GEOLOGY

UDC 622.276

https://doi.org/10.33271/nvngu/2021-2/005

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THE OPTIMAL METHOD FOR ASSESSING GAS RESERVES BASED ON THE CALCULATION OF GAS HYDRODYNAMIC PARAMETERS

Purpose. Development of a new methodology for calculating gas reserves for gas wells of any productivity.

Methodology. The calculation method was developed using the theoretical provisions of gas dynamics. It is based on the actual data from the study on gas wells in one developed mode.

Findings. For the first time, a methodology for calculating gas reserves was proposed during the development of one study mode. In parallel with the calculation of gas reserves, the possibility of analytical calculation of a significant number of gas-hydrodynamic parameters opens up.

Originality. The developed methods for calculating the value of the initial gas reserves and gas-hydrodynamic parameters of the studied gas objects have no analogs in domestic and world practice. The first of the methods is distinguished by the simplicity of calculation and the availability of the initial data for its use. The second is based on the differential, differential-integral, and integral methods to improve the accuracy of the calculated results.

Practical value. The new methods for calculating gas reserves will make it possible to quickly assess hydrocarbon raw materials in the investigated object. The availability, minimization, and accuracy of the initial data for calculating gas reserves are undoubtedly signs of the optimality of the method. The simplicity of the calculation makes it possible to widely use the technique. The use of a new methodology for interpreting the results of gas well research in one mode will make it possible to depart from the traditional research method. Due to this, the number of research modes is reduced by several times. It also means a reduction in emissions to the atmosphere if the well is not operated with backpressure at the wellhead. A significant reduction in the cost of the research process due to the reduction in research time is also a factor in significant savings in research funds.

Keywords: *well survey, method for calculating gas reserves, gas-saturated formations, gas-hydrodynamic parameters*

Introduction. Identifying gas reserves in each reservoir, the field as a whole and in all gas provinces is a very important task because the determination of gas reserves makes it possible to develop a strategic direction for investment in the gas industry.

To calculate the reserves of hydrocarbon raw materials, a multifaceted geological study on the field is required, with which oil and gas deposits are associated as well as knowledge of the peculiarities of their occurrence.

The accuracy of calculating gas reserves in gas wells depends on the quality of the industrial material obtained. When carrying out the necessary and high-quality complex of studies, the number of exploration wells can be significantly reduced. And at the same time, you can get complete data for calculating stocks.

The first calculations of hydrocarbon raw materials were carried out by the volumetric method and were of a random nature. From the literature it is known that the first calculation of reserves was carried out in the Crimean and Ilskiy districts of the Kuban in 1888. Subsequently, in 1921 the calculations were carried out by S. I. Charnotskiy using the simple statistical method. The systematic calculation of reserves began in 1926–1928. Since then, the issue of calculating reserves has been repeatedly revised. New methods were added that, to one degree or another, could claim universality. Estimates of reserves of raw materials are required for each layer or horizon, identified in the context of the field. Reserves of oil or gas and accompanying components present in them are divided into two groups according to their value. They belong to separate counting and control. The first includes balance reserves. Their development is economically feasible. The second includes off-balance reserves. Their development is currently unprofitable. But they can be considered as potential for future development.

The classification of underground reserves of a particular oil or gas reservoir is based on the degree of its exploration. Accordingly, reserves are divided into five categories:

prepared – A1;
explored – A2;
visible – B;
estimated – C1;
promising – C2.

Prepared are those that can be obtained from the formation using wells already drilled, in production or temporarily in production. To obtain raw materials from such wells, additional capital investments are not needed if the equipment and funds required to launch the wells were temporarily idle, if not to take into account the equipment and funds needed to put the wells into operation.

Explored reserves are those that can be obtained from new wells drilled in a given area. Moreover, for their laying, additional exploration work is not required.

Visible reserves can be obtained from new wells in sections of the gas-bearing horizon, whose sections are illuminated by logging data. At the same time, the reservoir itself has not yet been delineated, and new exploration wells must be drilled to carry out the delineation.

Promising reserves are reserves at horizons, whose productivity has not been established for boreholes, but it is assumed by analogy with production areas located in the same gas-bearing province.

