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THE METHOD OF MINING OF OIL OF HIGH STICKY WITH CHEMICAL ACTIVE ADDITIVES AND THERMAL VORTEX TUBE IN A HORIZONTAL WELL

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ABSTRACT

There are a large number of chemical and thermal methods for increasing the production of high sticky, high paraffinic oil and bitumen, which undoubtedly enhance oil recovery considerably. However, these methods require large financial investments, whether for equipment, new technology or the coolant itself or with chemical additives.

Take the case of several existing methods used in domestic heavy oil. According to the report of the Director General of JSC KazNIPImunaygaz Kurbanbayev M.I. and others in the JSC "Russian Oil and Gas Research Institute named by academician A. P. Krylov (JSC" VNIIneft") at the 3rd International Scientific Symposium": Theory and practice of application of enhanced oil recovery was held on the 20th to 21st September, 2011.

Key words: Horizontal well, Mining, Heavy oil, Oil and gas, Enhanced oil recovery.

INTRODUCTION

Kazakhstan requires the development of innovative technologies for the extraction of highly viscous oils. Organization of efficient production of stranded oil in the fields of Kazakhstan, unique in size, power, producing formation, the density of stock, the nature of the saturating fluids (highly paraffinic, solidifying or high viscosity of mineral pitch and gums) has been associated with overcoming significant challenges. The complexity of mining in Kazakhstan was that the most significant of them were practically devoid of the first and second stages of development. Therefore, the problem of application of new technologies for the development of fields in which traditional methods to extract significant oil reserves have been impossible for the deposits of Kazakhstan from the very beginning of

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development of these deposits were upto date. In this connection, it took the organization from the very beginning of their development of not only the traditional reservoir pressure maintenance systems, but also to maintain the reservoir temperature (Uzen field), and in-situ combustion techniques steam treatment impact (Karazhanbas), polymer flooding (Kalamkas), various methods cyclic of the water flooding (Uzen, Kalamkas), disaggregation of operating facilities (Uzen field) and much more[1].

EXPERIMENTAL

Chemical active and thermal vortex tube in a horizontal well

Thermal effects are one of the most effective methods of exposure to bench for intensification of mining improvement of production rate. It is now widely used different methods of thermal stimulation using the injection of hot water, steam, or in-situ combustion. The best fluids are among the technically possible and water vapor. Therefore, improving the efficiency of these methods has a direct practical significance.

The field application of steam to Kenkiyak intensification began with 1972. In 2001, in the eastern part of the field began pilot operations at a constant discharge for a couple of nine-marketplace system and steam cycles treatment wells (SCTW), resulting in increased efficiency of the design and selection of oil. The increase in well productivity is due to the reduction of oil viscosity and destruction asphaltic resinous sediment at the bottom whole wells, which leads to a decrease in hydrodynamic resistance of filtration system.

The field work was carried out as Karazhanbas to test technology SCTW. Analysis of results showed high efficiency of the technology: the average increase in oil production amounted to 10.7 cubic meters/per day, an increase in factor productivity-an average of 3-4 times[2].

In Kalamkas to align with the displacement front was started in 1981 the use of polymer flooding. Since 1983, the field started flooding sewn-polymer system (SPS). Technology was the fact that along with the creation of rim 0.1% of the polymer solution, occasionally (2 times per year) was handling viscoelastic compositions of injection wells to equalize the injectivity profile, and also of highly producing wells to limit the waterway from the high permeability layers.

During the period 2004-2006, technology is used by 33 injection wells. Analysis of the effectiveness of the work carried out by the surrounding wells, treated hydro dynamically associated with injection wells and reacted to conduct SPS (observed changes in the parameters of their work).

In general, during the analyzed period the average increase in crude oil amounted to 1.7 tons/day, the additional production from the wells-operation - 556.1 tn., the duration of effect - 250 per days, the success - 25%. During the analyzed period the cumulative additional oil from the wells of the work amounted to 53, 920 tons.

