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DEVELOPMENT OF A METHOD FOR INJECTING WATER INTO A RESERVOIR TO MAINTAIN RESERVOIR PRESSURE IN AN OIL FIELD

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Abstract. This article discusses a system for developing an oil reservoir using the pressure of regional waters. The system is used for reservoir-type oil deposits with natural water pressure or active elastic water pressure regime. It involves drilling out the deposit with production wells, locating them mainly in the purely oil part of the deposit in closed ("circular") rows parallel to the internal oil-bearing contour. This includes oil deposits with effective reduced wear regimes of deposits with water-pressure and active elastic-water-pressure regimes. Waterflooding cannot be developed when the permeability of the formations is low. As a result, some deposits are being developed under modern conditions.
Key words: Development system, impact methods, water flooding, oil displacement methods, water pressure regime, elastic water pressure regime, oil-bearing contour.

РАЗРАБОТКА СПОСОБА ЗАКАЧКИ ВОДЫ В ПЛАСТ ДЛЯ ПОДДЕРЖАНИЯ ПЛАСТОВОГО ДАВЛЕНИЯ НА НЕФТЯНОМ МЕСТОРОЖДЕНИИ

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Аннотация. В этой статьи рассмотрены разработка способа закачки воды в пласт для поддержания пластового давления на нефтяном месторождении. Систему применяют для нефтяных залежей пластового типа с природным водонапорным или активным упруговодонапорным режимом. Она предусматривает разбуривание заложи добывающими скважинами с расположением их в основном в чисто нефтяной части залежи замкнутыми («кольцевыми») рядами, параллельными внутреннему контуру нефтеносности. К этому относятся нефтяные залежи с эффективными пониженными режимами от износа залежей с водонапорными и активными упруговодонапорными режимами. Заводнение не

может быть освоено при низкой проницаемости пластов. Вследствие этого некоторые залежи разрабатывают современные режимы.
Ключевые слова: Система разработки, методы воздействия, заводнения, методы вытеснения нефти, водонапорный режим, упруговодонапорный режим, контур нефтеносности.

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Introduction.

The high pace of development of the oil and gas industry of Uzbekistan is inconceivable without improving the methods of exploration and development of oil, gas and gas condensate fields, both in the direction of accelerating exploration, obtaining the necessary initial data for the design and rapid commissioning of fields into development, and increasing the efficiency of each link of a single technological chain: formation-well-gas- and oil-gathering points-ground-based field structures-gas-, oil-pipeline-consumer.

The processes of development and operation of oil and gas fields are closely related to the patterns of filtration of hydrocarbons and water in the rocks that make up the productive formations. Therefore, the properties of rocks and formation fluids predetermine the rational technology for the development of oil and gas deposits and the economic indicators of their extraction from the subsoil [1; 4–5-p.].

The purpose of the work.

Currently, when using natural types of energy, oil deposits with effective natural regimes are being developed, for which artificial impact is not required, as well as deposits with special geological conditions under which impact methods cannot bring the necessary results or cannot be developed.

The use of new development methods (physicochemical, thermophysical, thermochemical, methods of displacing oil with miscible agents), in contrast to the well-developed water flooding method, also has its limitations. As a result, some deposits are developed using natural conditions [2; 235-p.].

It involves drilling out the deposit with production wells, locating them mainly in the purely oil part of the deposit in closed (“circular”) rows parallel to the internal oil-bearing contour. If possible, a staggered order of well locations is observed (Figure 1). To extend the water-free period of well operation, the distances between rows of wells can be set somewhat larger than between wells in rows.

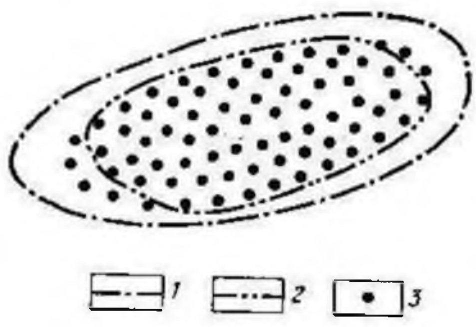

Figure 1. A system for developing an oil reservoir using the pressure of

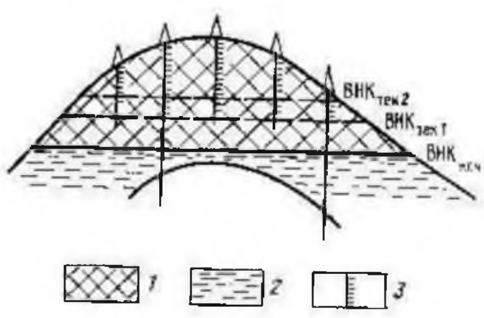

Figure 2. A type of system for developing an oil deposit using the

regional waters.