It has been established that complex physical phenomena occur in the reservoir, on which the recovery of the reservoir depends. In particular, the lithological composition of the rock, the physical characteristics of the fluid saturating the formation, the pressure in the formation, the presence of residual water in the formation, and so on [1]. Hence, it becomes clear that the calculation of gas reserves is a complex and laborious research problem that requires a comprehensive study on oil and gas reservoirs for its solution.

Gas reserves that can be obtained from the subsoil with the modern level of gas production technology are called balance reserves. The reserves that remain in the reservoir are off-balance sheet. Off-balance sheet gas reserves are not calculated. The composition of gases is very different; therefore, the reserves are calculated taking into account the composition (grade) of the gas.

Form and area, as well as thickness, reservoir properties, gas saturation and performance characteristics of productive strata (horizons) play a decisive role in the industrial assessment of field reserves. Moreover, the thickness of the productive horizons or individual reservoir layers can vary from a few centimeters to tens or even hundreds of meters.

In the balance sheet reserves of hydrocarbons, the withdrawn reserves are allocated and accounted for. There are those that can be removed with the most complete and rational use of modern technical means and technologies.

For gas fields put into development, it is possible to transfer reserves to higher categories. Such a transition is carried out according to the data of drilling and operation of production wells. In some cases, data from additional exploration wells are used for this.

That is, counting reserves is a complex change. And it requires complex and responsible technical and technological solutions.

Literature review. Under natural conditions, industrial gas accumulations occur both in the form of free gas in purely gas deposits or in gas caps of oil and gas fields and in oil deposits in the form of gas dissolved in oil. Even when it is in a dissolved state in oil, its amount can be quite significant and sufficient for use for the needs of industry and on a wider scale (at factories for synthetic raw materials, gasoline production, and so on). Naturally, due to different conditions of gas occurrence, there can be a different approach to determining its reserves.

If we analyze the methods which are now used to calculate gas reserves, it becomes clear that they are suitable precisely for different conditions.

The most commonly used one is volumetric method. In addition, there is also a method for calculating free gas reserves from data on the drop in reservoir pressure (sometimes it is called statistical or material balance method). Also, at one time, a modern new method was proposed and a material balance formula was derived, taking into account the component-wise production of formation fluids, changes in their physical properties during the development of the reservoir, the compressibility of the rock and the flow of water into the reservoir. This technique can be used for both gas and oil deposits. In this case, it is necessary to take into account the information connection between the calculation of reserves and gas-hydrodynamic studies in wells [2, 3]. This is due to the fact that the output data [4, 5], which are obtained in the study on wells, can serve as input data for the methods for calculating hydrocarbon reserves. The main problem is that the traditional approach to well testing allows obtaining a sufficient number of physical indicators [6]. That is, the possibilities of traditional well survey in this regard are limited. And then geophysical and laboratory studies come to the rescue. That is, it is logical to look for such ways to estimate reserves that would avoid laboratory or geophysical methods. In addition, the latter are not highly accurate and require a certain amount of work in the wells. The time taken to implement these methods should also be considered.

Purpose. The purpose of the research is to find new approaches to solving the problem of calculating the initial reserves of free gas. The basis for this was the existing methods for calculating free gas reserves and the base of initial data for calculating reserves.

To achieve the intended goal, the following steps were taken:

- to set the value of the output parameters for calculations;
- to solve the problem of finding a new method for calculating gas reserves in the best possible way.

The synergy of the two main stages will provide the necessary basis for a new way of calculating reserves.

Methods. The specified task for today can be considered theoretically solved. The developed method for preliminary calculation of the value of the initial gas reserves in gas wells, thanks to which it has become possible to calculate the reserves based on the actual data of the study on the gas object in only one mode, regardless of the nature of the gas flow to the bottom of the well.

This technique is the result of not only the analysis of existing methods for calculating gas reserves and their suitability for use in the case of research. At the same time, the availability and accuracy of parameters were also analyzed, which can be the basis for a new method for calculating reserves, as well as minimizing them in quantitative terms. It turned out that the technique not only solves the problem of calculating reserves, but, along with that, allows simultaneously solving the problem of analytical determination of a significant number of gas hydrodynamic parameters of gas wells, some of which were previously found using laboratory or geophysical methods. It is about porosity or net pay.

