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THE SYSTEM OF PRELIMINARY DISCHARGE OF RESERVOIR WATER ON DEPOSITS

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Abstract. Kazakhstan is one of the world's largest oil-producing regions. Among the explored and exploited deposits, the largest are Tengiz, Zhanazhol, Karachaganak, Uzen, Zhetybay, Kalamkas, Kumkol and a number of others. The extracted oils are very diverse in terms of their physical and chemical properties, the content of asphaltenes, resins and paraffins. Many of them contain significant amounts of carbon dioxide, sulfur and its compounds. Kazakhstan has extensive experience in the development, development and operation of such deposits and monitoring the associated environmental impact. It can be generalized and used in the further development of the industry. The composition of the products of all deposits is unique and is the determining element in the choice of technological schemes for its collection and preparation. Methods for increasing the depth of preparation, efficiency and reliability have been sufficiently studied, but due to changing requirements and existing achievements, the arrangement work is always creative in nature, and the technological solutions made are becoming more perfect. Water is the only component of well production that has natural contact with oil and must be returned to the natural environment. Waste waters include formation waters that are separated at almost all stages of oil treatment, and flushing waters introduced for desalting and final dehydration of oil. Before injection into the absorbing reservoir, they must be cleaned. To prevent the formation of stable emulsions, solid deposits and suspensions, a system of preliminary water discharge at the fields has been proposed. To intensify the processes of separating gas, water and mechanical impurities and gas from drained water, preserve the light, most valuable hydrocarbon components of oil, prevent oil and gas losses and environmental pollution, it is proposed to introduce a three-product multihydrocyclone into the system of preliminary formation water discharge at the fields. To intensify the processes of separating gas, water and mechanical impurities and gas from drained water, preserve the light, most valuable hydrocarbon components of oil, prevent oil and gas losses and environmental pollution, it is proposed to introduce a three-product multihydrocyclone into the system of preliminary formation water discharge at the fields. At the same time, the water quality improves to values suitable for injection into injection wells without additional treatment..

Keywords: oil and gas condensate field, reservoir water, emulsion, demulsifier, three-product multi-hydrocyclone, oil, gas, intensification, mechanical impurities, centrifugal pumps, water discharge, gravitational forces, desalination, dehydration, oil treatment.

Introduction

In connection with the involvement of countries that have emerged in the post-Soviet space in global integration processes and the attraction of foreign capital into their economy, the development of new industries and the improvement of old ones, incl. in the field of operation, development and development of deposits should be carried out on the basis of an analysis of existing experience in domestic and foreign practice.

In the conditions of an aggravating ecological crisis, research takes a certain direction (reliability and environmental friendliness) and relevance. First of all, this applies to industries that carry the risk of environmental pollution. These include systems for collecting, preparing and transporting products from oil and gas condensate fields with a high content of acid gases, sulfur and sulfur compounds.

The economic indicators of technical and technological solutions for the arrangement can be optimized by combining technological processes in the apparatus, reducing the length of communications and joint transport of oil and gas under high pressure to the OTU, etc.

The environmental and industrial reliability of technical solutions for the development of deposits with a high content of hydrogen sulfide is determined by the degree of concentration of processes at the OTU site, achieved by autonomy, tightness and compliance with the loading regime.

The development of the Karachaganak field was carried out in two stages. At the first stage, development was carried out for depletion with the supply of extracted raw materials to the Orenburg GPP.

At the second stage of pilot operation, dry gas is re-injected into the reservoir in order to maintain reservoir pressure (cycling process).

Based on the concept of the Karachaganak deposit, as consisting of three enlarged objects, two gas condensate and oil production facilities were operated by independent well grids. At the same time, some wells jointly operated objects I and II, and the main part of deep wells drained objects II and III.

Research aimed at developing scientific principles for improving the technology of collecting and treating oil and associated gas with a high content of hydrogen sulfide is relevant for the oil industry of the Republic of Kazakhstan and the oil-producing regions of the Russian Federation - the Republics of Bashkortostan, Tatarstan and a number of others.

Purpose of the study: Assess the impact of a change in the quantitative ratio of oil, condensate and formation water in the process of field development on the reliability of the technological scheme, indicate ways to improve it.

