Sequence optimization of chemical flooding development for class Ⅱ and class Ⅲ reservoirs

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Abstract

chemical flooding of major reservoirs is near the end,While water flooding level is serious for class Ⅱ and class Ⅲ reservoirs in the late stage of water flooding, chemical flooding of class Ⅱ and class Ⅲ reservoirs is regarded as an important scheme to replace the oil field production at the present stage because of high utilization degree.Compared with class Ⅱ reservoirs, class Ⅲ reservoirs have larger interlayer contradiction and smaller permeability.It is very difficult to realize the simultaneous matching of different oil layers with the same set of well pattern. So two sets of well pattern were established,including ASP flooding development of class Ⅱ reservoirs and polymer flooding development of class Ⅲ reservoirs. On the basis of fine geologic modeling, 12 sets of development plans belonging to water flooding and chemical flooding were established in experimental plot by the numerical simulation software of eclipse. The rational development order of class Ⅱ and class Ⅲ reservoirs and the injection time of chemical flooding are predicted and analyzed. Research shows that： for the same injection time and different development order，simultaneous development of class Ⅱ and class Ⅲ reservoirs has best development effect;for the same development order and different injection time,the earlier the injection time of chemical flooding, the better development effect.

Keywords

numerical simulation, development order, chemical flooding, injection time.

1. Introduction

With the constant development of oil field, some domestic oilfields have entered high water cut stage after Basic well pattern, first infill well pattern, secondary infill well pattern and the polymer flooding of main reservoir. After the development of water flooding, class Ⅱ and class Ⅲ reservoirs are high water content, it gradually become the main target of production to succeed due to the large proportion of the remaining oil[1]. as we all know, Chemical flooding enhances oil recovery by improving the oil flow ratio. So chemical flooding technology is adopted in class Ⅱ and class Ⅲ reservoirs to make up the scaling down of production[2]. Compared with class Ⅱ reservoirs, class Ⅲ reservoirs have larger interlayer contradiction and smaller permeability. It is very difficult to realize the simultaneous matching of class Ⅱ and class Ⅲ layers with the same set of well pattern[3]. So two sets of well pattern were established, including ASP flooding development of class Ⅱ reservoirs and polymer flooding development of class Ⅲ reservoirs[4]. The rational development order of class Ⅱ and class Ⅲ reservoirs and the injection time of chemical flooding are predicted and analyzed by the numerical simulation software.

2. General situation

The experimentation area is a short axis of anticline block. Axial direction is northeastern 25 °. The closed area is about 506 km2. The oil bearing area is 272.6 km2. The overall structure is relatively flat with a maximum inclination of 5 °. The fault distribution is small, and it is basically normal fault. The average elevation of oil-water interface is -1532 ~ -1563 m with no active edge water and bottom water distribution. The sedimentary environment of oil layer is generally large depression that formed in the Quantou Formation of Cretaceou. The oil reservoir in the experimentation area is in estuary Delta. The environment of sedimentary facies is great different in vertical and horizontal distribution because the phenomenon of water inlet and water withdrawal is common.

3. Geological model construction

3.1 Principle of grid construction

(1)X-Y coordinate system is used in Grid system, of which X direction runs east to west and is parallel to the direction of the based injection production well. Grid is uniform and rectangular shape.

(2)In order to ensure the production authenticity of four-boundary mesh in the simulation process, we add 2 rows empty grid with no attribute Outside the well grid.

3.2 Grid partition result

In accordance with the modeling requirements, we applied of 30 m × 30 m model to build the grid In plane. So grid number is 72×70. In the longitudinal direction, 20 sedimentary layers were established according to the different of sedimentary period of microfacies and sedimentary environment. In the whole reservoir geological model, the total number of grids is 100800.

3.3 Grid attribute assignment

In this part, it is necessary to assign the value for these attributes of permeability, porosity, saturation and so on. The mesh properties (porosity, permeability, effective thickness) are interpolated by the phase diagram by using interpolation software.

4. History matching of numerical simulation

After the geological model was established, the History fitting need to do according to the known production dynamic data. the water cut of the field is about 90% at present. Cumulative oil production is about 453.23×104 t . The recovery ratio is about 32.13%. Fit the data and the actual production data generally match and its matching effect is preferable.

5. Scheme and scheme prediction

In the experimental process, a total of 12 sets of schemes that belong to water flooding and chemical flooding are formulated for class Ⅱ and class Ⅲ reservoirs by the numerical simulation software of eclipse, in which there are 3 sets of water flooding schemes and 9 sets of chemical flooding schemes. As is shown in Table 1 and table 2:

Table 1 Foundation scheme of water flooding

Scheme	Water cut at present	Sequence of reservoir development
1	90%	first class Ⅱ until water cut is 98% then class Ⅲ reservoirs
2		first class Ⅲ until water cut is 98% then class Ⅱ reservoirs
3		simultaneous development of class Ⅱ and class Ⅲ reservoirs

The numerical simulation results of water flooding schemes are as follows: For scheme 1, the water cut of class Ⅱ reservoirs is 98% in May 2023 and the cumulative oil production of the process is about 50.89×104 t. Then it turns to water flooding of class Ⅲ reservoirs and its water cut is 98% until January 2029. Cumulative oil production of the whole process is 88.16×104 t and recovery ratio is 37.74%. For scheme 2, the water cut of class Ⅲ reservoirs is 98% in February 2022 and the cumulative oil production of the process is about 42.31×104 t. Then it turns to water flooding of class Ⅱ reservoirs and its water cut is 98% until March 2030. Cumulative oil production of the whole process is 90.56×104 t and recovery ratio is 37.93%. For scheme 3, The water cut is 98% until September 2024. Cumulative oil production of the whole process is 94.43×104 t and recovery ratio is 38.23%. The cumulative oil production of 3 sets ot scheme of water flooding is shown in Figure 1.

