Discussion on the Application of EOR Technology in Oil Field

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Abstract. The driving technology of tertiary oil recovery is a higher-level oil recovery technology based on primary and secondary oil recovery technology, which is an important technology to fully exploit oil resources. Compared with the secondary oil recovery technology, the tertiary oil recovery and displacement technology is a great leap in the field of technology, which will greatly improve the efficiency of oil recovery and displacement. Tertiary oil recovery technology is based on the dual effect of physical reaction and chemical reaction, which will better exploit oil and natural resources. At present, the EOR technology has been applied to many large oil fields, which has become a perfect production technology. Through the tertiary oil recovery technology, the production efficiency of the oilfield has been improved by one third. Firstly, this paper analyzes the working principle of tertiary oil recovery technology. Then, this paper analyzes the application of EOR technology.

Keywords: Oilfield, EOR technology, application

1. Introduction
Oil is a kind of non renewable energy, which is one of the most extensive energy sources in the world. At present, our life is full of the shadow of oil, which also leads to our increasing demand for oil[1]. With the continuous exploitation of oil resources, oil reserves will be reduced, which will increase the technical difficulty and efficiency of oil exploitation[2]. With the rapid development of science and technology, we continue to improve oil production and displacement technology, which also forms the tertiary oil production and displacement technology. At present, the secondary oil recovery technology is still a worldwide wide range of production technology, which is a kind of physical injection technology for oil recovery and displacement[3]. Secondary oil recovery technology makes up for the shortage of primary oil recovery and displacement technology, which greatly improves the oil recovery efficiency from 21% to 40%. However, 60% of the oil fields are not fully exploited, so a new oil recovery and displacement technology, namely tertiary oil recovery and displacement technology, has been developed. Through the technology of EOR, we can improve the efficiency of oil production.
2. Technical description of tertiary oil recovery

2.1. Concept of EOR and oil displacement

In China, the oil field production technology has experienced primary oil production, secondary oil production and tertiary oil production technology, which is a demonstration of the development of science and technology, and also a proof of the increasing demand[4]. The primary oil recovery technology is exploited by weather, which will greatly affect the oil recovery rate. Therefore, a large amount of oil will still exist in one-time exploitation of oil field, which causes a great waste of oil resources. With the development of society, a mining technology will cost a lot of manpower and material resources, which can not meet the economic needs[5]. Therefore, through the relationship between oil production and oil field pressure gradient, we invented the secondary oil recovery technology, which improved the oil recovery efficiency from 21% to 40%. With the maturity of secondary oil recovery technology, people still can not fully exploit the remaining oil reserves, which causes a great waste of oil field. Therefore, we invented the tertiary oil recovery technology, which further improved the production efficiency of the oilfield[6]. Through the use of various biological technology, physical technology and chemical technology, we can change the physical properties of crude oil or oil-water interface, which will improve the exploitation of remaining oil.

2.2. Working principle of EOR technology

At present, the secondary oil recovery technology is also the main technology of many oilfields, which is through the interaction between oil layers. The working principle of EOR technology is as follows. By injecting water into the reservoir, we can decompose the pressure of the reservoir, which will change the viscosity between water and oil. Therefore, the dispersed oil can be gathered again and collected easily, which will greatly reduce the waste of oil. Through the tertiary oil recovery and displacement technology, we can improve the water injection of the reservoir, which will improve the efficiency of oil displacement. Compared with the secondary oil recovery and displacement technology, the tertiary oil recovery and displacement technology can grasp the reservoir situation more accurately. Through the distribution of oil layer and water injection layer, we can show two situations more thoroughly, which will improve the oil production rate and production. Therefore, in the EOR technology, the most important factor is the displacement activator, which can increase the viscosity and boundary between water layer and oil layer.

3. Application of EOR technology

3.1. Thermodynamic oil displacement and production technology

The basic technical principles of thermodynamic oil displacement and production technology are as follows. First of all, we provide heat source to the reservoir resources in the formation, which will be used as heat source to support the increase of reservoir temperature. By controlling the fluid flow rate in the reservoir, we can reduce the viscosity level of crude oil, which will promote the reasonable improvement of oil recovery. At present, there are two main methods of thermal oil displacement, including the technology of burning oil layer and the technology of steam oil displacement. By studying the technology of thermal oil displacement and production, most scholars think that the
technology of thermal oil displacement and production can significantly improve the production, which will reduce the cost of oil production. Therefore, the thermodynamic oil displacement technology has been widely used in domestic oil fields, which can well complete the oil production work. The scope of application of thermodynamic oil displacement and production technology is shown in Table 1.

