue of protecting floating drilling rigs from corrosion is also on the agenda. Effective means of protection not only increase the service life of equipment and communications, but also increase their operational reliability and, as a result, contribute to solving the problems of environmental protection from accidental leaks of oil, gas and wastewater.

To date, a large number of studies have been devoted to the improvement and development of the theory of preventing metal corrosion of floating drilling rigs, as well as the search and development of new highly effective inhibitors of complex action on the prevention of formation of formations in wells, as well as the establishment of their mechanism of action. It should be borne in mind that in practice, many formations occurring in wells cannot be solved even by using imported chemical reagents in drilling fluids, which entails significant financial and material costs. Scientific and technical developments in complex work carried out at universities and research institutes have led to the creation of multifunctional reagents with two, three or more functions. Despite their high multifunctional qualities, many new reagents remain unclaimed due to the complexity of the processes for producing drilling fluids, the high financial costs of producing target products, and only individual reagents and waste are used as a basis for drilling fluids.

As can be seen from Diagram 1, various methods, tools, techniques and principles are used at each level.

The following can serve as elements of this system: the object of research; research objectives, methods and means of their solution. The analysis of studies devoted to the problem under consideration given in the previous section allowed us to formulate the main research objectives:

-the methodology of the system of methods for preventing oil-gas-water manifestations and open fountains in wells based on a complex of geophysical and geological-technological studies of wells was proposed;

-the mechanism of the formation of baric conditions in the well-layer system during drilling and their relationship with complications was determined;

-a method for determining the density of the solution that prevents the manifestation and hydraulic fracturing during well drilling was proposed;

-the technical and technological principles of increasing the stability of the water-separating belt in floating drilling rigs were scientifically substantiated;

- technological measures and proposals for increasing the technical and economic indicators of drilling offshore wells have been developed and substantiated;

- the scientific basis for the elimination of gas manifestations and open fountains from semi-submersible floating drilling rigs has been shown and the corresponding technologies have been developed;
- the possibility of identifying technogenic anomalies observed during drilling from floating drilling rigs and eliminating them has been shown.

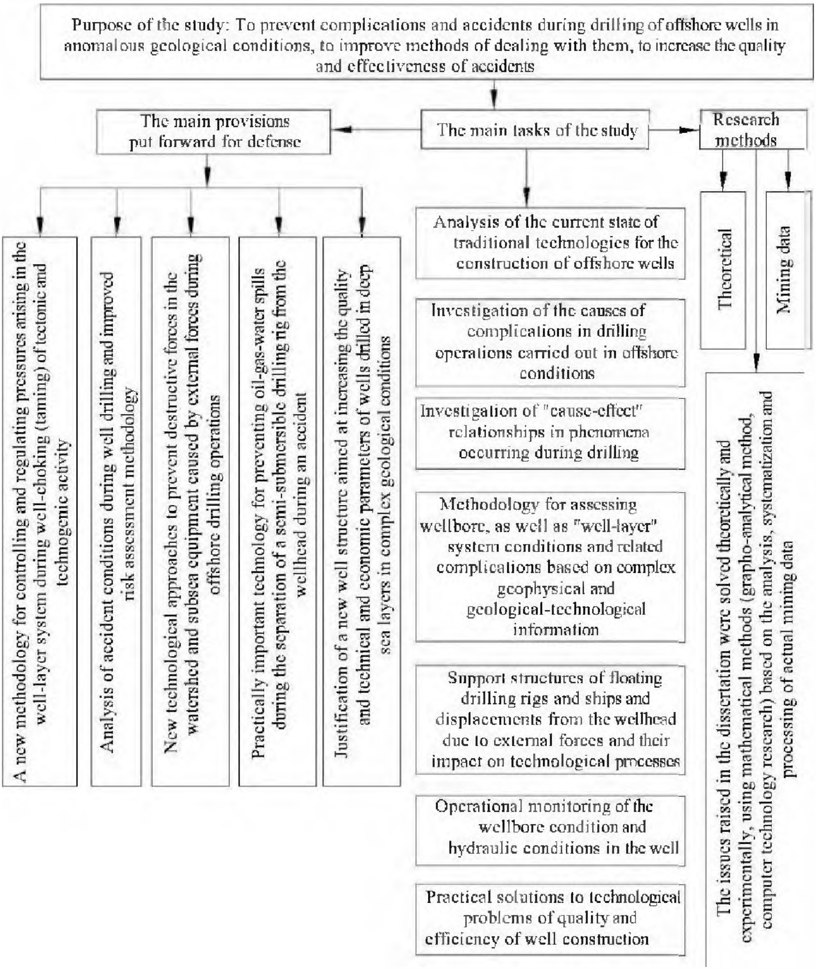

Diagram 1. Methodological elements of research

Table 1

Characteristics affecting offshore drilling with a semi-submersible drilling rig

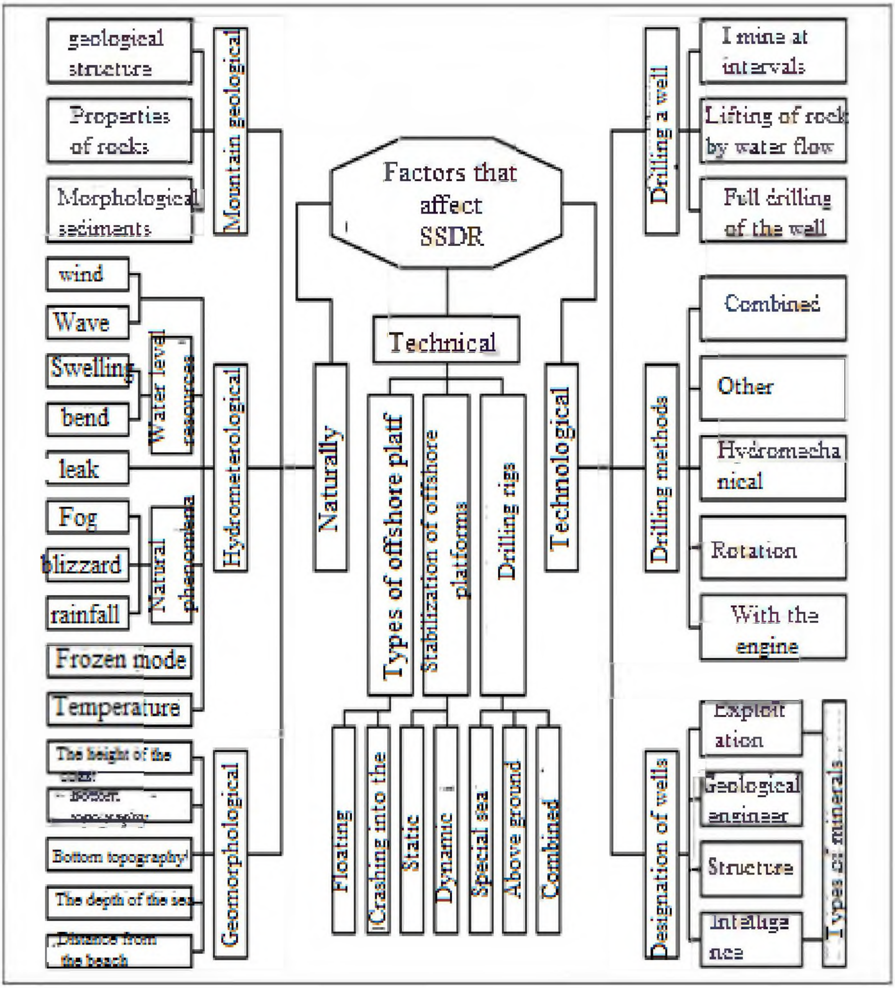

Table 2

Analysis of the main complications arising during the control of manifestations using mining signs and the algorithm for taking measures

Complications	Signs						Analysis		Downhole pres-sure
	Pressure in the circuit	Throttle pressure	Solution level in tanks	Productivity		When the throttle is fully open-ed	Pressure drop		
				On the way out	At the entrance		On the drill string	beltless	
Pollution of the passage of the hydromonitor ax	Δ						Δ		
Loss in ax passes	∇						∇		
Drilling pipe washing	∇	Δ					∇	Δ	Δ
Full throttle grip	Δ	Δ	∇		∇			Δ	Δ
Gradual grip of the throttle	Δ	Δ				Δ		Δ	Δ
Complete loss of solution circulation	∇	∇	∇		∇			∇	∇
Throttle flush	∇	∇				∇		∇	∇

Note: ▽-sudden decrease; ∇-decrease Δ-sudden increase; Δ-rise

Thus, the initial correct approach to maintaining the formation pressure in the wellbore in a state of equilibrium during drilling from floating rigs was considered to be the interpretation of the drilling fluid density from the mining data.

Naturally, not all of the tasks listed in the problem under consideration are of equal importance. The level of scientific research is mainly determined by how new and relevant the problems that scientists are working on are. The selection and formulation of such problems is determined by a number of objective and subjective conditions. However, any scientific problem differs from a simple question in that the answer to it cannot be found by transforming existing information. The solution of the problem always implies going beyond what is known, and therefore it is impossible to find it based on some ready-made rules and methods known in advance. This does not exclude the possibility and expediency of planning the study, as well as the use of some auxiliary tools and methods for solving specific problems of science and practice. The diagram shows the research tasks, the solution of which involves the use of methods implemented at two levels - empirical and theoretical.

The empirical methods of the current study (empirical level) are associated with the receipt and initial processing of primary data on drilling wells with floating drilling rigs, including geological, technical and technological data, properties of drilling fluids, etc. This also includes the design, planning and conduct of experimental methodological studies, processing of results, establishment of relevant dependencies, and their statistical evaluation.

The study of the properties of drilling fluids and the relationship between various parameters for taming oil gas-water wells is inextricably linked with the relevant observations, measurements, experiments and comparisons, and error assessment.

Despite the differences between the two methods of practical and theoretical research, they are closely related to each other and are the boundary condition between them.

Empirical research, which reveals new information through observations and experiments, stimulates theoretical research and sets new, more complex tasks for it.

In turn, theoretical knowledge, developing and concretizing its new content on the basis of empirical data, opens up new, broader horizons for empirical knowledge, directs and directs it to the search for new facts, and contributes to the improvement of its methods and tools.

The dimensions of the structural structure of hydraulic and floating structures depend on the value of its distance from the wellhead. The greater the allowable distances, the greater the flexibility of the equipment located on the seabed should be.

Before learning about oil-gas-water phenomena (OGW) it is necessary to review the laws of hydrostatics in the well-reservoir system.

Figure 1 shows the pressure change in the well during the rise of gas. It can be seen that as the gas bubble, the pressure inside of which is constant and equal to Play, approaches the wellhead, the pressure in the well increases. The most dangerous moment is when the gas reaches the wellhead.

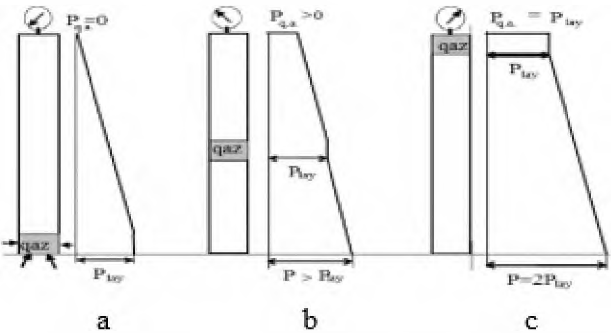

Fig. 1. Scheme of pressure changes in a sealed well with gas from the opened formation rising to the surface through the wellbore

At this time, the pressure is maximum at all points of the well, and as a result, it turns out that a very dangerous situation arises in terms of the collapse of the casing as a result of the internal action of the simple gravitational force of a small gas bubble, the dimensions of which do not correspond to the dimensions of the well. Therefore, it is necessary to be very careful when closing the wellhead during oil and gas manifestations. It is necessary to carefully monitor the pressure at the wellhead, open the valve in time ("release" it from pressure), thereby reducing the pressure at the wellhead, preventing it from exceeding the permissible value.

As a result, it is possible to take into account the stationary state of the upper and lower parts of the liquid. By applying the basic hydrostatic equations to the indicated parts of the fluid in a stationary state in the well, the depth indicator (negative for the upper part and positive for the lower) should be taken from the boundaries between the fluid and the gas.

During the rise of a gas bubble entering the well from the formation, three states of the fluid state in a sealed well can be considered:

- the gas does not dissolve in the fluid;
- the process of gas rise occurs under isothermal conditions;
- the well is sealed.

A certain volume of gas from the formation naturally moves upward along the wellbore (rise) under the influence of the Archimedean force. When gas moves from the formation to the well and through the wellbore to the wellhead, this process is called gas emergence, which can lead to an open gas fountain. In such cases, the well is closed with a preventer, after which equilibrium is created in the well at rest, and thus it will be possible to apply the laws of hydrostatics.

Three equilibrium states of the gas, when the gas bubble is located, are determined:

When analyzing the rise of a gas bubble in a sealed well, we considered the liquid to be completely incompressible and came to the formally correct conclusion that even a very small gas bubble can lead to a catastrophic outcome.

In reality, of course, everything is somewhat different. The fact is that this effect can only be observed if the volumetric deformation of the liquid under the influence of the pressure in the gas bubble is significantly less than the volume of the gas bubble floating in the well. It is known that with an increase in pressure of 10 MPa, the volume of the liquid decreases by 0.5%. Now, suppose that gas from a formation with a pressure of 30 MPa enters the well from a depth of 3000 m.