A significant contribution to the development of this industry as a whole and to its individual sections was made by both Russian (Soviet) and foreign scientists - chemists, physicists, technologists. Among them are V.P. Tronov, A.Kh. Mirzadzhanzade, A.I. Guzhov, N.N. Konstantinov, M.Z. Mavlyutova, G.N. Pozdnyshev, V.A. R.I., Bril D.M., Baker O., Cheves J.A., Hewitt J.F., Hoogendoorn G.J. and many others.

Materials and methods of research

The theoretical and methodological basis of the study is the theory of regulation of the sustainable development of the oil industry in various forms of management and integration processes of the development of the oil sector, the work of domestic and foreign experts in the oil industry. The reliability and reliability of the study is achieved through the use of scientific methods of analysis.

To achieve this goal, the following methods are used in the article: abstract-logical, analytical, experimental. In addition, the study used methods of dialectical cognition and a systematic approach.

Research results

The reservoir water extracted as part of the products of oil and gas condensate fields forms persistent emulsions during its movement to the preparation points, causes the formation of solid deposits and suspensions. Therefore, the separation of water is carried out at all stages of the movement. Water is supplied to the pre-discharge devices and buffer tanks.

There is a known system of preliminary water discharge at primary collection points, booster pumping stations of deposits [1,2]. It includes wells whose products are supplied to automated group measuring units (AGMU): a demulsifier dosing unit, a gas pre–extraction device (PED) - "depulsator", a separator of the 1st stage of separation, a pipeline with turbulent and laminar sections, a water pre-discharge apparatus, a buffer tank, a pump pumping partially dehydrated oil. The process is carried out in the following technological sequence.

A demulsifier is dosed into the watered one after automatic measurement on the AGMU. Oil is separated from gas at the STOP and gas separator of the 1st stage. Gas under its own pressure is transported to a gas processing plant, and oil passes through turbulent and laminar sections of pipelines in which the process of in-line demulsification of oil is carried out [3]. In the pre-discharge apparatus, water is separated from oil and sent to treatment facilities, and then to cluster pumping stations for injection into the reservoir in order to maintain reservoir pressure (MRP). Partially dewatered oil enters the buffer tank and is then pumped through the counter to the central collection point (CCP), where deep dewatering and desalination is carried out at oil preparation plants (OPP).

The main disadvantage is that due to the presence of hydraulic resistances in the system, during the movement of the gas-liquid mixture along communication lines, light hydrocarbon components in the form of gas appear and accumulate in the apparatus of preliminary discharge of water and the buffer tank. It periodically breaks through to receive centrifugal pumps at the time of their start-up and dramatically reduces their productivity. In practice, centrifugal pumps provide pumping of oils with a free gas content of no more than 3% by volume [4]. To ensure reliable operation of the pumps, the gas content of the oil has to be subjected to deeper degassing (vacuum, hot-vacuum) and the contained gas is directed to the torch. This leads to unjustified energy and material costs, complication of the oil pumping system, as well as to the loss of light, the most valuable hydrocarbon components of oil and to atmospheric pollution.

The reservoir water drained from the pre-discharge apparatus contains a certain amount of both dissolved and free gas. The residual gas, together with water, enters the treatment facilities or a block cluster pumping station. The presence of this gas in the water creates a fire hazard of the object and the gas contamination of the territory as a whole. In oil and water, there are also mechanical impurities and other suspensions in a certain amount, which together with oil enter oil refineries, and with water – to treatment facilities or injection wells. All this creates unsafe working conditions for equipment and facilities for the preparation and injection of water into the reservoir.

The processes of separation of gas from oil occur as a result of pressure reduction and imbalance between the gas and liquid phases, and water from oil - under the influence of gravitational forces. This leads to the fact, that a significant amount of gas and mechanical impurities remains in both oil and water, and a large amount of water remains in the oil sent for pumping to the (CCP).

To intensify the processes of separation of gas, water and mechanical impurities and gas from drained water, to ensure high reliability of centrifugal pumps, to preserve the light, most valuable hydrocarbon components of oil, to prevent oil and gas losses and environmental pollution, to increase the degree of purification of oil from water, water from petroleum products it is recommended to make the following additions to the existing system of preliminary reservoir water discharge at the fields.

The liquid flow after the turbulent and laminar sections of the pipeline is directed to a three-product multihydrocyclone (Figure 1), which allows the separation of heavy highly mineralized water and mechanical impurities from gas and oil in one technological apparatus due to the redistribution of pressure in the hydrocyclone elements of the apparatus by the field of centrifugal forces [5].

