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METHODS FOR EXTRACTING NATURAL BITUMEN AND VISCOUS OIL DEPOSITS

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Abstract
The article considers various methods for developing deposits with high and high viscosity oil, as well as some methods for developing natural bitumen deposits. It should be noted that methods for the development of bitumen deposits may differ significantly from methods for developing viscous oil fields, but in some cases, methods can be applied to both one and the other fields. The choice of the method is mainly influenced by the geological and physical properties of the oil containing reservoirs and the physical properties of the saturating fluid.

Keywords: High viscosity oils and natural bitumen; career and mining methods of development; «cold» ways of extraction; thermal methods of development; steam heat treatment of bottom hole well zones; injection into the reservoir of the coolant; process of the steam and gravitational effect.

Introduction

The problems of exploitation of natural bitumen and unconventional hydrocarbon raw materials are considered to be one of the urgent problems, mainly for countries with high industrial potential, developed infrastructure and highly qualified personnel.[1].

Natural bitumens are genetically degassed to varying degrees, have lost their light fractions, are viscous, semi-solid natural oil derivatives (maltas, asphalts, asphaltites) [2]. These, like bituminous rocks, are valuable multi-purpose raw materials for many industries. It is an additional source of hydrocarbon raw materials for the fuel and energy industry. It is used as an asphalt-concrete mixture in the construction industry. In metallurgical industries, it is used as a companion metal component.

According to the estimation of the United Nations, the geological resources of natural bitumen in the world are about 260 billion tons, of which the extracted resources are 70 billion tons, so about 70% of the resources are in Canada.

Heavy oil ((ρ_n^{20} =0,98) can be divided into three types according to the conditions of its formation in the territory of Uzbekistan: 1) according to changes in the zone of rapid hypergene-water-oilexchange;2) paleohypergene-unchanged; 3) heavy oils accumulated at a great depth.

Heavy oils of the first group include oils that have naturally come to the surface in the hilly areas of the Fergana basin (Shorsu, Shim. Rishton, Sel-Roho, etc.) and in the upper horizons. As a result of long-term exposure of mobile waters with low mineralization in tectonic intensive zones, aerobic-microflora and other atmospheric agents caused the loss of light gasoline fraction, partial deparaffinization and loss of other non-renewable elements. Such oils (naphthides) - mortars, asphalts, asphaltites, kerites are called intermediate oils in the process of formation of bitumen in the petroleum series.

Heavy oils of the second group are distributed in the Afghan-Tajik basin, in Paleogene deposits, high-sulfur (up to 5%) low-gasoline oil, aromatic hydrocarbons (NK - 300 0S fraction on average 28%), containing up to 25% nitrogen, up to 15% carbon dioxide enriched with gases. Such oils lie in carbonate-sulphate deposits and were formed under the influence of neotectonic movements that occurred in the Neogene-Quaternary period.

Heavy oils of the third group were found in horizons or layers at a great depth (2800 m) in different regions of Uzbekistan. These oils differ in the amount of asphaltenes, tar substances, and partially n-alkanes S15-S36 gas condensate deposits (Ortabuloq in Western Uzbekistan, Kamishladja in Turkmenistan, etc.). The high formation pressure allowed the retrograde transition of oil fractions to the gas solution, except for the gasoline-kerosene fraction. In this regard, this type of oil can be included in deep-residual oil.

In tectonic active zones, various natural bitumens in the oil line were formed as a result of the release of oil to the surface, denudation of oil layers, and the complex effects of atmospheric factors. In Uzbekistan, such bitumens are distributed in the areas adjacent to the Fergana mountain ranges, in the Surkhandarya basin and around the Zirabulok-Ziaetdin mountains [3].

Reserves of high-viscosity heavy oils and natural bitumen amount to 790 billion according to various estimates. 1 trillion per ton. up to tons, approximately 162 billion. tons of small and medium-viscous residue is 5-6 times more than recoverable oil reserves.

Exploration reserves of heavy oil and natural bitumen are few, currently, light and medium oil reserves are relatively more known [3].

The heavy oil field in the Orinoco Belt in Venezuela and the bitumen deposits in the eastern hills of the Western Canadian Basin are two of the largest in the world. The total initial reserve of oil is 3600 bln. constitutes a barrel. The reserve due to technology development is 900-1200 bln. can form a barrel.

Production of heavy oil began in the first decade of the last century in the USA, Venezuela, and Mexico, and developed rapidly in the 1940s [3].

Mining technologies of high-viscosity and natural bitumen deposits

There are various methods of extraction of heavy oil and natural bitumen deposits, which differ in their technological and economic characteristics. The use of one or another technology of extraction depends on the geological structure and bedding conditions of the layer, the physical and chemical characteristics of the fluid of the layer, the state and reserves of hydrocarbon raw materials, climatic and geographical conditions, etc. based on They can be conditionally divided into different groups according to their application:

1 – quarry and mine method of extraction;

2 - "cold" method of extraction;

3 – thermal methods of extraction.