Suppose that the height of the gas column is 10 m, and the gas bubble at the wellhead creates an additional pressure of 30 MPa on the liquid. Under the influence of such pressure, the liquid will be compressed by 1.5%, that is, the liquid level in the well (under the gas bubble) will be "held" at 45 m, which is 4.5 times more than the volume of gas. It is clear that this opportunity for gas expansion will lead to a decrease in pressure in the gas bubble, and equilibrium will occur at pressures much lower than those expected from calculations without taking into account the compressibility of the liquid. It has been established that the frightening limit of the effect of pressure increase described above is observed when the volume of gas at the wellhead and in the well as a whole exceeds 5% of the volume of the well, and it does not matter whether the gas enters immediately or gradually. Therefore, it is necessary to be extremely careful with wells under pressure or in temporary conservation with open gas layers.

For floating drilling rigs (vessels), if the wellhead is less or more, depending on its anchor structure, there will be decreases and increases in the cost of the rig. We will consider the stress arising in the lowered water separator and drilling tool in a semi-submersible floating drilling rig as a result of the rig being separated from the wellhead. In this regard, it has been shown that the external forces acting on the hydraulic equipment placed on the seabed and the laws of motion of floating drilling rigs are of great importance with complex technological measures. According to the studies on a semi-submersible floating drilling rig, the pressure balance of oil-gas-water phenomena was mathematically found by us as follows.

$$P_{st} + gp_m L_b = P_{q.a} + g\rho_m (L_q - L_r) - L_f) + g\rho_f L_f$$

Here, P_{st} -is the pressure in the solution column (standpipe). MPa;

g- is the free fall acceleration, m/sec^2;

L_b – length of the drill pipe, m;

$P_{q.a}$ – wellhead pressure in the annular space, MPa;

ρ_m – density of the drilling fluid, kg/m^3;

Lq – well depth, m;

Lr – length of the riser;

L_f – fluid filling depth, m;

ρ_f – average fluid density in well conditions, kg/m^3.

However, since the wellhead equipment of semi-submersible drilling rigs and drilling vessels is located at the bottom of the sea, the sea depth factor is not taken into account in this formula.

As we know, there are abnormal pressures in most of the wells drilled in the Caspian Sea. Let us look at the occurrence of anomalous pressure in the following scheme (Fig. 2):

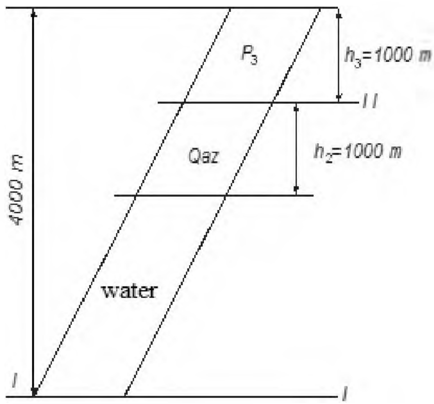

Fig. 2. Scheme of gas rising to the surface in a productive layer

Let us assume that gas and water are located in the productive layer in the sequence shown in the scheme. At the I-I level, the pressure will be P_1=40 MPa. This is the actual value of the pressure.

Now let's calculate the pressure at level II-II:

PII - P1 - P2 -P3

Here, P2 is the pressure of the h1 column of the water part; P3 is the corresponding pressure of the h2 column of the gas part. For the considered case, P2 = 20 MPa; P3 = 0.1 MPa. Thus,

PII = 40-20 -0.1 = 19.9 MPa.

Thus, the pressure of the gas layer located at a depth of 1000 m is 19.9 MPa instead of 10 MPa. This is anomalous pressure. This should be taken into account in oil gas water manifestations due to the complications arising in drilling wells with floating drilling rigs.

Analysis of the given mining data shows that the operation of raising and lowering the tool is as dangerous as drilling, and manifestations can occur at any time.

It is known that manifestations can occur at any time in drilling, for this the hydrostatic pressure created by the drilling fluid must be less than the formation pressure. In this case, the flow of fluid from the formation to the well begins. The diagrams below provide information about the accidents that have occurred.

Hydrostatic pressure has two properties: hydrostatic pressure acts in the normal direction to the surface and is directed into the fluid; the hydrostatic pressure at any point in the fluid is the same in all directions and depends on the coordinates of the point at which it is applied.

The selected methods for taming manifestations are carried out in three mandatory stages.

At the first stage, hydraulic communication is established between any section of the damaged wellbore and the wellhead equipment.

At the second stage, the taming of the well is carried out in a mode calculated with the fluid during the process.

With the interruption of the process of entering the formation fluid into the well, the second stage ends and the transition to the third stage begins.

The third stage aims to remove the drilling fluid and residual formation fluid from the well and inject the solution necessary to control the well phenomenon.

Studies have shown that oil gas water phenomena do not occur suddenly.

However, in some cases, on a semi-submersible drilling rig, on the contrary (on the Shelf-2 drilling rig, 1989), it was not possible to determine the phenomenon with the available detection factors.

The fight against phenomena is effective when they occur early. In order for the initial control to be successful, the above-mentioned stages must be carried out sequentially.

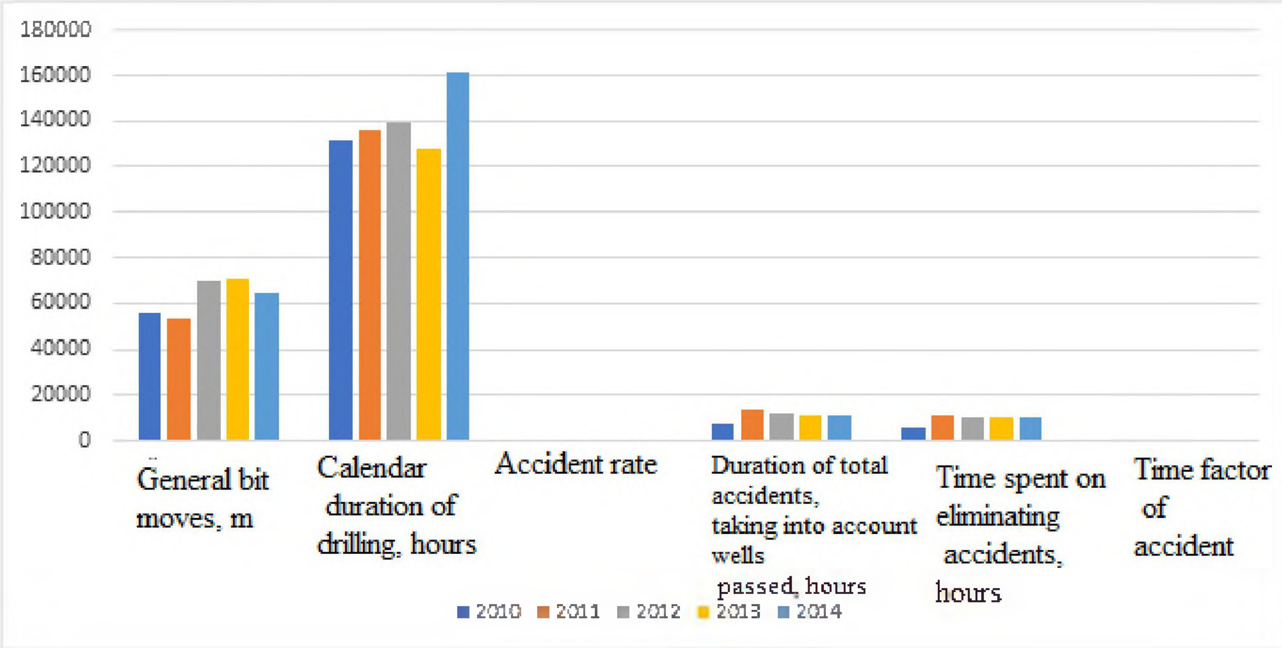

Diagram 2. Accidents in oil and gas wells

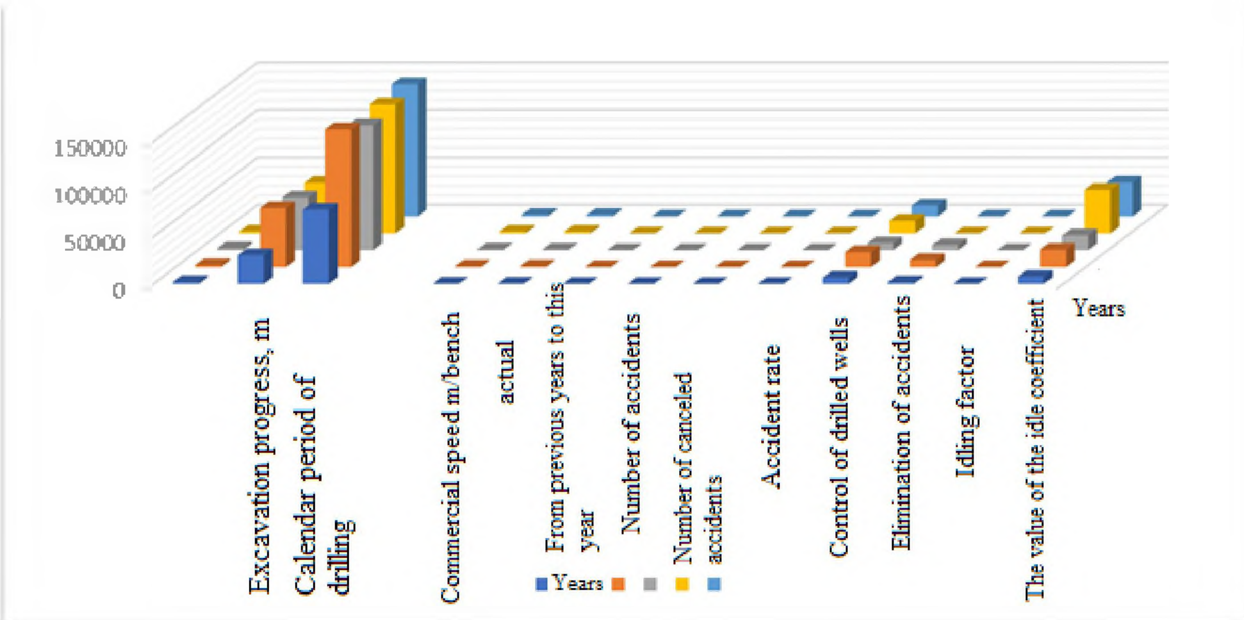

Diagram 3. Accidents in oil and gas wells by total stroke

Therefore, in order to assess the effectiveness of the application of any method, it is necessary to solve the following issues when drawing up a plan and choosing a drilling mode:

1) Determination of the routes for injecting the solution into the well;

2) The volume, density of the drilling fluid, type and number of drilling units must be calculated;

3) The final stage schedule has been drawn up.

The choice of injection routes depends on the specific geological mining conditions and the design of the emergency well, the number of pipes lowered into it, the condition of the wellhead and the pressure (forced) lowering of the pipelines.

Until now, little attention has been paid to theoretical and experimental studies in this area for wells drilled by semi-submersible floating drilling rigs.That is why attempts are being made to determine the maximum pressure by eliminating the hydrodynamic pressure and oil-gas-water phenomena during various technological operations on semi-submersible floating drilling rigs.

It should be noted that the hydrodynamic pressure depends on the length and diameter of the choke line in the solution circulation system, the curved conductors of the choke line in the preventer itself, the clay crust deposited on the inner diameter of the choke line during long-term operation, etc.

In order to prevent the current situation from becoming more complicated during drilling on semi-submersible floating drilling rigs, let us consider the change in hydrodynamic pressure when eliminating oil-gas-water phenomena.

Oil-gas-water phenomena, as the initial stage of the emerging open fountain, usually appear in the form of a gas cap that forms in the well under certain conditions.

In the given case, the value of the bottom hole pressure is determined from the following expression, taking into account (Shevtsov)[1]:

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[1] Ibrahimov, R.S. Safarov Y.I. Innovative methods in combating complications and accidents in drilling oil and gas wells. Monograph. / Baku: Turkhan NPB, – 2016. – 326 p.

$$P_{qd} = (\rho_1 L_1 + \rho_1 L_1{}' + \rho_2 L_2)g + P'_{sür} + P''_{sür} + P'''_{sür} + P_{ti} + P_q + P_{ht} + P_{qa}$$

Here, ρ_1– density of the working drilling fluid, kg/m^3,

ρ_2– density of the drilling fluid after weighting, kg/m^3,

$L_1, L_1{}'$ - height of the drilling fluid column above and below the gas pack, m;

L_2 – height of the weighted drilling fluid column, m; g – free fall velocity, m/s^2,

$P'_{sür}, P''_{sür}, P'''_{sür}, P_{ti}$ – respectively, $L_1, L_1{}'$, L_2 - frictional pressure losses during the movement of drilling fluid column elements, MPa,

P_q - gas column pressure, MPa,

P_{ht}– hydrodynamic pressure, MPa,

P_{qa}– wellhead pressure, MPa.

Since the value of hydrodynamic pressure depends on the length of the drill string, in the event of an emergency separation in semi-submersible floating drilling rigs (the preventer is located on the seabed), we do not take into account the distance of the drill string from the rotor to the seabed. During ballasting operations in semi-submersible floating drilling rigs, it is necessary to take into account the eccentricity of the wellhead.

