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FUNDAMENTALS OF DEVELOPING HYDRODYNAMIC (TECHNOLOGICAL) MODELS OF OIL AND GAS RESERVOIRS UNDER CONSTANT OPERATION AND SOLUTIONS TO TECHNOLOGICAL PROCESSES IN THE COURSE OF DEPLETION

Specialty: 2525.01 –Development and depletion of oil and gas fields

Field of science: Engineering Science

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GENERAL DESCRIPTION OF WORK

Urgency of the research topic and the degree of development. Depletion of new oil and gas fields based on optimized projects is of utmost importance in the development of the oil and gas industry. In the thesis, the surveying, exploration, and prospecting of new promising structures, putting new structures into operation, drilling new wells, and launching the process of operating the field in total are also essential stages and are accompanied by a large amount of financial resources. To this effect, before such deposits are included in industrial development, the preparation of more rational depletion projects, the prediction of development indicators on a multivariate basis is of vital importance and is considered one of the key issues for this industry.

In the process of the development of oil and gas fields, measures such as drilling wells, implementing different methods of stimulation, identifying production and identifying and eliminating existing defects require additional costs, so it is important to accurately predict the consequences of these activities in advance at any stage of the development process. In this regard, the implementation of the injection process or any other geological-technical measures to enhance the oil production coefficient of the layers has a rather large economic significance. In the case of offshore oil and gas condensate fields, similar measures cost more financially. Therefore, using modern software tools to make calculations more accurate and flexible, it is important to build a practical hydrodynamic model of the field, correctly determine the location of new wells, provide accurate production forecasts for the coming years, correctly select wells for the injection process, and at the same time reliably model the development process of the field considered to be engineering works.

Taking into account the foregoing, the issues investigated in the dissertation, i.e., the creation of hydrodynamic (technological) models of oil and gas fields in constant operation, the design of the impact on the formation in the modeling of oil and gas fields, the development of new methods for increasing the efficiency of production wells, the development of advanced oil and gas fields in

Azerbaijan creation of geological and hydrodynamic models and development of new and innovative technology and technological equipment are of great relevance.

Object and subject matter of research. Development of optimized hydrodynamic (technological) models of oil and gas fields in continuous operation and increasing the efficiency of technological processes during operation.

Purpose and objectives of research:

1. Evaluation of the current state of the field and selection of the exploitation strategy based on the creation of constantly active hydrodynamic models of Azerbaijan's oil and gas fields;
2. On the basis of modeling of Azerbaijan's oil and gas fields, detection of existing deficiencies, increasing the reliability of the projects of methods of stimulation on the layer and increasing the accuracy of the forecast of development indicators;
3. Development of new methods of operational management of oil and gas wells, taking into account the processes taking place in separate blocks of the field, in the well bottom zone and wells in a complex manner;
4. Development of mathematical and technological methods to increase the operational efficiency of gaslift wells, as well as new technologies for solving problems arising in operational technological facilities;
5. Development of new methods of interpretation of researches of oil and gas condensate deposits;
6. Taking into account the main features of transportation systems, integrating issues related to the development and operation of hydrocarbon deposits into a single system and creating a scientific-theoretical-practical basis for optimizing hydrocarbon production of deposits with a systematic approach;
7. Creation of new methods of eliminating traditional problems in order to increase the efficiency of operation of oil and gas wells:

- Development of solutions for technological operations;
- Creation of well screens of new construction for gas and gas condensate wells;
- Formulation of solutions to prevent inorganic salt deposits.

Methods for solving the tasks set

The issues raised in the dissertation work were carried out using mathematical modeling methods, modern computer programs, experimental and mining research.

Provisions for defense:

1. Improved hydrodynamic models of Azerbaijan's oil and gas fields under constant operation;
2. Rational design of reservoir impact methods based on modeling of oil and gas deposits of Azerbaijan;
3. A new mathematical model developed based on the method of group calculation of arguments in gas lift wells;
4. Advanced start-up devices and flow regulator for gas lift wells;
5. A new mathematical model created for determining the pressure gradient based on the wellhead data without holding the gas condensate well;
6. A developed and more convenient method of interpretation of studies of oil wells in an undefined mode;
7. Higher-quality gel-forming compositions created for technological operations;
8. Well screen of a new design, which ensures the strength of gas and gas condensate wells;
9. A new chemical agent developed to prevent inorganic salt deposits formed during oil and gas production in wells.

Scientific novelty of the research:

1. Permanent hydrodynamic models of Azerbaijan oil and gas fields were created and a more complete and rational analysis of development systems was carried out;
2. On the basis of the modeling of oil and gas deposits of Azerbaijan, the projects of methods of formation stimulation were fundamentally developed and the reliability of the improved model was optimized;
3. A new mathematical model with increased accuracy was created for determining the pressure gradient based on the method of group calculation of arguments in gas lift wells;

4. Improved start-up devices and consumption regulator were developed for gas lift wells;

5. A more convenient and more accurate method for determining the parameters of the reservoir and the well on the basis of the wellhead data without storing the gas condensate well was proposed;

6. A new, practical and accurate method of interpretation of oil wells researches in undefined mode was created;

7. New innovative chemical agents have been developed that ensure the reliability of technological operations;

8. For gas and gas-condensate wells, a well-bottom filter with a new design has been developed. The new filter provided the strength of the well bottom zone and made it possible to increase the production of the well;

9. A more effective chemical composition has been developed to prevent inorganic salt deposits formed during oil and gas production in wells.

Theoretical and practical significance of the research.

The provisions of the dissertation were fulfilled in the following applied works:

- In "May 28" OGPU, in well No. 222, a test of the well bottom wire filter complex against sand formation was carried out, and as a result of the filter application, an additional 580 tons of oil and 1.5 million m3 of gas were obtained;

- In wells No. 2649, 2210, 1858, 1134, 2619, 2674, 2063, 2676, 1922, 1939, 2686, 2687 of "Oily Rocks" OGPU, a gelling agent was used for water isolation. As a result of the application, a total of 391 tons of additional oil was obtained;

- In order to eliminate the salt deposits occurring in the equipment of the produced water disposal service area at the H.Z. Taghiyev OGPU, a new composition developed against inorganic salt deposits was applied to produced water. The results have been satisfactory.

- Development of geological and hydrodynamic models of "Gunashli" and "Karabagh" fields of "Azneft" PU, restoration of development history, design of new production wells, selection and justification of the method of formation stimulation and prediction of development indicators;

- Development of geological and hydrodynamic models of the "Kurovdag" field of "Shirvan Oil" JV, adaptation of the hydrodynamic model and forecasting of development indicators by designing and modeling the injection process for the final development stage of the field;

- Development of geological and hydrodynamic models of Kursangi and Karabakhli fields of "Salyan Oil" LTD, adaptation of hydrodynamic model, design and modeling of new production wells were used in forecasting of development indicators.

- Republic of Azerbaijan patent No. I 20120048 was obtained for "Gel forming composition";

- Patent No. 1 20140033 of the Republic of Azerbaijan was obtained for "Gel forming composition";

- Patent No. I 2020008 of the Republic of Azerbaijan was obtained for "well screen for gas and gas condensate wells";

- Republic of Azerbaijan patent No. I 20210088 was obtained for "Composition for preventing inorganic salt deposits formed during oil and gas production in wells".

Contribution of the author.

The author directly participated in the planning of the scientific research presented in the dissertation, setting the issues, choosing research methods, creating hydrodynamic models and conducting laboratory research. In addition, he led the selection and justification of the topics of all published scientific works and reports covering the subject of the dissertation, creation of research methodology, summaries of scientific literature and analysis of results. The author was also the head and responsible executor of the scientific research works carried out at the SOCAR "OilGasScientificResearchProject" Institute, which formed the content of the dissertation work.

Approbation and application of work.

The main terms of the completed dissertation work were explained in reports at various conferences:

- Abstracts of International Scientific-Practical Conference Papers. February 25-26, 2010. 75, Baku;

- Materials of the International scientific and practical conference "Modern problems of the oil and gas complex of Kazakhstan". Aktau, Volume I 23-25 February 2011. 256-258;

- Materials of the International scientific and practical conference "Modern problems of the oil and gas complex of Kazakhstan". Aktau, Volume I, February 23-25, 2011, p. 262-265;

- Abstracts of the reports of the VIII International scientific and practical oil and gas conference "Use of innovative approaches to increase the efficiency of drilling and repair of wells". Kislovodsk October 10-14, 2011. 35;

- "New technologies in oil and gas extraction" II International Scientific-Practical conference. September 06-07, 2012, Baku;

- Proceedings of the V International scientific and practical conference "Problems of innovative development of the oil and gas industry". Almaty, KBTU, February 21-22, 2013, p. 279-280;

- Proceedings of the International Scientific and Practical Conference "Innovative development of the oil and gas complex of Kazakhstan". Aktau, April 25-26, 2013, part 1. 62-64;

- Materials of the International scientific-practical conference, "Innovative development of the oil and gas complex of Kazakhstan", Aktau, April 25-26, 2013, part 1. 204-207;

- Materials of the International scientific and practical conference "Innovative development of the oil and gas complex of Kazakhstan". Aktau, April 25-26, 2013, part 1. 207-210;

- X International scientific and practical oil and gas conference dedicated to the 50th anniversary of the creation of SEVKAVNIPIGAZ and the 20th anniversary of OJSC "North-Caucasian scientific research project institute of natural gases", October 21-24, 2013;

- XI International Scientific and Practical Oil and Gas Conference. Kislovodsk, October 27-31, 2014, p. 58-59;

- XII International Scientific and Practical Oil and Gas Conference. Kislovodsk, September 28-October 2, 2015, p. 26-27

- SPE Annual Caspian Technical Conference and Exhibition held in Baku, Azerbaijan, November 1-3, 2017.

Published papers.

The main content of the dissertation is covered in 40 scientific works, including 18 scientific articles, 1 monograph, 17 conference materials and 4 inventions.

The name of the institution where the dissertation work was performed

Dissertation work was performed at SOCAR, "OilGasScientificResearchProject" Institute.

Structure and volume of the work

The dissertation consists of an introduction, 5 chapters, a bibliography of 193 names and 7 appendices. The work is expressed in 488 pages, there are 166 tables and 299 pictures. Dissertation work is 369,700 characters, excluding pictures and tables.

The author extends his gratitude to the management of the "OilGasScientificResearchProject" Institute and the employees of the "Database and Modeling of Fields under Commingled Developed" department for their help and support in the implementation of the work.

SHORT SUMMARY OF WORK

The introduction offers the main provisions of the dissertation, justifies the relevance of the research conducted on the topic of the dissertation, and explains the scientific innovations of the work, the main terms defended and the methods of solving the issues.

The first chapter is dedicated to the selection of the strategy for creating hydrodynamic (technological) models of oil and gas fields under constant operation, such as Karabakh and Umid fields.

In addition to the fields under development, the survey, exploration, and prospecting of new prospective structures is a crutial period in the oil industry. That's why it is important to prepare development projects and predict development indicators on a multivariate basis before entering such fields into industrial development. The main goal in creating the development project is to develop and select the optimal method that ensures efficient operation of the reservoirs. Against the background of numerous calculations, the most important of the main directions to achieve this goal is the modeling of deposits or prospective structures. Because modeling helps the development engineer to create various calculation options, to simulate the change of various parameters depending on time, and on the basis of all this, not only from the technical and technological point of view, but also from the economic point of view, and to choose the optimal development mode of the field.

For this purpose, using modern programs, the issue of geological-hydrodynamic modeling of the Karabakh field, which is considered a prospective structure discovered by only three exploratory wells, was studied, the basics of modeling various development options of the structure were shown in conditions of information scarcity, the risks affecting the process were evaluated, uncertainties were studied, along with the modeling process, the degree of influence on the development process is determined.

A hydrodynamic model-reservoir simulation is created by reservoir engineers and its main purpose is to analyze the flow of fluids in a porous medium using finite difference methods and obtain data for the pre-reservoir development and operation cycle (Figure1).

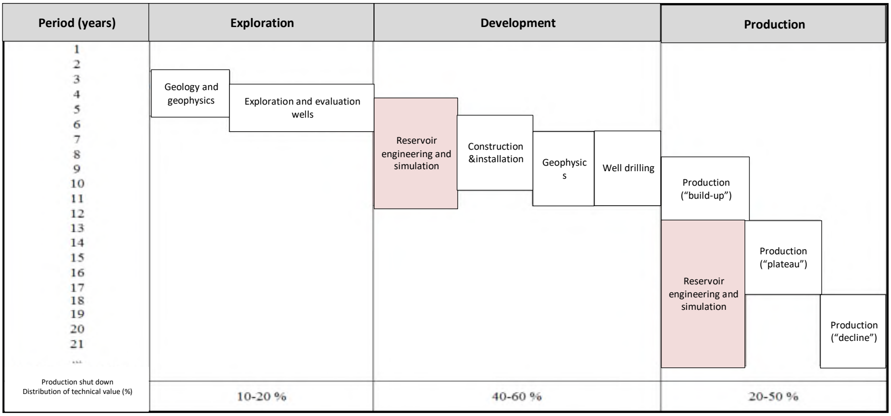

Figure 1. The position of the simulation during the operation of the reservoir

Oil companies use Eclipse, VIP Nexus, Imex, GEM, Tempest and other reservoir simulator programs for various development purposes.

