DEVELOPMENT INNOVATIVE METHODS FOR INCREASING OIL RECOVERY DURING THE PRODUCTION OF HIGH-VISCOSITY AND PARAFFIN OIL

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Abstract

In the article considered, increase of oil recovery traditional and innovative thermal methods, development of high-viscosity and waxy oil and gas field.

Key words: *oil, reservoir, oil recovery, radioactive waste, innovative methods.*

Introducion

Due to the depletion of light oil in the world has increased the interest in hard oils. One of the factors of classifying oils to hard is a high viscosity and high content of paraffin. World reserves high-viscosity and paraffin oil and bitumen are estimated according to the latest data of 810 billion tons, which is almost 5 times higher than the residual recoverable oil reserves of low and medium viscosity [1]. Kazakhstan's share is about 750 million tons of high-viscosity and paraffin oil and 6.8 billion tons of bitumen. The enormous potential of these resources to date used insufficiently. And this is in many due to the anomalous properties of high-viscosity and paraffin oil, which create complex problems at all stages of production: reservoir development, operation of wells, oil transportation and processing.

On the territory of Kazakhstan identified 30 deposits of high-viscosity and paraffin oil. Of them in the industrial development of deposits are Uzen, Zhetybai, Karamandybas Kumkol Aschisay, Karajanbas Kalamkas, Kenkiyak and so on. From them oil of the deposits of Uzen, Zhetybai, Karamandybas, Kumkol and Aschisay extremely saturated with dissolved in it paraffin (is a mixture of solid hydrocarbons with the melting temperature of 90-100^{0}C) with a high content (above 20%) and resins and asphaltenes.

Results and interpretation

Traditional thermal methods of oil recovery increase

Today in world practice there are various ways of development of deposits of high-viscosity and paraffin oil, which are caused by the geological structure and conditions of a bedding reservoir , physico-chemical properties of formation fluid, state and reserves of hydrocarbon raw materials climatic and geographical conditions etc. Conditionally they can be divided into three groups: 1 - quarry and mine development methods; 2 -«cold» means of production; 3-thermal methods of production [2].