Adverse weather conditions (wind, sea waves, strong underwater currents, etc.) cause changes in hydrodynamic pressure during technological operations. Due to vibrations, tilting and differential of semi-submersible drilling rigs, the hydrodynamic pressure increases or decreases, which is reflected in the manometer. It can be written by the following formula:

$$P = P_{st} - P_{ht} \pm P'_{ht}$$

Where, P_{st} –is the static pressure, MPa,

P'_{ht} - the additional hydrodynamic pressure created as a result of vibrations of semi-submersible drilling rigs, MPa.

In mining conditions, the value of the additional hydrodynamic pressure is determined as follows.

When flushing the well (before lifting the tool), the pressure in the circulation system (Pout) at different flow rates of the drilling fluid is determined using the readings of the installed manometer. Then, when the semi-submersible drilling rigs are lowered (raised) into the well with the flushing, the readings of the manometer are recorded and the pressure (Pset) is determined.

$$P_{mn}\text{-}P_{out}=P_{ht}'$$

This difference characterizes the amount of additional hydrodynamic pressure that occurs during the performance of technological operations on semi-submersible floating drilling rigs.

It is important to know the density of heavy drilling fluid and the maximum pressure at the wellhead during well drowning on semi-submersible floating drilling rigs.

The density of the well drowning fluid can be expressed for semi-submersible floating drilling rigs by the following formula:

$$\rho_{heavy} = \rho + k + \frac{P_{iz.k}}{0{,}103(L - l_{rayzer})}$$

Where, ρ – the density of the washing fluid during the manifestation, kg/m^3,

k – the safety factor, which takes into account the fact that the hydrostatic pressure during the well drowning exceeds the formation pressure; it is taken depending on the depth, overcoming hydraulic fracturing: up to 1500 m – 0.036; 1500-3000m – 0.020; above 3000m – 0.010 is accepted);

$P_{iz.k}$ – excess pressure in the closed state of the submersible equipment on semi-submersible floating drilling rigs, kg/cm^2;

L – well depth or length of the casing, m.

l_{rayzer} – length of the water separator casing (riser), m.

When eliminating oil-gas-water manifestations, the highest pressure in any cross-section of the well occurs when the upper gas boundary approaches it. After passing the upper boundary, the pressure in this section drops sharply. When eliminating oil-gas-water manifestations, the maximum pressure is determined, but for semi-submersible floating drilling rigs, the maximum pressure formula requires a change.

In the case of a closed subsea equipment, that is, when the drilling tool is located on the "shoe" of the casing:

$$P_{ymax} = P_{qd} - (\Delta P_{dr} + \Delta P_{ə})$$

Where, P_{qd}- pressure at the bottom of the well,

P_{dr} – pressure losses along the length of the throttling line,

$P_ə$ - pressure losses in unbent pipeline sections in the subsea preventer equipment.

This formula, obtained by us, is useful for practical calculations, this formula can also be used when preparing a project for well construction.

The analysis shows that after the formation is opened by a well, the natural stress state of the rocks is disturbed. This phenomenon has a significant impact on the indicators characterizing the performance of the well or the formation. This can lead to a decrease in the permeability and porosity of the formation. It is also possible to influence the stress state of the rock by changing the temperature in the wellbore zone.

Table 3

Dependence of wellhead pressure on the volume of injected fluid during choke

SSDP Shelf-3			SSDP Shelf-1		
Washer fluid volume, l/s	Pressure at the wellhead, MPa		Washer fluid volume, l/s	Pressure at the wellhead, MPa	
	On "Well Drowning Methodology"	With the proposed formula		On "Well Drowning Methodology	With the proposed formula
17,5	13,5	10,0	52,0	6,0	5,0
30,0	15,7	12,5	53,0	6,7	5,7
47,5	17,8	14,5	55,7	8,5	6,5
60,5	18,0	15,0	60,5	12,0	7,8
75,5	19,5	16,5	69,5	10,5	10,0
85,5	23,6	18,0	71,8	9,8	9,5

As can be seen from the table 3, the pressure at the wellhead calculated by the proposed formula is lower than the pressure calculated by the “Well Choking Method”. This is explained by the fact that the formula takes into account local resistances and other features.

1. The issue of creating the foundations of a system that allows for a comprehensive classification of offshore drilling rigs, ensuring a complete study of geological conditions, the possibility of

complications, and making technological decisions has not been sufficiently developed.

2. The following is necessary for making the most correct and justified technological decisions:

Table 4

Risks in the well

Risk	Effect, result	Preventive measures/Contingency planning
Well wall collapse	Loss of power, seizure of the instrument	During the tool lift, the well should be filled with mud. Materials that reduce water content should be continuously added to the drilling mud.
Drilling mud absorption	Loss of cycle, occurrence of complication	The density of the drilling fluid should be maintained at 1.25-1.30 g/cm3 at 250-700 m, and 1.35-1.40 g/cm3 at 700-1200 m. If absorption occurs, anti-absorption materials should be used depending on its degree.
Oil and gas manifestation	Well wall collapse, tool retention, fountain	The drilling mud density (1.65-1.72 g/cm3) should be maintained in accordance with the drilling program.

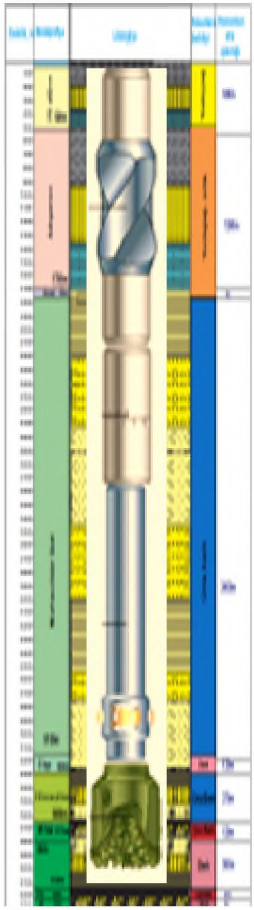

Fig. 3. Drilling tool

Thus, the analysis of the current state of problems related to drilling wells in deep-sea conditions made it possible to determine the following.

Analysis of the geological-physical conditions and characteristics of the field in question and the factors affecting the selection of technical means and effective technology for drilling wells in offshore conditions.

Table 5

Drilling plan

Indicators	Years						
	2009	2010	2011	2012	2013	2014	2015
Total bit travel, m	30381	62439	55852	53487	69662	70392	64360
Calendar duration of drilling, hours	78616	145011	131478	135743	139334	127532	161249
Commercial speedm/machine-month : plan actual	329 369	706 709	726 704	1750 1714	1751 1774	1836 2030	1758 1283
Number of accidents from last year to this year	1	1	0	0	3	2	1
Number of accidents	4	6	3	6	9	5	4
Number of canceled accidents	2	5	3	5	8	5	4
Accident rate	0.131	0.096	0.053	0.112	0.129	0.071	0.062
Total duration of accidents, taking into account drilled wells, hours	6629	15702	7413	13402	11591	10607	11365
Time spent on eliminating accidents, hours	1754	7536	5484	1063.7	997.5	987.2	1007.3
Idle coefficient	0.0238	0.0551	0.042	0.0800	0.0724	0.0779	0.0630

It is known that drilling conditions and technical means, as well as technologies, represent a complex system in which, along with specific factors, there is also a factor such as uncertainty, and therefore the selection of a specific solution is a complex process.

In this regard, it is of interest to obtain information, analyze it and make decisions taking into account the mentioned conditions, which justifies the formulation of research objectives and their expression.

The second chapter deals with the study of accidental complications in wells drilled on the continental shelf of the Caspian Sea, a characteristic analysis of the causes of open fountains occurring on floating drilling rigs, an analysis of accidents occurring in drilling in the Baku and Absheron archipelagos, the development of new methods for detecting oil and gas water manifestations, the causes and time of occurrence of oil and gas manifestations (fountains), the study of gas manifestations when the drilling pipe is lifted from the bottom of the well, the pressure generated in the annular space at the wellhead, the improvement of fountain (discharge, manifestation) preventers and manifold complexes, and experimental methods for preventing manifestations (fountains).

The chapter deals with the statistical analysis of 11 fountains that occurred in SOCAR. These were:

1978 – 2 / wells №59 "Bahar", №44 Palchig pilpilesi);

1979-2 / wells 25 and 73 "Bahar");

1980 2 wells 25a and 52 balka Zhdanova);

1982 2 (well №50, 62 jara Lam);

1983 1 (well №4 Rakushechnaya);

1989 2 (DDSP-2 Guneshli, well 88 Bulla deniz).

9 of the 11 wells were drilled and 2 were in operation (25 Bahar and DDSP-2). The complications (oil-gas-water-manifestations) that occurred since 2010 were considered.

It should be noted that it was possible to close well No. 73 in the Bahar field, while in the remaining ones, the closure of the open fountain did not give positive results. The failure to carry out some preventive work that led to the formation of the open fountain was considered. When conducting research in one of these wells, we see that on August 17, 2013, at about 23:00 at night, a gas fountain occurred at a depth of 5868 m when opening the VIII horizon of the productive-narrow layer in well No. 90 in the "Bulla-deniz" field. An explosion occurred in the well and the gas began to burn. 2.5-3 thousand cubic meters of natural gas were burning per day.

When determining the losses of the solution injected into the well during the well choke, it is necessary to determine the density of the solution and hydraulic losses in the pipes, as well as the resistance to the filtration of the layer. We know that filtration is proportional to the viscosity of the fluid moving according to Darcy's law. Therefore, the well's drowning depends on the density, viscosity, and relationships of the injected fluid. Thus, the transition processes in the well occur more quickly than in the formation.

After testing the production casing in the Bahar field in exploration well No. 59 (with 50 MPa water), the drilling fluid density was switched to 2060 kg/m^3 and the NKB was raised for perforation (in the interval 5200-5198 m). It should be noted that in this interval the drilling fluid density was opened with 2110 kg/m^3. Recommendations were given to prevent such cases from occurring.

Scientific justification of the selection of well structure for deposits located in the Baku archipelago. The structures of the Baku archipelago are characterized by complex and difficult geological conditions due to the conditions for drilling wells. First of all, the difficulty lies in the fact that when drilling Upper Pliocene sediments characterized by anomalously high layer (AHL) and pore (APM) pressures, intensive water manifestations, wellbore narrowing, cavern formation, well wall collapse, etc. occur.

In this regard, a large number of wells were canceled here for technical reasons before reaching the design depth.

In the present work, the calculated pore pressure gradient (MPG) of clays determined by geophysical methods and actual materials of wells drilled in the Baku archipelago areas were used.

Therefore, these should also be taken into account when choosing the well structure and the density of the drilling fluid.

Now, let us look at the selection of the well structure through the complications that occur during the drilling process along the geological section, in addition to geophysical survey work:

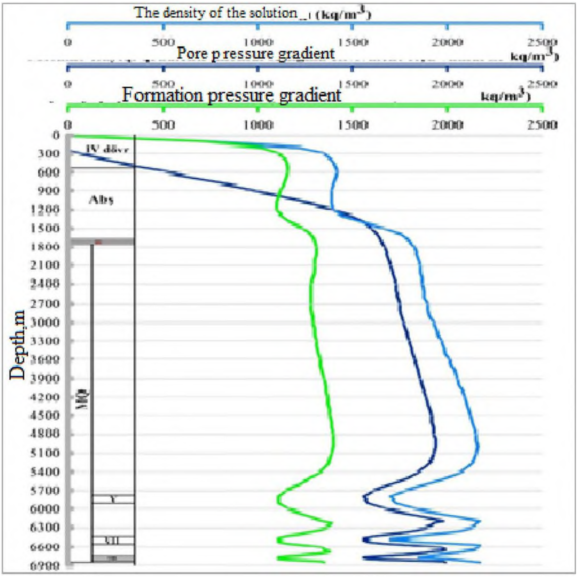

Fig. 4. Scheme of increasing pore pressure gradient

We have extensively analyzed the complications and geological section that occur during the drilling process in the 1200–2800-meter interval of well No. 91 drilled in Block I of the Bulla-Deniz field in the II stage. Therefore, in the next wells to be drilled in this block, the 473.1 mm casing should not be lowered to a depth of 2800 meters, but after entering the productive layer sediments (Surakhani layer) for 200 meters, and in connection with the specification of the depth of lowering of the next casing with a diameter of 339.7 mm relative to the ceiling of the V horizon, as a result of the re-analysis of the drilling conditions of the wells drilled in this block, it is determined that in wells No. 33, 55, 58, 89 and 91, the casings were lowered to different depths, not 50 m above the ceiling of the V horizon, as envisaged in the well design.

Our purpose in drawing this conclusion is that the complications that occurred in the wells we indicated were not taken into account when designing the next wells.

Taking into account the analysis of geological and geophysical surveys conducted by us in the fields located in the Baku archipelago, the analysis of geological complications that occurred during drilling and drilling, the lithological composition of the geological section, and also the depth, it was proposed to take into account the stratigraphic section when choosing the well structure.

Based on mining data and experience, a design scheme of the well structure predicted to be drilled in the Bulla-Deniz area was proposed.

In order to assess the impact of complications occurring in wells drilled in the Caspian Sea on the overall drilling progress, a correlation dependence was established between them.