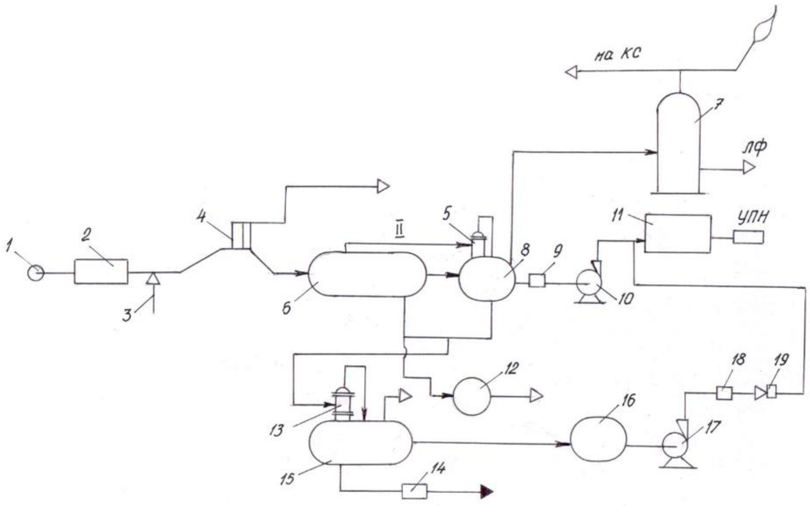

Figure 1 – Installation of pre-discharge of reservoir water

In addition, a film flow mode is carried out in these elements due to an intro-ductory device of a special design. It also contributes to degassing of oil. In the center of each hydrocyclone element, a zone of increased pressure is formed, where dis-solved gases and the lightest hydrocarbon components are collected in the collection of a multihydrocyclone. The highly mineralized water and mechanical impurities separated in the peripheral zone of each multi-hydrocyclone element pass into the sludge collector and are removed into the wastewater treatment system.

The water is then sent to an individual multihydrocyclone, where gas, petrole-um products and sludge are separated from water. The water is thus purified and sent to injection wells. At the same time, drained water from the buffer tank is sent to this multihydrocyclone (see the picture).

The gas from the multihydrocyclones and buffer tank is directed to the injector chamber mounted on the pump outlet. This allows for constant suction of light hy-drocarbon components from the collection of multihydrocyclones. The working agent of the active nozzle of the injector is oil pumped out of the buffer tank.

According to the proposed system, a gas-oil mixture with a water content of up to 90% by weight, a temperature of 200 C from well 1 enters an automated group measuring unit 2, where the well production is automatically measured. Then it is processed with a demulsifier 3, in the gas pre-selection device 4 and in the separator 1 of the separation stage 6, the gas 11 is separated and sent through the multihydro-cyclone 5 to the gasoline separator 7, from which the gas enters the compressor sta-tion, and the excess is sent to the torch. The stable product from the tank 8 is fed through the counter 9 by the pump 10 to the central collection point 11 and then to the oil treatment plant. Water from tanks 6 and 8 is collected in the sump 12 and then sent under pressure to NUR-3500, where it is processed in the field of centrifugal forces in order to separate into oil, gas and water. For deeper purification, the latter water enters the water treatment plant 14 and then into the reservoir pressure mainte-nance system. From the tank 15, the separated oil enters the collector 16 and the pump 17 through the counter 18, and the gas-oil mixture is fed by the injector 19 to the central collection point 11.

Drainage water, together with mechanical impurities and other suspensions from the multihydrocyclone 13 and buffer tank 15, is directed to water purification from sludge, petroleum products and residual gas. The gas from the multihydrocy-clones and buffer tank is sucked off by the ejector 19, the working agent of the active nozzle of which is the degassed oil pumped out by the pump.

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Water is the only component of the produced well product that has natural contact with oil and is subject to return to the natural environment. Waste waters include formation waters that are separated at almost all stages of oil treatment, and flushing waters introduced for desalting and final dehydration of oil. Before injection into the absorbing reservoir, they must be cleaned.

Wastewater treatment at the fields is one of the most important elements of the general technological scheme for the preparation of well products and includes all or a number of the following steps:

- purification from dispersed impurities (oil, solid suspension);
- removal of dissolved (hydrogen sulfide and hydrocarbon) gases;
- collection and processing of oil sludge.

For all types of cleaning, there are established requirements that determine their quality, technologies and technical means have been developed, the choice of which is an integral part of research and design work. The quality of cleaning is the subject of constant monitoring of environmental organizations.