Quarry and mining method of extraction.

Natural bitumen heaps are mined by open (quarry or mine) and underground (mine, mine-well) methods.

Hard bituminous shale can lie almost at the surface, but bituminous rocks can lie at depths of up to 750 meters (Peace River Mine, Canada), sometimes even deeper. Usually, the mining depth does not exceed 150-200 meters, in many cases mining is carried out at a lower depth.

Extraction of oil products by the pit method consists of two main operations: extraction of oil rocks underground and transportation to the refinery for extraction of oil. Mining with this method has low capital and operating costs, and after carrying out additional work on the extraction of hydrocarbons from the rocks, a high coefficient of oil recovery is provided: from 65 to 85%. Excavators, scrapers, bulldozers, and other mining techniques are used to bring rocks up.

The Athabasca bituminous sand mine in Canada (Alberta province) is the largest mine in the world. The thickness of the sands is up to 90 meters, and the depth of the sands is up to 600 meters. Sands with quartz porosity up to 30%. Bitumen saturation is from 2 to 18%, on average 8%.

Extraction by the mining method can be carried out in two different modifications: a cleaning mine (raising hydrocarbon-saturated rocks to the surface) and mine-wells (drilling vertical and inclined wells in the productive layer to process the rocks above the layer and collect oil from these processed rocks) [5].

The clean-up shaft method is used only in productive layers up to 200 meters deep, this method has a much higher oil recovery coefficient (up to 45%) compared to well methods. When using this method at a great depth, the efficiency of the method decreases due to the passage of hydrocarbon-unsaturated rocks, because at present, this method is economically effective if the rocks contain rare metals in addition to hydrocarbons. The mine-well method of extraction can be applied to productive layers up to 400 meters deep, the coefficient of oil permeability is much lower than the cleaning-mine method, and a large number of wells are required to be drilled. The principle of using the mine-well method is as follows. If the mountain developments are below the oil and gas productive horizons, drainage wells are drilled in them (usually 10-12 wells are drilled), oil flows under the influence of gravity factors into a special channel prepared in advance, which is dug obliquely to the side of the oil storage area. If the mining development is above the oil and gas productive horizons, then wells are also drilled, but the oil is extracted by pumps. High-viscosity oil is transported through the canvas with the help of water in an open manner without gaseous components. After that, this oil is pumped up from the oil storage area.

In order to increase the productivity picture of final oil and natural bitumen and to ensure the complete processing of the reserve in the mine-well method of production, steam-heat effect is used in the formation. This method is called the hot-ice method, it is used up to a depth of 800 meters and has a high oil recovery coefficient (up to 50%). However, compared to mine and mine-well methods, management is more complicated. Yareg mine is an example of heavy oil piles mining.

Mining of the Yareg mine is divided into three stages:

1) Experimental use of wells on the surface of the earth;

2) Mining method of extraction;

3) Extraction by the mining method with the effect of heat on the layer.

The exploitation of wells on the surface of the earth led to the extraction of 2% of oil. It is for this reason that the idea of drilling mine wells appeared, ending in a gallery system in the horizons lying above.

Mining is carried out according to two systems:

1) Ukhtali, in which the piles are drained through a dense network of vertical or slightly inclined wells (up to 50 meters deep), which are drilled from the overlying tuffite horizon rock formations located 25 meters above the productive layer;

2) Inclined wells - inclined wells up to 200 meters long, located in the upper part of the formation in the form of a gallery system, are drilled hexagonally (on an area of 8-12) in the lower part of the horizon.

Such two-system wells made it possible to increase the coefficient of oil recovery up to 6%. Steam heat was used to increase oil permeability.

The efficiency of any production system is determined by economic indicators - the cost of oil production, the rates of oil recovery and oil recovery coefficient.

"Cold" methods of oil extraction

"Cold" methods of heavy oil extraction can be criticized, first of all, "CHOPS" method, this method has the possibility of producing oil along with sand due to the erosion of weakly cemented reservoir rocks and creating conditions suitable for the formation for the flow of oil and sand mixture (Lloydminster field in Canada). When using the "CHOPS" method, operating costs are low and large investments are not required, but in this case, the oil recovery coefficient does not exceed 10%. In "cold" oil extraction, pumps with special equipment are widely used (for example, a screw pump), with the help of these pumps, specially formed formation fluid and sand mixtures are withdrawn. Sand mining creates long channels (or pits) with high permeability. experiments show that some channels can escape up to 200 meters from operational wells. High-permeability channels together with foamed oil provide a high oil recovery ratio, and high productivity is observed in several oil-rich reservoirs in the Lloydminster Cone. There are several limitations to cold mining technology's commercial viability. According to the current estimates, the oil production volume is 36,500 m3/day. (230,000 barrels/day), while the production volume is predicted to decrease by 50% in the next decade. Such a decrease in productivity is caused by the following criteria:

- lack of deposits suitable for obtaining products by the cold method;
- watering of wells due to the flow of water through the network of channels;
- reduction of layer pressure and layer energy;
- low liquid flow and high gas factor;
- due to the above reasons, there is no opportunity to use the wells for more than 7-8 years.