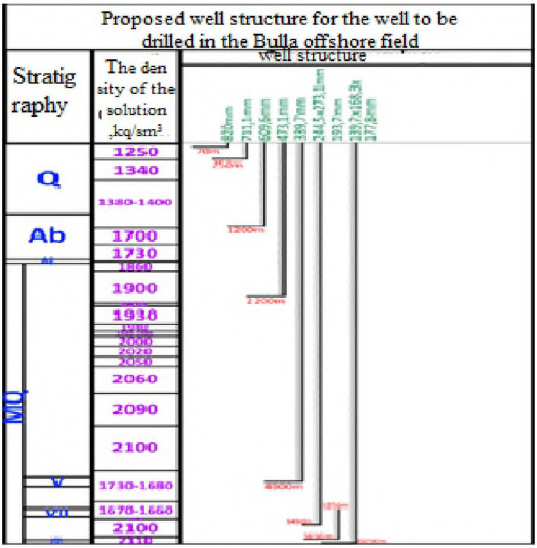

Fig. 5. Well structure predicted to be drilled in the Bulla-Deniz area

The obtained values of the elasticity coefficients basically indicate that there is the following relationship between the overall drilling progress and complications:

1. A 1% increase in the lost drilling progress during the NGST leads to a 2.06% decrease in the overall drilling progress;

2. A 1% increase in the lost drilling progress during tool breakage leads to a 1.98% decrease in the overall drilling progress;

3. A 1% increase in the lost drilling progress during the absorption of the solution leads to a 0.08% decrease in the overall drilling progress.

Based on all this, the following conclusions can be made:

In order to assess the impact of complications occurring in wells drilled in the Caspian Sea on the overall drilling progress, it would be advisable to conduct drilling operations based on the results of an algorithmic model (mathematical expectation of random variables).

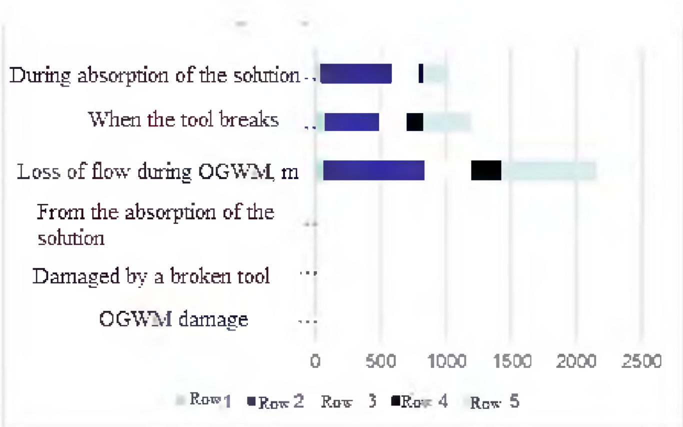

Diagram 4. Number of lost drilling runs during complications

First, it is necessary to implement innovative measures on the indicators of lost drilling progress during oil-gas-water manifestations, in the second stage, innovative measures on the indicators of lost drilling progress during tool breakage, and in the third stage, innovative measures on the lost drilling progress during fluid absorption.

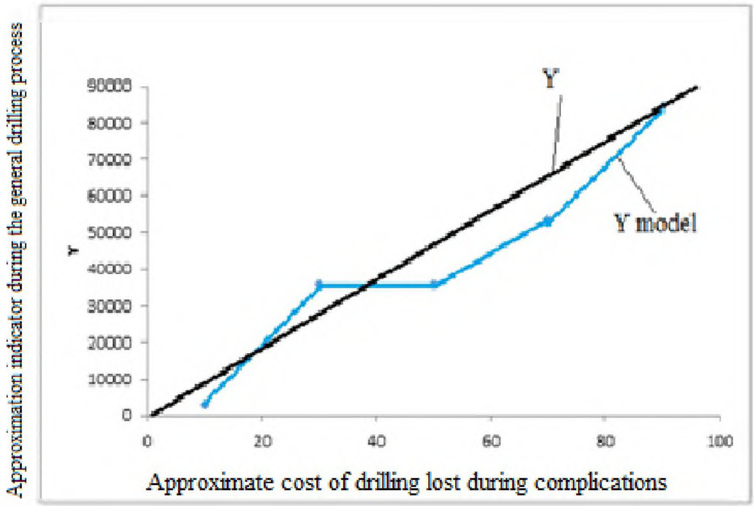

Fig. 6. Dependence between overall drilling progress and complications

The case of an emergency separation of a semi-submersible drilling rig was considered (Fig.7).

An emergency separation of a semi-submersible drilling rig occurs when the tilt and differential of the rig, as well as its horizontal movement relative to the well axis, due to waves caused by a storm at sea, exceeds ±5, but when the distance of the rig from the wellhead increases by more than ±5-6, the semi-submersible drilling rig is urgently separated from the drilling point[2].

Given the fact that the Caspian Sea experiences stormy weather for about 280 days, emergency separation of the semi-submersible drilling rig from the drilling point is often carried out.

Drilling of oil and gas fields located at the bottom of the Caspian Sea is carried out with a semi-submersible drilling rig at a depth of 3,500-7,500 m. These fields are mainly oil and gas fields.

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[2] Kuliyev R.I., Rza-zade S.A., Ibragimov R.S. Features of well suppression during emergency disconnection of a semi-submersible drilling rig / ANKH. – 1991, No. 5.pp. 27-29

Therefore, when the semi-submersible drilling rig is separated from the drilling point for a long time, gas can accumulate in the preventer block at the wellhead, which can lead to an increase in pressure in the well, which can lead to hydraulic fracturing and the formation of griffons.

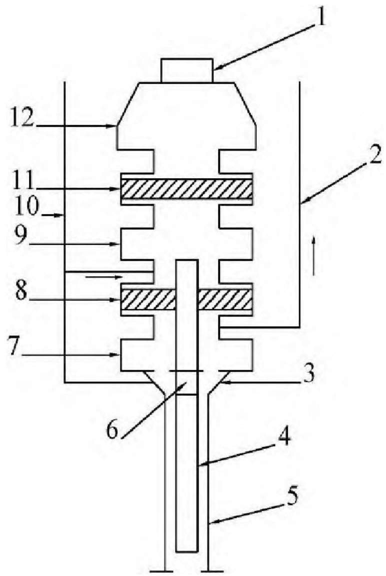

Fig. 7. Diagram of the equipment for preventing the fountain when the drill pipe is in the well

1 – hydraulic coupling (collector connector), 2 – choke line, 3 – pipe head, 4 – drilling tool, 5 – protective belt, 6 – left-right tool (separator), 7 – lower plate preventer, 8, 9 – middle and upper plate preventers, respectively, 10 – throttling line (throttling), 11 – plug-cutter plate preventer, 12 – lower universal preventer

When the semi-submersible drilling rig is connected to the drilling point, the gas accumulated in the preventer block poses a particular danger, since the wellhead is left unattended for a long time.

Therefore, before connecting the semi-submersible floating drilling rig to the wellhead at the drilling point, it is necessary to choke the well, that is, first prevent gas from entering the well or reduce the pressure.

There are two new methods of choke the well: with the drill pipe completely lifted from the wellhead, or with the drill pipe placed in the well.

The second case is of greater interest. In this case, it is proposed to eliminate the phenomenon as follows (Fig. 7).

If the sea swell reaches critical dimensions, they begin to lift the drilling tool.

When it is lifted above the "shoe", they use a special tool (right-left tool - separator) and, using a hydraulic coupling, they seat it on the head of the pipe (or on a plate preventer). Then, they open the upper part of the drill pipe, close the preventers, open the hydraulic coupling and the unit is removed from the drilling point.

After some time, when the stormy weather conditions subside, the wind and waves weaken, the rig approaches the drilling point and, with the help of a hydraulic coupling, it is connected to the underwater part of the riser. At the same time, the choke line and the choke line are connected to the surface part.

If necessary, choke or choke is carried out through the drill pipes until the plate preventer and the cutting preventer open (shown by arrows in Figure 7). However, the method of stepwise choke of the well is used. This method is used if the pressure in the annular space has increased to maximum values.

Then the throttle (closing device at the outlet) is opened and the pressure in the space behind the belt decreases, but at the same time the balance in the well is lost, i.e. pqd<play and the fluid from the formation begins to flow more intensively into the well. Although the maximum pressure value behind the pipe is short-lived (gas quickly leaves the well), after a while condition for flushing and throttling of the well are created (shown by arrows in Fig. 7). This continues until the next pressure increase, which is usually weaker, and then it becomes possible to control the well (i.e., until equilibrium is achieved). After the well is choked, the preventers are opened and the casing is raised and the well is continued to be drilled.

During the complex testing of wells drilled with a semi-floating drilling rig, the prevention of open fountains is considered. Increasing the efficiency of geological exploration work when drilling wells on the continental shelf using a semi-floating drilling rig is considered one of the main reserves for assessing the oil and gas composition during reservoir testing. Reservoir testing on a semi-floating drilling rig is considered one of the most important tasks of the technical team.

Successful well completion depends on the correct assembly of the formation tester complex and the lower part of the drill string, the design of all subsea wellhead equipment, and the correct packer of the formation tester complex.

During the testing of wells with a semi-submersible drilling rig, a layout of the testing tool complex was developed based on the analysis of field data.

Its distinguishing feature from other structures is the installation of the depth shut-off valve above the preventer block (Fig.8).

To carry out work with the test tool complex (SAC), special equipment is used, with the help of which the following work is carried out:

-study of the collector operation in various modes;

-checking the fluid and removing it from the line fluid to the combustion unit;

-injecting fluid into the drill pipes, i.e., drowning the well after processing.

In a semi-floating drilling rig, the space from the preventer blocks (1) to the wellhead (5) is considered especially dangerous. Therefore, a ball valve (4) is additionally connected under the wellhead.

In a semi-floating drilling rig, the assembly of the test tool complex is carried out in the following sequence: tail pipe, test tool complex, heavy drill pipes, drill pipe, special device for the casing head (6), etc.

The results obtained showed that the effective implementation of testing and inspection work on a semi-submersible drilling rig depends on the performance of the submersible wellhead equipment, the correct selection of the location of the formation tester and packer.

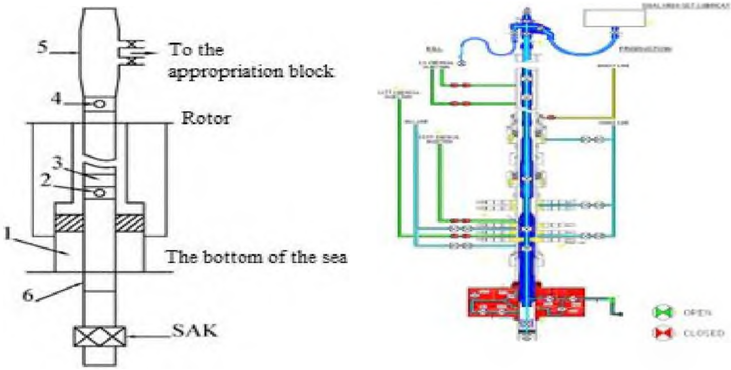

Fig. 8. Scheme of subsea wellhead equipment during well testing on a semi-submersible drilling rig

We proposed to install a progressive tool and a safety conductor (left-right conductor) at the wellhead located in deep layers of water based on the formation tester complex and not to hang on the metal block as a result of the device shaking.

The third chapter studies the maximum pressure value and the reasons for the ingress of formation fluid into the well in the fight against gas-oil-water phenomena in wells drilled by semi-submersible drilling rigs, the development of a program for changing the pressure with gas rise in a closed well, open fountaining on a semi-submersible drilling rig and methods for combating them.

The work also recommends combating fountaining to prevent complications.

The technology of obtaining drilling fluids based on various clays found in Azerbaijani deposits, and the production of Zykh and Garachukhur clays based on oil refining reagents is considered.

With the increase in drilling depth for oil and gas extraction in the Caspian Sea, the use of heat-resistant mineral raw materials, including Zykh and Garachukhur clays, in conditions of mineralization and temperature at the wellhead is one of the urgent issues.

The resistance of Zykh and Karachukhur clay suspensions to the action of salt coagulation is explained by the peculiarity of their crystal structure. In addition, the needle-like shape of the crystals contributes to the formation of such strong corner-to-corner, corner-to-edge and edge-to-edge contacts in the clay-water system that Van der Waals molecular interactions are able to resist the thickening of the layers in the cationic volume and the breakdown of the contacts. Due to the layered structure of the crystals, their external surface is not very large. Coagulated ions adsorbed inside the zeolite-like channels do not have a significant effect on the hydrophilicity and stability of the system.

This section presents the results of laboratory studies of drilling fluids based on Zykh and Karachukhur clay (8%) modified with oil refining copolymer (SONP-1 and polyacrylamide (PAA)).

The following reagents were used as stabilizing additives to SONP-1 and polyacrylamide (PAA) solutions: soda ash, sodium chloride and calcium; alkali, 40% formalin solution and soot (soot). After heating, the drilling mud treated only with hydrolyzed PAA is characterized by an unacceptably high filtration - more than 40 cm^3.

The sequence and time factor were strictly observed when preparing the drilling mud. Measurements of the parameters of the drilling mud at a temperature of 20°C were carried out immediately and in the morning of the next day.

The approximate chemical composition of the drilling mud for preparing the mud from Zykh and Garachukhur clays is given in table 6.

Let's look at the preparation of drilling mud. Zykh and Karachukhur clays of a certain mineralogical composition are soaked in mineralized water and after reaching maximum swelling, calcium soda and saz (sulfur) are added. The polymer is dissolved separately. Formalin alkali is added to the polymer solution and dispersion takes 1 hour. Swelled clay paste is introduced into the polymer solution. Dispersion of the drilling mud lasts 3 hours. Thermal treatment at a temperature of 95°C lasts 4 hours.