After a deposit is discovered, its recoverable reserves must be calculated and a decision must be made as to whether or not it is economically viable. This work can be determined more precisely with reservoir simulation. This software service is used to prepare various deposit development scenarios and optimize the development strategy.

The application of the mentioned types of layer modeling has been started in several Azerbaijani fields and many results have been achieved.

Formation pressure in onshore fields has decreased, the viscosity of oil has increased due to the release of gases dissolved in oil, and since the rocks are fragile, their exploitation has become more difficult. Productivity and economic aspect of increasing oil yield of the field should be fully analyzed in advance.

In solving such problems, using reservoir modeling can facilitate the determination of which additional impact methods are effective for a given field and when to start, by developing different scenarios in advance.

Hydrocarbon reservoir modeling combines several important fields such as geophysics, geology, petrophysics, reservoir development and operation, and mathematics. The main goal of a comprehensive and accurate study of deposits is to determine their condition in advance and to investigate ways to increase the final oil yield.

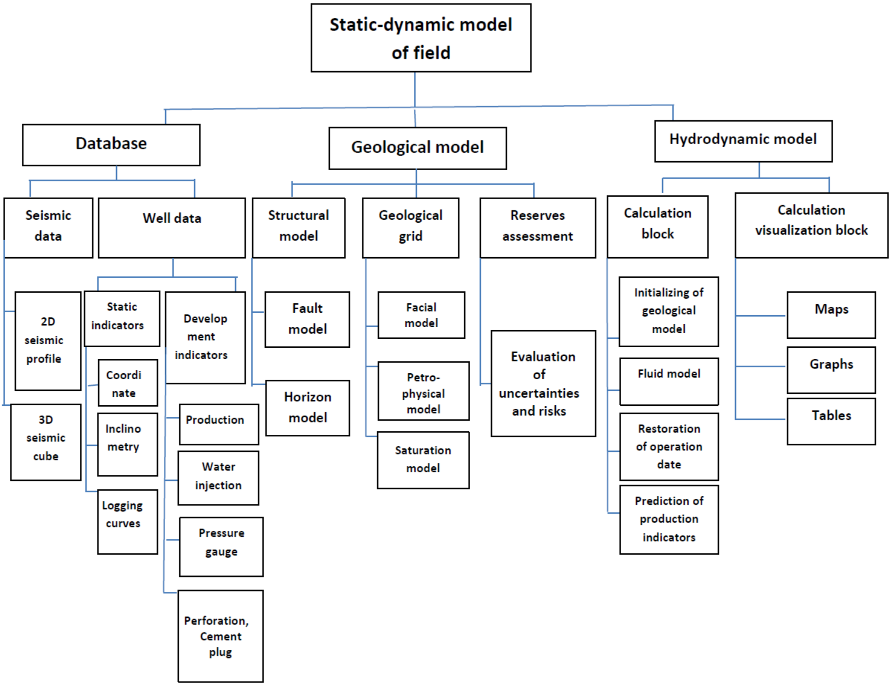

Figure 2. Structure of the oil and gas field model

Modeling of hydrocarbon reservoirs mainly consists of two stages: static and dynamic modeling. The geological model of the deposit belongs to the static model. The dynamic model is the hydrodynamic model of the bed.

The structure of the oil and gas field model is shown in Figure 2. In accordance with the indicated structure, the construction of the hydrodynamic model of the Karabakh field and the specification of the parameters were carried out.

Based on the development project of the Karabakh field, the assessment of the prospect of using the potential of the Ashrafi, Aypara, Dan uduzu fields was investigated. Construction of geological and hydrodynamic models of Ashrafi and Aypara structures and production indicators forecast.

In the development project of the Karabakh field, the issue of forecasting the probable oil and gas production of these structures was considered in order to evaluate the perspective of using the potential of the Ashrafi and Aypara structures. For this, geological and hydrodynamic models of these structures were built.

According to the interpretation of the seismic cube, there are 3 faults in the Ashrafi field. Faults are considered permeable; they do not form a block. The QUQ, QD, QAD and Gala formations were traced from the seismic cube.

A well was drilled into the deposit, and oil and gas were obtained from the QUQ and QAD formations. In the construction of the geological model, according to the logging diagram of the drilled well, the QUQ formation is divided into 3 layers with small thicknesses, and the QAD formation is divided into two layers.

The location of oil-water and gas-water contact depths along the horizons of QUQ and QAD has been determined. Since 1 well was drilled into the structure and no complete information was obtained as a result of the seismic attribute analysis, the average values of the formation parameters obtained based on 1 well were used in the construction of the geological model and in the calculation of the initial geological resources. In the calculation of reserves, according to the Karabakh field, the volume coefficient of oil is 1.29, and the volume coefficient of gas is 0.0036. Information about reservoir parameters and reserves is given in table 1.

As we mentioned, no well was drilled in the Aypara structure.

Table 1

Average values and reserves of reservoir parameters on the Ashrafi field

Horizon	Fluid	Thickness, m	Sand content	Porosity	Water saturation	Reserve, mln. m^3
QÜQ	Oil	48	0.25	0.22	0.4	2.705
QAD	Gas	37	0.83	0.22	0.28	5070.39

The seismic attribute was revealed as a perspective structure as a result of the analysis.
According to the well drilled in the Ashrafi field, which is adjacent to the Aypara field, it is accepted that the oil-bearing horizon of the QUQ is also in Aypara. The average thickness in the QUQ horizon is up to 20 meters. Faults do not form a block across the horizon.
Since the structure well was not drilled, in the construction of the geological model and the calculation of the initial geological resources, the seismic attribute was obtained based on the analysis, and the average values of the layer parameters were used. In the calculation of reserves, the coefficient of oil volume is 1.5. Information about reservoir parameters and reserves is given in table 2.

Table 2

Average values and reserves of layer parameters on the Aypara structure

Horizon	Sand content	Porosity	Water saturation	Capacity factor m^3/m^3	Reserve, mln. m^3
QÜQ	0.63	0.22	0.3	1.5	12.09

In order to predict the probable production indicators of both structures, hydrodynamic models were built based on geological models. 2 wells have been installed in the Ashrafi structure - 1 oil well is located in the QUQ horizon, and 1 gas well is located in the QAD horizon. 2 oil wells have been placed in the CQU horizon of Aypara structure. The proposed wells for both structures were proposed with subsea completions. The oil well in the Ashrafi structure is horizontal, and one of the oil wells in the Aypara structure is vertical, and the other is horizontal.
Information about wells proposed for the Ashrafi structure - construction, filter, restrictions (boundary conditions) imposed on oil and gas wells in the model are given. So, pump compressor pipe- 5.5″, completion- 7″, screen – OHGP, horizontal completion length – 500 m, restrictions on horizontal oil well – initial oil production – 1200 m3/g, minimum wellhead pressure – 50 atm, maximum depression - 80 atm, limit of dilution - 98%, minimum pressure in the

well bottom - 150 atm. Restrictions imposed on the gas well - initial gas production - 1.5 million m3/g, minimum wellbore pressure -150 atm, minimum gas production -100 thousand m3/g were accepted.
In hydrodynamic calculations, the year 2022 was assumed as the starting time of the wells. Calculations for oil wells were made in 2 variants - with the application of the gas lift operation method and without gas lift. It should be noted that no method of impacting the layer is provided. The results of the calculations for the noble structure are shown in table 3 and table 4.

Table 3

Estimated oil (with the application of gaslift) and gas production of wells proposed for the Ashrafi structure

Date	Years		Total	
	Oil, thous. m^3	Gas, mln m^3	Oil, thous. m^3	Gas, mln m^3
2022	183.6	245.154	183.6	245.154
2023	353.259	572.123	536.859	817.277
2024	129.011	556.943	665.87	1374.22
2025	56.119	550.43	721.989	1924.65
2026	1.034	547.55	723.023	2472.2
2027	-	547.5	-	3019.7
2028	-	376.83	-	3396.53
2029	-	130.41	-	3526.94
2030	-	68.03	-	3594.97
2031	-	45.23	-	3640.2
2032	-	12.37	-	3652.57

Two subsea oil wells, one vertical and the other horizontal, have been planned for the Aypara structure. Information about the proposed wells - construction, screen, limitations (boundary conditions) imposed on oil and gas wells in the model are as follows:
- vertical well indicators and limitations - pump compressor pipe - 5.5″, completion - 7″, screen - OHGP, initial oil production -700 m3/g, minimum wellhead pressure - 50 atm, maximum depression -80 atm, limit of dilution - 98%, minimum well bottom pressure -150 atm. Horizontal oil well restrictions - pump compressor pipe - 5.5″ completion

Table 4

Estimated oil (without gas lift) and gas production of proposed wells for the Ashrafi structure

Date	Years		Total	
	Oil, thous. m^3	Gas, mln m^3	Oil, thous. m^3	Gas, mln m^3
2022	183.6	245.154	183.6	245.154
2023	148.461	559.711	332.061	804.865
2024	-	549.005	-	1353.87
2025	-	547.5	-	1901.37
2026	-	547.49	-	2448.86
2027	-	547.5	-	2996.36
2028	-	375.09	-	3371.45
2029	-	131.83	-	3503.28
2030	-	68.49	-	3571.77
2031	-	45.34	-	3617.11
2032	-	12.39	-	3629.50

- 7″ screen - OHGP, horizontal completion length - 500 m, Initial oil production - 1200 m3/g, minimum wellhead pressure - 50 atm, maximum depression - 80 atm, water limit - 98%, minimum pressure at the bottom of the well -150 atm. has been accepted.

Here, in hydrodynamic calculations, 2022 is taken as a condition for the start-up time of the wells. Calculations in 2 options

- it was carried out with the application of gas lift operating method and without gas lift. In the modeling of this structure, no method of fromation stimulation was considered. The results of calculations for the Aypara structure are shown in Tables 5-7.

Then, on the basis of the optimized geological and hydrodynamic model, the optimization of the development options of the Karabakh field was given and extensive calculations were made for various scenarios. Extensive calculations and investigations were carried out in 4-5 scenarios in each of the 5 options. These calculations were made with the aim of predicting various scenarios that may arise in future development options under conditions of uncertainty of Water-Oil, Oil-gas contacts. The forecast of production indicators is given according to the integrated model, so the joint modeling of

Table 5

Estimated total oil production (with the application of gas lift) of wells proposed for the Aypara structure

Date	Years		Total	
	Oil, thous. m^3	Gas, mln m^3	Oil, thous. m^3	Gas, mln m^3
2022	290.7	35.6182	290.7	35.6182
2023	693.5	84.9718	984.2	120.59
2024	693.76	85.004	1677.96	205.594
2025	605.83	74.23	2283.79	279.824
2026	449.42	55.064	2733.21	334.888
2027	285.56	34.761	3018.77	369.649
2028	141.41	16.971	3160.18	386.62
2029	72.17	8.567	3232.35	395.187
2030	39.37	4.629	3271.72	399.816
2031	23.04	2.703	3294.76	402.519
2032	7.47	0.879	3302.23	403.398

Table 6

Estimated total oil production (without gas lift) of proposed wells in the Aypara structure

Date	Years		Total	
	Oil, thous. m^3	Gas, mln m^3	Oil, thous. m^3	Gas, mln m^3
2022	290.7	35.6182	290.7	35.6182
2023	693.5	84.9718	984.2	120.59
2024	666.6	81.675	1650.8	202.265
2025	427.55	52.387	2078.35	254.652
2026	206.79	25.337	2285.14	279.989
2027	52.46	6.427	2337.6	286.416

subsurface and surface infrastructure, taking into account the risk analysis, allows solving many actual issues at a new qualitative level. The integrated model includes the geological-hydrodynamic model of the field, the fluid movement model in the tubing, the fluid the assessment of risks and economic parameters.

Table 7

Estimated production figures as a result of the modeling of the Ashrafi and Aypara structures

Fields	Oil, thous. m^3		Gas, mln. m^3		Number of wells
	Gas lift	Without Gas lift	Gas lift	Without Gas lift	
Ashrafi (QUQ and QAD)	723.023	332.061	3652.57	3629.5	1 oil, 1 gas
Aypara (QUQ)	3302.23	2337.6	403.398	286.416	2 oil

In addition to being the "brain" of a modern bed, the integrated model is also its main design (appearance). Through the integrated model, it is possible to solve the following issues:

• Assessment of potential probable production;

• Production estimation according to different development concepts in the field;

• Selection and consideration of downhole and surface equipment;

• Optimization of equipment operation modes;

• Determination (selection) of adjustment parameters;

• Reservoir management in online mode.