"VAPEX" method can be added to the ranks of the "Cold" method of extracting heavy oil and natural bitumen using solutions, according to which the solution is pumped into the layer in gravity drainage mode. According to this method, exposure to the formation using steam from horizontal wells is estimated. A solution chamber is formed from these due to driving solution above (hydrocarbon solution as well as ethane or propane). Oil is diluted due to the diffusion of solutions in it, and under the influence of gravity, it flows along the boundaries of the chambers towards the wells where the product is extracted. According to this method, the coefficient of oil recovery reaches 60%, but the rate of response is much lower.

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Thus, the "cold" methods of extracting heavy oil and natural bitumen deposits have a number of disadvantages. These disadvantages include limitation of maximum oil viscosity and low production rate. Therefore, in the design of the production of heavy oil and natural bitumen fields, it should be carried out in connection with the influence of the layer by the thermal method.

Thermal method of extraction

The thermal method of oil field extraction is divided into two principles of different appearance. The first layer is based on the internal combustion process, which is created by burning coke residues in the bottom zone of drip wells (usually using a TEN-type bottom-of-the-well heating installation), in which air (for dry fire) or air and water (wet for fire) the fire front is moved by means of hadash. The second form, widely used abroad, is based on driving the heat carrier (from the surface) in the oil formation [5].

These methods are based on the fact that when oxygen (air) is pumped into the formation, it reacts with the oil in the formation, releasing a large amount of heat (internal combustion of the formation). These methods are based on the accumulation of heat in the productive layer from the transfer of heat accumulated as a result of the burning of oil at the bottom of the well into the formation. Air driven into the layer moves the combustion zone inside the layer. The following methods are used in the use of oil piles [4]:

1. Directly directed "dry" combustion, oil is burned at the bottom of the air pumped well, and the combustion zone mixes with the pumped air and moves towards the liquid extraction well; Direct wet burning or medium wet burning, in which air and water are pumped in a certain ratio to the layer. As a result, a boiling water rim is formed in front of the combustion front, that is, heat enters the zone in front of the combustion front, which in turn leads to an increase in the oil recovery coefficient with a sharp reduction in the consumption of the driven air.

The second process is relatively effective. In this case, all the same factors as when steam is pumped into the formation are used in oil extraction, in addition, additional factors specific to this process (mixture of carbon dioxide gas with water, oil extraction using surface-active substances, etc.) are also used.

The greater the depth of the layer, the higher the air driving pressure, so high-pressure compressors are used. When using this method, choosing piles at a depth of 1500-2000 m gives a positive result. Such methods can be used when the viscosity of the layer in the heap is from 10 to 1000 mPa·s. Such oils contain a large amount of heavy fractions and serve as fuel during combustion. According to the technological capabilities and economic indicators of the combustion process, it is recommended to use it when the permeability of the rock is greater than 0.1 μm2 and the oil saturation is greater than 30-35%.

The advantage of these methods is felt when the permeability of the rocks in the middle part of the object is good, the oil-saturated thickness is 70-80 m and more. Under the influence of the combustion process in the middle part of the object, the low-conductivity rocks lying above and below it are also heated.

During dry combustion, the temperature reaches 700 0C, so this method can be used in terrigenous collectors, while carbonate collectors are consumed at this temperature.