Then, a standard method is used to determine the main parameters of the drilling muds: relative viscosity, specific gravity, 30-minute soak, static shear stress for 1 and 10 minutes, filter shell thickness, daily rinsing and pH of the medium. When electrolytes are introduced into the system with polyacrylamide (PAA) in a ratio of

10:1, the conventional viscosity (T) increases to 468 seconds, and the drilling fluid absorption (B) exceeds 40 cm^3, the ultimate static shear stress (SSG), daily rinsing, filter shell thickness (K) are reduced to zero and should be pH=7 (table 6).

The drilling fluid with copolymer (SONP-1) polymer has the following characteristics: T-85 sec, B-30-5 cm^3, SSG for θ-1 and θ-10 minutes and daily rinsing are equal to zero, the shell thickness is 1.2 mm, the pH of the reaction medium is 6 (example 9). Increasing the concentration of salts together with reagents (calcium soda, alkali, formalin, sulfur) makes the system more flexible, the latter contributes to the stabilization and significant improvement of the main parameters of the drilling fluid.

At this time, the viscosity of the drilling fluid decreases (from 160 to 70 seconds), the flow rate decreases to 8 and 10 cm^3, the static shear stress for 1 minute is 3/12 and for 10 minutes – 9/16 mg/cm^2, daily flushing -0/0, the thickness of the clay crust is 3/4 mm, the pH-system is -7/7 (samples 5-15).

Table 6 shows the technological properties of drilling fluids based on Zykh and Karachukhur clays, modified with polyacrylamide (PAA) and a copolymer based on oil refining - SONP-1 (clay 8 wt %, Na_2CO_3 - 25 g/l, pH = 7).

Technological properties of drilling fluids modified with polyacrylamide (PAA) and a copolymer based on oil refining - SONP-1 are given in table 7.The use of a drilling fluid that meets the geological and technical conditions of drilling, increases the service life of equipment, saves expensive chemical reagents, clay powders and weighting agents has led to the successful implementation of this drilling fluid in many wells and its use as one of the decisive factors in drilling.

This subsection discusses the results of testing the properties of bentonite drilling fluids in fresh and salt water in a thermostat device at 112°C.

The purpose of the work is to adjust the filtration against absorption of the solution and increase the salt resistance of low-clay drilling fluids.

Table 6

Approximate chemical composition for preparing mortar from Zykh and Garachukhur clays in drilling

The name of the clay	Components, by weight percent									
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	MnO	Na_2O	K_2O	Losses on drying, etc. components	Hygroscopic water
Zykh clay	52,92	16,48	8,03	4,76	2,38	1,00	1.41	1,07	6,17	5,78
Garachukhur clays	55,03	18,00	7,05	3,76	2,60	0,08	2,08	1,42	7,67	2,31

Table 7

Technological characteristics of drilling fluids

№ example	Polimer	example, T, °S	Salts, q/l		Alkaline, q/l	For ma-lin 40 % p-p)	feel, q	Indicators of the solution			SSG, mq/sm²		Stability, 0 %	Shell thickness K, mm
			$CaCl_2$	NaCl	NaOH			T, sek	γ q/sm³	B, sm³ 30 min	θ_1 min	θ_{10} min		
1	0	20	1	10	0	0	0	32	,13	>40	28	35	18	3
2	0	20		10	0,16	0	0	16	,12	>40	25	28,6	53	5
3	0	100	1	10	0.16	0	0	16	,11	>40	3,2	3,2	36	5
4	PAA	20	1	10	0,16	0,6	0,5	468	,1	>40	0	0	0	0
5	PAA	20	1	10	0,16	0,6	0	60	,09	10.5	1,2	1,6	0	0
6	PAA	20	1	100	0,16	0,6	1,5	160	,09	8	3	9	0	3
7	SONP -1	100	1	100	0,16	0,6	1,5	70	,08	10	12	16	0	4
8	SONP-1	20	1	10	0,16	0,6	1,5	93	,07	5	17	24	0	1
9	SONP-1	100	1	10	0,16	0,6	1,5	85	,10	5	0	0	0	1,2
10	SONP -1	20	10	100	0,16	0,6	1,0	100	,11	6	8,5	10,6	0	2
11	SONP -1	100	10	100	0,16	0,6	1,0	87	,09	6,4	10	11,5	2	1

Sodium bentonite, which is one of the most highly dispersed clay materials and has the ability to quickly swell and easily dissolve in water, was used to prepare the clay emulsion.

Benotonite clay is characterized by a high content of sodium cations, according to the Gedroits nomenclature it is sodium clay.

This table also shows that drilling fluids with SONP-1 polymer are relatively stable compared to PAA medium: the saturation varies in the range of 5.0...9.2 cm^3, the ultimate static shear stress θ_1 and θ_{10} minutes are 8.5...12 and 10.6...14.3 mg/cm^2, the thickness of the clay crust is 1-2 mm, and the pH of the medium is 7 (samples 9-15).

As a result of laboratory studies, it was determined that the most effective additives for improving the main parameters of the drilling fluid based on Zykh and Garachukhur clays are the following: PAA, SONP-1, NaCl, $CaCl_2$, NaOH, 40% formalin solution, soot (soot), applied in the following quantities, respectively: 1; 0.8%; 100; 10; 0.16; 0.6; and 1.5 g/l.

A bentonite drilling fluid based on polymethylacrylamide (PMAA-2) was considered.

The use of a drilling fluid that meets the geological and technical conditions of drilling, increases the service life of the equipment, saves expensive chemical reagents, clay powders and weighting agents has led to the successful implementation of this drilling fluid in many wells and its use as one of the decisive factors in drilling.

This section discusses the results of testing the properties of bentonite drilling fluid in fresh and salt water in a thermostatic device at 112°C.

The purpose of the work is to adjust the filtration against absorption of the solution and increase the salt resistance of low-clay drilling fluids.

The following reagents were used as stabilizing additives to the solution of the polymer polymethylacrylamide (PMAA-2) (1.0…2.3% by weight): SONP 3 (1.5%) calcium soda – 25 g/l, sodium chloride – 100 g/l, calcium hydroxylide (10 g/l) hydrate) – 0.5 g/l, 40% formalin solution.

To prepare the clay emulsion, sodium bentonite was used, which is one of the most highly dispersed clay materials and has the ability to swell quickly and dissolve easily in water. Benotonite clay is characterized by a high content of sodium cations, according to the Gedroits nomenclature it is sodium clay.

The content of highly dispersed particles, which is identical to the viscosity of clay solutions, is significantly higher in a solution made from bentonite clay than in other clays, which gives preference to bentonite clay in terms of the lower filtration capacity of this solution due to the denser packing of particles on the filter surface.

It is known that the stronger the hydration of the ionic shell around clay particles, the less sensitive this clay is to electrolytes. As can be seen, in this regard, bentonite clay is more hydrated, maintains a higher degree of dispersion even in the presence of electrolytes, and produces viscous solutions at relatively low concentrations of various clay properties. The specific properties inherent in bentonites are determined by the structure of the crystal lattices of the minerals included in the composition of these clays. The main mineral of bentonite is montmorillonite, which has the formula:

$$Al2O_3 — 4SiO — n\ H_2O.$$

The drilling fluid is prepared as follows: bentonite of a certain mineralogical composition is soaked in mineralized water and, after reaching maximum swelling, calcium soda is added. The polymer is dissolved separately. At the end of the working day, formalin alkali is added to the polymer solution and left overnight.

The speed of the drilling fluid dispersant varies in the range of 0.5-1.7 m/sec, depending on the dispersed phase and the dispersion medium. The mixing time of the drilling fluid is 15-20 minutes.

The parameters characterizing the properties of the drilling fluid were measured by the generally accepted method: conventional viscosity (T, 100 sec), specific gravity (γ, g/cm^3), flowability (filtration) in 30 minutes (V, cm^3), static shear stress (mg/cm^2) for 1 and 10 minutes (mg/cm^2) (mg/cm^2) for 1 and 10 min. thixotropy coefficient (Kt), structure formation index (Pk, mg/(cm^2.s)) in accordance with the “Methodology for monitoring drilling fluid parameters” on standard laboratory instruments.

From the data in Table 8, it is clear that when applying one weight % of the polymer polymethylolacrylamide (PMAA 2) (based on PMAA copolymer) without mineralization, the flowability of the drilling fluid is 17 cm^3, and when mineralized, it exceeds 35 cm^3 in 30 minutes. Increasing the amount of polymer introduced under mineralization conditions to 2.3% leads to a positive result. In this case, the absorption within 30 minutes is not more than 11 cm^3, the shell thickness is 2 mm, daily dilution is 6%, the SSG concentration in 1 minute is 7 and in 10 minutes is 12 mg/cm^3, the thixotropy coefficient is 1.71, the system is stable and thixotropic. However, increasing the temperature of the reaction medium above 112ºC neutralizes the effect obtained (see Table 8). The system loses its stability and thixotropy, and the absorption increases. The indicators of drilling fluids based on Polymethylolacrylamide (PMAA 2) of different concentrations are shown in Table 8.

It should be noted that the polymer retains its properties at a temperature of 149 ºC. Thus, the polymer (PMAA 2) only at temperatures up to 112ºC can absorb and form a shell.

In the process of drilling wells in geologically complex areas, numerous complications occur when drilling from self-propelled drilling rigs (oil-gas-water manifestation, loss of solution, collapse of the open part of the wellbore, etc.). Technical works of both domestic and foreign authors are devoted to their study.

One of the complications is gas flow during drilling wells from floating drilling rigs. The issues of clarifying the nature, classification of gas manifestations, measures for preventing and eliminating their consequences are considered. However, in order to finally resolve the above issues, a comprehensive analysis of all events occurring during the gas manifestation process in a drilling rig is required.

When strong gas manifestations occur in drilling wells, if it is impossible to drown the well by intensive gravity and degassing of the drilling fluid, the wellhead is hermetically sealed with a preventer block to prevent open fountains. Typically, in complex areas, six preventers are installed at the wellhead, with manometers at their outlet to monitor pressure changes in the choke line[3].

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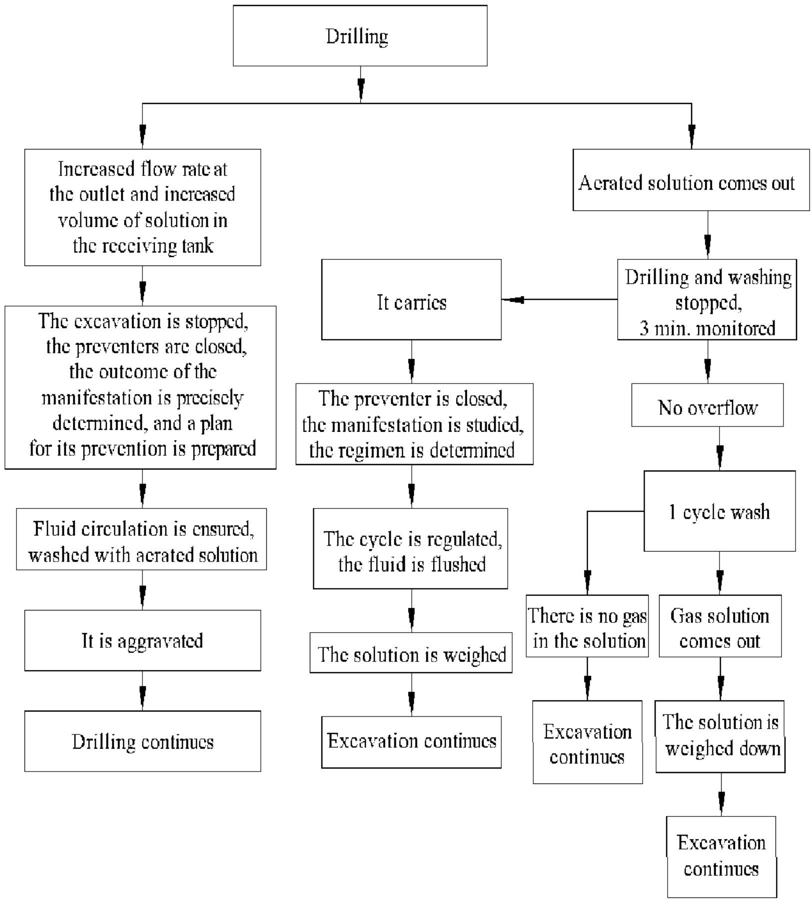
[3] Ibragimov R.S. Investigation of the gas-liquid separation problem in a closed drilling well of self-lifting drilling rigs SOCAR Proceedings Special Issue No.1(2023) 007-011.