The method for the study on gas wells was developed in two versions. The first one is for gas wells of medium and low productivity. The second one is for exploration of high-rate gas wells. Traditional known methods were used to create a new method for investigating medium-rate gas wells in industrial practice. For example, these are the method of constant sampling, isochronous method, express method, method of monotonous – stepwise change in production rates. All of them require 5–8 study modes. In this case, each mode consists of opening the well to operate in the mode and then closing the well to stop its operation. Reservoir pressure is recorded P_{res}, as well as bottomhole pressure P_{bot} and gas flow Q. The value $P_{res}^2 - P_{bot}^2$ on different modes is calculated. Next, we build a graphical relationship between $\frac{P_{res}^2 - P_{bot}^2}{Q}$ and Q. The resulting curve allows us to determine the coefficients of linear A and inertial resistance B of the equation of gas inflow to the bottom of the well. The method for their determination is graphical. If the reservoir pressure is unknown, the coefficients of the inflow equation can be calculated analytically using the known formulas. At the same time, the information result is 5–7 gas-hydrodynamic parameters of the studied objects together with the coefficients of the inflow equation.

New methods of research do not require practicing 5–8 modes. It is enough to work out only one mode. In this case, the readings of the change in pressure over time are recorded. That is, the so-called inflow curve and the pressure build-up curve are recorded (for an open, operating well and a closed one, respectively). The new method for calculating the gas-hydrodynamic parameters of gas wells uses these two curves for interpretation.

Based on the mathematical processing of these curves, it is possible to analytically calculate the coefficients of the inflow equation and at least twenty more gas-hydrodynamic parameters of gas wells.

The most valuable is the analytical calculation of the porosity coefficient and the effective thickness of the reservoir. No other methodology can provide an analytical definition of these indicators.

In addition, the following are calculated: the cumulative radius of the well, the skin effect, the radius of the drainage contour, gas permeability near the bottom and remote zones of the formation, the plugging factor, the productivity factor, the coefficients of permeability and conductivity, the effective pore diameter of the reservoir, and so on. That is, the effectiveness of the calculation increases several times. Moreover, all gas-hydrodynamic parameters are found analytically. This eliminates instrumentation measurements. Also, you do not need to apply geophysical methods to measure certain indicators, which have so far been used in calculating gas reserves. First of all, we are talking about the analytical calculation of the porosity factor and the effective reservoir thickness. That is, analytically obtained results are always considered accurate. In comparison with them, measurements with instruments depend on their accuracy class and carry a certain error.

That is, new methods of well survey allow obtaining a significant number of physical indicators. Among them there are those that are necessary and sufficient for calculating gas reserves using a new method. This means self-sufficiency of the gas well survey in one mode.

In contrast to the methods for calculating the gas-hydrodynamic parameters of gas wells of any productivity, the latter are relatively complex. And it consists in the application of differential, integral and differential-integral methods.

The method for calculating gas reserves, as opposed to the method for calculating the hydro-gas-dynamic parameters of gas-saturated objects, is quite simple and available in practical application.

To implement the method for calculating gas reserves, it is not even necessary to have a software product, since the simplicity of the formula and the availability of the initial data do not require a significant amount of calculations. However, to speed up calculations, such a program was compiled by the authors in the Mathcad environment. According to the calculation of the gas-hydrodynamic parameters of the formations based on the data of gas wells studies in one mode, such software products have been developed and they are needed for calculations, since the number of calculations is significant and rather complicated. This approach is justified from the point of view of the accuracy of the results obtained. That is, the quality of these parameters is much higher than when traditional research methods (in 5–8 modes) and the methods that serve are used for the same purpose.

Interesting and important is the ability to also calculate the permeability coefficient, the piezoconductivity coefficient, the actual gas flow rate from the formation, and the macro-roughness parameter. This is because they have been only components of the so-called complex parameters.

Thus, it is possible to solve practically two problems – to calculate the initial gas reserves and obtain a full range of gas-hydrodynamic information about the object under study.

First, we consider the currently existing methods of calculating gas reserves. Let us analyze the possibilities of existing methods.