Technological scheme of pilot work is tested the impact of water-gas technology (WGT) in the test area Kalamkas. We hope that the test results are positive the technology, which will begin full-scale introduction of HBV Kalamkas.

An important condition for enhanced oil recovery is the most efficient use of working agent of repression. For example, at a late stage of development Uzen improve sweep efficiency is achieved by -

- The selective isolation of high permeability reservoirs, which was crowding out the front, with the achievement of redistribution of flow displacement front;
- Ensuring a high detergency reactive displacing agent with respect to oil with high content of paraffinic-asphaltic resinous substances[3].
- In order to achieve selective isolation of high permeability reservoirs, as well as provide high detergency reactive displacing agent in the field work was carried out:
- Injection of cross-linked polymer system (SPS) with compositions based on water-soluble polymers and reagents stitches;
- Processing bottom zone of injection and production wells, water-soluble polymer-surfactant compositions of multi-functional and other more active methods of exposure (HP etc.).

In order to increase the productivity of wells and enhanced oil recovery through active involvement in the development of poorly drained areas and interlayer, as well as increasing the scope of flooding through improved hydrodynamic connection between the wells used in the fields of hydraulic fracturing (HF).

The deposit "Ozenmunaygaz" HF has been conducting since May 2003. The method is based on the creation of holes in the stress limits of interrupting the productive strength of rocks, i.e. the reservoir is pumped under high pressure fluid, which leads to the formation of layers of "man-caused" cracks with different orientations and lengths upto 100 m and more. Fixing cracks in the course of the operation is carried out to fill the proppant (grains of quartz sand, artificial seeds, etc.). Using of hydraulic fracturing of oil flow increase averaged 12 tons/per day.

The effectiveness of hydraulic fracturing is caused by the fact that the permeability of fractures after the fracture is very high. The expansion and deepening of the natural and the creation of new fractures, penetrating deeply into the formation, leads to a significant increase in the average permeability in the face zone of wells and a corresponding increase in their production rates. In general, the technology of hydraulic fracturing for the conditions of the deposit is highly efficient (80%). However, there is a difference in the manifestation of the effectiveness of the horizons, and, therefore, to assess the success of work in each case requires an individual approach, taking into account the results of geophysical, hydrodynamic studies, the degree of development of reserves[4].

The program of activities to implement cross-linked polymer injection technology systems (SPS) on experimental plots XIII, XIV, XV and XXI horizons are characterized by an increase in the growth of water production was designed and implemented in Uzen in 2002. The technology is aimed at improving the current and final recovery factor by increasing the water flood sweep efficiency.

Thus, we can conclude that the applied methods of enhanced oil used in the fields certainly productive, but do not have the novelty and require improvement. Today, when the ecology and economy are urgent calls for a conscious society, you must use the most economically and environmentally sought innovative ways.

Our proposed method is based on innovation method of discharge of the oil layer of the mixture of hot and reactive carrier gas at a downhole using downhole ejector. As the working fluid supplied to the nozzle of the ejector-situ is used a heated surface environment (chemically active liquid, gas). As the heated coolant mixed with the gas produced is used in passing petroleum gas or a mixture of flue gas exiting the boiler. To increase the temperature of the mixture flow supplied to the oil reservoir, at the outlet of the ejector installed downhole thermal vortex tube. Feed the mixture into the formation of reactive hot coolant gas is carried out either continuously or intermittently.

The method can be applied mainly in the development of reservoirs containing oil of high viscosity and higher, including the presence of the underlying oil reservoir formation water.

The aim is to simplify the method of obtaining a chemically active mixture of hot gas and coolant management in the down hole heat generated during compression of the gas.