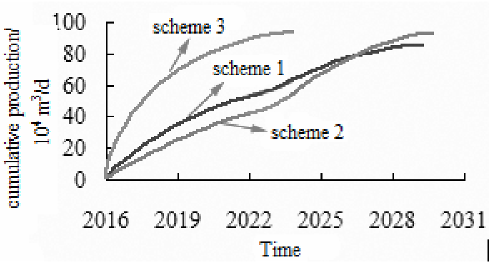

Fig. 1 Cumulative oil production of water flooding

Table 2 chemical flooding scheme

Scheme	Injection timing	Sequence of reservoir development	Scheme arrangement
4	water cut is 90%	first class Ⅱ until water cut is 98% then class Ⅲ	ASP flooding of class Ⅱ and polymer flooding development of class Ⅲ, injection concentration is 2000 mg/g, injection rate is 0.15 pv/a
5		first class Ⅲ until water cut is 98% then class Ⅱ	
6		simultaneous development of class Ⅱ and class Ⅲ	
7	water cut is 94%	first class Ⅱ until water cut is 98% then class Ⅲ	
8		first class Ⅲ until water cut is 98% then class Ⅱ	
9		simultaneous development of class Ⅱ and class Ⅲ	
10	water cut is 98%	first class Ⅱ until water cut is 98% then class Ⅲ	
11		first class Ⅲ until water cut is 98% then class Ⅱ	
12		simultaneous development of class Ⅱ and class Ⅲ	

The numerical simulation results of chemical flooding schemes are as follows: For scheme 4, class Ⅱ reservoirs adopts to ASP flooding and the water cut is 98% in May 2025, then it turns to polymer flooding of class Ⅲ reservoirs and water cut is 98% until January 2029. stage for recovery degree is 16.73%; For scheme 5, class Ⅲ reservoirs adopts to polymer flooding and the water cut is 98% in January 2024, then it turns to ASP flooding of class Ⅱ reservoirs and water cut is 98% until January 2035, stage for recovery degree is 17.35%; For scheme 6, It's simultaneous development of class Ⅱ and class Ⅲ reservoirs and water cut is 98% until August 2027, stage for recovery degree is 18.17%. class Ⅱ and class Ⅲ reservoirs is firstly developed at the same time until October 2019 when water cut is 94% in scheme 7~9, then it turns to chemical flooding. For scheme 7, class Ⅱ reservoirs adopts to ASP flooding and the water cut is 98% in February 2025, then it turns to polymer flooding of class Ⅲ reservoirs and water cut is 98% until April 2030. stage for recovery degree is 10.59%; For scheme 8, class Ⅲ reservoirs adopts to polymer flooding and the water cut is 98% in February 2024, then it turns to ASP flooding of class Ⅱ reservoirs and water cut is 98% until February 2031, stage for recovery degree is 11.06%; For scheme 9, It's simultaneous development of class Ⅱ and class Ⅲ reservoirs and water cut is 98% until July 2026, stage for recovery degree is 11.62%. class Ⅱ and class Ⅲ reservoirs is firstly developed at the same time until September 2024 when water cut is 98% in scheme 10~12, then it turns to chemical flooding. For scheme 10, class Ⅱ reservoirs adopts to ASP flooding and the water cut is 98% in October 2028, then it turns to polymer flooding of class Ⅲ reservoirs and water cut is 98% until December 2031. stage for recovery degree is 7.28%; For scheme 11, class Ⅲ reservoirs adopts to polymer flooding and the water cut is 98% in May 2027, then it turns to ASP flooding of class Ⅱ reservoirs and water cut is 98% until August 2032, stage for recovery degree is 7.55%; For scheme 12, It's simultaneous development of class Ⅱ and class Ⅲ reservoirs and water cut is 98% until January 2030, stage for recovery degree is 7.96%.

By comprehensive analysis of water flooding and polymer flooding programs we can find that: for the same injection time and different development order，simultaneous development of class Ⅱ and class Ⅲ reservoirs has best development effect, the main reason is that it can alleviate the contradiction between the class Ⅱ and class Ⅲ reservoirs; for the same development order and different injection time, the main reason is that the earlier the injection time of chemical flooding, the better development effect, The earlier the injection timing, the more obvious the role of oil by chemical flooding

6. Conclusion

For the same injection time and different development order， simultaneous development of class Ⅱ and class Ⅲ reservoirs has best development effect;for the same development order and different injection time,the earlier the injection time of chemical flooding, the better development effect.

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