The authors proposed a device for flotation wastewater treatment [6] from oil inclusions.

The amount of water in various states in the pore space of soils can vary from 5 to 65%. Therefore, in case of accidents on oil pipelines associated with their rupture, as well as in case of other spills of oil and oil products, one cannot neglect the fact that water is contained in the pores of the soil. Water in soils from sedimentary rocks may contain various salts that increase its density. Depending on the amount of salts dissolved in water, its density varies from 1.0 103 kg/m^3 to 1.26 103 kg/m^3. Thus, we have two fluids with different properties that interact in a porous medium.

The penetration of oil into the soil through pores in which there is no moisture will occur very slowly due to the viscosity of the oil itself. If we take into account that natural precipitation in the form of rain and snow gets into oil spills, then the filtration of a complex fluid system will occur due to the surface interaction of this system with the soil skeleton, in which the surface tension of water plays a dominant role.

As a result of the interaction of dispersed particles with oil, it leads to a decrease in the viscosity of the latter. Therefore, the interaction of oil with water under natural conditions does not lead to the formation of an emulsion. Water or its droplets do not remain in suspension in oil due to the high density of water.

Ultimately, filtration in porous media should be considered as a layer-by-layer movement or as a transport movement. In this case, the transport for oil is surface phenomena occurring between oil and water.

Therefore, it is necessary to know the specific amount of water in the pore space of the soil. With a decrease in surface tension and wettability of the soil skeleton, relative humidity decreases in proportion to the square of these values. When studying oil filtration, it is necessary to take into account its interaction with water present in the pores of the soil, the relative humidity of which is determined by the formula

$$\varphi_{\text{o}} = \left(4\delta^2 \cdot \cos\theta / \rho_{\text{в}} \cdot \rho_{\text{г}} \cdot g^2 \cdot h^2 \cdot r_{\text{o}}^2\right) \cdot 100\% . \quad (1)$$

The flow of water with incomplete filling of the pores of the soil will obey the laws of hydrodynamics, and the movement of fluid in other states will obey other laws arising from the laws of surface tension and evaporation. In addition, the absence of a lower limit of applicability of the Darcy law suggests that under certain conditions a special type of fluid flow arises, which has not yet had a mathematical description of the dependence on the surface tension of the fluid and wettability.

Other areas of study of the problems of fluid filtration in porous media are the study of the equation of motion and continuity under various boundary conditions, etc.

At the same time, the exact solution of these equations is reduced to special mathematical methods and their practical use for specific problems is not always possible. For practical application, they are solved by approximate methods, such as methods of a small parameter, finite differences, sum representations, etc.

At the lowest liquid content, water is absorbed into the soil grains in the form of films and then, with increasing humidity, fills first small and then larger pores. When all the pores are filled, the liquid acquires the ability to move under the action of gravity.

However, when the liquid flows in layers with absorption without pressure, the filling of pores does not occur. In this case, the flow will prevail due to the interaction of the lower layer liquid with the soil skeleton, which is determined by the surface tension of the liquid and the wettability of rocks. In this case, the bottom layer is water with dispersed solid particles.

Then the description of this type of motion corresponds to the equation

$$\partial m\rho_{\mathbf{B}} / \partial t + \operatorname{div}\rho_{\mathbf{B}} V_{\mathbf{B}} = -\partial q / \partial t, \quad (2)$$

where V_w – is the speed of water movement with incomplete filling of soil pores, m/s; q is the density of liquid runoff or the specific amount of water contained in the pore space of the soil.

Conclusion

Thus, an improved system of preliminary discharge of reservoir water in the fields using a hydrocyclone is proposed, which ensures high quality separation of water and mechanical impurities and gas; reliability of centrifugal pumps; preservation of light, most valuable hydrocarbon components of oil; a high degree of purification of oil from water, water from petroleum products; prevention of oil and gas losses and pollution of the environment.

It should be noted that in case of accidents at oil pipelines associated with their rupture, not only soil and groundwater are polluted, but also atmospheric air, which is especially strong in cases where spilled oil is on the surface due to its intensive evaporation.

Determined that:

- the process of oil filtration is complicated by the presence of water in various states in the pore space;
- the amount of liquid in the pore space is determined by physical and mechanical quantities characterizing the interaction of the liquid with soil minerals;
- dependence of relative humidity on soil wettability and surface tension is proportional to the squares of these values;
- the rate of liquid filtration into the soil depends on the grains of the soil and the surface tension of the liquid.