**Table 1.** The scope of thermodynamic oil displacement and production technology application

| Parameter                        | Steam injection | Burned reservoir |
|----------------------------------|-----------------|------------------|
| Viscosity of formation crude oil (MPa.S) | >30             | >10              |
| Crude oil density (g.cm⁻³)       | 1.000           | 0.802-1.000      |
| Porosity (%)                     | >20             | >20              |
| Average residual oil saturation (%) | >40             | >40              |
| Reservoir pressure (MPa)         | <10.0           | <15.0            |
| Effective thickness of oil layer (m) | 5-25           | 3-15             |
| Permeability (μm²)               | >0.10           | >0.10            |

**3.2. Gas injection and oil recovery technology**

Gas injection and oil displacement technology is one of the most widely used technologies in tertiary oil recovery and oil displacement. The basic working principle of gas injection oil recovery technology is as follows. We can change the different pressure of oil layer by injecting a variety of mixed gas, such as carbon dioxide, nitrogen, flue gas, and natural gas. Among them, there are many ways of gas injection, such as huff and puff gas injection, gas water alternate gas injection, composite gas drive, and direct gas drive. In the process of gas injection and oil displacement, there is a positive correlation between displacement efficiency and pressure. Therefore, by increasing the pressure, we can improve the displacement efficiency, which is of great significance for oil exploitation. However, when the pressure increases to a certain extent, the pressure between oil and gas will reach a miscible state, which will improve the oil displacement efficiency, generally maintained at about 90.0%. For our country, we will use a lot of coal every year, which will produce too much carbon dioxide in the combustion, which leads to the abundant carbon dioxide resources. Therefore, in the practice of oil field production, carbon dioxide miscible gas injection is the most widely used oil recovery technology. The main technologies of gas injection drive oil production are gas injection string structure and gas injection integrated wellhead, as shown in Fig. 1 and Fig. 2 respectively.

**Figure 1.** Gas injection string structure  **Figure 2.** Gas injection integrated wellhead
3.3. Chemical flooding technology

In the same way, chemical flooding is also a widely used technology in tertiary oil recovery. According to the actual situation of petroleum exploitation in China, chemical substances include many types, such as polymers, surfactants, and alkaline water. Among them, this paper takes polymer flooding technology as an example to explain the basic principle. The viscosity of water can be increased by adding water-soluble polymer into water of appropriate dosage, which will reduce the oil-water fluidity ratio. The main principles of surfactant flooding are as follows. By means of surfactant injection, the surface tension of surface oil reservoir soil and oil resources will be significantly reduced, which will improve oil recovery. The basic principle of alkaline water flooding is as follows. Through the chemical reaction between alkali water and crude oil, we can generate surfactants, which will change the wettability of crude oil. At the same time, with the decrease of interfacial tension between oil and water, emulsification will take place in the reservoir, which will realize the efficient capture of oil resources. At present, our country has realized the ASP flooding technology combining alkaline water, surfactant and polymer, which is a method with alkylbenzene sulfonate as the main agent. Through the combination of alkali water, surfactant and polymer with natural gas, we have successfully achieved the composite oil recovery and displacement technology test. Through the application of the scheme in oilfield exploitation practice, we have achieved good results.

4. Conclusions

In the current oil field exploitation activities in China, secondary oil recovery and displacement technology is still the main part of exploitation activities. However, we need to use the technology of EOR to exploit it scientifically and reasonably, which will fully realize the advantages of the technology of EOR in the face of traditional technology. By increasing the oil production rate, we can further alleviate the energy shortage in China. In this paper, the principle of secondary oil displacement technology and tertiary oil recovery technology are analyzed and compared. This paper describes the development history of oil recovery and displacement technology in oil field by describing the advantages of tertiary oil recovery and displacement technology. Finally, this paper describes three kinds of the most important EOR technology, which has been widely used in major oil fields.

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