Oil-bearing contours: 1 – external; 2 – internal; 3 – production wells.

pressure of bottom water.

1 – oil; 2 – water; 3 – perforation interval; position water-oil contact (WOC); WOC_{in} – initial, WOC_{cur} – current

Results and discussion.

The considered placement of wells and their perforation best correspond to the process of introducing marginal water into the reservoir, replenishing the withdrawal of fluid from it. From the oil-water zone, oil is displaced by water to the wells. In the process of development, the oil-bearing contours "contract" and the size of the deposit decreases. Accordingly, the wells of the outer ring row are gradually watered and decommissioned, then, through certain stages, the wells of subsequent rows [3; 285–286-p.].

System using bottom water pressure. The system is used for massive oil deposits that have a water-pressure or active elastic-water-pressure regime. When developing such deposits, the displacement of oil by water is accompanied by a widespread rise in the water-oil contact (WOC), that is, intervals of the deposit located approximately at the same hypsometric marks are sequentially watered; the size of the deposit decreases. The placement of wells on the deposit area and the approach to perforating the productive part of the section depend on the height and other parameters of the deposit. When the height of the deposit is measured in tens of meters, the wells are spaced evenly and the formation in them is perforated from the roof to some conventionally accepted boundary, located several meters away from the OWC (Figure 2).

When the reservoir height is 200-300 m or more (which is typical for some massive deposits in carbonate reservoirs), it is preferable to place wells along a grid condensing towards the center of the reservoir, maintaining the principle of equality of oil reserves per well. In this case, the approach to opening the productive part of the section in wells depends on the filtration characteristics of the deposit. With low oil viscosity - up to 1-2 mPa·s, high permeability and a relatively homogeneous structure of the productive strata, it is possible to open the upper part of the oil-saturated capacity in wells, since under such conditions oil from the lower part can be displaced to the opened intervals. With low oil viscosity and heterogeneous structure of reservoir rocks or with increased oil viscosity, sequential opening of oil-saturated capacity can be realized [4; 161-p.].

Development system using the energy of gas released from oil. The system is used in dissolved gas mode and involves drilling out the production facility, usually along a uniform grid with perforation in all wells of the entire oil-bearing capacity.

Development system with joint use of formation water pressure and gas cap gas. The system for developing the oil part of a gas-oil deposit involves the use of a mixed regime of the deposit and the displacement of oil by contour water and gas from the gas cap. With this system, wells are placed along a uniform grid and only part of the oil-saturated capacity is perforated into them with a significant deviation from the contacts [5; 93–94-p.].

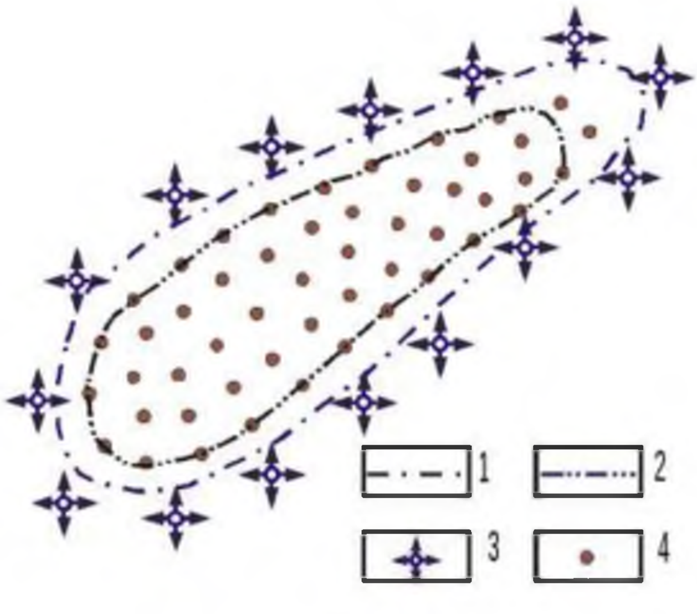

Figure 3. Oil reservoir development system with edge flooding

Oil-bearing contours: 1-external, 2-internal; Wells: 3 – injection, 4 – production.

A system using the pressure of formation water at a stationary GOC (gas-oil circuit). The system provides for the extraction of oil from an oil and gas deposit (with a potentially mixed natural regime) only through the introduction of formation waters with a constant volume of the gas cap. Stabilization of the gas oil reservoir in its initial position is ensured by regulating the pressure in the gas cap by selecting from it through special wells strictly justified volumes of gas corresponding to the rate of pressure reduction in the oil part of the deposit [6; 187–188-p.]. Methods for substantiating optimal perforation intervals when developing the oil part of a deposit, low oil viscosity, high formation permeability, and the presence of impermeable layers in the formation section that increase its anisotropy.