The main method for calculating free gas reserves is the volumetric method. The pressure drop method is also widely used. To determine the initial amount of gas in the reservoir, the results of studying the geological, physical and chemical properties of the object can be used. The physical properties of the gas are also used. It is necessary to have data on reservoir pressure, temperature and chemical composition of the gas. The behavior of the gas in the process of changing pressure and temperature also plays a role. All these indicators for gas objects can be obtained without much effort due to the constancy of the gas composition and its homogeneity. At the same time, the initial data for its use can be obtained at the exploration stage and, if possible, when carrying out a trial operation of a gas deposit. However, the trial production mode is available mainly for shallow wells through technological and technical difficulties.

To use the volumetric method for calculating gas reserves, it is necessary to perform a certain number of works. These include the correlation of well sections to identify the lithological and stratigraphic complex of oil and gas bearing layers and impermeable separations between them. It is also necessary to identify reservoirs and determine the gas-hydrodynamic parameters of the reservoir and the fluids saturating it. As a result of this list of works, it is possible to create a static model. Finally, the gas reserves are calculated V in accordance with the degree of study on the deposit, according to the formula set out in [5].

Another well-known method for calculating gas production is the pressure drop method. This method exploits the relationship between the amount of gas withdrawn at regular intervals and the pressure drop in the gas field. Compliance with these conditions is real only in gas deposits, which are characterized by a gas regime.

If the volume of pores filled with gas during operation is stable and does not change, then it is possible to apply this method.

The calculation formula for determining the producing balance gas reserves is set out in [6].

In the case of trial operation of wells, it is necessary to conduct especially careful observations over the behavior of the working and statistical pressure in the working wells. In piezometric wells, it is necessary to control the static water level. To confidently control the pressure drop by 0.2–0.3 MPa, it is necessary to use high-precision pressure gauges. If there is liquid in gas wells, downhole pressure measurements should be carried out with deep pressure gauges. In this case, the amount of fluid and rock removed should be measured for various well operating modes.

When calculating free gas reserves, it is especially important to accurately determine the average reservoir pressure. In this case, it is defined as the weighted average value over the pore space volume according to isobar maps (reservoir pressure maps). The work map is superimposed on the isobar map. The map determines the average reservoir pressure from the intersection points of these maps.

If the level of gas content is large – 500 m and more, then the change in reservoir temperature and gas compression ratio over the entire volume of the reservoir should also be taken into account.

In this case, gas reserves are calculated for each elementary volume of the formation, taking into account its reservoir properties in it. At the same time, gas reserves for the entire productive gas reservoir are equal to the sum of gas reserves in elementary volumes.

The disadvantages of this method are: the impossibility of using it in the case of a water pressure regime; the need to conduct two studies with an interval of a certain period of time. It should be noted that the material balance method, which is the basis of this method, can be used for conditions of partial formation water pressure at which the well operates. Then the water which has entered the reservoir is determined by the equation by K. Schiltuis, A. Everdingen and V. Hirst or the simplified method by V. Hirst. In this case, the correction factors are found approximately. That is, the method cannot be marked with high precision.

So, we can say that the described methods for calculating free gas reserves in a certain sense are not ideal, since they have somewhat limited capabilities, or suffer from the low accuracy of the results obtained.

Specialists of Ivano-Frankivsk University of Oil and Gas B.A. Chernov and V.I. Koval have developed a universal method for assessing the initial hydrocarbon reserves at the level of the Ukrainian patent [7].

The material balance method used by them makes it possible to determine the mode of operation of the deposit. The influence and potential along the contour area is also determined. Reservoir pressure is also assumed during reservoir development. Finally, the geological reserves of the field are estimated. The authors of [7] believe that there is no need to use a geological or gas-hydrodynamic model. It is also not necessary to know the exact geological structure of the reservoir. To perform calculations, one needs to have a small amount of data. The required input data include: hydrocarbon production, measurements of reservoir pressure over time, properties of the reservoir fluid. As you know, the material balance method is based on the constancy of the mass of the hydrocarbon substance during the development process. That is, the initial amount of substance in the formation is equal to the sum of the substance extracted from the formation and the substance that remained in it. However, in practice, to calculate the initial stocks, an equation is used not from the amount of mass, but with the amount of volume. In order to take into account the aspects of mixed reservoir development and avoid errors in the calculations, it is proposed to rely on the formation of hydrocarbons. Therefore, new coefficients were introduced into the material balance equation. In this regard, the features of the assessment of the initial reserves of reservoir hydrocarbon systems developed both taking into account the effect of depletion of reservoir energy and taking into account the possibility of maintaining reservoir pressure, were analyzed. The peculiarities of using various formulas of material balance and methods for assessing the initial gas reserves, which are based on them, were also studied. The result of the analysis of the features of the assessment of the initial gas reserves and the study on the features of various formulas of the material balance was a new methodology and a material balance formula was obtained, taking into account the component-wise production of reservoir fluids. It took into account the change in their physical properties during the development of the reservoir, the compressibility of the rock and the flow of water into the reservoir. Such a technique can indeed be applied to both gas and oil deposits. Thanks to this, it can be considered universal. In addition, for a purely elastic regime, the calculation of the value of the initial gas reserves can be carried out in a wide range of reservoir pressure changes.