RESULTS AND DISCUSSION

The goal is achieved by serving on the set in the wellbore above the producing formation ejector separate threads on the surface of the heated coolant to the working ejector nozzle borehole and gas in the low-pressure chamber borehole ejector. Below is a borehole installed ejector heat vortex tube, which serves the flow coming out of the borehole ejector mixes the hot coolant from the gas. Escaping the heat of the vortex tube flow of hot gas is directed to the thermal effects on the oil reservoir and the flow of cold gas from the vortex tube, is directed to discharge into another object of development. As the coolant is mixed with hot gas ejector in the well is used associated gas. Before serving in the hole it is sent to the low pressure chamber mounted on the surface of the liquid-gas ejector, the nozzle which serves the working pressure of chemically active liquid. Gas-liquid-gas mixture coming out of this ejector, sent to the liquid-gas separator, the gas output of which is connected to an injection well annulus, and exit to the entrance of cold liquid coolant in the heat generator. As a mixed coolant are used flue gases, and before entering the injection well is sent to the low pressure chamber ejector nozzle on the work which serves the working agent: a compressed gas or liquid chemically active. Bleed line of the ejector is connected to a gas separator, which is coming out of the gas is directed to an injection well annulus, and the liquid in the flow of coolant. Cooked in the well fluid mixture of hot gas is fed to the bottom, flooded oil reservoir interval. The selection of products is carried out from the top, unwatered interval of the oil reservoir the same or different penetrated only the upper part of the reservoir wells[2].

Cooked in a well chemically active mixture of hot coolant gas is fed into the reservoir in the cyclic mode, and in the intervals between the injections is carried out the selection of products from the same wells. Before serving, in a layer of the mixture obtained in well with the hot coolant gas is injected into the reservoir consistently rim of ammonia (or an aqueous solution) and hydrochloric acid. As the coolant supplied to the nozzle of the ejector-situ are used a hydrocarbon liquid (crude oil, hydrocarbon condensate, alcohols) or a gas (hydrocarbon, carbon, nitrogen, air). Alternate feed to a working ejector nozzle downhole hot fluid is applied to the working tip of the hot gas ejector.

The proposed technology is based on the compression of the gas and receiving gas-liquid mixture in the well ejector, and the released due to compression of the gas thermal energy is used for additional heating on the bottom hole flowing into the oil layer of the mixture formed from a fed to the ejector downhole hot fluid (for a working nozzle) and gas (in the low-pressure chamber piston). This proposed solution differs from the known according to which the gas is compressed to the required pressure and mixed with the coolant on the surface. Using of the downhole heat is accepted which is produced during compression of the gas before it is mixed with the coolant.

Temperature of the coolant gas in the absence of gas compression can be determined by the formula:

$$Tсм1 = \frac{C_1G_1T_1 + C_2G_2T_2}{C_1G_1 + C_2G_2} \quad \text{…(1)}$$

Where C, G, T, respectively, the specific (mass), heat, mass flow and temperature of the mixed media at the inlet of the ejector, the indices 1 and 2 denote, respectively, the coolant and the gas.

When gas is compressed, mixed with hot coolant in the well ejector, heat capacity is allocated

$$C_2G_2T_2\left[\left(\frac{P_{cm}}{P_2}\right)^{\frac{k-1}{k}} - 1\right]$$

Temperature of the mixture at the outlet of the ejector will then be equal to:

$$T_{cm}2 = \frac{C_1G_1T_1 + C_2G_2T_2\left(\frac{P_{cm}}{P_2}\right)^{\frac{k-1}{k}}}{C_1G_1 + C_2G_2} \quad \text{…(2)}$$

Where $P_{2,}$ P_{sm}, blood pressure, respectively, the gas at the inlet of the ejector and the mixture at the outlet of the ejector; k ratio of specific heats of the gas supplied to the ejector. From (1) and (2) the following relation between the values T_{sm1}и T_{sm2}:

$$\frac{T_{cm2}}{T_{cm1}} \frac{1 + \overline{C}U\frac{T_2}{T_1}\left(\frac{P_{cm}}{P_2}\right)^{\frac{k-1}{k}}}{1 + \overline{C}U\frac{T_2}{T_1}} \quad \text{…(3)}$$