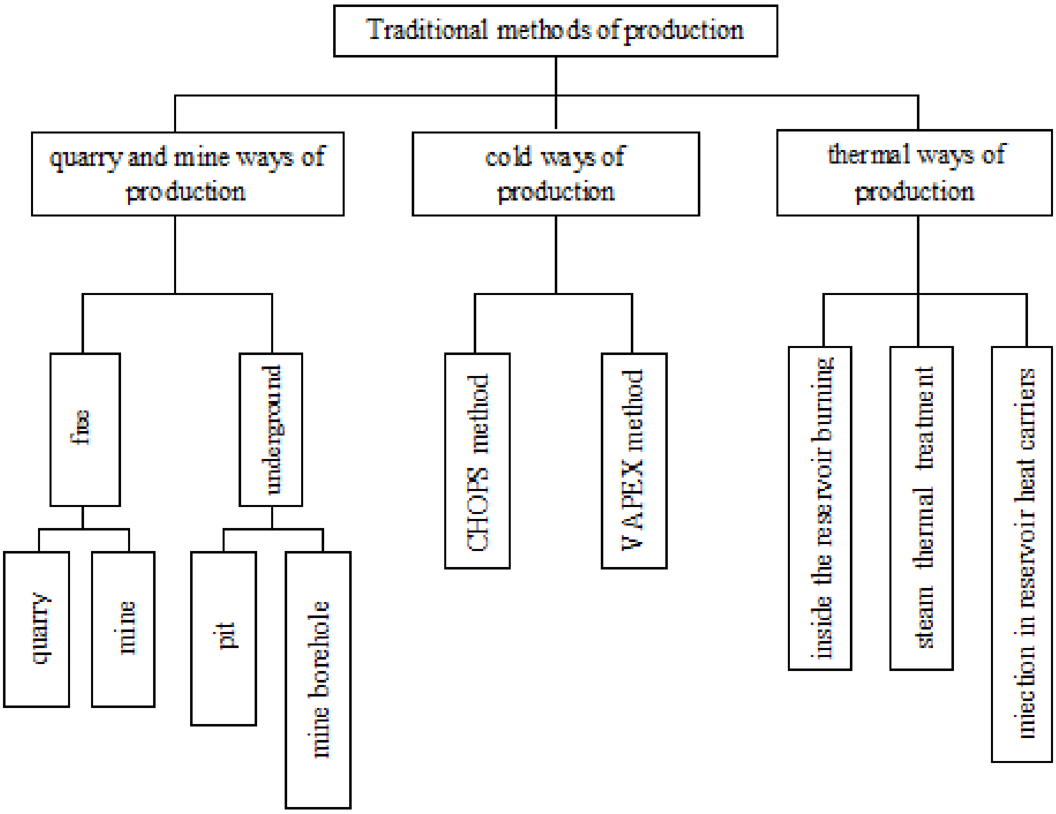


Fig.1. Traditional thermal methods of oil recovery increase

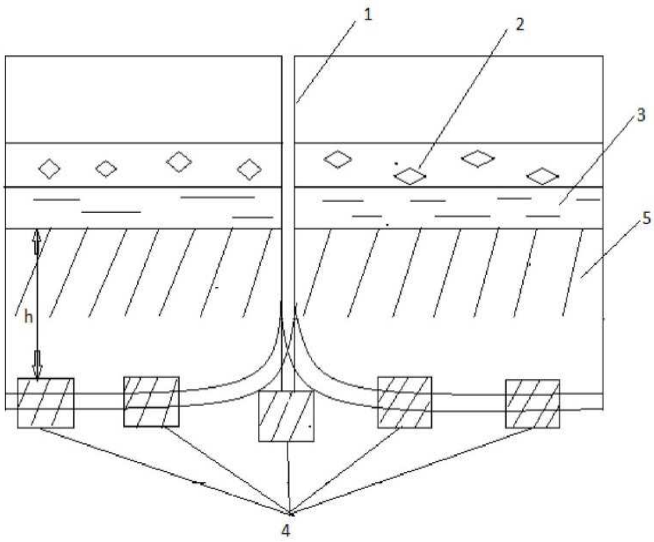
Innovative methods of oil recovery increase

Use of the energy of radioactive waste

To the innovative methods of development of heavy oil and bitumen can include a very large number of ways, but we chose invention patent of the Republic of Kazakhstan (19) KZ (13) A4 (11) 24391, (51) C21B43/24(2009.01) authored by Akhmedzhanov [1]. The technical purpose of which is to ensure the permanent warming up of the reservoir area with thermal sources of long-term actions, such as nuclear waste disposed under the hydrocarbon reservoir (figure 2). Solution of a technical problem of this method is achieved by the fact that under the oil reservoir are horizontal wells with the placement of waste of the nuclear industry produce heat, which are placed in the not-destroying containers. The number of installed containers is determined from the activity of waste and thermophysical properties of rocks of the reservoir and its sole.

This method of deposits development allows to influence on oil layers long-acting heat source and simultaneously promotes recycling and disposal of waste of the nuclear industry.

To achieve a temperature in the reservoir up to the required value development carry out the normal way using a vertical or horizontal wells.



1- well; 2- oil reservoir; 3 - plantar water; 4 - long-acting heat source;
5 - rock sole reservoir

Fig.2. The layout of radioactive sources of heat in a horizontal well

Example of the method. There is a hydrocarbon deposit (high viscosity, high paraffinic oil, bitumen, gas hydrates), located at a depth of more than 500 m. Extraction of hydrocarbons from the deposit is difficult due to high viscosity, high paraffinic oil, bitumen. To reduce the viscosity of oil, and bitumen, as well as the translation of hydrates in the gaseous state is required heat treatment layers long-acting heat source. As such a source of heat use radioactive nuclear waste. To do this, under the reservoir of hydrocarbons (high viscosity, high paraffinic petroleum bitumen and gas hydrates) conduct horizontal well. In this well placed radioactive waste. Horizontal well with the radioactive waste placed in it cork with cement mortar.

Way of development of high-viscosity, high paraffinic oil, bitumen, oil and gas hydrates, including the drilling of horizontal wells, characterized in that in a horizontal wells are placed containers with an active nuclear waste, heat, and the number of installed containers is determined proceeding from the activity of waste and thermophysical properties of hydrocarbon reservoir rocks and soles of the reservoir.