To use the pressure drop method, it is necessary to have well test data. The duration of the trial operation in each specific case is set taking into account the acquisition of reliable initial data for the application of the method.

In large fields, it should not be recommended to estimate gas reserves using the pressure drop method when it is reduced only by MPa. With such a small pressure drop, the reservoir is only partially covered by depression. Therefore, the results may be wrong. At the same time, an indicator of incomplete coverage of the reservoir with depression is unstable gas production per unit of reservoir pressure reduction.

If we look at the methods from the point of view of the reservoir mode of operation, the volumetric method can be applied for any mode. The pressure drop counting method can only be effectively used in gas mode. For the gas-water-pressure mode, the efficiency of the method drops sharply. With an effective water pressure mode, the application of the method is completely excluded. In this respect, the method of Ivano-Frankivsk scientists [7] is effective.

These calculation methods for individual wells can be used only in the case of completely destroyed layers. When drilling new wells, the phenomenon of interaction of wells in the conditions of gas migration in the reservoir can cause inaccuracies in the calculation of gas reserves. This is due to the complexity of the pressure redistribution in the reservoir.

The criterion for the accuracy of the calculations of gas reserves is the value of residual reserves.

Finally, in carbonate and fractured dense sandstones, it is usually difficult to obtain deposit volume parameters to accurately determine the average formation pressure in a given volume. In this case, gas reserves should be determined either graphically or by the method of material balance in the presence of relevant data.

Results. Based on the analysis made, the task was set to develop such a method for preliminary estimation of the value of the initial gas reserves [8], which would provide simplification of the calculation method by reducing the amount of initial data; reduction of a significant volume of geophysical surveys (only one survey mode is sufficient, which combines the well operation mode and well shut-in to take PRC).

The possibility of developing such a method for assessing the initial gas reserves on the basis of the actual data of a single study mode would mean the possibility of calculating gas reserves, together with the calculation of the spectrum of gas-hydrodynamic parameters of well testing. That is, the study on gas wells in a single study mode would solve two problems at once. Moreover, this possibility is real for gas wells of any productivity.

To implement the method for calculating the initial gas reserves, physical quantities are used: pressure, temperature; gas compressibility coefficients, taken according to the study and after its completion, and the total gas withdrawal measured under atmospheric conditions.

The calculation of the value of the initial stock is carried out according to the formula, detailed in the materials of the patent [8].

It can be seen from the formula that only four physical quantities are used – pressure, temperature, gas compressibility factor and the total volume of gas inflow during the study. This means that the minimum amount of initial data greatly simplifies the approach to calculating gas reserves. But the most valuable thing is that all these initial data can be obtained only through a well survey in one mode. That is, there is no need to determine the porosity coefficient. It is necessary to find the effective reservoir thickness. And there is no need to find the area of the feed circuit for a gas-bearing object. That is, you can exclude a number of works that are usually carried out to determine the specified values. In other words, laboratory or geophysical procedures become unnecessary for this. This means saving not only time and a certain number of technological procedures. This also means obvious cost savings.

In this regard, it makes sense to remember the accuracy of the result obtained. And as you know, laboratory or geophysical methods are not very accurate. First of all, this is due to imperfect equipment and the presence of a human factor.

Thus, thanks to the application of the proposed calculation method, we have achieved the set goal: simplification of the calculation method; reducing the amount of initial data. In this case, the availability of initial data is important, the acquisition of which does not require any preliminary work.