Where $$U = \frac{G_2}{G1}\overline{C}\frac{C_2}{C_1}$$

To further increase the temperature at the proposed bottom hole coming out of the borehole ejector flow of gas sent to the vortex tube, which due to manifestations of "the effect of Ranko," one of the outgoing flows of the vortex tube is heated and the other cooled. According to this paper, the temperature of the hot gas flow is determined by the formula:

$$T_\Gamma = \frac{T_C - \mu T_X}{1-\mu} \qquad \ldots(4)$$

Where - T_c the temperature at the inlet of the vortex tube,

T_x - temperature of the cold gas flow; μ - the mass fraction of cold gas stream; $\mu\ G_x/G_c$; G_x - mass flow of cold gas outflow; G_c - mass flow rate of gas fed into the vortex tube.

The proposed technology can be used as a coolant hot water, steam, hot gas or hot liquid hydrocarbon (oil, hydrocarbon condensate, alcohols, etc.) as well as the feed gas into the well casing-head petroleum or natural gas, nitrogen, carbon dioxide, air, flue gases. For the heated coolant is proposed to use generators, such as furnace coils, mounted near the injection wells. The method provides the ability to make maximum use of thermal energy, to utilize associated gas and oil extracted with water, and gases of combustion (flue gases) leaving the set of generators on the surface of the heat (stoves). The flue gases, pre-compressed on the surface is fed into the well for further compression and mixing with the work is supplied to the ejector nozzle borehole hot coolant, and is formed in the well ejector reactive mixture of hot coolant from the flue gas is directed into a productive (oil) layer[3].

The method is as follows (Fig. 1). The structure of the system consists of a hole 1, the inner column of tubing 2, heat generator 3, line hot coolant from the heat source 4, the tubular annulus 5, column 6 outer tubing, operating the nozzle 7, subsurface ejector 8, 9 in the inlet chamber of the low-pressure downhole ejector 10, a productive (oil) layer 11, a packer 12, the vortex tube 13, inlet in the vortex tube14, the hole from hot gas from the vortex tube 15, channel 16, opening out of cold gas from the vortex tube 17, the second object of development 18, packer between productive (oil) layer and a second object of development 19.

Figure 1 shows the gas compression technology and the additional heating due to this mix the coolant with the gas ejector in the well when applying for a working ejector nozzle hot coolant and low-pressure chamber in the downhole gas ejector.

In a hole in the inner column of tubing 2 from the heat source 3, for which the furnace can be used with an intermediate coolant is supplied via four hot heat transfer fluid (water, steam, hydrocarbon liquid). In annulus 5 (between the inner casing 2 and the outer casing pipes used tubing) from the source of the gas supply; hot coolant is directed to operating the ejector nozzle 7 borehole 8, and gas from the annulus through the inlet 9 in the low-pressure chamber 10 wells ejector. Coming out of the ejector mixture of reactive hot coolant gas is sent to the reservoir 11 (in this case tubular annulus between the borehole production casing 1 and the outer casing tubing above the producing formation 6 11 pre-packer cover 12).