Integrated models can play a role in directly solving important practical issues at different stages of field development and at different management levels:

- Designing the reservoir, making strategic decisions.

At this stage, the presence of an integrated model allows you to choose one or another development variant of the project, basically taking into account all factors.

As a solution to the typical questions that will arise - choosing the concept of field development (for example, it is enough to install one DKS or it is more convenient to install two DKS, to increase the power of the DKS or to conduct hydraulic analysis of the formation by adapting the operation mode of the wells to more powerful pumps). Also, at this stage, issues related to justifying the effectiveness of the application of these or other elements of intelligent reservoir technology can be resolved (for example, at which points of the surface network, the importance of measuring the gas factor, what decisions should be made during these measurements, and at the same time, it is necessary to consider the issues of economic efficiency).

Evaluation and optimization of various measures, optimization of measures during the operational management stage, during development within the framework of the integrated model (hydraulic fracturing in the formation, effects on the wellbore zone, etc.), optimization of well operation mode (pump selection, gas-lift optimization, selection of the operating casing diameter, etc.) .), as well as a wide range of important issues related to the optimization of the operational mode of the terrestrial network (changing the diameter of transmission lines, shifting transmission lines, etc.) were solved.

- During the monitoring of the field development, the integrated model can reflect the performance of the field if there is an existing idea about the characteristics of the formation and surface equipment in the field.

Within the framework of the Garabag project, an integrated model has been built for the main scenario of the oil layer (variant 3) variant of the QUQ horizon. For this purpose, the METTE software package of the ROXAR company was used. METTE is a tool for performing joint thermo-hydraulic calculations on reservoir - well - surface systems and equipment in the oil and gas industry. Through the integrated model built in the METTE software package, the following issues are addressed:

During the prediction of field development, various development scenarios, preparation of drilling schedule, monitoring and optimization of production, selection of technological modes for production wells and equipment, determination of potential opportunities for oil and gas production, selection of equipment, calculation of the power of pumps and compressors, and also, the development system of the field design and management of complex situations (e.g. formation of hydrates, formation of paraffin deposits) can be solved.

An integrated model was created for the oil option base scenario. For this case, 6 oil wells are proposed in the production system, and 3 gas wells are proposed in the QAD. The reservoir input parameters for the integrated model are the hydrodynamic model of the Karabakh field built in the Tempest software package, the well models built in the Prosper software package, and the parameters of the transport system shown in table 8.

Within the framework of the integrated model, the changes of the current and total prices of oil and gas production over the years were shown during the calculations made according to a single algorithm, taking into account the results of the hydrodynamic model of the field, the construction and dimensions of the wells, the design and parameters of the transportation system.

Table 8

Transport system parameters for the integrated model

Pipes	Diameter, mm	Pressure, bar	Length, km
Oil pipe	350	35	30
Gas pipe	500	45	35

Sensitivity analyzes were carried out in the hydrodynamic model for static and dynamic parameters, and production probabilities were shown as a result of the analysis.

Uncertainty analysis of some primary data used in the hydrodynamic model and their change functions depending on pressure was carried out, and the degree of influence of these parameters on production indicators in forecast calculations was checked through sensitivity analysis. It should be noted that the analysis of uncertainties for each option, determination of sensitive parameters and determination of their stimulation is a time-consuming and complex task. Therefore, the determination of uncertainties and sensitivity analysis were performed only for the base scenario of the oil layer of the QUQ horizon (option 3) and for the model of the QAD horizon.

The degree of sensitivity of the following parameters was analyzed as uncertain parameters:

- Sensitivity according to PVT properties of formation fluid: change of oil and gas volume coefficients according to pressure, change of oil and gas viscosities according to pressure, change of dissolved gas factor according to pressure.

- The sensitivity of the phase curves characterizing the layer percolation according to the Korey method:

Variation of the phase curves according to the end points, bending shape of the phase curves according to the Korey exponent, sensitivity according to permeability, sensitivity according to the permeability of fractures, sensitivity according to the pore volume of the aqueous zone.

The variation ranges of many of the mentioned parameters were taken based on the statistical analysis of the value intervals of the analogous parameters of other similar deposits.

The degree of influence (sensitivity) of these selected parameters on production indicators was analyzed based on the tornado diagram.

The 3D geological model built on the V and VII horizons of the Umid field was adapted ("upscaling") and a hydrodynamic network ("grid") was obtained. All information about the network is provided. The geological model was loaded into the hydrodynamic model, the perforation intervals and dates of all operational wells, gas, condensate and water production data, the dependencies of the physical-chemical and thermodynamic properties of the fluid were also loaded into the hydrodynamic model. In determining the PVT properties of formation fluids and relative phase permeability functions of formations, using the analogy of Shah Deniz field data, single hydrodynamic models of V and VII horizons were established and the development history was restored. The development plan of V and VII horizons has been drawn up in 3 different variants, and the development indicators of both horizons have been predicted until 2040. The layout scheme of the wells planned in the Umid field with the intended inclinometry is shown in figure 3, the comparison of the gas extraction coefficient by options is shown in figure 4, and the comparison of the condensate extraction coefficient by options is shown in figure 5.

After the hydrodynamic model is fully established, it is possible to solve any problem by modeling any stimulation methods in the studied fields in various options, and these issues are discussed in detail in the next chapter.

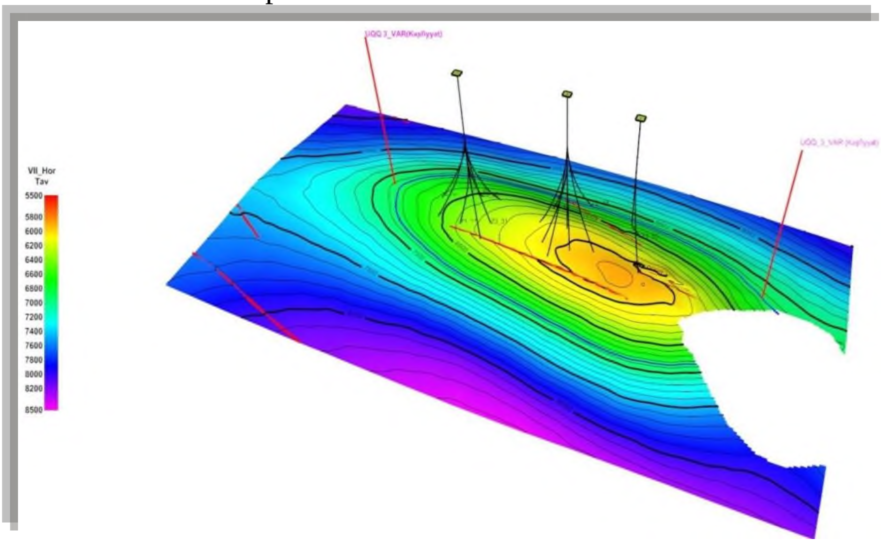

Figure 3. Location scheme showing the intended inclinometry of the planned wells in the Umid field

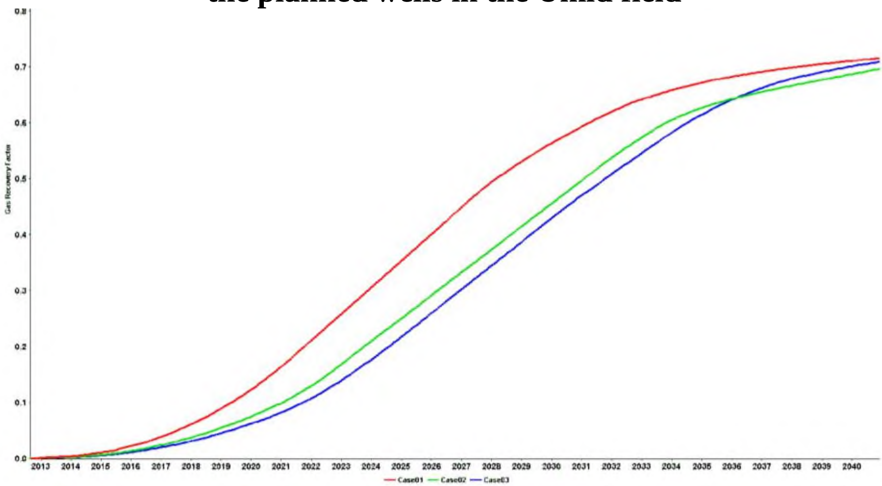

Figure 4. Comparison of gas recovery coefficient by options

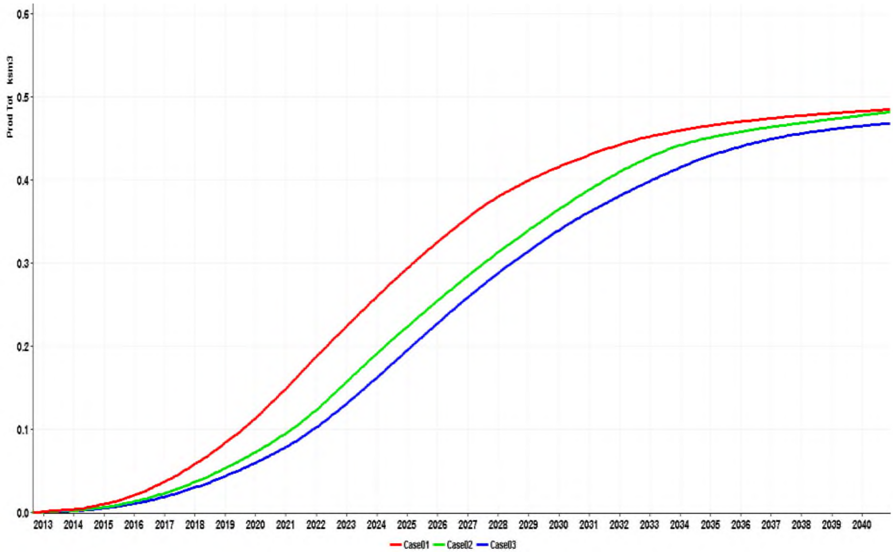

Figure 5. Comparison of the condensate recovery coefficient by options

In the second chapter, the issues of designing formation stimulation methods, determining the number of stimulation wells and the optimal variant of the formation impact process, and choosing an effective forecast option using the modeling of deposits were solved.

In accordance with the solution to the problem, the database of the Pereriv Suite Reservoir of the "Gunashli" field was updated, the altitudes, inclinometry, perforation, production, pressure data of new wells were collected and uploaded to the database, the formation parameters of the Pereriv Suite Reservoir were determined for the new wells and the correlation of these wells with other wells structure in the model has been further refined.

The development process was modeled by updating the established single hydrodynamic model of the Pereriv Suite Reservoir, based on this, the optimal location of the wells intended for injection in Shallow Water Guneshli in the structure, the optimal amount of water that can be injected, the effect of injected water on the performance indicators of Shallow Water Guneshli was studied, and the effectiveness of the injection process intended to be intensified was predicted.

The conducted scientific-research works were performed in accordance with international standards using modern software packages of the world's leading companies in the field of reservoir modeling. By using modern software tools, a three-dimensional model of the Pereriv Suite Reservoir in Guneshli field IX tectonic block was divided into A, B, B1 (bottom), C, D, E layers. The area expected to be most affected by the injection process in Shallow Water Gunashli and the wells in this area are shown in Figure 6.
The location of the horizontal well, which is planned to drill in these layers through a special open screen 260 m long, has been assigned to the area where the leakage capacity parameters are satisfactory - layers B (lower) and C with a thickness of 54 m.
Through the model of the horizontal well, the production indicators of the well were predicted for the gas lift operation method at different values of the formation and wellhead pressures, the diameter of the tubing, and the supplied gas volume.