The proposed counting model can be used in an industrial environment.

Conclusions. Solving the problem of calculating the initial reserves of free gas, solved at the level of the patent of Ukraine, allows solving two problems in parallel, one of which is the calculation of gas reserves, and the other is the calculation of more than twenty gas-hydrodynamic parameters of a productive gas reservoir. Both solutions are based on such initial data that are obtained as a result of the study on productive gas objects in one study mode. Moreover, it consists of two processes: the process of well operation in the mode and recording the pressure recovery curve after stabilization of the inflow mode. The availability of both processes and the initial data that can be recorded at the same time fully ensure the solution of both problems.

So, another method has been created for calculating the value of the initial gas reserves [8]. It is simple and affordable both in use and in terms of the raw data on which it is based. Two unconventional methods for calculating the gas-hydrodynamic parameters of productive wells have also been created [9, 10]. They are based on a well survey in one mode. A significant reduction is obvious in the cost of several times the technological process of gas wells research. Certain self-sufficiency of the process of researching gas wells in one mode can also be stated. On the one hand, it makes it possible to obtain initial data for calculating more than twenty parameters of the well-reservoir system. On the other hand, it allows one to calculate the value of the initial gas reserves in the investigated gas object. Solving two such complex and important tasks at once is an important factor in the rational development of gas fields.

It is thanks to this that such a direction in the study on gas wells becomes real, which will significantly reduce the cost and speed up the process.

The transition from traditional methods of research in 5–8 modes to research of productive wells in only one mode can be considered a significant step in optimizing the research process in general.

It is necessary to note the immediate prospects for the implementation of the proposed approach. The near future opens the way for evolutionary changes in well test technology. In general, fundamental sciences are very rarely subject to change. But not in this case. Only a departure from the traditional 5–8 study modes provides several times the study time. That is, it saves time, and therefore money to be spent. And the possibility of counting at the research stage using a new technology is a source of savings due to the exclusion from the initial data for calculating gas reserves such data that are obtained by additional geophysical or laboratory methods. There is no doubt that a significant economic effect will be reflected in the cost of the produced hydrocarbon raw materials.

If we go further in our reasoning, then the thought suggests itself to make it a reality to conduct well surveys in the trial operation mode. In fact, this means a transition from well testing while drilling wells to exploration.

By this time, testing of gas wells while drilling with gas release to the surface (in trial operation mode) was carried out very rarely and only in shallow wells, as an exception. If it is possible to test wells with gas release to the surface, then the actual data obtained will be the basis for calculating the gas-hydrodynamic parameters of the reservoirs and for preliminary calculation of the value of the initial gas reserves. At the same time, the actual data obtained amaze not only in quantity, but also in quality, because they are calculated analytically.

Thus, even at the drilling stage, it is possible to draw conclusions not only about the presence of hydrocarbons in the investigated object, but also about their quantity. In practice, this means a real possibility of assessing gas reserves in exploration wells. That is, running production strings into the wells will be justified.

In the case of insignificant gas reserves or in its absence, it will not be necessary to spend funds, materials and time for running strings and other related operations on such wells.

This approach to the study on gas targets in the process of drilling and solving the issue of the expediency of running production strings can be a source of such a significant economic effect, the cost of drilling exploratory wells will decrease significantly.

However, for the implementation of such a project, the work of scientific teams is required to develop new technical means for wells of only shallow depth. Technical means are required for working at different depths, that is, of a smaller diameter. And here the quality of the equipment and the quality of the materials from which it should be made will be decisive.

At present, the technology for studying gas wells in one mode has already been created [10, 11]. The methodology for its maintenance has been developed. They work have been tested in an industrial environment. And the method for calculating the initial gas reserves based on its actual data is also presented.

Therefore, this view of the study on gas wells in one mode can be considered universal, because its performance is currently the highest. This amount of information is not provided by any of the known methods for testing gas wells. And none of them is a raw data platform for calculating initial gas reserves.

The introduction of new research technologies and a method for calculating the value of the initial gas reserves can be considered a catalyst for optimizing research processes at the global level.