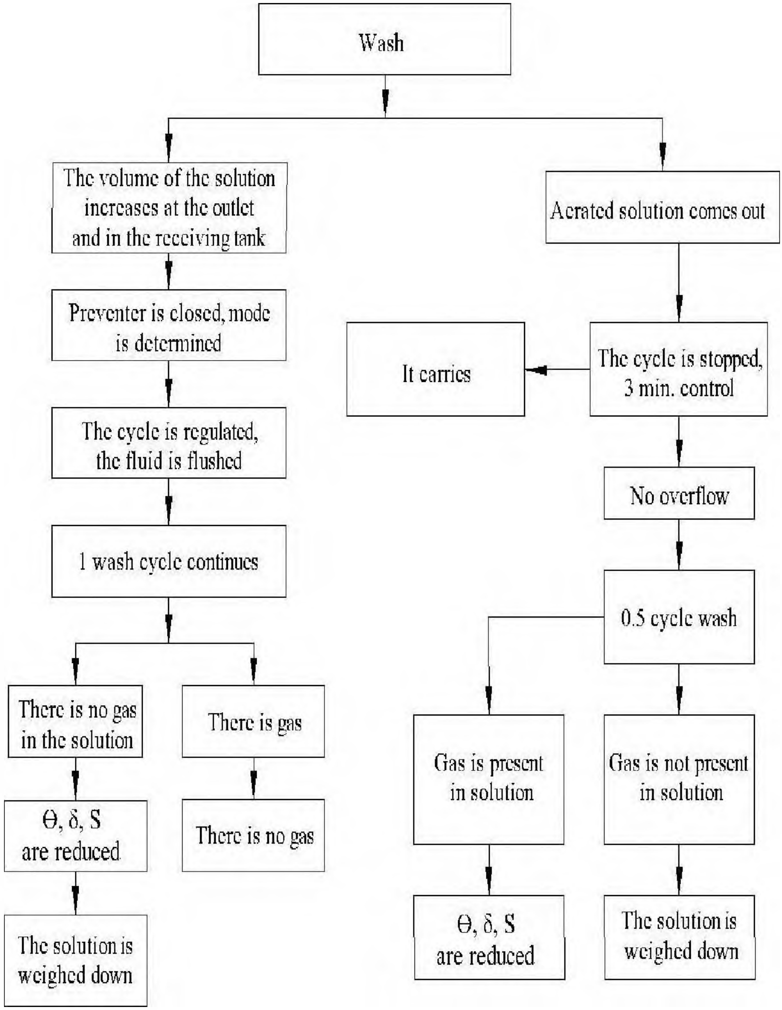
Table 8

Drilling fluid parameters

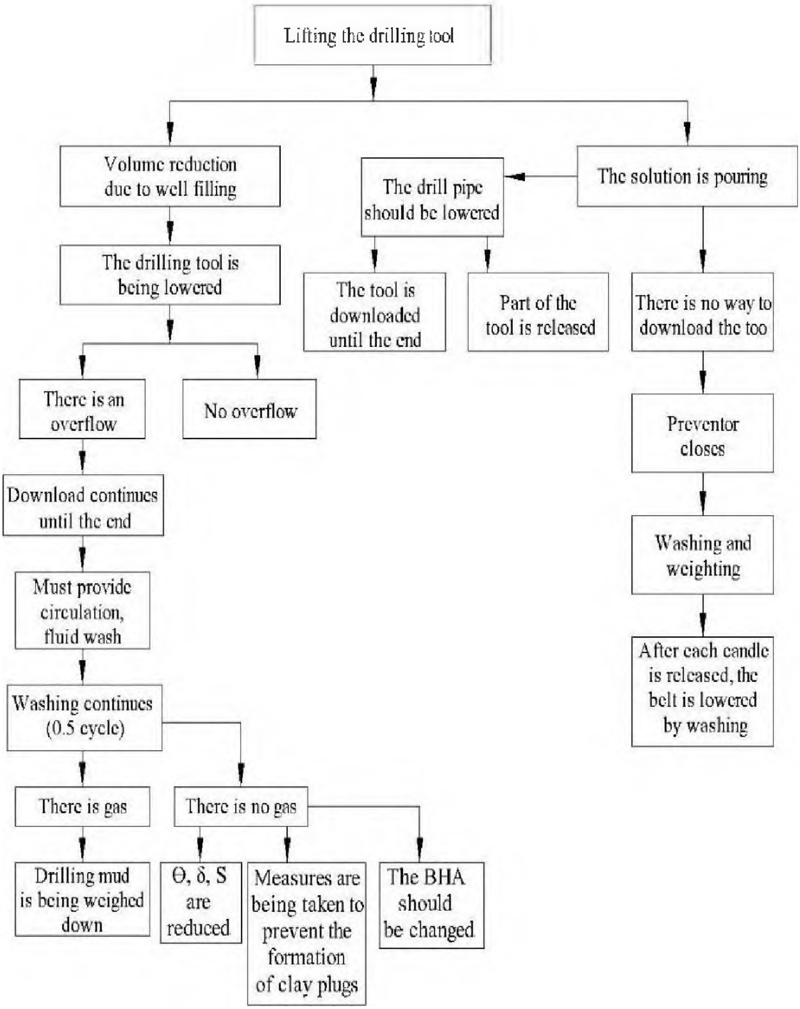
№ example	PMAA 2, %	Salts q/l		T, °S	Drilling fluid indicators						
		NaCl	$CaCl_2$		T, s	γ, q/sm³	Bsm³	SNS 1/10 mq/sm²	K, mm	O, %	K_T
1	1,0	-	-	20	15	1,08	26	31/43	4	25	1,38
2	1,0	-	-	112	16	1,06	17	12/18	2	2	1,50
3	1,0	100	10	112	40	1,02	35	0/0	4	18	0
4	2,3	100	10	112	68	1,08	11	7/12	2	6	1,71
5	2,3	100	10	115	84	1,10	15	18/23	5	28	1
6	2,3	100	10	120	105	1,10	16	21/26	5	30	1,23



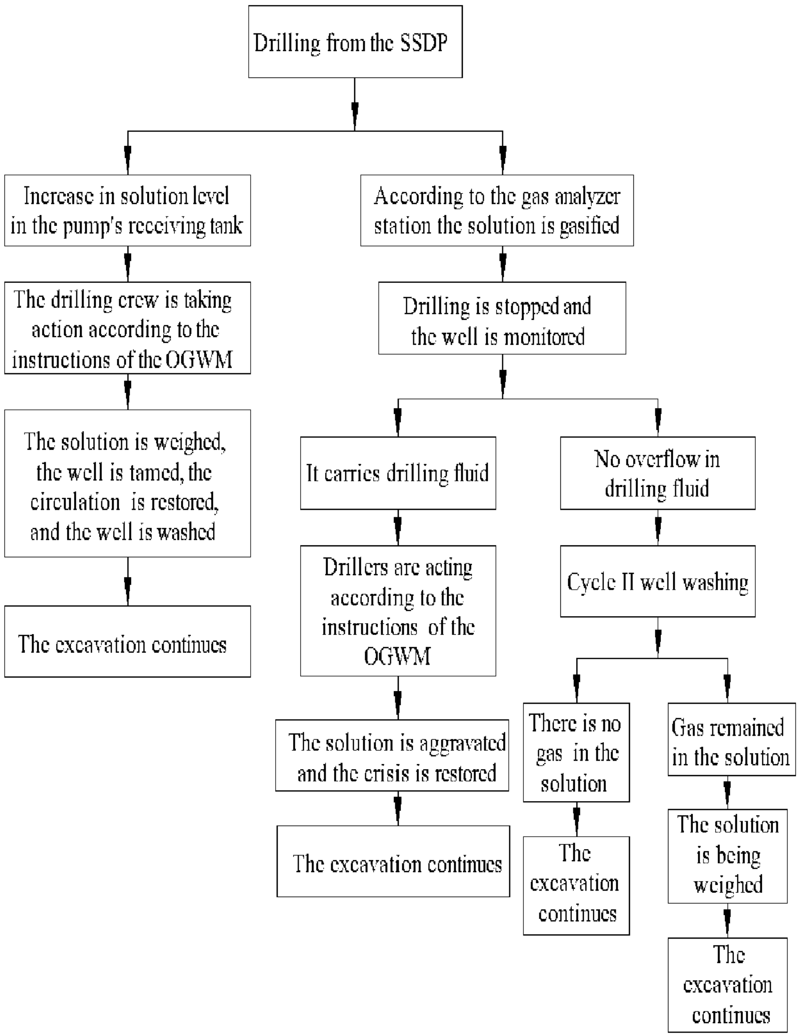
Scheme 1. Block diagram of the algorithm for investigating a manifestation that occurred during excavation using experience and mining materials and taking measures



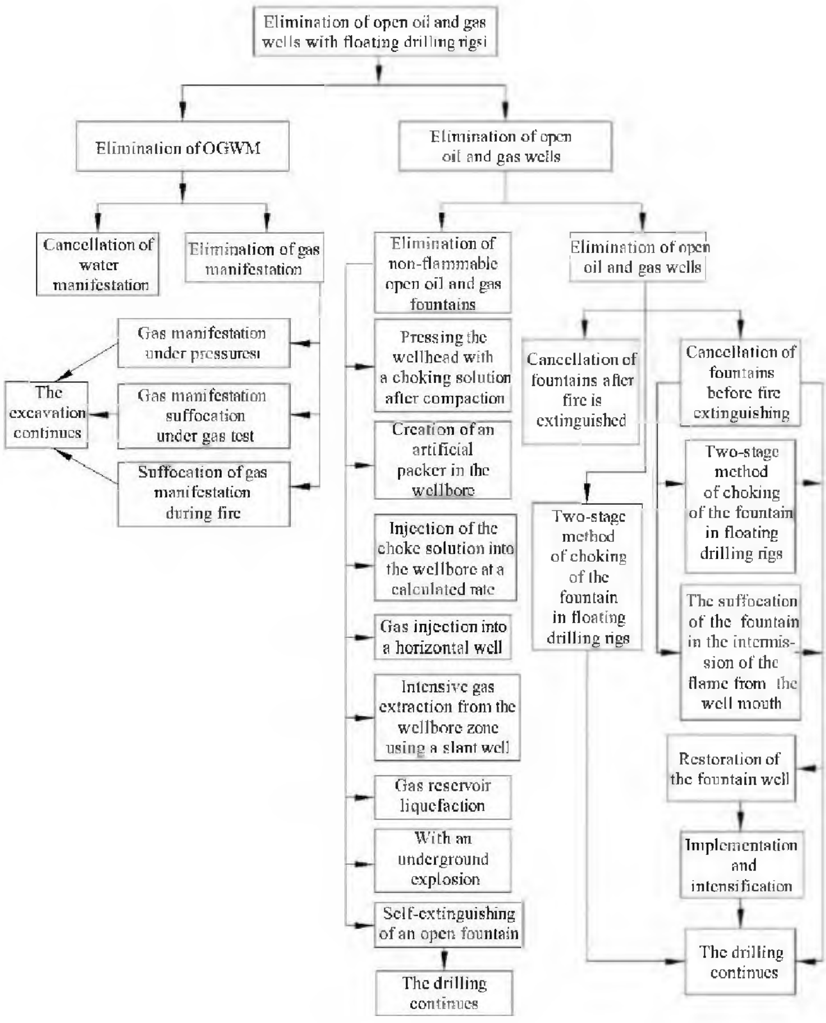
Scheme 2. Block diagram of the algorithm for investigating and taking measures during the washing of a well using experimental and mining materials



Scheme 3. Block diagram of the algorithm for investigating and preventing a manifestation that occurred during the lifting of a tool using experience and mining materials and taking measures



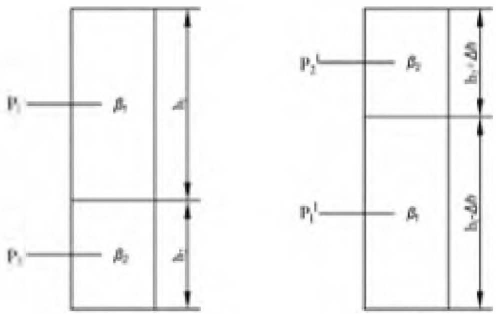
Scheme 4. Block diagram of the algorithm for carrying out measures to eliminate open oil and gas fountains using experimental and mining materials



Scheme 5. Block diagram of the algorithm for carrying out measures to eliminate open oil and gas fountains during drilling using experience and mining materials

Scheme 6. Block diagram of the algorithm for carrying out measures to eliminate open oil and gas fountains during tool lifting using experimental and mining materials

If the wellhead is closed at the beginning of the gas-oil-water phenomenon, then the initial state will be a mixture of gas and drilling fluid. After equilibrium is reached at the bottom of the well, the pressure increase occurs only during the upward movement of gas, so the flow of fluid from the formation to the well stops. Block diagrams of open wells and methods of combating them on a semi-submersible drilling rig.



a b

Fig. 9. Ratio of oil and water volumes in vertical cylinders

It will be assumed that the gas will move towards the wellhead, passing through the drilling fluid, creating a compact gas mixture of any strength. Then the initial pressure at any time will be written as follows: (Fig. 10.b)

Thus, since the gas does not expand when moving up in a closed wellhead, the pressure in the well can be assumed to be the same. Then

$$P_i = P_{q.a_i} + g\rho L_i$$

So, if the gas rises to the wellhead without expanding, then the gas pressure will be determined by the following expression[4]:

$$P_2 = P_{lay} \cdot V_0 / V_2$$

Here, if $V_0 = V_2$, then $P_2 = P_{lay}$.