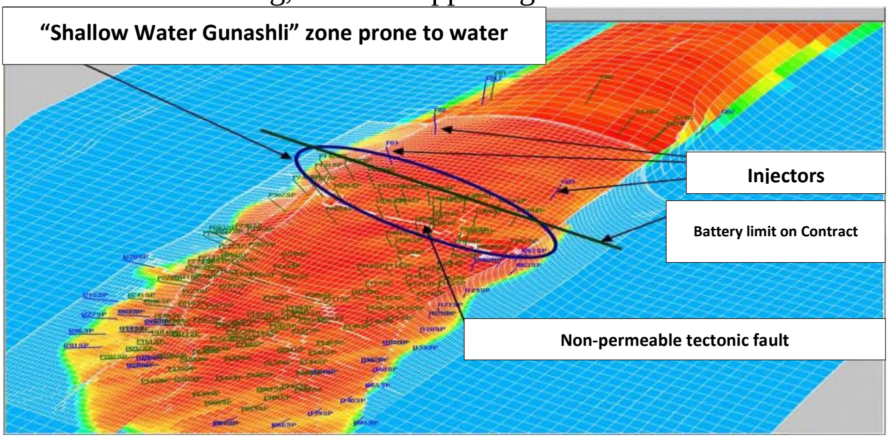

Figure 6. The area where the injection process is expected to have the greatest impact in Shallow Water Gunashli and the wells in this area

The hydrodynamic model of the injection and gas injection processes in the shallow Gunashli field was investigated.
As a result of injection, formation pressure in the Deep Water section of the Gunashli field is expected to rise to about 400 atm. Due to the fact that the Shallow Water Gunashli, Deep Water Gunashli, Chirag

and Azeri reservoirs have the same structure, it is known that there is a hydrodynamic connection between them. As a result of the process of injecting into the Deep Water part of the Guneshli field, it is assumed that the formation pressure will increase sharply (up to 70 atm within 4 years) in the area close to the contract zone of the Shallow Water Guneshli operated by SOCAR, i.e. in the V, X, XIV tectonic blocks. On the one hand, this can lead to a sharp increase in oil production, a sharp decrease in the gas factor, and on the other hand, a sharp increase in reservoir pressure and water production.
The purpose of carrying out the above works in this chapter is also to determine the level of interaction in the Shallow Water Gunashli, Deep Water Gunashli, Chirag and Azeri fields and to investigate in advance the negative situations that may occur in the Shallow Water Gunashli when water is injected into the Deep Water Gunashli. At the same time, it is intended to facilitate taking appropriate measures against those cases by SOCAR and to make maximum use of possible positive cases.
PetroWorks and ZMap were used to build the geological model, VIP was used to build the hydrodynamic model, and PROSPER software packages were used to analyze the operating modes of the wells.
Taking into account the above, the effectiveness of the intensification of FLD and X-horizon injection in the Shallow-Water Gunashli field in the hydrodynamic model was investigated and suggestions were made.
Then, in the hydrodynamic model, the effect of joint management of FLD and X horizon injection and gas injection processes on the oil yield coefficient was investigated in the shallow Gunashli field.
Since it is impossible to carry out the gas injection process in the Pereriv Suite Reservoir (PSR), the investigation of the joint effect of the injection and gas injection processes through the hydrodynamic model was calculated only for the X horizon.
The base option considered more efficient for water injection, and for gas injection, 1500 thousand m^3/day, 1000 thousand m^3/day, 500 thousand m^3/day, 250 thousand m^3/day, 150 thousand m^3/day from each of the two wells hypothetically placed in the crest part of the horizonthe "gas injection" option was chosen. The predicted state of

the water-oil periphery of the Pereriv Suite Reservoir in January 2021 is given in Figure 7.

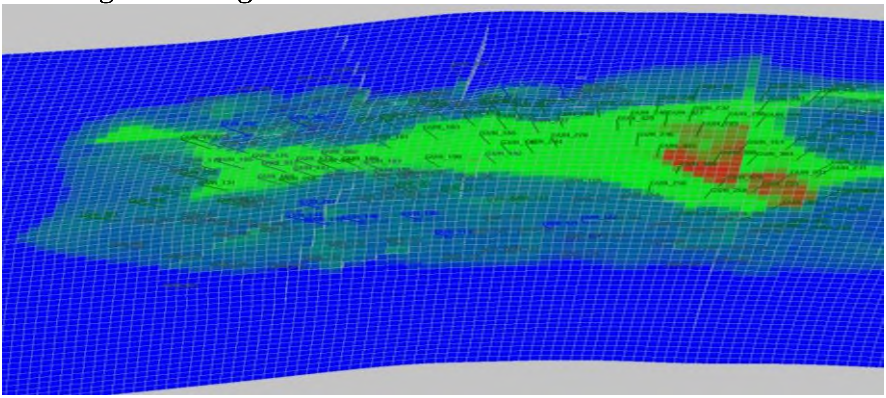

Figure 7. Predicted state of the water-oil periphery of the Pereriv Suite Reservoir (PSR) in January 2021

Research introduces that in this case, the gas injection process is not effective, and additional oil is recovered only as a result of the effect of the injection process. The structural view of the proposed injectors is given in Figure 8.

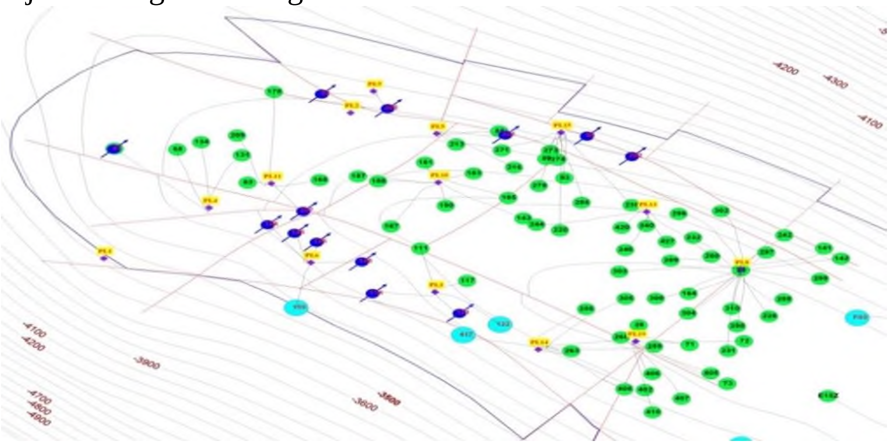

Figure 8. Structural view of the proposed injectors

currently producing well in PSR, • ləğv olunmuş və ya FLD-dən işləməyən quyular abandoned or non-producing wells in PSR, proposed water injectors, operational water injectors

The negative impact of the gas injection process is caused by the location of the production wells relatively close to the crest part of the field, ingress of the injected gas into the production wells, the decrease of the relative phase permeabilities due to the oil, and as a result of all this, the oil production in the production wells decreases and the gas production increases. Another proof of this is the decrease in oil production by increasing the volume of gas injected from the injection wells. On the other hand, regardless of its volume, the injected gas reduces the efficiency of the basic version of the injection process.

The dynamic or integrated model, created and tested on the basis of Azerbaijani fields, includes the solution of field development problems and the optimization of methods of formation stimulation, as well as the improvement of well performance control. The problems in this direction, such as bed-well unit hydrodynamic system, have been reviewed and the following issues have been developed. These issues are explored in detail in the next chapter.

The third chapter discusses the development of new methods for increasing the operational efficiency of wells in the development of oil and gas fields.

Operational management of liquid-gas mixture depending on the spatial geometry of risers, coordination of reservoir-well hydrodynamic systems and regular management of this relationship are considered to be the main elements of identification of hydrocarbon production. For this purpose, the operational characteristics of directional and vertical gas lift wells were compared. Depending on the geometrical position of the risers in annular space, the law of motion of the liquid-gas mixture was investigated and the equation was clarified.

In this chapter, two gas lift well start-up devices and an in-well working agent flow controller are developed in order to safely operate sandy directional gas lift wells. All three devices have a diameter of 89 mm and a length of 40 cm.

The equipment used to start the well and the flow regulator are structurally simpler than the bellows type "Г" valves used in holes today, and its development requires incomparably less cost.

In order to ensure efficient operation of wells with compressor-free gas lift, let's explain the structural features and working principle of the first unit for putting the used gas lift wells into operation.
It should be noted that the technological result of the application of the used device consists in regulating the gas transportation to the well, preventing the premature shutdown of the device, and successfully starting the wells. Figure 9 shows the scheme of the developed device.
The device consists of coupling 1, lower limit ring 2, moving groove 3, ball valve 4, saddle 5, 6, adjuster 7, spring 8, additional groove 9, washer 10, adjusting nut 11, additional limiting ring 12, body 13, annular channel 14 and radial channel 15.

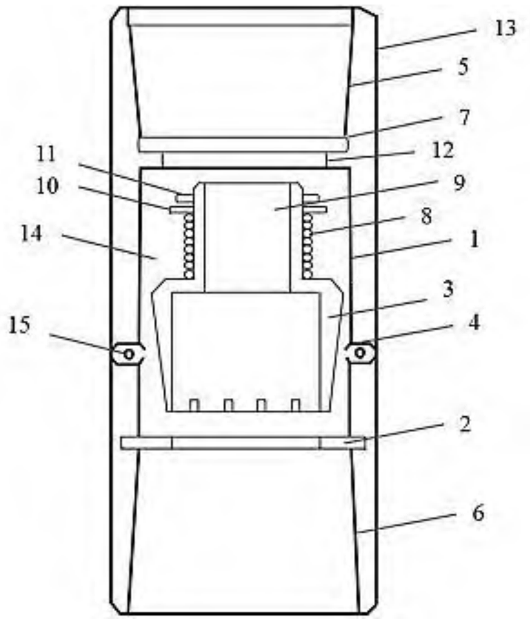

Figure 9. Scheme of the developed device I

The working principle of the device is as follows. Adjustments are made to prevent gas from entering the lift before the device is run into the well. This operation is carried out by adjusting nut 11 and spring 8. After the well start-up process equipment is adjusted and placed on the lift, it is run into the well, then it is assembled in the wellhead fittings and the gas is transported to the pipeline. The gas passes through the ball valve 4 through the radial channels 15 and enters the tubing. Above the depth where the gas is transported in the pipes, the liquid column gasifies and the pressure drops in front of the device. As a result, the speed of the gas entering the lift increases. The gas acts on the upper part of the moving groove, lifting it, as a result of which the washer rests on the limiting ring 10.

When the speed of the gas transported to the pipes increases further, the spring 8 is compressed, under the condition of gas regulation, the cavity continues to move up, a situation is obtained where the spheres 4 are pressed into the lower small diameter part of the cavity and hold the cavity in this position, the spheres 4 sit on the saddle 6, the gas moves to the elevator securely closes the access channel.

Thus, after the upper unit is closed, the liquid column is compressed by the pressure of the gas transported behind the pipeline, a part of it passes through the valve of the lower unit to the lifting pipes, and a part is compressed into the layer. As a result, the level of the liquid column behind the pipe drops, and the second device from above is freed from the liquid level, and the gas from behind the pipe enters the riser pipes from the 2nd device. The gas entering the tubes gasifies the gas-liquid column in the tubes above the 2nd device, the pressure in the tubes decreases, the cavity moving as in the first device rises up, the ball moves to the small diameter lower part of the cavity 4 and is pressed into the cavity and keeps it in this position.

At the same time, the ball 4 sits on the saddle 6 and closes the way for the gas to enter the lifting pipes, as in the device located above. In this way, the 2nd starting device is also ignited, the gas compresses the liquid column behind the tube by its pressure, freeing the 3rd device from the liquid cover as shown in the upper device, and the 3rd device is activated.

Thus, the actuation devices throughout the elevator are alternately activated and deactivated. In the process of work, all starting devices are closed, gas enters the pipes only from the shoe of the lifter. In this case, the well is fully exploited.

The spent unit reduces gas consumption during well start-up, allows to increase the production of the well, and also provides a reduction in the start-up time and turnaround of the well.

The technical and technological result of the solution of the second device developed for launching gas lift wells is to ensure the adoption of gas lift wells by simplifying the construction of the previously developed device and increasing its operational reliability.
For this purpose, in the radial channels of the coupling-shaped upper and lower limiter device with a ball valve and a moving slot inside, the radial channels are made at a sharp angle relative to the axis of the clutch, and the upper limiter and the moving slot are equipped with rings made of magnetic material, the same poles of which are placed in front of each other.
At the same time, it can move relative to the upper limiting clutch. Instead of the adjustment spring of the device, replacing the same poles with magnetic rings located in front of each other increases the reliability of the device. The implementation of radial channels at a sharp angle relative to the axis of the coupling ensures reliable closing of the ball valve.
Figure 10 and Figure 11 show the layout of the device along the elevator and the schematics of the device itself.
The device consists of a nipple 1 holding the lower limiter 2, a coupling 3 and radial channels 4 executed at an acute angle with its body; it consists of spheres 5 placed inside these channels, a fixed saddle 6 on which it sits, an unstable saddle 7, a moving groove 8 placed inside the coupling, and magnetic rings 10, 12 whose poles of the same name are placed in front of each other on its 9 and upper limiter 11 .
The working principle of the device. Before running the device into the well, it does this by changing the distance between the grooves 8, which ensure that the flow of gas from the back of the pipe into the pipes is interrupted. This operation is performed by rotating the upper limiter on the groove made inside the coupling (such an external groove is also made on the upper limiter). Then the device is placed on top of the riser pipes at a distance according to the calculation according to the scheme shown in figure 10 and released into the well. The wellhead is assembled to the fixture and gas is supplied to the wellbore and the development of the well begins.