The uniqueness of the combination of a new well survey technology, a new method for calculating gas-hydrodynamic parameters and a new method for calculating gas reserves can become a starting point for starting research on gas wells in an open hole [11]. This is a new layer of research and development work that must be carried out to solve this problem.

For each state, such technological approaches and methodological developments should now be at the forefront of applied problems of underground fluid dynamics.

And if our state is interested in reducing the cost of hydrocarbon products, then the solution of such problems should be given maximum attention and funding. Undoubtedly, they can bring a very significant economic effect to the gas industry.

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Оптимальний метод оцінки запасів газу на основі розрахунку газогідродинамічних параметрів

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Мета. Розробка нової методики розрахунку запасів газу для газових свердловин будь-якої продуктивності.

Методика. Методика розрахунку розроблялася з використанням теоретичних положень газової динаміки. Вона базується на фактичних даних дослідження газових свердловин на одному відпрацьованому режимі.

Результати. Запропонована вперше методика проведення підрахунку запасів газу при відпрацюванні одного режиму дослідження. Паралельно із підрахунком запасів газу відкривається можливість аналітичного розрахунку значної кількості газогідродінамічних параметрів.

Наукова новизна. Розроблені методики розрахунку величини початкових запасів газу й газогідродінамічних параметрів досліджуваних газових об'єктів не мають аналогів у вітчизняній і світовій практиці. Перша із методик відрізняється простотою розрахунку й доступністю вихідних даних для її використання. Друга базується на диференціальних, диференціально-інтегральних і інтегральних методах для підвищення точності одержуваних результатів розрахунку.

Практична значимість. Нова методика підрахунку запасів газу дозволить проводити оперативну оцінку вуглеводневої сировини в досліджуваному об'єкті. Доступність, мінімізація й точність вихідних даних для розрахунку запасів газу без сумніву є ознаками оптимальності методики. Простота розрахунку дає можливість широкого використання методики. Застосування нової методики інтерпретації результатів дослідження газових свердловин на одному режимі дасть можливість відходу від традиційного способу дослідження. Завдяки цьому кількість режимів дослідження зменшується в кілька разів. Це означає також скорочення викидів до атмосфери, якщо свердловина не працює із протитиском на гирлі. Значне здешевлення процесу дослідження завдяки скороченню часу дослідження теж є фактором істотної економії коштів на дослідження.

Ключові слова: *дослідження свердловин, метод підрахунку запасів газу, газонасичені пласти, газогідродинамічні параметри*

Оптимальный метод оценки запасов газа на основе расчета газогидродинамических параметров

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Цель. Разработка новой методики расчета запасов газа для газовых скважин любой продуктивности.

Методика. Методика расчета разрабатывалась с использованием теоретических положений газовой динамики. Она базируется на фактических данных исследования газовых скважин на одном отработанном режиме.

Результаты. Предложена впервые методика проведения подсчета запасов газа при отработке одного режима исследования. Параллельно с подсчетом запасов газа открывается возможность аналитического расчета значительного количества газогидродинамических параметров.

Научная новизна. Разработанные методики расчета величины начальных запасов газа и газогидродинамических параметров исследуемых газовых объектов не имеют аналогов в отечественной и мировой практике. Первая из методик отличается простотой расчета и доступностью исходных данных для ее использования. Вторая базируется на дифференциальных, дифференциально-интегральных и интегральных методах для повышения точности получаемых результатов расчета.

Практическая значимость. Новая методика подсчета запасов газа позволит проводить оперативную оценку углеводородного сырья в исследуемом объекте. Доступность, минимизация и точность исходных данных для расчета запасов газа без сомнения являются признаками оптимальности методики. Простота расчета дает возможность широкого использования методики. Применение новой методики интерпретации результатов исследования газовых скважин на одном режиме даст возможность отхода от традиционного способа исследования. Благодаря этому количество режимов исследования уменьшается в несколько раз. Это обозначает также сокращение выбросов в атмосферу, если скважина не работает с противодавлением на устье . Значительное удешевление процесса исследования благодаря сокращению времени исследования тоже является фактором существенной экономии средств на исследование.

Ключевые слова: *исследование скважин, метод подсчета запасов газа, газонасыщенные пласты, газогидродинамические параметры*

Recommended for publication by I. M. Fik, Doctor of Technical Sciences. The manuscript was submitted 28.09.20.