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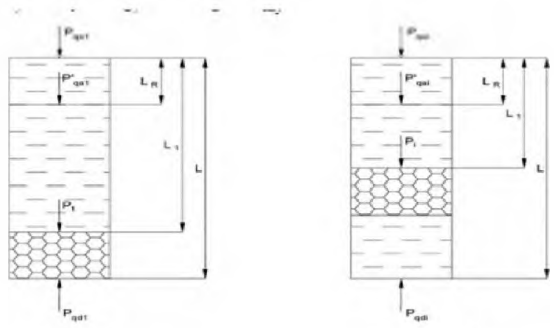
[4] Ibrahimov R.S. Combating accidental complications and oil-gas-water manifestations during drilling of oil and gas wells at sea and on land. Baku: Monography, Azernashr,2017, 324 p.



a b

Fig. 10. Scheme of gas and drilling fluid mixture

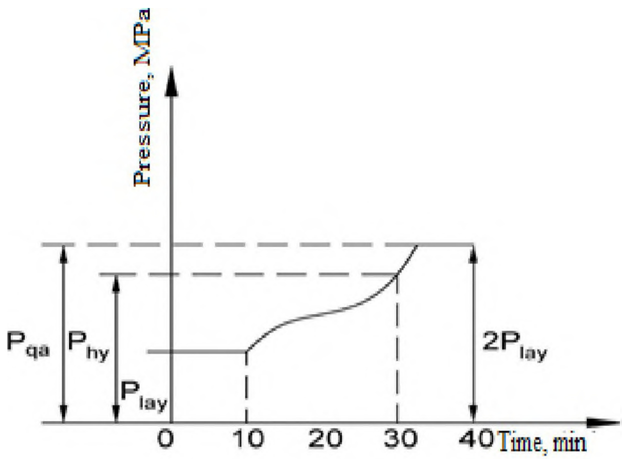


Fig.11. Diagram of pressure on the shoe

As a result, the pressure when the gas pack reaches the wellhead can increase by about two times, i.e. the hydrostatic pressure of the drilling fluid is equal to the formation pressure, and for real conditions, due to the deformation of the casing, the strength of the wellbore rocks, gas compression, etc., the pressure at the bottom of the casing shoe will be slightly less than the hydraulic fracturing pressure of the formation (Fig. 11). Fig. 12 shows the actual pressure curve depending on the location of the gasified pack movement on the Semi-Dala floating drilling rig Shelf-3.

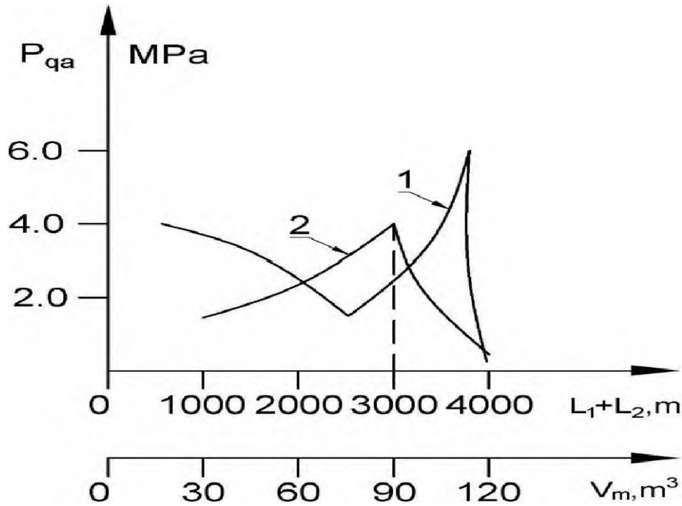


Fig. 12. Actual pressure curve depending on the location of the gasified package movement on the semi-submersible floating drilling rig Shelf-3

The following pictures show well drowning schemes (Fig.13).

Thus, it is clear from the above tables 12 and 13 that when the well is drowned with heavy drilling fluids, if there is a discrepancy between the actual and reported values, well wall shifts (P-effect) occur in the well, which creates a plastic-plastic environment in the drilling fluids. When the well is drowned with heavy drilling fluids, a pressure drop occurs due to the effect of the well wall effect.

The fourth chapter provides a classification of floating drilling rigs and an analysis of their impact on the technological processes carried out in them. This chapter shows the impact of floating drilling rigs on the technical and economic indicators of drilling at sea, an analysis of the systems for organizing the drilling service of floating drilling rigs.

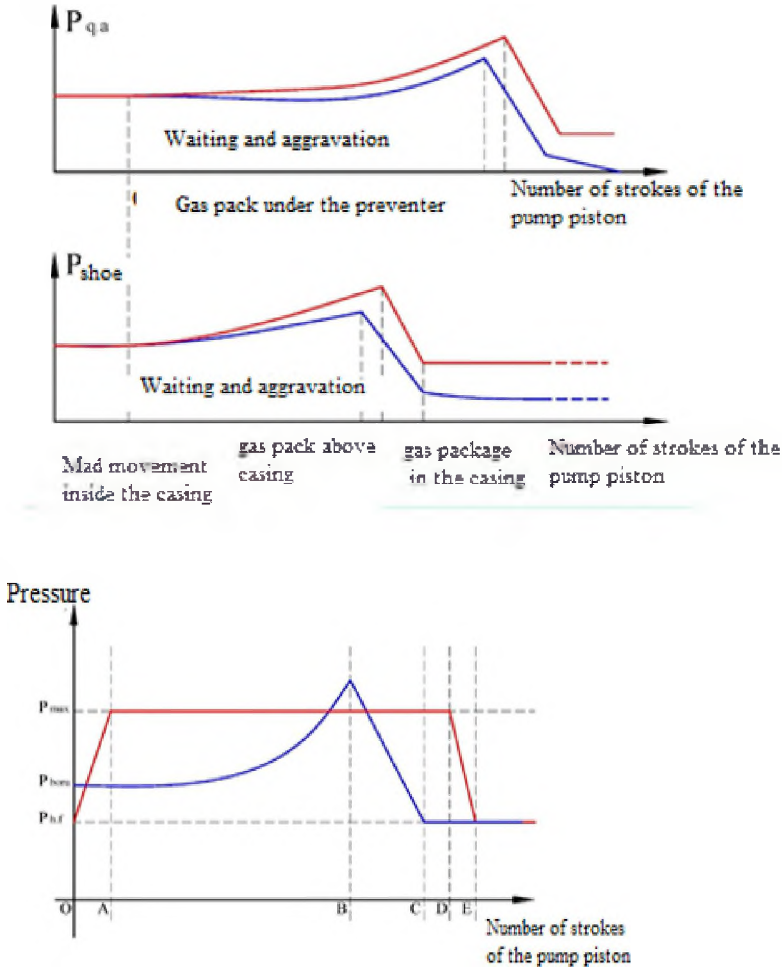


Fig. 13. Scheme of smooth (smooth) well drowning

The following two combinations of loads will be the most unfavorable in the report on deep support foundations of offshore drilling rigs:

a) the simultaneous effect of waves, wind, permanent and temporary loads acting during drilling;

b) simultaneous effect of wave, permanent and temporary loads acting during operation.

In this case, in the first case, the wave load should be taken without taking into account the cover, and in the second case, with its consideration. In addition, since there is a phase shift between the increases in wind and wave speeds, which is not constant in time, and gradually increases during the simultaneous action of wave and wind loads, we reduce the latter by 20% as the least dangerous.

In addition to the compressive forces found to check the stresses arising in the elements of the support block, the bending moments arising in the supports from the wave load were also determined.

When determining the bending moments, the values of the previously found horizontal velocity sums of water particles were used.

In this case, for the first combination of loads (for the first period of drilling), the Pxsr values will be taken without taking into account the coverage of the shafts under consideration with algae and shells, and for the second combination (for the operation period - without taking into account the cover).

To simplify the calculation of the elements of the support block, we assume that the single-span beams are freely supported at the nodes and are loaded with a uniformly distributed load with an intensity equal to the average intensity of the wave pressure falling on the shaft under consideration.

Studies have been conducted to determine the node loads transmitted to the block pillars and stabilizing columns from the wave pressure on the elements of the network and communications in floating structures.

As can be seen, all the shafts of the support block (in sections selected from constructive considerations) are significantly understressed, which can be a guarantee for the long service life of the structure.

In this chapter, the calculation of the general strength of the support structure of the floating drilling rig, permanent vertical loads, support design for vertical loads on a self-propelled floating drilling rig, temporary vertical loads, support design for wave loads, determination of the profile of the reference wave, determination of wave loads, the body (block) of the unit on the crest of the wave, determination of the wave pressure transmitted from the network to the block mast, determination of support reactions and forces due to the effect of wave pressure on the foundation support blocks, checking the stresses in the support block elements, and the technical and technological state of the subsea wellhead equipment complex were theoretically analyzed. The determination of the loads acting on the drill string lowered without a riser on a semi-submersible drilling rig was theoretically substantiated and the importance of their correct installation in terms of the correct selection of tensioning systems on floating drilling rigs was shown.

This chapter shows that support structures are the main leading elements of self-propelled face drilling rigs. Often they determine the rigidity and strength of the structure as a whole. The number of support structures is determined when choosing the type of self-propelled face drilling rigs.

The dissertation shows the lack of precise recommendations for preventing stresses arising in the supports due to the formation of complications in the well.

According to the manufacturing technology, the first type of support (leg) structure prevails. The choice of the support structure is closely related to the type of riser. The support and riser are usually designed together and are called the lifting unit.

When performing existing technical and technological processes, it was found that the most loaded section of the support is located in its upper and lower parts. In the middle part, the support is almost the least loaded.

The multiplicity of structures of the support and nodes does not allow giving a general methodology for their calculation.

To determine the maximum wave load on a floating drilling rig, we place the rig in the most unfavorable position relative to the wave profile. To do this, we connect the vertical axis of one of the blocks with the crest of the reporting wave. In this case, the axis of the second block will be located at a distance of 28.5 m from the crest of the wave, the rig.

In order to calculate the construction of a floating drilling rig in the regions of offshore oil fields, ensuring the strength and stability of hydraulic structures, the wave regime of that region was studied.

After the floating drilling rigs are anchored to the drilling point, divers study the seabed and, depending on the suitability of the platform for the selected location, the lowering of underwater wellhead equipment and drilling of the well are started.

The construction of the well and the installation and dismantling of wellhead equipment are carried out in the following sequence.

Hydrotechnical structures placed on the seabed perform a horizontal-rotational tilt relative to the seabed. Drilling vessels and semi-submersible floating drilling structures move on a completely flat plane under the influence of external forces.

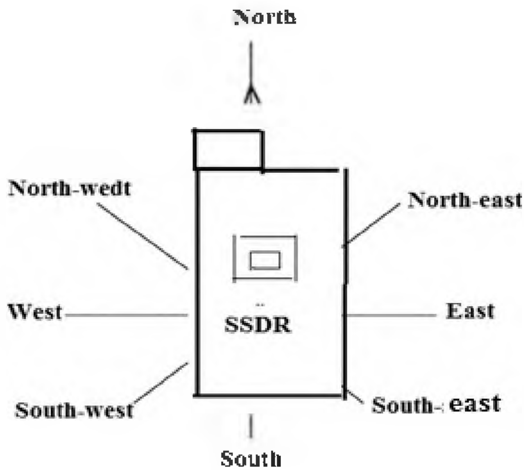


Fig 14. Scheme of placement of the SSDR according to the change in wind speed in the Gunashli region

This is the relevance of the issue under consideration. In this work, the stress arising in the water separator and drilling tool lowered into the semi-submersible drilling rig should be considered as a result of the device's separation from the wellhead. To solve these issues, it is necessary to study the external forces acting on the hydraulic equipment and the laws of motion of these devices.

Until now, the case of complex separations from the wellhead has been considered little. In this dissertation, the separation of semi-submersible drilling rigs and drilling ships from the wellhead due to the influence of external forces has been considered at a complex level.

In order to calculate the construction of a floating drilling rig in the regions of offshore oil fields, and to ensure the strength and stability of hydraulic equipment, it is necessary to know the wave regime of that region perfectly. The quantities characterizing the wave regime are wave elements. Wave elements include the height of the wave, its length, period, the position of the wave crest relative to the sea level, etc. At any point, wave elements depend on the wind speed, its duration, the relief of the seabed, and the depth of the sea. The direction of wave repetition coincides with the direction of wind repetition.

The systems that hold floating drilling rigs, the determination of the loads acting on the drill string lowered without a riser in semi-submersible floating drilling rigs, the mathematical analysis of the systems that hold them with the help of the anchor system are given, and the application of the developed measures in production is discussed.

Determination of loads acting on a drilled pipe without a racer on a semi-submersible drilling rig the importance of the correct installation of traction systems in floating drilling rigs has been demonstrated.

It is shown in this chapter that support structures are the main leading elements of self-shield surface drilling rigs. Often they determine the rigidity and strength of the structure as a whole. The number of support structures is determined when choosing the type of self-propelled floating drilling rigs.

The dissertation shows that there are no clear recommendations to prevent tensions in the supports due to the formation of complications in the well.

According to the manufacturing technology, the first type of support (leg) construction prevails. The choice of support structure is closely related to the type of lift. The support and hoist are usually designed together and are called lifting lead.

While performing the existing technical and technological processes, it was found that the most loaded section of the support is located in its upper and lower parts. In the middle part, the support is almost less loaded.

The diversity of the designs of supports and knots does not allow to give a general methodology for their calculation.

To determine the maximum wave load on a floating rig, we place the latter in the most inconvenient position relative to the wave profile. To do this, we connect the vertical axis of one of the blocks with the vertex of the report wave comb. In this case, the axis block of the second block will be located at a distance of 28.5 m from the peak of the wave, and the largest forces will be formed in the elements of the device.

Underwater wellhead equipment complex installed on the seabed is widely used in the practice of drilling wells from floating drilling rigs (floating drilling rigs). Such placement allows floating vehicles to be less susceptible to mechanical damage to equipment placed on the seabed.

After anchoring from the floating rigs to the drilling site, the divers study the seabed and begin to unload the subsea well equipment and drill the well according to the suitability of the platform to the selected location.

Construction of the well and installation and dismantling of the wellhead equipment is carried out in the following sequence.