The first moving notch 8 sits on top of the lower limiter 2. The gas compresses the liquid column behind the pipe, reaches the first injection device located above the lift from the wellhead. A part of the fluid that is compressed behind the pipe passes through the well launch devices into the pipe, and a part is absorbed by the formation. After the first launch device from above is freed from the liquid cover, the gas from behind the pipe enters the lifting pipes, passing through the radial channels 4 of the clutch 3 and the area formed between the ball and the fixed saddle 7, as well as the backs made in the lower part of the moving groove 8.

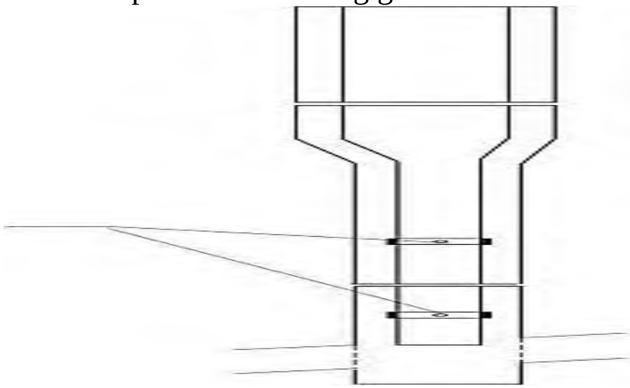

Figure 10. Scheme of location of the device along the lift

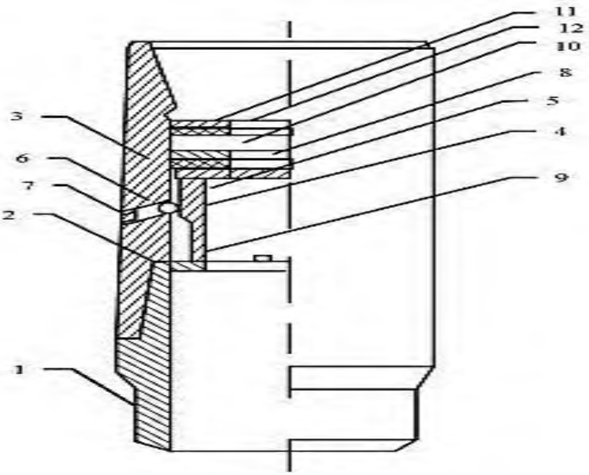

Figure 11. Scheme of the second device developed for running gas lift wells

Gas aerates the fluid in the tubing above the unit above and the pressure varies up to the wellhead. Aerated fluid is forced into the well flow line. The speed of the fluid increases in the moving cavity. A pressure drop occurs in the moving cavity. The pressure drop and the velocity head work together to overcome the 8 gravity of the moving cavity and lift it up. However, the upward movement of the moving engraving 8 is prevented by the mutually repelling force of the poles of the magnetic rings 10, 12 of the same name. When the velocity pressure of the liquid and the compensator of the pressure forces in the moving cavity overcome the compensator of the gravitational force of the cavity and the repulsive forces of the magnetic rings, the cavity moves up and its lower part stops in front of the sphere 5. Then the ball 5 gets the opportunity to move towards the axis of the lifting tubes, and it moves along the inclined surface of the radial channel 4 and sits on the fixed saddle 6, at the same time entering the outer small diameter area of the lower part of the moving groove and holding it in this position. In this case, the path of the gas from the back of the tube to the inside of the tube is closed, and the pressure of the gas firmly presses the ball against the 5 inner fixed saddles and the moving groove. Behind the pipe, the gas continues to compress the liquid level. The fluid continuously enters the tubes through the discharge devices arranged below along the elevator.

Thus, the level behind the pipe drops, and the second device from above is freed from the liquid cover, and the gas enters the pipes from behind the pipe, passing through the launch device of this well. The gas entering the pipes aerates the fluid in the pipes and raises it to the top of the well. At a certain speed of the liquid-gas mixture and as a result of the pressure drop in the cavity, the cavity moves up and prevents the movement of gas from behind the pipe to the pipes, as in the first device. The third, fourth and subsequent devices located below are activated similarly to the devices above. After the pipeline gas compresses the fluid up to the shoe of the riser pipes, it enters the shoe and lifts the fluid from the pipes to the wellhead.

Thus, the well is mastered from the slipper. Then the mode of operation of the well is established. Lifting pipes, working in the well established technological mode all the starting devices placed on it are closed.

If it is necessary to wash the sand plug in the well, then the delivery of the working agent to the back of the pipe is stopped. The well is depressurized, the fitting is opened at the mouth of the well, and the sand plug is washed by releasing washing pipes one by one from above.

During the well washing operation, in all injection devices, the ball 5 sits on the outer saddle of the device and prevents the washing fluid from passing behind the pipe. After the well is flushed, the wash pipes are lifted from the well, the fountain fittings are assembled, gas is supplied behind the pipe, and the well is mastered and put into operation as described above.

Thus, the washing operation is carried out without lifting the riser pipes and well starting devices from the well, which significantly reduces the repair time. This feature of the device makes it necessary to use it in offshore reservoirs.

It is known that preparing the gas in the offshore gas lift system and regulating its transportation to the wells creates technical and technological difficulties. These difficulties require the isolation of light hydrocarbon fractions and water vapors from the gas and its adjustment to ensure the consumption of the gas provided for in the technological mode in the conditions of the complex hydrodynamic relationship of the wells.

Various technological schemes and chemical compositions are known to dry the gas, process it and prevent hydrate formation. Various devices and regulators are used to regulate gas delivery to the well. These measures require large capital investment and service. In marine conditions, these measures create extremely great difficulties in a gas lift system without a compressor.

Therefore, a special in-well device (regulator) was developed to ensure efficient operation of wells with gas lift without compressor. The processed flow regulator regulates the amount of processed gas supplied to the well. Most importantly, this device keeps the bottom pressure in the well stable. This allows the well to be exploited in the established technological mode. Figure 12 shows the developed device schematically.

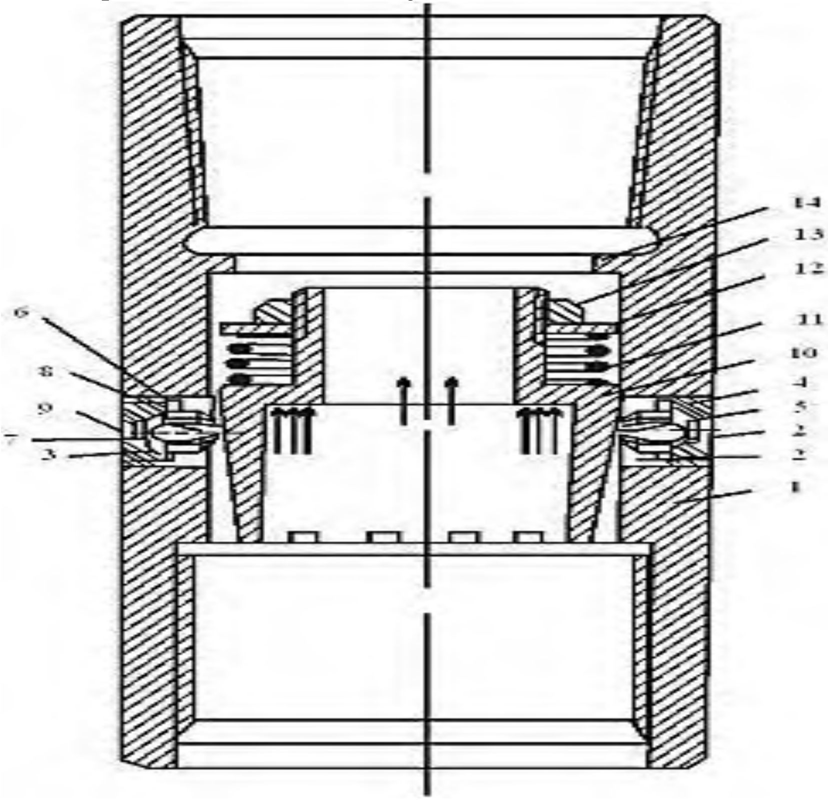

Figure 12. Schematic view of a special downhole device (flow regulator).

The device consists of a coupling 1, a radial channel 2, a valve 3, a body 4, a conical 6 and a spherical 7-sided connecting node 5, a conical 8 and a spherical 9-shaped saddle, a two-stage sliding groove 10 and a spring surrounding it from the outside in its small diameter part 11, a washer 12, It consists of a nut 13 that tightens the spring and adjusts the device, 14 that limits the sliding groove in the upper position, and a nipple 15 that acts as a seat in the lower part.

The operational principle of the device. Before the device is run into the well, by means of the adjustment nut 13, the spring 11 of the device is compressed according to the liquid-gas drop from the small diameter part of the sliding groove.

The device is placed on the riser pipes near the elevator shoe below the gas lift valves and acts as a working gas lift valve. After the equipment is run into the well, the working agent is transported behind the pipe, passes through the gas lift valves, enters the riser pipes, and aerates the liquid column in the pipes and compresses it into the flow line of the well. After the liquid column is compressed behind the pipe and run the device from the liquid cover, the gas directly passes through this device and enters the lifting pipes. In the device, the gas first enters the sliding groove 10 and when passing through its variable cross-section, a pressure drop occurs, the gas passing through the device into the pipes aerates the liquid, the density of the gasified liquid continuously decreases along the elevator.

As a result, the gas pressure drop in the device increases even more. This pressure drop occurs when passing through the large and small diameter sections of the sliding groove.

As the pressure of the liquid-gas mixture in the pipes decreases, the speed of the gas entering the pipes increases. The value of this pressure drop is $\Delta P = (P1 - P2)$.

Here: P1 is the gas pressure in the large diameter part of the sliding groove; P2 is the gas pressure in the small diameter part of the sliding groove.

When the pressure drop at the top exceeds the hammer of the sliding groove, the groove moves up, the washer 12 located under the adjustment nut 13 rests on the shoulder of the upper part of the clutch 1, the groove 10 continues its upward movement under the pressure of the gas, the spring 11 is compressed, as a result of the upward displacement of the groove 10, the connecting node 5 moves down by sliding along the outer conical surface of the 6 large diameter lower part of the groove.

As a result, the gas passing area between the sliding groove and the connecting node 10 increases and the volume of gas entering the pipes increases. If the amount of liquid from the well increases, then the density of the liquid-gas flow in the pipes increases, the pressure drop above decreases, the spring 11 pushes the sliding groove 10 down, the area formed between the connecting node 5 and the sliding groove 10 decreases, and the amount of gas entering the lifting pipes from this area decreases also shrinks.

It follows from this that the consumption of the working agent changes depending on the bottom pressure of the well, that is, the device can be adjusted in such a way that it keeps the bottom pressure stable in the working project of the formation and eliminates the influence of other wells and ensures that the well works in the established technological mode.

On the other hand, the device does not require the preparation of gas above the ground and the installation of a regulator in the gas line. This means that the probability of hydrate formation in the gas line decreases. If there is a gas object in the well, or the gas factor of the well itself is high, then the device makes it possible to use the gas lift scheme inside the well.

The service life of downhole equipment is determined based on the equipment's operating instructions.

Various accidents may occur in the well due to the lifting of the equipment (the packer is caught in the well, the gas lift valve is riveted in its groove, the cut-off valve is not closed, the rope breaks in the rope technique, etc.).

Ionomer and polymer, which can be used in improving the filtration properties of formations, sealing and other elements of oil well systems, cleaning the internal space of pipelines, separating fluid flows in wells and pipelines, conducting hydraulic fracturing of formations, changing the filtration properties of formations, in other technological operations and maintenance, multifunctional gelling compositions with a stable structure consisting of binders, nanoparticles and water, with high sand retention, colmoting and separation capabilities have been developed.

It is known that gas-condensate wells switch to pulsating mode due to fluid accumulation in the formation and wellbore when the formation (well bottom) pressure drops below the retrograde condensation pressure. Such operation of wells leads to premature failure of the bottom zone and well equipment, sand flow and accidents. Taking this into account, a well filter developed with a new technology for oil, gas and gas-condensate wells was developed. The filtering element of the filter from the inside, the outer diameter is equal to the outer diameter of the filtering element, the length is 200-250 mm, the thickness is 10 mm, on the outer surface, the lengthwise width and height of the channels correspond to the support shafts of the filtering element, holes are opened on the surface between two adjacent channels, and both ends are inward. It is equipped with a support joint with an inclination of 45° and attached to the shafts. Thanks to this, the strength of the filtering element increases. In order to avoid the problem of reducing the percolation area of the support junction, holes are opened in the area between the adjacent channels.

The proposed well screen is shown in Figure 13, with a cross-section of the support joint, with the placement of channels and holes on the support joint.

