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Methods for Increasing Oil Recovery at Oil Deposits with High-Viscous Oil, Advantages and Disadvantages

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ABSTRACT: The article analyzes the main advantages and disadvantages of modern methods of increasing oil recovery. Due to the fact that the extraction of high-viscosity oils is by far the most basic problem in the field of oil development, this article is relevant.

KEY WORDS: coefficient, deposit, well, stratum, viscosity, debit, oil solubility, use, watering, method, acceleration, effect.

I. INTRODUCTION

Over the past decade, the share of difficult to extract, including heavy, highly viscous oils and natural bitumen, has significantly increased in the structure of reserves in Uzbekistan. At the same time, the extraction of such raw materials is growing much more slowly than its share in the total reserves.

The issue of developing the resources of such oils is especially relevant now, in connection with the recent decrease in the growth of reserves of conditioned oils.

Heavy oils and natural bitumen are characterized by a high content of aromatic hydrocarbons, resinous-asphaltene substances, a high concentration of metals and sulfur compounds, high densities and viscosities, increased coking properties, which leads to high production costs, it is almost impossible to transport through existing pipelines and unprofitable, according to classical schemes, oil refining.

Production of heavy high-viscosity oils using conventional oil technologies leads to low oil recovery and the loss of valuable associated components, which results in lost profits and harm the environment. Bringing the feedstock to the required quality is achieved by diluting with lighter oil or refining to obtain the so-called synthetic oil. Sometimes, special heated pipelines are built to transport heavy high-viscosity oils, which also increases production costs.

Most existing refineries (refineries) are not designed to process heavy, highly viscous oils. Some heavy high-viscosity oils can be processed at refineries mixed with conventional oils using traditional technologies. Other such oils can be processed only at specialized enterprises producing a limited range of petroleum products. The solution to the problem of the rational processing of heavy high-viscosity oils is complicated by the fact that the data on their properties and composition are very incomplete, contradictory and not systemic in nature. The lack of information makes it difficult to attract new investors to resolve the issue of processing new types of raw materials for them.

II. METHODOLOGY

The production of heavy high-viscosity oils and natural bitumen is economically feasible and possible only due to the development and application of effective technologies for their processing to produce marketable petroleum products with a high difference in market price from cost. This will make it possible to recoup the costly technologies for their production, many times exceeding the same costs for the production of conditioned oils.

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Mining technology. To date, there are many known technologies for the extraction of heavy oils and natural bitumen, which in practice have proven their effectiveness: these are Cyclic Steam Stimulation – CSS, Steam–Assisted Gravity Drainage – SAGD, Cold heavy–oil production with sand – CHOPS, Vapor Extraction – VAPEX, Solvent Aided Process – SAP, Toe to Heel Air Injection – THAI), новая технология CAPRI (CAtalytic upgrading Process in–situ on the base of THAI, involving the use of oxidation catalysts.

Currently, various methods are used to develop deposits of natural bitumen, the applicability of which is determined by the geological structure and conditions of bedding, the physicochemical properties of the reservoir fluid, the state and reserves of hydrocarbons, climatogeographic conditions, the presence of infrastructure, and other factors. The most popular are quarry mining and thermal mining methods.

With the career development method, the rock saturated with bitumen is extracted in an open way, and therefore the possibility of using this method is limited to a depth of up to 75 m. After the rock is extracted, additional work is required to obtain synthetic hydrocarbons from it (at the plants upgraders).

The most promising thermal method for developing natural bitumen deposits is considered to be SAGD technology, developed by the British oil and gas company BP (Beyond petroleum, until May 2001, the company was called British Petroleum). SAGD technology provides for the drilling of two horizontal wells located parallel to each other through oil-saturated thicknesses near the bottom of the formation. The steam produced by natural gas is injected into one of the wells, which runs about 5 m above the producing well. Steam heats and reduces the viscosity of bitumen, which, together with condensed steam, flows into the producing well. Since oil is always in contact with a high temperature steam chamber, heat loss is minimal, which makes this development method economically viable.

A feature of the implementation of investment projects for the development of hard-to-recover oil reserves is the requirement of continuous use of expensive technologies and modern methods of increasing oil recovery, which are estimated to be 3-4 times more expensive than oil production from traditional deposits. Without a constant increase in the number and search for new methods, the development of these objects is almost impossible. As a result, under the current system of taxation, the economic results from the further development of these hard to recover deposits do not reach positive values.

III. RESULTS

About associated non-ferrous metals. Heavy oils are classified as alternative sources of hydrocarbons, since they differ from conventional oils not only in increased density, but also in their component composition. In addition to hydrocarbons, heavy oils contain naphthenic acids, sulfonic acids, ethers and esters, as well as rare non-ferrous metals in conditioned concentrations. Currently, there are no effective technologies for the extraction of titanium and its compounds, which are contained, for example, in Yareg oil. It is noteworthy that in Russia there is not a single enterprise producing titanium dioxide, and significant needs for titanium concentrates and pigments produced on their basis, in the presence of domestic stocks of raw materials, are covered by imports.

