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ПОВЫШЕНИЕ НЕФТЕОТДАЧИ ИСТОЩЕННЫХ МЕСТОРОЖДЕНИЙ ПОСРЕДСТВОМ ЗАКАЧКИ ДИОКСИДА УГЛЕРОДА

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В данной работе рассматриваются методы повышения коэффициента извлечения нефти (КИН). Составлен краткий обзор на метод воздействия углекислого газа на пласт. Рассмотрены виды технологий воздействия диоксида углерода на пласт. Описаны основные преимущества и недостатки данного метода.

Ключевые слова: Коэффициент извлечения нефти, методы увеличения нефтеотдачи, растворение в нефти, закачка углекислого газа в пласт, карбонизированная вода, диоксид углерода в сверхкритическом состоянии.

ENHANCED OIL RECOVERY OF DEPLETED FIELDS BY INJECTION OF CARBON DIOXIDE

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In this paper, the methods of increasing the oil recovery coefficient (KIN) are considered in this paper. A brief overview of the carbon dioxide exposure method was compiled. The types of technologies of carbon dioxide impact on the formation are considered. The main advantages and disadvantages of this method are described.

Keywords: Oil recovery coefficient, methods of increasing oil recovery, dissolution in oil, injection of carbon dioxide into the reservoir, carbonized water, carbon dioxide in a supercritical state.

Oil production on the territory of the Russian Federation is one of the most important stages for the country's oil and gas industry. Due to this fact all regions of Russia are existing with a high level of fuel availability. But in spite of this, there is a global politic for the conservation of non-renewable resources. One of these resources is the most important raw material in the world – it’s oil. Deposits of oil tend to deplete with such signs: a decrease in reservoir pressure, high flooding of the production product, a decrease in annual well flow rates. Therefore, many countries of the world, like Russia, are trying to rationally use non-renewable reserves along with the maximum depletion of the developed fields.

To extract the residual product, a variety of methods is used based on increasing the oil recovery coefficient. Among them, the main methods are thermal, chemical, gas, hydrodynamic and combinations of the above. In this article, the usefulness of gas recovery methods is researched.

These methods are based on injection of gas into the reservoir. A significant difference between these methods from others is the use of an injected agent, namely gas, which is currently the most inexpensive agent of all used. There are four types of gas methods: pumping air into the formation, using associated petroleum gas to increase the oil recovery factor, exposure of carbon dioxide on the formation, injection nitrogen, the usage of flue gases, etc.

Such techniques are among the most high-potential and promising, they are able to reduce the residual oil saturation in the affected area to 2-5%. Since most of the residual oil in the known developed fields remains in the form of flooded residual reserves, gas technologies are fundamentally important, because above mentioned oil deposits are more difficult to extract than from non-flooded formations. A theory is confirmed by the possibility of gas dissolving in water and oil.

The most effective of the gas methods for enhanced oil recovery is the injection of carbon dioxide into the reservoir. Experimental studies have repeatedly noted an increase in the capacity of oil as a result of the dissolution of carbon dioxide in it, as well as a decrease in the viscosity of crudes and an increase in density (oil "swelling" occurs) [1].

The interfacial tension at the boundary of water and oil decreases while gas injection. Moreover, an inevitable expansion of the rock’s wettability with water is observed, as well as the transition of the oil film located on the rock from the film to the drip state.

Such advantages lead to wide usage of carbon dioxide as an injecting agent in oil and condensate recovery, especially in the USA and Canada. This method is implemented and applied worldwide in the following types:

1. Carbon dioxide injection technology based on injection of carbon dioxide into the reservoir in liquid or gaseous form without other auxiliary agents.

2. Carbon dioxide injection technology based on the injection of carbonized water (saturated with CO_2) into the reservoir.

Water saturated with carbon dioxide is injected into the formation, thus creating a layer of the displacing substance, which, in turn, squeezes out the remaining oil. The method of pumping water with carbon dioxide is more effective than traditional flooding because the addition of carbon dioxide reduces the viscosity of water while carbon dioxide dissolves in it. The main benefit of this technology is the relatively low consumption of carbon dioxide compared to other methods of its application in case of using carbonized water in the reservoir. However, it is less effective in comparison with the combined effect of CO_2 in the liquid or gas state on the formation. After injection of carbon dioxide in its pure form and subsequent injection of carbonized water, the efficiency of the method increases significantly. It happens especially due to the influence of carbon dioxide on the volume of the oil film and heavier components on the pore walls, which subsequently leads to a decrease in their area of contact with the pore walls, cracks and voids. Together, these processes greatly simplify the leaching of oil film and components from these voids.

3. Carbon dioxide injection technology based on injection of CO_2 into the reservoir in a supercritical state. The method of using carbon dioxide in a formation in a supercritical state has a huge potential for the production of high-viscosity oil. CO_2 in this state is highly effective as a solvent and is considered to be an environmentally friendly. Another feature of carbon dioxide is a huge

solvent capacity which occurs in areas of high pressure and constant temperature. Carbon dioxide in a supercritical state turns into gas when it leaks into the environment. Usually, carbon dioxide cannot harm the environment as it is an integral part of the vital activity of living organisms and is presented in the environment in certain quantities.

It is worth noting that such gas method combines a positive effect of the issue of carbon dioxide utilization and the problems of global warming caused by CO_2 emissions. The source of this agent are usually various power plants, where this component is captured after the combustion of natural hydrocarbon gas.

Based on the results of the analysis of the world experience in applying the injecting carbon dioxide technology into oil-saturated formations, the main parameters affecting the increase in oil recovery factor, as well as their boundary values, were identified:

1. Porosity, % (15~25);
2. Permeability, mD (10~50);
3. Pressure, Mpa (10~20);
4. Temperature, oS (60~100);
5. Viscosity, sDr (1.5~10) [2].

In addition to the main positive factors, the method has negative effects of exploitation. The main drawback is the predisposition to cause rapid corrosion of the metal. Well are usually equipped with corrosion-resistant equipment, as well as equipment for storage, injection into the reservoir and transportation of carbon dioxide while an application of this method.

Moreover, the unpredictability of the process of dissolving carbon dioxide is also can be considered as a meaningful disadvantage. If carbon dioxide is not completely mixed with oil, only heavier fractions remain in the oil, since carbon extracts light hydrocarbons from it. This can result in decrease of the oil mobility, which significantly complicates its subsequent extraction [3].

The last but not the least fact is that carbon dioxide has an ability of forming crystallohydrates when saturated with water vapor, which, in turn, significantly complicates the process of pumping the agent, its storage and transportation. Moreover, the temperature of saturated oil can rapidly decrease with a growth of the carbon dioxide concentration. Consequently, it can lead to the formation of undesirable asphaltene-resinous-paraffin deposits during the development of deposits.

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