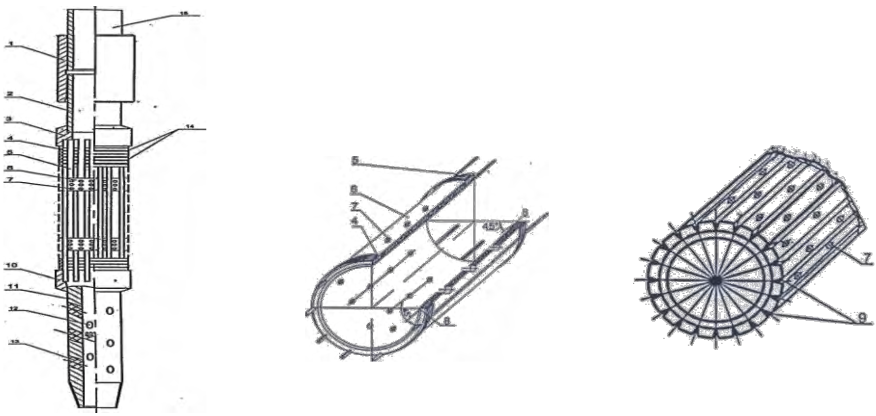

Figure 13. Well screen illustrated with support assembly and elements

The equipment assembly consists of the following parts: bracelet 1, nipple 2, upper protective threaded ring 3, cross-section triangular wire 4, support shafts 5, support joint 6 and holes opened on it 7, the support joint is inclined at an angle of 45° inward at both ends 8, channels opening on the support joint 9, lower protective threaded ring 10, connecting short tube 11, holes 12 directed at an angle of

60°, plugs of metal actively reacting with acid 13 and slits 14 between the wires.

The order of assembly, installation and operation of the well filter is as follows: On the support joint 6 with holes 7 on it and both ends inclined at an angle of 45° to the inside, the supporting shafts 5 are placed in the channels 9 opened along the circle at equal distance and fixed by welding. A wire with a triangular cross-section 4 is wound on the supporting shafts 5 with a given step and connected by point welding at their contact point. A protective threaded ring 3 is attached to the upper end of the filter element, and a protective threaded ring 10 is attached to the lower end. 1 nipple 2 is attached to the upper protective threaded ring with 3 bracelets. A connecting short tube 11 is connected to the lower threaded ring 10, which is connected to the metal plugs 13 that are actively reacted with acid to the holes 12, which are directed upwards and make an angle of 60° with the axis.

The assembled complete filter is run into the well through the tubing 15 and is installed in front of the operational facility by placing gravel behind it. The product (gas, gas-condensate) filtered from the layer under certain pressures passes through the gravel layer, through the slits 14 between the wires of the filter element and through the holes 7 on the support node 6, enters the filter and is lifted to the ground surface. 4 Particles with a diameter of less than 0.1 mm from the mechanical mixtures brought with the product from the formation are raised to the surface and the well is operated in a normal mode for a long time.

During the operation of the well, if for various reasons (silting of the gravel layer, clogging of the cracks in the wireline track with sand particles, etc.) the production efficiency decreases or stops completely, if formation sand and gravel are observed, if it is impossible to inject gas into the gas reservoirs, check the filter and eliminate the malfunction for lifting. It is necessary to remove the equipment set from the well. For this, the inside of the filter is washed and cleaned, a calculated volume of 15% hydrochloric acid is injected through the washing tubing and the pipes are raised 20-30 m above the acid level, the wellhead is hermetically sealed and the chemical reaction between the acid and plugs 13 is complete and it is kept quiet for 7-8 hours for the threaded holes 12 to fully open. During this time, the reaction between the acid and the plugs 13 opens the holes 12 and the connection between the interior of the filter and the space outside the filter is established. The washing operation is resumed by lowering the washing pipes. The gravel particles from the space of the filter enter the filter 12 through the upwardly directed holes and are lifted to the ground surface with the washing liquid. After the gravel pack filter is completely flushed from the site, the washing pipes are pulled out and the internal pipe holder is run into the well through the tubing, and the equipment assembly holding the filter is completely pulled out of the well without any complications. After the malfunction in the equipment is eliminated, the newly assembled set of equipment is run into the well and installed, and the well is put into operation.

The economic benefits of applying the filter are achieved through the income from the additional gas extracted from the wells, and the cost savings due to the reduction of the number of maintenance.

The influence of the liquid-gas system on the reservoir has been studied and a new method of increasing oil yield has been developed. Experiments were conducted on prepared homogeneous and layered non-homogeneous porous layer models. It was found that the displacement ratio during displacement of oil from pores with surfactant and gas mixture is higher than with all other working agents.

In the fourth chapter, the methods of determination of formation, formation-well parameters, injection based on hydrodynamic modeling of oil and gas fields, determining the location of new wells, and characteristics of inter-block connection were considered.

Based on the dimensions of the wellhead of the operational gas-condensate well, the method of determining the formation-well parameters is given. Here, the development of more effective methods for determining reservoir and well parameters in a new computational and graphical way by analyzing well data is one of the

main issues we are facing. This solution method is given in detail in the dissertation work.
Here, a similar problem is addressed, but differently, using wellhead data from a study of three steady-state gas wells. At the same time, the obtained data are processed by a new method, which allows to determine not only the values of coefficients a and $(b+\theta)$, but also the values of formation pressure and well mode, as shown below. The research results of the wells are given in table 9.

Table 9

Research results of wells

Well type	mode	$P_{lay}^{ölç}$, MPa	Q, th. m^3/day	$P_{q.a.}^2 e^{2S}$	$\frac{P_{lay}^2 - P_{q.a.i}^2 e^{2S_i}}{Q_i}$
Gas	1	25.0	100	611.0	0.14
	2	25.0	200	577.0	0.24
	3	25.0	300	523.0	0.34
	4	25.0	400	449.0	0.44
	5	25.0	500	355.0	0.54
Condensate	1	20.82*	115.5	419.9	0.1175
	2	20.82*	154.04	411.996	0.1394
	3	20.82*	203.88	397,67	0.1756
	4	20.82*	259.38	377.416	0.2161

The formula for this is written like this:

$$\begin{cases} P_{lay}^2 - P_{q.a.i}^2 e^{2S_2} = aQ_1 + (b+\theta)Q_1^2 \\ P_{lay}^2 - P_{q.a.i}^2 e^{2S_1} = aQ_2 + (b+\theta)Q_2^2 \end{cases} \quad (1)$$

where 1 and 2 correspond to mode numbers.
By solving the system equation
We have

$$P_{q.a.i}^2 e^{2S_1} - P_{q.a.i}^2 e^{2S_2} = a\,(Q_2 - Q_1) + (b+\theta)(Q_2^2 - Q_1^2) \quad (2)$$

If we divide each limit of equation (1 and 2) by $(Q_2 - Q_1)$) we get

$$\frac{P_{q.a.i}^2 e^{2S_1} - P_{q.a.i}^2 e^{2S_2}}{Q_2 - Q_1} = a + (b+\theta)(Q_2 + Q_1) \quad (3)$$

To determine the graph of formation pressure and coefficients a and $(b + \Theta)$ based on the data of the three modes of the well (Fig. 14), we define three points characterizing the dependence.

$$P_{q.a.i}^{2} e^{2S_1} - P_{q.a.i}^{2} e^{2S_2} \Big/ (Q_i - Q_1)^{Q_i + Q_1} \qquad (4)$$

Then the data obtained in three modes on the graph

$$P_{q.a.i}^{2} e^{2S_1} - P_{q.a.i}^{2} e^{2S_2} \Big/ (Q_i - Q_1)\ {}^{Q_i + Q_1} \qquad (5)$$

are plotted on the graph in coordinates (Fig. 14).

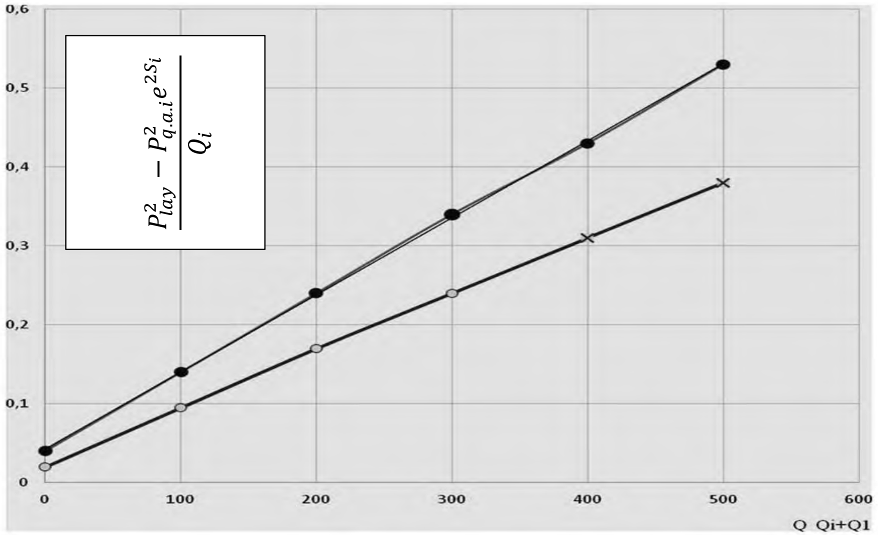

Figure 14. Comparison of the calculated results (x) of the conventionally applied (o) and proposed well survey methods without stopping the well

As can be seen from Figure 14, the dependences obtained by the two methods fall on a straight line, which indicates that the coefficients a and $(b + \Theta)$ can replace each other. Based on the above result, we determine the formation pressure according to the formula $P_{lay}^2 = P_{q.a.i}^2 e^{2S_i} + Q_i y_i$ without using coefficients. Here $y_i(Q_i + Q_1)$ is the numerical value of the i-th point of the corresponding y-axis.

Knowing the formation pressure

$$\frac{P_{lay}^2 - P_{q.a.i}^2 e^{2S_i}}{Q_i} = f(Q_i) \qquad (6)$$

we determine the two points of the mode parameters according to the known method and place them in figure 124 (table 10).

As can be seen from Figure 14, the new points lie on a common straight line with the previous ones, and the graphically determined values of a and $(b + \theta)$ agree with the above, indicating a good agreement between the indicator curves of the two interpretation methods.

Table 10

Results of research of wells in three modes

Well type	#mode	$P_{lay}^{ölç}$, MPa	Q_i+Q_1 min m^3/day	$P_{q.a.}^2 e^{2S}$	$\frac{P_{lay}^{2S} - P_{q.a.i}^{2S_i} e^{2S_i}}{Q_i - Q_1}$	P_{lay}^{qraf}, MPa	Q_{lay}^{qraf}, th. m^3/day	$P_{q.a.}^2 e^{2S}$ graph.
Gas	1	25.0	300	611.0	0.34	25.0	-	-
	2	25.0	400	577.0	0.44	25.0	-	-
	3	25.0	500	523.0	0.54	25.0	-	-
	4	-	-	-	-	25.0	400	449.0
	5	-	-	-	-	25.0	500	355.0
Condensate	1	-	-	-	-	20.82*	115.5	419.9
	2	20.82*	357.92	411.996	0.2874	20.82*	-	-
	3	20.82*	413.42	397,67	0.3283	20.82*	-	-
	4	20.82*	463.26	377.416	0.3698	20.82*	-	-

As can be seen from Figure 14, the curve constructed in coordinates in three modes $\frac{P_{lay}^2 - P_{q.a.i}^2 e^{2S_i}}{Q_i - Q_1} = f(Q_i + Q_1)$ and in five modes $\frac{P_{lay}^2 - P_{q.a.i}^2 e^{2S_i}}{Q_i} = f(Q_i)$ lie on a curved straight line constructed in coordinates.

Thus, according to the known values of formation pressure $P_{yi}^2 e^{2S_i}$ in three modes, according to the formula $P_{lay}^2 = P_{q.a.i}^2 e^{2S_i} + Q_i y_i$ the formation pressure is 25.0 MPa (measured = 25.0) will be equal.

In addition, the results of studies of gas condensate wells in four modes (table 10) are presented (see figure 14). Preliminary data and results of calculations are shown in table 10, and the table shows the compatibility of the formation pressure indicators determined by our simplified method with the indicators obtained by previously tested methods.
The results of the calculations (see table 10) show that the proposed graphical method allows determining the formation pressure with a fairly high accuracy in the stationary flow of gas and gas condensate, taking into account the wellhead parameters in the three operating modes of the well.
Modeling based on the data of the three modes of operation of the well allows to significantly reduce the labor volume of mining operations.
Thus, according to the proposed method, the amount of data obtained in 3 stationary operating modes is sufficient to estimate the hydrodynamic parameters of reservoirs and wells.
Here, data on wellhead parameters obtained during the study of three steady-state gas wells are used. At the same time, the obtained data are processed by a new method that allows determining not only the values of coefficients a and $(b + \theta)$, but also the values of formation pressure and well mode.
The results of the calculations allow the proposed graphical method to determine the formation pressure with a fairly high accuracy, taking into account the parameters of the wellhead in the stationary flow of gas and gas condensate, in the three operating modes of the well.
In this chapter, the method of determining permeability in oil fields (on the example of Gunashli field) is also developed. One of the main issues is the correct determination of the permeability of the layers in the calculation of oil and gas resources, in the development of field development projects and in general in their exploitation. In connection with this, hydrodynamic studies are carried out in the deposits by various methods, and as a result of them, formation pressures and leakage parameters of the formations are determined. In these studies, the pressure recovery method is more widely

applied. When conducting research with this method, the well is set to nonoperational mode for several hours, sometimes several days, a pressure recovery curve is established by means of a depth manometer inserted into the well, and then "touchers", Horner et al. The filtering parameters of the layers are calculated by methods. The disadvantage of these methods is that when the well is stopped to carry out research, it may lead to oil loss, formation of a sand plug due to the deposition of sand in some wells, etc. causes complications.