Vanadium and nickel, extracted from heavy high-viscosity oil, are qualitatively superior to analogues obtained from ore. Therefore, developed countries prefer to use precisely "oil" metal in innovative technologies, where higher purity is required than in foundry. For example, Canada and Japan completely get vanadium from heavy high-viscosity oils, in the USA more than 80% of vanadium is extracted from oil. Since 2003, demand for vanadium has begun to grow at a faster pace, and this trend is likely to continue.

Heavy high-viscosity oils also contain such unique components as naphthenic acids, sulfonic acids, ethers and esters, which can be extracted during processing according to a special scheme. The cost of these components in the volume of marketable products resulting from processing may exceed the cost of petroleum products. Thus, to increase the economic efficiency of the development of heavy high-viscosity oils, modern technologies are needed to expand the range of marketable products obtained from the extraction and processing of these raw materials.

The creation of new effective technologies for the preparation and processing of heavy unconventional hydrocarbon feedstocks is an urgent task, the solution of which will significantly improve the reproduction of the country's raw material base due to the cost-effective involvement of high-viscosity oils and natural bitumen in the development of deposits.

Almost all fields, regardless of their geological characteristics, are developed using traditional technologies: with water flooding or in natural mode. At the same time, it is obvious that the use of water flooding is inefficient in a number of deposits with carbonate, fractured porous reservoirs, and abnormal oils. On many of them, CIN is less than 15–20%.

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This is due to the fact that when cold water is injected into a fractured formation, low-permeability intervals, including the main oil reserves, are blocked by water that fills the highly-permeable channels, and it is almost impossible to involve them in development. For such objects, technologies are needed that can effectively act on low-permeability reservoirs. These include thermal methods. When coolant is injected into the formation, which also breaks through highly permeable zones, less permeable sections of the collector warm up due to thermal conductivity and are involved in development. In this regard, light oil deposits confined to carbonate and fractured porous reservoirs, especially those with a hydrophobic characteristic, can also be considered promising objects for applying thermal methods.

The experience of other countries, for example, the USA, where the average project recovery factor with a significantly worse inventory structure is 41 percent due to the widespread use of new technologies, is significant. Of the 360 projects using modern methods of increasing oil recovery (EOR) that are implemented in the world over the year, 166 projects (46%) are thermal methods, mainly steam and thermal, and 70 projects (42%) are used in the United States. The analysis results show that thermal methods are effectively used in a wide range of oil viscosities (20–50000 mPa * s) in extremely heterogeneous fractured reservoirs. Recently, around 80 million tons of oil is annually produced in various countries of the world due to thermal methods, which accounts for 65% of all world production using EOR.

IV. CONCLUSION

Reasons for the decline in oil recovery. There was a situation when oil companies (endowed with reserves) in practice are not interested in applying modern methods of increasing oil recovery (hereinafter - EOR), but instead use methods of selective intensification of oil production from active reserves, including if they lead to a decrease in design oil recovery. Researchers rightly point out that during the period of high oil prices, the majority of producing companies in the world, trying to get superprofits, carried out intensive selection of hydrocarbons from a high-yield well stock, which led to the transfer of a significant part of recoverable reserves to hard to recover and, consequently, to huge losses of hydrocarbons. Additional production due to the use of modern EOR in the country is steadily decreasing and its volume in total oil production is practically not noticeable.

Obviously, production in fields with hard-to-recover reserves using modern EORs requires additional costs, and vice versa, abandoning them and developing accessible fields reduces the cost of raw materials, which suits companies, shareholders and investors, because provides profit. In this case, the so-called unprofitable wells, a concept widely used in literature and business circulation, but absent in Russian legislation.

Based on the experience gained, the adjustment of both the field of application of some methods and their possible effectiveness was started. First of all, this concerned physical and chemical methods. First, theoretical and then field data showed that the adsorption of chemicals on the surface of porous media can have a much greater negative effect on the effectiveness of the methods than previously thought.

Significantly more serious were the problems of regulating the in-situ combustion process, as well as corrosion in oil wells. The problem of transporting liquid carbon dioxide from a petrochemical plant to a field during the implementation of the method of pumping carbon dioxide into formations was also unsuccessful.

The economic efficiency of almost all methods was lower than previously expected.

However, on the whole, progress in the development of the process of applying thermal, gas, and chemical methods is evident before. With the transition of the oil industry to a new management system, the mechanisms for stimulating oil recovery have ceased to function, the activity of scientific research has substantially decreased, and the volume of application of the methods has begun to decline. An alarming tendency has been aggravated by a constant decrease in the average project oil recovery coefficient with a continuing increase in the share of hard-to-recover reserves over a relatively short period. In 2050, global energy demand can double or triple compared to 2000, given the further development of modern industries. The share of renewable energy sources is steadily growing and may reach 30% by 2050. Due to the fact that the huge energy deficit will not disappear anywhere, oil and gas will play a leading role in the global energy industry for several decades. At the same time, the depleted oil fields are depleted, which makes the search for new reserves and increased oil recovery during their development even more urgent. Consequently, the high demand for hydrocarbons puts forward tasks that must be solved by effective and innovative methods.

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