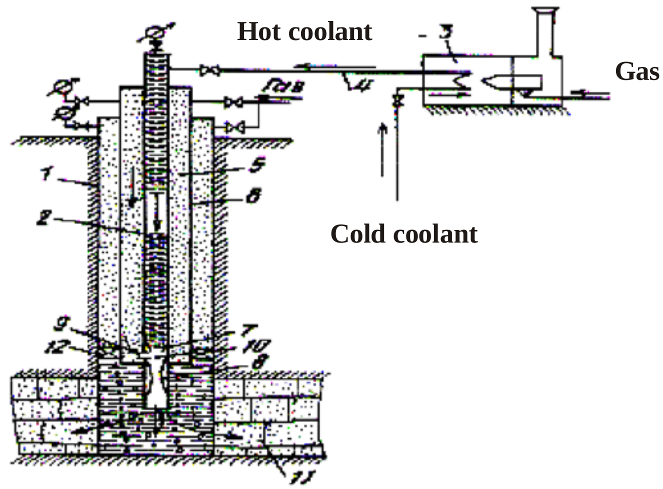

Fig. 1: The technology of gas compression and auxiliary heating

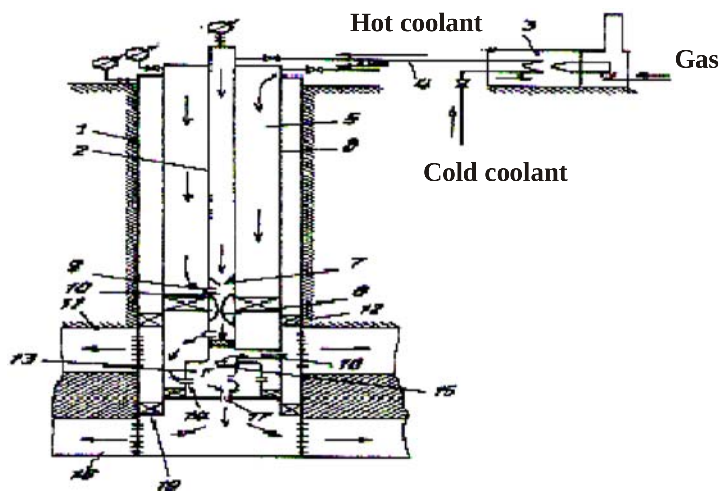

Fig. 2: Technology that provides a receipt to the downhole flow of high-temperature mixture is used a vortex tube, Ranque Hilsha

Emanating from a borehole ejector mixture by compressing the gas receives an increase in the amount of heat ΔQ (5) and the temperature coming out of the borehole ejector mixture is determined by the Eq. (2).

$$\Delta Q C_2 G_2 T_2 \left[\left(\frac{P_{см}}{P_2} \right)^{\frac{k-1}{k}} - 1 \right] \quad \ldots(5)$$

The additional increase in temperature coming into the reservoir of gas-liquid mixture by heat ejector in the well is an important and useful that makes it possible to obtain a higher recovery factor.

The technology provides a receipt to the downhole flow of high-mix using a vortex tube (Ranque effect). In addition to the technology presented in Figure 1, is lower ejector 8 is installed downhole vortex tube 13, into which the mixture (gas, steam), preheated, and emanating from a borehole ejector enters through the inlet 14 in a vortex tube in a vortex tube flows are separated by a mixture of , the hot gas stream through the opening 15 and channel 16 enters the oil reservoir 11, a cold gas flow through the opening 17 receives a second object of the development of 18, separated from the productive (oil) reservoir 11 packer 19. This technology allows the oil reservoir to file split in the vortex tube flow of the mixture at a temperature higher than in the technology shown in Fig. 1.

CONCLUSION

The proposed technology has the ability to maximize heat the oil reservoir containing a highly viscous, high-paraffinic, bituminous deposit, but for a more efficient production technology to create a system of oil field development, we propose to use the above technology as injection wells, as well as the extractive use of horizontal wells. In the process of heating the reservoir oil is less viscous and can be transported to the surface of the horizontal well.

Studies of the development with the use of horizontal wells can increase the coverage of the reservoir thermal effects, and increase the volume of oil, hence, the oil recovery. We offer innovative technology of heavy oil production with the use of chemically active fluids and thermal vortex tubes is feasible and currently requires a number of structural refinement details of the placement of the equipment and horizontal wells in the thickness of the formation.

Thus, it is proposed to work on highly viscous oil reservoirs by increasing not only the temperature of the oil reservoir, as well as maintain the pressure of the oil reservoir.

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