The disadvantage of this work is that within a short period of time warming up of the reservoir is stabilized. Therefore, in this paper warming up of the reservoir is carried out with the variable heat source, timed by the logarithmic law. Underground disposal in the form of a cubic container is in the mountain rock. Containers have on the corridor scheme on certain distance from each other.

Thermochemical technologies

Technologies based on the combination of thermal influence with injection into the formation of the chemicals from the surface, improving the ratio of viscosity or increase the wetting reservoir heat carrier, such as thermo polymer and thermo alkaline. widely covered in the literature.

Therefore, the report covers only the new technologies based on inside the reservoir effective displacing and increase the coverage of the formation agents. Is one of such technologies injection in the heated layer of nitrogen containing compounds, which are used in agriculture, are products of the large-tonnage production are low cost, are fireproof and have low toxicity. At elevated temperatures (about 70-150^{0}C) they decays with allocation of gases (CO_2, N_2) and alkaline solutions, positively influence on process of oil extraction [4].

From big group of nitrogen-containing chemical reagents researches of efficiency of application of a carbamide are widely known only. At the same time others of nitrogen-containing chemical reagents possessing new properties, represent also considerable interest as ammonium carbonate salts some of them, for example, etc. can decay at much smaller temperatures, than a carbamide.

Table 1 - Characteristics of nitrogen-containing compounds used in experiments

№	**Name**	**Formula**	**Temperature decomposition, °C**	**The generated chemical reagents**
1	carbamide	$CO(NH_2)_2$	100-150	CO_2, NH_3
2	ammonium carbonate salts	$(NH_4)_2CO_3$+NH_4HCO_3	>70	CO_2
3	solution of a carbamide and ammonium carbonate in ammoniac water	$CO(NH_2)_2$+NH_4HCO_3	70-150	CO_2, NH_3
4	Ammonium nitrite	NH_4NO_2	>70	NH_3, NO
5	Sodium nitrite	$NaNO_2$	>100	N_2

As a result of decomposition, such as carbamide in front of the injected heat carrier in the reservoir moved rim of carbon dioxide and ammonium hydroxide. When this happens, the combined impact of the reservoir of heat, carbon dioxide and alkaline solution ammonium hydroxide. The decomposition of 1 tons of urea is excreted 746,6 m^3 ammonia and 373,3 m^3 carbon dioxide. Released ammonia and carbon dioxide simultaneously perform the role of tracer substances that can control the character of distribution in the reservoir injected agents.

One of the mechanisms that increase oil recovery at the injection almost all of nitrogen compounds into the reservoir, subjected to heat, formation of carbon dioxide, which is characterized by the following properties:

- dissolves in oil and reduces its viscosity; the dissolution of CO_2 in oil increases its volume and, consequently, increases the rate of oil displacement;
- the dissolution of CO_2 in the reservoir water increases its viscosity;
- reduced interfacial tension oil-water and improving wettability breed water, which also boosts displacement factor.

Along the way, it should be noted that the injection of CO_2 currently one of the most common in the world of technology to improve oil mainly of light oil deposits. Number of projects by the injection of CO_2 in the world in 2010 amounted to 124, including 105 in the United States.

The decomposition of nitrogen-containing chemicals, in addition to CO_2, are formed as well alkaline solutions that increase the efficiency of oil displacement.

The use of sodium nitrite, decaying emitting nitrogen, poorly soluble in the liquid, allows you to create a reservoir stable gas phase and increase the efficiency of oil displacement, and moving displacing agent on the layer, which is especially important when developing deposits containing an anomalously viscous oil, to establish communications between the wells.

Technology of steam gravitational effects SAGD

SAGD operations requires the drilling of two horizontal wells, located parallel to one another [3]. Wells are drilled through the oil-saturated thickness near the soles of the reservoir. The distance between the two wells, as a rule, is 5 meters. The length of horizontal wells reaches 1000 meters Upper horizontal well is used for steam injection into the reservoir and create a high-temperature steam chamber (figure 3).