Combustion in wet and very wet processes occurs at temperatures of 400-500 and 200-300 0C, respectively, so they can be used in both terrigenous and carbonate reservoirs.
The dry combustion processes also effective in the density work of well locations and the use of thermo physical methods. In the process of wet combustion, if the size of the heated zone in front of the combustion front is large, the density of the location grid of wells is 16-20 ha/well [4].
The method of driving heat transfer in oil formation has two different technologies. The first is based on the heat carrier and its characteristic oil leakage. Such a difference, based on the type of heat carrier used, is called the steam heat effect and the boiling water effect in the layer. The second is steam heat treatment of the bottom zone of the well receiving the product. In this case, saturated water vapor is used as a heat carrier [5].
As a fuel for combustion, a part of the remaining oil is consumed in the layer remaining from gas combustion, water vapor, water, vaporization of oil fractions in front of the combustion front and other complex physico-chemical processes. 5-25% of oil reserves are burned. According to the researchers, fuel consumption increases with increasing oil density and viscosity, and decreases with increasing permeability [5].
Oil extraction using steam. It is a method base don’t the use of heaps with a high viscosity 40-50mPa·s, and is used incases In the former Soviet Union and Uzbekistan, the process of impacting the formation by sending water along with steam is base don’t theory. The steam sent to the layer occupies 20-30% of the volume of the heap space, creates a high-temperature border in it and mixes with the water pumped into the layer. As a result of using this method, the oil recovery coefficientes 0.4-0.6 and higher.
The effect of this method can be seen in the reduction of the viscosity of formation oil, in the purification of oil in the vapor spread zone, in the melting and draining of tar, asphalt and, etc. stuck to the walls of the pores of the rock-collectors.
According to the con-geological description, when choosing piles where this method can be used, first of all, low loss of steam when moving in the well and then in the layer is taken into account. It is effective to use this method when the depth of the layer is up to 1000 m, because the greater the depth, the greater the loss of heat. The method is use full only if the thick nesses of the layer saturated with oils 10-40 m. If the thick nesses is low, heat can transfer to the layers above and below the productive layer.
If the thick nesses of the oil-saturated layer is very large, only a part of it can be covered by heat, in such cases the layer is divided into objects. It is use full to use the method when the collecting characteristics of the rock sare high (porosity coefficient is high earth 0.2%, permeability is greater than 0.5 μm2), because in such cases, less heat is spent on heating the rocks of the productive layer. This process works well when using piles with high in it all oil saturation because very little heat is used to heat the formation waters.
If the rock reserve oil shave low stability, steam injection into the formation can disrupt the formation, result in gin rock particles coming to the surface from the fluid extraction wells, and pore size reduction and, in turn, permeability reduction as a result of the clay rocks in the formation. There fore, when choosing objects, it is better that the rocks in the layer have high stability and less clay content (less than 10%). The most convenient to use the method are mono mineral is square and stones, and less convenient are polymict (clay rock fragments) sand

stones. Application of the method is effective when the distance between the wells is 200-300 m.

Oil extraction using boiling water. This method is used in the use of oil piles with high viscosity, as well as in increasing the coefficient to foil extraction from high paraffin oil piles. In this method, the factors mentioned in the steam injection method are used to increase the oil extraction coefficient. But the method of squeezing oil from the formation using boiling water is less efficient and requires a large amount of water to heat the formation. Since the heating zone of the formation lags behind the oil displacement front, a volume of boiling water 3-4 times larger than the volume of the cavity is pumped into the productive formation.

This method is used in conditions where, due to a slight decrease in the temperature during the use of the heap, paraffin may settle in the layer and the pores of the rock maybe blocked. In order top revent precipitation of paraffin, boiling water whose temperature is higher than the temperature of the formation is pumped into the formation (the temperature loss is taken into account until the water reaches the bottom of the well).

Also, heat loss in the well and in the formation is taken into account in the selection of objects, as well as in the case of steam injection into the formation [5].

CONCLUSION

Thus, high-viscosity oil and natural bitumen reserves are somewhat larger than traditional low- and medium-viscosity oil reserves, and difficult-to-extract crude deposits are widespread in the world.

Canada, USA, Russia, Venezuela, Nigeria and other countries are actively developing heavy oil and natural bitumen deposits.

High viscosity oil and natural bitumen should be considered as complex raw materials. High-viscosity oil and natural bitumens contain valuable heteroorganic compounds such as petroleum acid, sulfoacids, simple and complex ethers, metalloporphyrins, sensitizers, organic semiconductors, which serve as a source of unique catalysts. These components and compounds are used in biology, biotechnology, chemical technology, microelectronics, therefore, there is a high demand for these products in countries with rapid development of technology.

Development of the direction of extraction of high-viscosity oil and natural bitumen includes the following activities:

- study of foreign experience in extraction of high-viscosity oil and natural bitumen deposits;
- analysis and development of rational methods of extraction of high-viscosity oil and natural bitumen, as well as development of methods of increasing oil permeability for maximum extraction of all useful components;
- development of technology for extracting products from high-viscosity oil and bitumen in the field, and this obtained product should be compatible with the movement of main pipelines;
- development of technology aimed at increasing the scale of high-viscosity oil and natural bitumen processing and extraction of related components and creation of oil processing capacity;
-solving specific environmental problems associated with extraction, transportation and processing of high-viscosity oil and natural bitumen.

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It should be noted that extraction of high-viscosity oil and natural bitumen is not considered a trend today, but it will have its place in the near future.

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