In order to calculate the construction of a floating drilling rig in the areas of offshore oil fields, to ensure the strength and durability of hydraulic structures, it is necessary to know the wave regime of the region. Quantities that characterize a wave mode are wave elements.

The wave elements include the height of the wave, its length, period, the position of the wave peak according to sea level, and so on. aiddir. At any point, the wave elements depend on the wind speed, its duration, the relief of the seabed, and the depth of the sea. The direction of repetition of the wave coincides with the direction of repetition of the wind.

he methods of maintaining a floating rig at the wellhead include:

1. With the help of an ordinary ship anchor system;

Chain and rope wings are applied to the anchor system.

Traditional marine equipment anchor chains are assembled with the help of a spindle or spindle and are carried out with the use of high traction. The anchor system with a rope is assembled at the expense of a winch. Anchors are two-claw (Hall) and admiral type.

Let's look at the condition of this type of rig after bringing it to the drilling site. A special drilling rig (1200 hp) was designed for mapping drilling. An anchor system weighing 250 kg has been installed on the back and front of the ship.

Each anchor has a wing length of 250 meters and is connected to the drum of an electrically integrated winch. Behind this Sokol drilling rig, a 600m deep drilling rig has been installed. This ship has a special boat, which allows you to place the anchors on the seabed.

The disadvantage of this anchor system is that it is difficult to get out of the anchor in hurricane weather.

The chapter shows that the wellbore is in a state of complex tension. The design of the rig should take into account the main forces acting on it. The effect of forces on different areas of the pipeline during drilling is due to its interaction with the walls of the well.

Based on this, the loads are calculated taking into account the effect of forces on different areas of the pipeline. The direction and cost of the forces, in turn, depend on the profile of the well. The drill pipe takes the form of a stepped screw line that changes under the influence of axial loads, support reactions and torque. The theoretical substantiation of the spatial bending of a long shaft is given in the works of A.N. Dinnik. The study of the deformations of the drill pipe conducted by PV Balitsky on the model confirmed that the compressed part of the pipe under the existing loads during the drilling process takes the form of a variable step screw line.

The describes the displacement of a floating drilling rig from the wellhead under the influence of external forces and their technological processes. It also examines the effect of a rig's displacement from the wellhead on an axial axis, the strength characteristics of the anchor system during the displacement and bending of a rig, a semi-submersible floating rig, and the oscillation of a rig, semi-submersible floating rig. , the nonlinear structure of the oscillation of a semi-submersible floating rig is theoretically substantiated.

The dissertation shows that the report on the anchorage of the wing to the ground is made in two schemes:

1. Free throwing of the anchor wing into the water;
2. Fasten at one point to a firmly fastened anchor.

Figure 15. shows an anchor scheme for a floating rig.

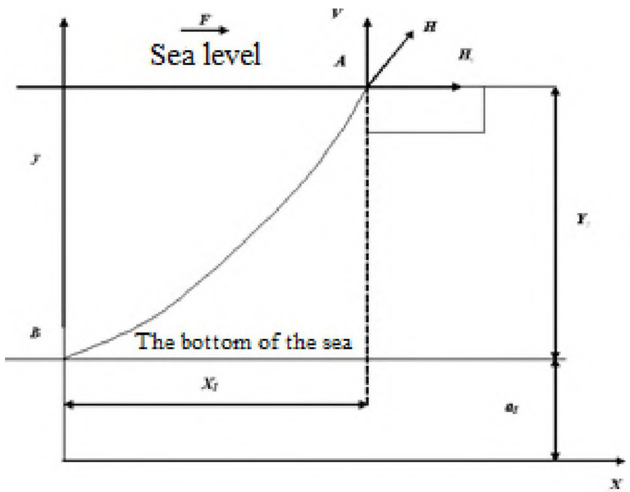


Fig. 15. Anchored scheme on a semi-submersible floating rig

The displacements of the drilling vessel from the wellhead under the influence of external forces and their technological processes are described. Here, the study of the effect of the displacement of the drilling vessel from the wellhead under the influence of constant forces on the axial load applied to the shaft, the strength characteristics of the anchor system during displacement and deflection of the drilling vessel, semi-submersible floating drilling rig, the linear formulation of the problem of rocking of the drilling vessel, semi-submersible floating drilling rig and the nonlinear structure of the problem of rocking of the drilling vessel, semi-submersible floating drilling rig are theoretically justified.

The displacement of the watershed belt caused by the deflection of the floating drilling rig is theoretically investigated. This section also includes the released displacement, inertial forces resulting from the deflection of the floating drilling rig, the deflection of the belt in the area between the rotor and the seabed, the calculation of the axis of the water separator belt, and the intermediate state of the upper support in the vertical direction on the floating rig.

This section considers the external forces acting on the water separator belt connecting the subsea wellhead equipment and the rig.

The following forces act on the water separator belt:

1. The effect of periodic wave pressure on the unprotected part of the belt;

2. Pressure resulting from the action of water currents;

3. Inertia and resistance forces. These are caused by the swinging of the rig;

4. Forces resulting from the weight of the water separator belt.

The displacement of the diversion pipeline resulting from the bending of the floating rig has been studied on a case-by-case basis. This section also shows the displacement, the inertial forces caused by the bending of the floating rig, the bending of the pipe in the area between the rotor and the seabed, and the separation of the upper support in the vertical direction on the floating rig.

This section examines the external forces acting on the subsea well equipment that connects the facility to the subsea well equipment.

The dividing pipe is affected by the following forces:

1. Periodic effect of wave pressure on the unprotected part of the pipeline;

2. Pressure caused by water flows;

3. Inertia and resistance forces. These are caused by the oscillation of the device;

4. Forces due to the weight of the water pipe.

The splitter belt usually tests the rotation of the entire belt on the lower support.

Write the total power in the following expression:

$$F\tau = \frac{h}{2}\theta_m n_1^2 M_h \sin n_1 t$$

Here, Mh is the weight of the watershed.

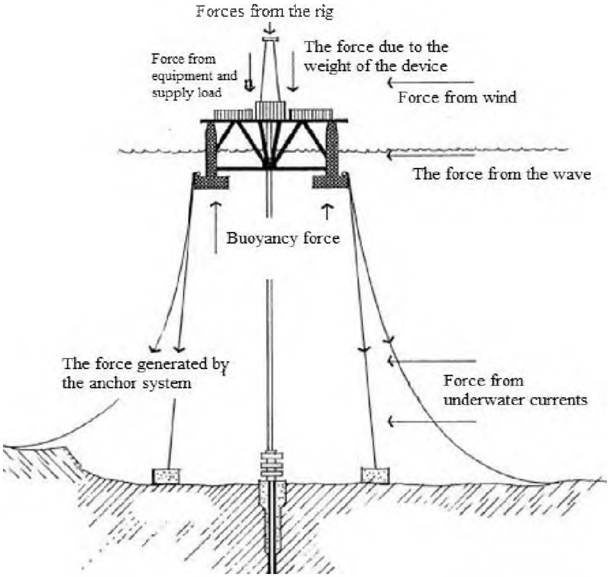


Fig. 16. Diagram of the directions of forces acting on a semi-circular saw blade

The speed of the water supply pipeline is determined by the following expression:

$$V=\theta_m \rho n_1 \cos n_1 t$$

f the speed of the underwater flow is known, the water pressure can be found from the following expression:

$$x = Cx\frac{\gamma}{2g}V^2 d$$

Total pressure:

$$P = \frac{\gamma d}{2g}\int_0^{l=h} V^2 C_x dx$$

Here, Cx is any resistance coefficient; γ is the specific gravity of water; d is the diameter of the separator.

If n1t = 0, then the water pressure reaches a maximum and is given by:

$$P_{mx} = C_x\frac{\gamma d}{2g}\theta_m^2 \rho^2 n_1^2$$

With this expression, it is possible to calculate the pressure created by water in the watershed by knowing the area where the floating rig is located and the underwater flow. In general, hydrometeorologists take underwater currents in the Caspian Sea at a speed of 0.35 m / s.

Figure 16 shows the general cross-sectional forces acting on the aquifer at the same time.

Cross-sectional forces acting on the separation pipe:

$$T = \frac{\pi^2 EF}{4l^2} f^2 \pm \frac{EF\Delta l}{l} + s$$

Bending equation:

$$\frac{EF\pi^4}{4l^4} f^3 + \left(\frac{EJ\pi^4}{l^4} - \frac{\pi^2 EF\Delta l}{l^3} \right) f = \frac{4q_1^0}{\pi} + \frac{2q_2^0}{(l-c)\pi} \left(l - c - \frac{l}{\pi} sin \frac{\pi c}{l} \right) + \frac{4}{\pi} q_4^0$$

Thus, it is clear that as the water depth increases, the stresses in the watershed increase.

Due to the experience of standing at the drilling point on a floating drilling rig, the support above the initial position of the rig may be detached due to the effect of transverse shear forces. Such spacing is based on the presence of a drilling compensator at the top of the pipe. Figure 18 shows the spacing of the upper support.

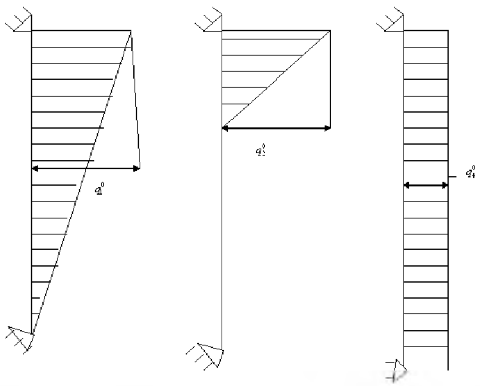


Fig. 17. Anchored scheme on a semi-submersible floating device

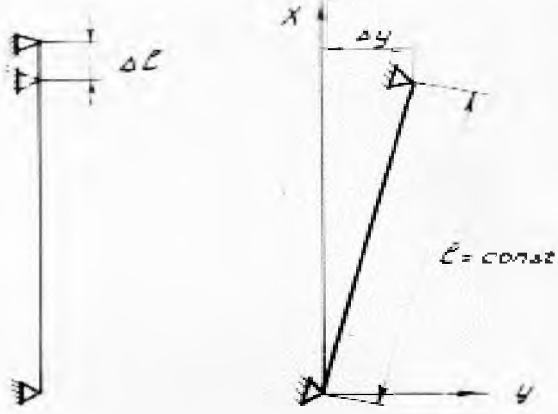


Fig. 18. Water separator support spacing scheme

The decrease of the upper support is up to Δl. The value of the boundary value of the problem differs from the boundary value of the immovable support shown earlier:

x = l; u = -Δl

Bending equation:

$$\frac{EF\pi^4}{4l^4}f^3+\left(\frac{EJ\pi^4}{l^4}-\frac{\pi^2 EF\Delta l}{l^3}\right)f = \frac{4q_1^0}{\pi}+\frac{2q_2^0}{(l-c)\pi}\left(l-c-\frac{l}{\pi}sin\frac{\pi c}{l}\right)+\frac{4}{\pi}q_4^0$$

Thus, the calculations show that when the value of Δl increases, the stresses in the chain axis increase suddenly.

Thus, the maintenance of drilling vessels at the wellhead during stormy weather conditions during offshore drilling was studied in this work, the application of chain and cable ropes in the anchor system was considered, and the disadvantage of the anchor system was shown, which is that it becomes difficult to leave the anchor in stormy weather.

The regulation "Control of pressure generated in the "Well-layer" system" prepared for wells drilled in the Caspian Sea was applied to floating drilling rigs during drilling.

SUGGESTIONS AND RESULTS

1. For the first time, using the theory of elastic environment, a method was given to increase the cementing quality of the protective belt, taking into account the contact factors;

2. For the first time, the causes of the "piston" effect in the "well-bed" system were identified and technological measures were taken to prevent it;

3. The mechanism of anthropogenic pressure during drilling has been determined and recommendations have been given to prevent its complication;

4. Floating drilling rigs are the main hydraulic structures for drilling in the deep layers of the sea. As a result of the study, it was determined that for the operation of floating facilities in the Caspian Sea: wind 8 points, ripple up to 6 points; to stay at the wellhead: the wind should take 10 points, the ripple up to 7 points;

5. The linear theory of the oscillation of ships in the linear design of floating drilling rigs has been adopted. Experimental data have confirmed that the displacements are close to the harmonic character. In the reports

it is shown that the effect of water weight and resistance on the floating rig storage system is negligible;

6. As a result of research, it was determined that the use of wellbore engines is recommended when drilling floating rigs. This is because there is no additional torque or contact stresses in the belt;

7. Positive results have been obtained when another nearby Semi-Floating Drilling rig is used to suffocate open fountains in a semi-submersible drilling rig;

8. For the first time on the basis of theoretical studies, formulas have been proposed to determine the hydraulic fracturing gradient, taking into account the seepage of the fluid and the zenith angle of the wellbore. The proposed formulas allow be clearly defined;

9. The risks of existing accidents should be investigated in advance and it is important to take measures to prevent them using known methods and technologies;

10. It has been established that the process of occurrence, the signs of its occurrence occur in a certain order, and the specific gravity of the drilling mud can never be increased due to its gasification;

11. It has been experimentally determined that the taming of a well with the application of the "Standby and Aggravation" method during the partial absorption of the drilling mud gives good results in a semi-floating drilling rig.

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[1],[3],[5],[6],[21],[22],[28],[29] - problem formulation, analysis, evaluation and application of results

[7],[8],[9],[10],[14],[15],[17],[18],[19],[20]-problem formulation and application of obtained results in production

[11],[12],[13],[16] authors' participation is equal

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