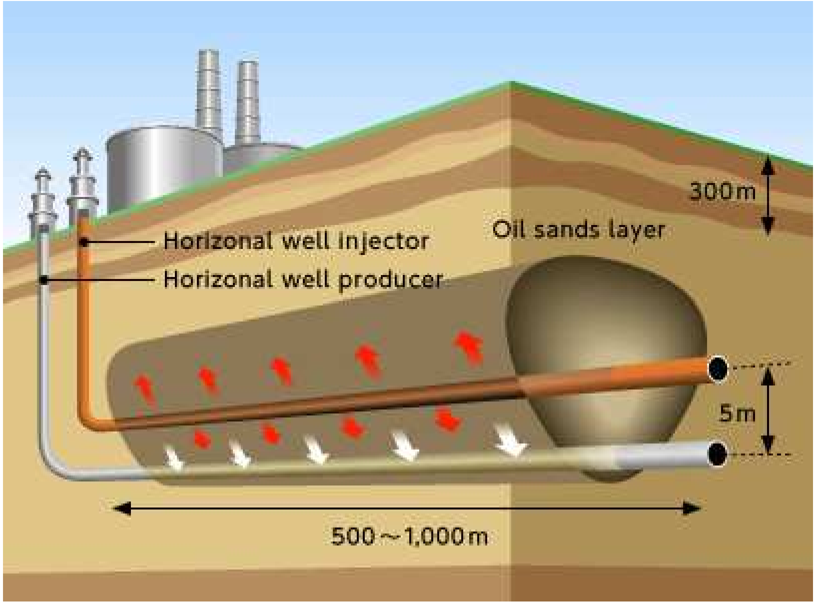


Fig.3. Scheme of steam gravitational effects SAGD

During this process, two horizontal wells, divided by distance vertically, are near the soles of the reservoir. The upper horizontal well is used for steam injection, which rises up and creates above the well a kind of large steam chamber, and the bottom of the well is used to collect the extracted fluid (brine water, condensate and oil). Rising steam condenses on the border of the camera, heating and carrying oil in operational well. This process helps to achieve a high recovery ratio and large oil output at an economical values of oil steam factor (OSF). Butler has developed an empirical correlation for determination of oil output in the result of the SAGD process as a function of the reservoir properties and oil. This correlation is expressed by the formula:

$$q = 2\sqrt{\frac{1.5\varphi\Delta S_0 kg\alpha H}{mv_s}}$$

The process of steam gravitational effects begins from the stage before the warm-up, during which (a few months) is circulation couple in both wells. Due to conductive heat transfer involves heating the reservoir area between the mining and injection wells, reduces the viscosity of the oil in this area and, thus providing the hydrodynamic coupling between the wells.

At the basic stage of production is already steam injection to the injection well. Downloadable pairs, due to the difference of densities, making her way to the top of the reservoir, creating increasing in size steam chamber. On the boundary surface of the steam chamber and the cold of the oil-saturated thickness happens constantly in the process of heat exchange, in which the steam is condensed in the water and together with warmed-up oil flowing down to the producer under the influence of gravity.

The growth of the steam chamber up continues until it reaches the roof of the stratum, then it starts to expand in hand. The oil will always be in touch with high-temperature steam chamber. Thus, the heat loss is minimal, making this way to develop a profitable from economic point of view.

First SAGD project was implemented canadian developers on the world's largest deposits of natural bitumen - the Sands of Athabasca, Canada. During the first stage of the project in 1988 were drilled three pairs of wells with the length of horizontal section 60 M. In these wells was perfected the classical scheme of парогравитационного drainage. KEANE element was 50%, while the accumulated паронефтяное ratio did not exceed 2,5 that confirmed the economic viability of the project. On the next stage of the project in 1993 was started commercial development of deposits of three pairs of wells with the length of horizontal section of 500 meters For monitoring the development process was drilled 21 observation well equipped with thermocouples and piezometric pressure sensors.

In the other major reserves of heavy hydrocarbons country Venezuela first starting SAGD project was implemented in 1997. The results of the experimental industrial developments showed that the development of high-viscosity oil (10000-45000 MPa*s) a new method increases the coefficient of oil extraction up to 60% compared with 10% during cyclic steam-thermal processing of the wells.

There are several key issues that companies using technology SAGD, must overcome to achieve profitability technology. Is:

- Achievement of maximum efficiency;
- Optimal separation of oil and water;
- Water treatment for reuse in the production of steam. Effective use of chemicals is the main condition of successful the solution of these problems.

Conclusion

For increase of oil recovery are the most effective thermal methods. However, currently getting heat for heating of oil in layers is very costly. One of the sources of heat, you can use the heat generated by the nuclear waste production proposed by the authors [1] it achieve a double effect, namely heat recovery and disposal.

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