Water flooding method in different geological conditions. The use of the water flooding method for the development of oil and gas-oil production facilities with different characteristics has led to the need to create variations of the method (Figure 3), each of which is most appropriate in certain geological conditions.

The next step in the development of the water flooding method was the transition in a number of deposits to peripheral water flooding. Bringing the artificial feed circuit closer to the extraction zone in this way increased the capabilities of the water flooding method [7; 207–208-p.]. Erosive types of intra-circuit flooding have been developed and the geological field conditions in which they are most acceptable have been determined (Figure 4).

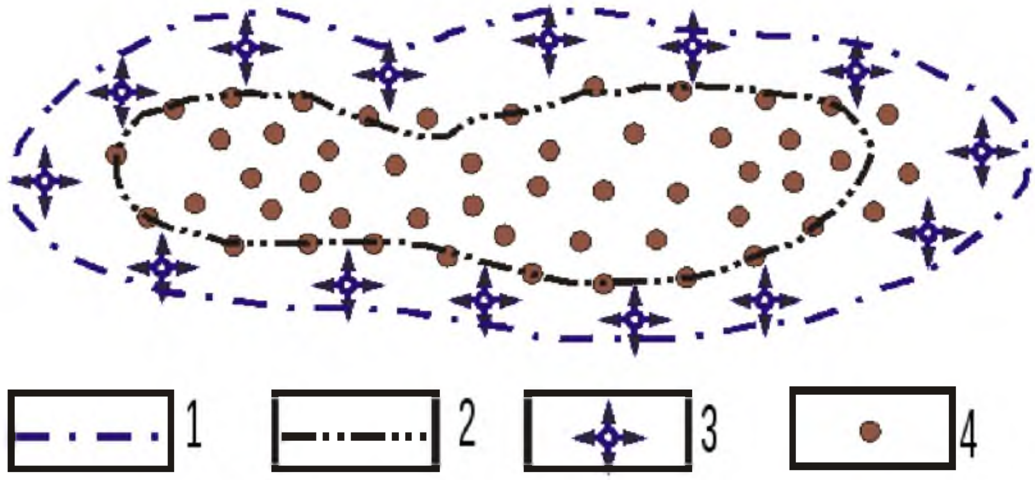

Figure 4. Oil reservoir development system with peripheral flooding
Oil-bearing contours: 1-external, 2-internal; Wells: 3 – injection, 4 – production.

New methods for developing oil deposits and geological conditions for their use. It is currently customary to call new development methods all methods of influencing the formation that differ from the widely used water flooding method. New methods are needed to develop oil deposits where water flooding cannot be applied at all, for production facilities where traditional water flooding does not provide high oil recovery rates [8; 368–369-p.]. Many new methods are expensive and require the use of scarce reagents or complex equipment, so when designing and implementing them, special attention should be paid to economic issues.

Water flooding using chemical reagents. This group of new methods is based on injecting aqueous solutions of chemicals with a concentration of 0.02-0.2% into productive formations. Solutions are injected in a volume of 10-30% of the total volume of reservoir voids to create a rim that displaces oil [9; 178-p.]. With their help, the range of reservoir oil viscosity values can be significantly expanded (up to 50-60 mPa·s), at which it is possible to use impact methods based on water flooding. The use of methods in the initial stages of development allows us to expect an increase in oil recovery factors compared to their value under normal conditions. Water flooding by 3-10%.

The most suitable solution for this process is considered to be a solution of polyacrylamide (PAA) using the lime neutralization method. The addition of PAA to the injected water increases its viscosity and, therefore, reduces the relative viscosity of the reservoir oil: $\mu_0 = \mu_n/\mu_{in}$.

The method is recommended for deposits with high reservoir oil viscosity-10-50 mPa·s. Taking into account the possibility of reducing the injectivity of injection wells due to increased viscosity of the solution and, accordingly, low rates of development of deposits, the method is advisable to use when the permeability of reservoir rocks is significant - more than 0.1 μm^2. Deposits with a relatively homogeneous structure of productive strata, predominantly of the pore type, are favorable [10; 310–311-p.].

Conclusions.

When a solution is filtered in a porous rock medium, the polymer is adsorbed on the walls of the voids. The intensity of this process is especially noticeable when the first portion of solution moves in the formation, when the formations are significantly watered with mineralized water as a result of previous development, and when the reservoir rocks are highly clayey [10, p. 275]. At the same time, it is believed that the method can be most effectively applied to new deposits (with low water saturation of the formations) with low clay content of the reservoirs (no more than 8-10%). Due to the loss of the ability of polymers to thicken water at high temperatures, it is advisable to use the method at a formation temperature of no higher than 70-90 °C. The permissible depth of productive deposits is determined by the pressure loss due to friction of the viscous fluid in injection wells and the magnitude of the geothermal gradient.

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