Hydrodynamic studies in wells in the reservoir are mainly carried out by the fixed mode method, that is, the operating mode of the studied well is changed with a wellhead plug, and after the mode is fixed, bottomhole pressure and production are measured and formation pressure is calculated with a known formula. After the reservoir pressure is calculated, permeability and percolation parameters are determined using Dupi's formula using other known parameters.

As is well known, Dupi's formula is given for hydrodynamically completed wells. Later, due to the characteristics of the degree of opening of the layer (spring), the percolation resistance coefficients c_1, c_2 were added in order to apply that formula to hydrodynamically incomplete wells.

The resistance coefficient c_1 is applied to wells where oil and gas enter through perforations from the production pipeline. In such wells, the filtration area S consists of the sum of the areas of the side surfaces of the channels opened by perforators. In order to make the calculation more accurate, it is possible to replace that area with a cylinder with an area equivalent to it.

The coefficient c_2 characterizes the degree of opening of the layer. Some literature shows that when using Shurov curves, to find c_2, it is necessary to determine the ratio of the opened layer thickness (z) to its total thickness (h). This relative opening expression (in percent) δ $\delta \frac{z}{h} 100$ is marked on the abscissa axis and the determination of c_2 is shown from the curves constructed between δ and a $(a=h/D)$. However, finding c_2 by this method does not give a true result. Thus, the full thickness of the layer (h) is not oil or gas, so the filter is not opened throughout this thickness, and the product does not enter the wellbore from the entire thickness. Therefore, instead of the expression "The entire thickness of the layer", it is necessary to use the expression "The effective thickness of the layer" and take it into account in the calculations (if there is a need to use the Shurov curve).

In most wells of the deposits, the effective thickness of the layers is completely drilled on separate horizons, and in some wells, a part of the horizon or the formation is drilled in. This situation is possible when the bottom of the layer and the latter is surrounded by a non-permeable layer. In this case, the effective thickness included in the formula must be taken as the effective thickness of that part, because other parts that make up the total effective thickness do not participate in the oil and gas ingress into the bottom of the well, and they should not be taken into account in the calculations.

If the effective layer thickness is fully opened, then it will be δ=100%. This means that the oil and gas thickness of the layer has been fully opened, and the c_2 coefficient here is equal to zero.

Taking into account the above, we can write the permeability from Dupi's formula for drilled and screened wells as follows:

$$k = \frac{Q\mu b_n \ln\frac{R_k}{r_{qekv}}}{2\pi h \Delta P} \qquad (7)$$

where k-conductivity, mkm^2; Q- liquid production of the well, t/day; h-layer effective thickness, m; ΔP-pressure difference, MPa; μ- liquid viscosity, mPas; b_n-volume coefficient; R_k – the radius of the feeding contour of the well, m; r_{qekv} is the equivalent radius of the well, m.

The advantage of this formula is that it is based on experimentally obtained without using Shurov curves, etc. it is possible to calculate well production and seepage parameters.

The obtained results are 2-5 times higher than the results calculated for conductivity ("touches", Horner), on average the conductivity is 10^{-3} mkm^2 for FLD (142-314), 10^3 mkm^2 for horizon X (115-385) and 10^3 mkm^2 for horizon IX (83-326) is 10^3 mkm^2 and completely matches the core data.

Without using experimentally obtained Shurov curves it is possible to calculate well production and seepage parameters

The reservoir properties of the layers of "Kursangi" and "Garabaghli" fields were studied and the layer parameters were determined. Structural maps of the "Kursangi" field by horizons, distribution maps of effective thickness, distribution maps of porosity, maps of changes in water saturation by area have been constructed.

As a result of the researches, the depths of the horizons, total and effective thicknesses, and tectonic breaks have been determined, and based on this, distribution maps of these parameters have been constructed for the I-VIII horizons.

Structural maps of the "Garabaghli" field by horizons, distribution maps of effective thickness, distribution maps of porosity, maps of changes in oil saturation by area have been constructed.

Based on the hydrodynamic model, the location of newly drilled wells has been determined. Thus, after the development of the "Kursangi" and "Garabaghli" fields was restored, the location and coordinates of the new well to be designed were determined using the distribution of the current oil saturation coefficient on the field, and the cutting peaks and total depth of each horizon were determined. The structural map of the "Kursangi" field (according to the ceiling of the 1st horizon) and the structural map of the "Garabaghli" field (according to the roof of the 1st horizon) are shown with the designed production wells.

In the process of restoration of development history, the reported values of oil, water, gas production indicators and pressure changes of each well and general field were superimposed (identified) with the actual data. The forecast of production indicators for "Kursangi" and "Garabaghli" fields has been given.

After the development history of "Kursangi" and "Garabaghli" fields was restored, using the distribution of the current oil saturation coefficient on the field, the location and coordinates of the newly designed well were determined, and the sectional peaks and total thickness of each horizon were determined. The structural map of the "Kursangi" field (according to the roof of the 1st horizon), the structural map of the "Garabaghli" field (according to the roof of the 1st horizon) and the location of the new wells are indicated, showing the designed production wells.

The injection process in oil fields in the final stage of development is modeled taking the Kurovdag field as an example.

After a fully functional hydrodynamic model was created and the development history was restored, the current state of residual oil saturation was determined for both I and Lower Absheron horizons. After the distribution of the final oil saturation, the location of the water-oil contour and the residual oil reserves are known, the locations of the injection wells for the injection process have been determined. Since both horizons are in the final stage of development and consist of a large number of tectonic blocks, in order to be efficient in the injection process, during the layout of injectors, in addition to the location and amount of residual oil reserves, the tectonic faults surrounding the horizon, the correlation of injection wells and production wells that will be influenced by them very serious attention has been paid. That is, although the injection process was modeled on a general horizon, the issue was solved locally within the framework of individual tectonic blocks to effectively obtain the result of the process. Therefore, it has been proposed to use mainly inactive stock and very small producing working wells as stimulating wells to cover tectonic blocks where more residual oil reserves have been accumulated.

After that, the proposed wells were placed in the hydrodynamic model of the horizons as water pumping wells, experimental calculations were made by giving the date of the start of injection, the depths to be pumped, the absorption capacities of the horizons (the volume of water to be injected), water injection pressures depending on the current formation pressures, etc. has been determined. Information about wells proposed for the I and Lower Absheron horizons is given in table 10.

In order to study the effect of the injection process in the model, production indicators were predicted during 10-year injection of the horizons, and these forecast indicators were compared with the forecast of the development indicators without injection. It should be noted that the drilling of new production wells was not planned during the forecast period.

The forecast of current oil production with and without injection for 10 years on the horizons is given.

The following results were obtained as a result of the modeling of the injection process in the I and Lower Absheron horizons of the Kurovdag field:

- It has been determined that the injection process is promising in the I and Lower Absheron horizons;
- 11 injection wells, including 8 wells from the active fund, 3 wells from the inactive fund, and 10 injection wells, including 5 wells from each of the active and inactive fund, were proposed for the Lower Absheron horizon;
- The possibility of injecting water into each well on the I horizon with a pressure of 12 MPa, with an average volume of 180 m^3/day, and with a pressure of 10 MPa, with an average volume of 155 m^3/day into the Lower Absheron horizon;
- In the process of drilling the I horizon, an additional 453,696 m^3 of oil, and 230,108 m^3 of oil from the Lower Absheron horizon, are forecasted within 10 years.

Later in this chapter, in the process of developing the "Bahar" field, the study of the inter-block connection and the interaction of the wells was studied on the basis of the model. It was determined that a number of wells cover a small drainage area with the main production wells located in the drainage area. Based on the map, it is possible to determine the effective placement of wells in blocks and to predict the drilling of the optimal number of production wells.

Similarly, maps of drainage zones of wells were constructed according to condensate production. Drainage coefficients were determined and mapped to determine the interaction between the wells in each horizon (X, QUQ).

As a result of the reports, a map of equal correlation coefficients was constructed, and based on this; it was determined whether the interaction between wells is weak or strong. It has been shown that correlation coefficients less than 0.5 indicate weak correlation between wells. Wells located in the field with a correlation coefficient greater than 0.5 are relatively highly correlated.

Also, using the material balance, the initial reserve and recoverable residual reserve of the X horizon and QUQ formations were evaluated,

the dynamics of pressure changes over the years were monitored and predicted.
The application of the new technologies and equipment developed in the fifth chapter is reflected in mining conditions.
H.Z. Tests were carried out on the equipment of the groundwater disposal service area at the Tagiyev OGPD. During the tests, 3 tons of the anti-salt precipitation agent was injected into the reservoir with a volume of 100 tons of formation water and left there for 30 minutes with a 2-hour break. Comparisons of relevant analyses were made before and after the application of the agent. As a result of injecting a new composition treated against inorganic salt precipitation, the increase in the amount of ions in all cases indicates that salt precipitation is prevented by the effect of the processed composition.

Application of the newly developed technology for water isolation with a gel-forming composition for the purpose of water isolation in wells No. 2649, 2210, 1858, 1134, 2619, 2674, 2063, 2676, 1922, 1939, 2686, 2687 of "Oil Rocks" OGPD 2019-2021 - In 2010, application works were carried out using the gel-forming composition and a total of 391 tons of additional oil was obtained.

The application of well screen for gas and gas-condensate wells based on new technology, it was possible to increase the time between repairs and flow by preventing the mechanical mixtures that filtered to the bottom of the well and could not be lifted by applying the well bottom filter equipment. In the "28 May" OGPD, the application of the bottom wire screen filter complex was carried out in wells #222 with sand production. While the daily production was 35 tons of oil and 22 tons of water before the application, after the application, 80 tons of oil without water and 17000 m^3/day of gas were put into operation, and in addition, 580 tons of oil and 1.5 million m^3 of gas were recovered.

MAIN OUTCOMES

1. Permanent hydrodynamic models of Azerbaijan oil and gas fields have been created:

- Based on the development project of the "Karabagh" field, the assessment of the potential of the "Ashrafi", "Aypara" fields was investigated;

- Geological and hydrodynamic models of "Ashrafi" and "Aypara" structures were established and production indicators were predicted;

- Based on the hydrodynamic model established for the "Kursangi" and "Garabaghli" fields, the location of newly drilled wells has been determined. Thus, after the restoration of the development status of the "Kursangi" and "Garabagli" fields, the location and coordinates of the new, to be designed well were determined using the distribution of the current oil saturation coefficient on the field, the cutting peaks and total depth of each horizon were determined;

- The 3D geological model of the "Umid" field, built on the V and VII horizons, was "upscaled" and a hydrodynamic "grid" was obtained and all information was provided. The geological model is loaded into the hydrodynamic model. By using the analogy of "Shah Deniz" field data, single hydrodynamic models of V and VII horizons were established and the development history was restored. In 3 different versions, the development plan of V and VII horizons was drawn up and the development indicators of these horizons were predicted until 2040;

- On the basis of the hydrodynamic model developed for the "Bahar" field, drainage coefficients were determined and maps were constructed to determine the interaction between the wells in each horizon (X, QUQ). It was determined that a number of wells cover a small drainage area by being located in the drainage area of the main operational wells. At the same time, the initial reserve and recoverable residual reserve of the X horizon and QUQ formation were evaluated, the dynamics of pressure changes over the years were monitored and predicted.

2. On the basis of modeling of Azerbaijan oil and gas fields, methods of stimulating the formation have been designed:

- The optimal location of the wells to be used for injection in the "Shallow Water Gunashli" field in the structure, the optimal amount of water that can be injected, the effect of the injected water on the performance indicators of the "Shallow Water Gunashli" field has been studied, and the effectiveness of the injection process, which is intended to be intensified, has been predicted;

- The optimal placement of injection wells in the structure, the optimal volume of injected gas and the effect on performance indicators for gas injection in the "Shallow Water Gunashli" field were studied, and the effectiveness of the gas injection process was predicted;

- As a result of the modeling of the injection process in the horizons of the Kurovdag field, it was determined that the injection process in the I and Lower Absheron horizons is promising. In the process of drilling the I horizon, additional 453,696 m3 of oil, and 230,108 m3 of oil from the Lower Absheron horizon are forecasted within 10 years.