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ҚОЙНАУҚАТТЫҚ СУДЫ АЛДЫН АЛА АҒЫЗУ ЖҮЙЕСІ КЕН ОРЫНДАРЫНДА

Аңдатпа. Қазақстан әлемдегі ең ірі мұнай өндіруші өңірлердің бірі болып табылады. Барланған және пайдаланылып жатқан кен орындарының ішінде ең ірілері – теңіз, Жаңажол, Қарашығанақ, Өзен, Жетібай, Қаламқас, Құмкөл және басқалары. Физикалық-химиялық қасиеттері, асфальтендер, шайырлар мен парафиндердің құрамы бойынша өндірілетін мұнай өте алуан түрлі. Барлық кен орындары өнімдерінің құрамы бірегей және оны жинау мен дайындаудың технологиялық схемаларын таңдау кезінде айқындаушы элемент болып табылады. Дайындық тереңдігін, үнемділікті және сенімділікті арттыру әдістері жеткілікті зерттелген, бірақ өзгеретін талаптар мен қол жетімді жетістіктерге байланысты орналастыру жұмыстары әрдайым шығармашылық сипатқа ие және қабылданған технологиялық шешімдер жетілдірілуде. Құрғатылған судан газды, суды және механикалық қоспалар мен газды бөлу процестерін қарқындату, мұнайдың жеңіл, неғұрлым құнды көмірсутекті компоненттерін сақтау, мұнай мен газдың жоғалуын және қоршаған ортаның ластануын болдырмау үшін кен орындарында қаттық суды алдын ала ағызу жүйесіне үш өнімдік мультигидроциклон енгізу ұсынылады. Қабатты суды алдын ала ағызу жүйесінде мультигидроциклондар мен инжекторды қолдану тауарлық өнімнің сапасын едәуір жақсартуға әкеледі: мұнайдағы судың мөлшері, мұнайдағы бос газ, бірдей өнімділіктегі механикалық қоспалар. Бұл ретте судың сапасы қосымша тазартусыз айдамалау ұңғымаларына айдауға жарамды мәндерге дейін жақсарады.

Түйінді сөздер: мұнай-газ конденсатты кен орны, қабаттық су, эмульсия, деэмульгатор, үшөнімді мультигидроциклон, мұнай, газ, интенсификация, механикалық қоспалар, ортадан тепкіш сораптар, су ағызу, гравитациялық күштер, тұзсыздандыру, сусыздандыру, мұнай дайындау.

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СИСТЕМА ПРЕДВАРИТЕЛЬНОГО СБРОСА ПЛАСТОВОЙ ВОДЫ НА МЕСТОРОЖДЕНИЯХ

Аннотация. Казахстан является одним из крупнейших мировых нефтедобывающих регионов. Среди разведанных и эксплуатирующихся месторождений наиболее крупные – Тенгиз, Жанажол, Карачаганак, Узень, Жетыбай, Каламкас, Кумколь и ряд других. Добываемые нефти по своим физико-химическим свойствам, содержанию асфальтенов, смол и парафинов весьма разнообразны. Состав продукции всех месторождений уникален и является определяющим элементом при выборе технологических схем ее сбора и подготовки. Методы повышения глубины подготовки, экономичности и надежности достаточно изучены, но в силу меняющихся требований и имеющихся достижений, работы по обустройству всегда носят творческий характер, а принимаемые технологические решения становятся совершеннее. Для интенсификации процессов отделения газа, воды и механических примесей и газа из дренируемой воды, сохранения легких, наиболее ценных углеводородных компонентов нефти, предотвращения потерь нефти и газа и загрязнения окружающей среды, в систему предварительного сброса пластовой воды на промыслах предлагается ввести трехпродуктовый мультигидроциклон. Применение мультигидроциклонов и инжектора в системе предварительного сброса пластовой воды приводит к значительному улучшению качества товарной продукции: по содержанию воды в нефти, свободного газа в нефти, механических примесей при одинаковой производительности. При этом качество воды улучшается до значений, пригодных к закачке в нагнетательные скважины без дополнительной очистки.

Ключевые слова: нефтегазоконденсатное месторождение, пластовая вода, эмульсия, деэмульгатор, трехпродуктовый мультигидроциклон, нефть, газ, интенсификация, механические примеси, центробежные насосы, сброс воды, гравитационные силы, обессоливание, обезвоживание, подготовка нефти.