3. Mathematical and technological methods have been developed in order to increase the operational efficiency of gas lift wells:

- A mathematical model was developed for determining the pressure gradient based on the method of group calculation of arguments in gas lift wells;

- In order to ensure the efficient operation of gaslift wells and to supply the technologically prepared gas to the well in the required volume, flow regulators and start-up devices have been developed.

4. New methods of interpretation of oil and gas-condensate field studies have been developed:

- A new method of interpretation of studies of oil wells in undecided mode was developed;

- The method of determining the parameters of the reservoir and the well was developed based on the wellhead data without saving the gas-condensate well.

5. New methods have been developed to increase the operating efficiency of oil and gas wells:

-Gel-forming ingredients for technological operations have been developed;

- A well filter for gas and gas-condensate wells has been developed;

- Compositions have been developed to prevent inorganic salt deposits.

6. The influence of the liquid-gas system on the formation was studied and a new method of incremental oil yield was developed. Experiments were conducted on prepared homogeneous and layered non-homogeneous porous layer models. As a result of the experiments, the following results were obtained:

- the final oil displacement coefficient is 3.9% higher than the horizontal position of the model during the compression of oil with gas from the model of a homogeneous porous layer whose upstream is 45° higher than the downstream. If the upstream angle is 45° lower than the downstream, the oil displacement is higher in both cases (9.4% and 5.5%, respectively);

- the final oil displacement coefficient is 2.2% higher than the horizontal position of the model during the compression of oil with gas from the non-homogeneous porous layer model, the upstream of which is 45° higher than the downstream. If the upstream angle is 45° below the downstream, the oil displacement is higher in both cases (7.7% and 5.5%, respectively);

- during compression of oil with water and gas portions, the coefficient of compression with oil in a homogeneous medium is 7.1% higher than the coefficient of compression with oil in a layered non-homogeneous medium;

-When comparing surfactant solution and gas compression with water-gas mixture compression, the coefficient of compression with oil is 15.2% higher in a homogeneous porous medium, and 14.3% higher in a layered non-homogeneous porous medium;

- it was determined that the compression coefficient during compression of oil from pores with surfactant and gas mixture is higher than with all other working agents.

7. The proposed methods have been successfully applied in production:

-In order to eliminate the salt precipitation occurring in the equipment of the groundwater disposal service area at the H.Z. Tagiyev National Water Treatment Plant, a new inorganic composition was applied to the groundwater;

- 391 tons of additional oil as a result of the application of the gel-forming composition processed for the purpose of water isolation in the "Oil Rocks" OGPD, and 580 tons of oil and 1.5 million m^3 of gas in addition to the application of the well bottom wire screen filter complex in combat with th sand production in the "28 May" OGPD received. In general, 971 tons of additional oil and 1.5 million m^3 of gas were produced due to the application of the results of the dissertation.

The main outcomes of the dissertation have been published in the following proceedings and academic periodicals

1. Abdullayev, V.D., Abbasov, Z.Ya., Yusifov, Yu.B. The method of determining the properties of layers and wells by measurements at an operational wellhead // News of ANAS, Baku 1998, No. 2, pp. 44-47.
2. Abdullayev, V.C., Hamidov, N.N. Study of phase transformations of gas transported from the "Bulla-Daniz" and Narimanov gas reservoirs // "Khazarneftgazyatag-2004" scientific-practical conference reports, November 2004, pp. 148-151.
3. Abdullayev, V.C. Ways to enhance the productivity of wells operating on gas lift method in the "Gunashli" field // "Khazarneftgazyatag-2004" scientific-practical conference reports, November 2004, pp. 151-155.
4. Abdullayev, V.C., Ismayilov, Sh.Z. The method of determination of permeability in oil fields // Azerbaijan oil industry, 2005, No. 4, pp. 25-28.
5. Abdullaev, V.D., Huseynov, M.A., Nabiev, K.M. Investigation of the degree of permeability of tectonic fractures in the process of development of the "Bahar" field //Proceedings of the IX

International Energy Forum "Gas and oil LPG". Yalta 14-16 September 2006, pp. 1.
6. Abdullayev, V.C., Huseynov, M.A., Nabiyev, K.M. Study of the interaction between blocks and wells in the development process of the "Bahar" field // Scientific works of the "Neftgazlayiha" Institute, 2008, No. 24, pp. 96-100.
7. Abdullayev, V.C., Huseynov, M.A., Mustafayev, R.T., Hasanaliyev, M.G. Construction of geological models of the PS01 and AP01 horizons of the Kurovdag field // Scientific Works of the "Neftgazlaiyha" Institute 2009, No. 25 pp. 10-17.
8. Abdullayev, V.C., Huseynov, M.A., Nabiyev, K.M., Hamidov, N.N. Modeling of the injection process in the "Kurovdag" field / Scientific Works of the "Neftgazlaiyha" Institute, 2009, No. 25, pp. 93-101
9. Huseynov, M.A., Abdullayev, V.C., Nabiyev, K.M., Hamidov, N.N. On the construction of the hydrodynamic model of the prospective structure and the prediction of performance indicators // Azerbaijan oil industry, 2009, No. 8-9, pp. 79-81.
10. Abdullayev, V.D., Huseynov, M.A., Nabiev, K.M., Gamidov, N.N. On the creation of a hydrodynamic model and forecasting of indicators for the development of a perspective gas-condensate structure // Scientific Works of the "Oilgasscientificresearchproject" Institute, 2010, No. 1, pp. 29-33.
11. Abdullayev, V.C., Huseynov, M.A., Hamidov, N.N., Safarov H.A. Modeling of the injection process in oil fields at the final stage of development // Azerbaijan oil industry, 2010, No. 5, pp. 22-25.
12. Huseynov, M.A., Abdullayev, V.C., Hamidov, N.N., Nabiyev, K.M. Prediction of production indicators of designed wells using modern software // Azerbaijan oil industry, 2010, No. 12, pp. 23-25.
13. Abdullayev, V.D., Huseynov, M.A., Nabiev, K.M., Gamidov, N.N. Study of water injection into the Deep Water section of "Gunashli" to displace it to the shallow part with the installation of a hydrodynamic model // Abstracts of the Proceedings of the International Scientific-Practical Conference "New Technologies in Oil Recovery", February 25-26, 2010, pp. 75.

14. Abdullayev, V.D., Gamidov, N.N. Forecasting indicators of the development of a prospective gas-condensate structure using a hydrodynamic model // Materials of the International scientific-practical conference "Contemporary problems of the oil and gas complex of Kazakhstan", Aktau, February 23-25, 2011, Volume I, pp. 256-258.
15. Abdullayev, V.D. Investigation of the influence of water injection and changes in field development indicators using a hydrodynamic model // Materials of the International scientific and practical conference "Modern problems of the oil and gas complex of Kazakhstan", Aktau, February 23-25, 2011, Volume I, pp. 262-265.
16. Abdullayev, V.D. Modeling of stimulation of oil reservoirs at the later stage of development//Abstracts of reports of the VIII International scientific and practical oil and gas conference "Using innovative approaches to increase the efficiency of drilling and well repair", Kislovodsk, October 10-14, 2011, pp. 35.
17. Abdullayev, V.D., Mammadov, T.N. Comparison of reservoir simulator and grids. pp 108-110.
18. Suleymanov, B.A., Abdullaye,v V.C. Gel forming composition. Patent of the Republic of Azerbaijan İ20120048, 2012.
19. Abdullayev, V.D. Study of intensification of water injection based on modeling the development process of the Gunashli field // “Oilgasscientificresearchproject” Institute, Scientific Works, 2012, No. 1, pp.16-24.
20. Abdullayev, V.D. Modeling the process of water injection into oil fields at a late stage of development // Proceedings of the V International Scientific and Practical Conference “Problems of Innovative Development of the Oil and Gas Industry”, KBTU, Almaty, February 21-22, 2013, pp. 279-280.
21. Abdullayev, V.D., Mammadov, T.N. Comparison of grids and unstructured gridding approach in optimization of hydrodynamic modeling // Materials of the International scientific and practical conference “Innovative development of the oil and gas complex of Kazakhstan”, Aktau, April 25-26, 2013, part 1, pp. 62-64.
22. Abdullayev, V.D. Study of the impact of water injection on the development indicators of the Gunashli field // Materials of the

International Scientific and Practical Conference, "Innovative development of the oil and gas complex of Kazakhstan", Aktau April 25-26, 2013, part 1, pp. 204-207.
23. Abdullayev, V.D., Gamidov, N.N. Hydrodynamic modeling and forecasting of indicators for the development of promising structures // Materials of the International scientific and practical conference "Innovative development of the oil and gas complex of Kazakhstan", Aktau, April 25-26, 2013, part 1, pp. 207-210.
24. Abdullayev, V.D. Method for determining the dynamic pressure gradient in directional gas-lift wells//X International Scientific and Practical Oil and Gas Conference dedicated to the 50th anniversary of the creation of SEVKAVNIPIGAZ and the 20th anniversary of the North Caucasus Research Design Institute of Natural Gas OJSC, Stavropol, October 21-24, 2013 , pp. 65-66.
25. Abdullayev, V.D. Modeling and forecasting of horizontal well performance // XI International Scientific and Practical Oil and Gas Conference Kislovodsk, October 27-31, 2014, pp. 58-59.
26. Ismayilov, F.S., Suleymanov, B.A., Abdullayev, V.C., Valiyev, E.F., Bayramova, Sh.S. Gelatinizing composition Patent of the Republic of Azerbaijan I 20140033, 2014.
27. Huseynov, M.A., Abdullayev, V.C., Hamidov, N.N., Heydarov, O.I., Maharov C.Sh., Gasimov I.A. Prediction of operational indicators of horizontal wells based on formation and well models // Azerbaijan oil economy, 2014, No. 5, pp. 13-18.
28. Abdullayev, V.D., Huseynov, M.A., Ismayilov, M.M., Nabiyev, K.M. Creation of a three-dimensional geological model of the Gunashli field to increase the efficiency of additional development // SOCAR Proceedings, 2014, No. 2, pp. 75-82.
29. Abdullayev, V.D., Huseynov, M.A., Hamidov, N.N. Forecasting the operating modes of a horizontal well depending on various parameters, XII International Scientific and Practical Oil and Gas Conference // Kislovodsk, September 28-October 2, 2015, pp. 26-27.
30. Abdullayev, V.D., Ibrahimov, Kh.M.,.Kazimov, F.K. Shafiyev, T.Kh.Experimental studies of oil displacement by gas and water-gas mixtures // SOCAR Proceedings, 2016, No. 1 pp. 51-57.

31. Mammadov, T., Javadzade, R., Abdullayev, V. Impact of Thin Oil-rim to the Development of Gaz-condensate Fields in the south caspian Basin // SPE-189010-MS, SPEAnnual Caspian Technical Conference and Exhibition held in Baku, Azerbaijan, 1-3 November 2017, 13 p.
32. Ismayilov, F.S., Nasibov, S.M., Kazimov, Sh.P., Afandiyev, I.Y., Abdullayev, V.C. Well screen for gas and gas-condensate wells. Patent of the Republic of Azerbaijan I20200008, 2020.
33. Abdullayev, V.D. Comparative study of the operational characteristics of directional and vertical gas-lift wells and study of the influence of pressure gradient // SOCAR Proceedings 2020, No. 3 pp. 108-116.
34. Abdullayev, V.C. New approach for two-phase flow calcuation of artifical lift // SOCAR Proceedings 2021, № 1, p.49-54.
35. Ismayilov, S.Z., Abdullayev, V.C., Garagozov, E.Sh., Qasımov, I.A., Ismayilov, Z.Z. Application of drilling of multilateral well on the basis of new technology and model in south Caspian basin // SOCAR Proceedings 2021, № 3, p.31-35.
36. Abdullayev, V.C. Comparative investigation of operational characteristics of inclined and vertical gas lift wells and study of the effect of pressure gradient//Scientific Petroleum, 2021, No. 1, p. 46-55.
37. Abdullayev, V.C. The main directions of creating geological-technological (hydrodynamic) models of oil and oil-gas fields under constant operation, Baku, 2021, 160 pages.
38. Samadov, A.M., Agha-zadeh, A.D., Ismayilov, O.D., Abdullayev, V.C. Composition to prevent inorganic salt deposits formed during oil and gas production in wells. Patent of the Republic of Azerbaijan I 20210088, 2021.
39. Abdullayev, V.C. A special regulatory downhole equipment for gaslift wells // Scientific Petroleum, 2022, No. 1, pp.46-51.
40. Abdullayev, V. J. Study of the law of motion of a gas-liquid mixture and determination of the equation depending on the geometric position of the risers in annulus // Bulatov Readings, Krasnodar 2022, No. 1, pp. 143-149.

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