Weak alkali ASP flooding in the second type reservoir in the A Oilfield
Profile control technology and effect

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Abstract: Profile control technology refers to the operation of plugging high permeability layers from injection wells, which can adjust the suction profile of injection layers and improve the ultimate recovery. In this paper, the heterogeneity of the weak alkali ternary compound block of the second kind of oil layer in the A area of the some Second Division is strong, the injection conditions between well groups are different, the injection pressure level of some wells is low, the suction conditions of each sedimentary unit are different, and the comprehensive water cut of the block is high. In order to alleviate the contradiction between in formation and in plane, improve the utilization rate of chemical agents, and improve the ultimate recovery rate of the block, the deep profile control is carried out according to the characteristics of the oil layer development of the well group. Ten profile control wells were selected to adopt the profile control system of one and two polymer gel, which is a water shutoff agent for oil production. The polymer solution was used to carry particles for deep profile control. In this paper, the characteristics of profile control technology and the method of well and layer selection are studied, and the change law of dynamic index after profile control is analyzed in detail.

1. Introduction
Weak alkali ASP flooding was put into operation in November 2014, and prepolymer slug was injected in October 2017. By the end of 2017, there were differences in injection conditions among well groups in the block, the injection pressure level of some wells was low, the suction conditions of each sedimentary unit were quite different, and the comprehensive water cut of the block was high, which affected the development effect of the block.

1.1. part of the injection pressure level is low and the suction capacity is strong
There are 118 injection wells in the second class oil reservoir in the some oilfield, 114 of which are currently open. The average injection pressure is 8.5MPa, the distance from the fracture pressure is 5.1mpa, the daily injection volume of single well is 57m3, the injection intensity is 4.9m3/d · MPa · m, and the specific suction index is 0.6m3/d · MPa · M. In terms of injection pressure classification, there are 24 wells with pressure less than 7MPa, accounting for 20.9% of the total number of wells, and the specific suction index is 0.87m3/d · MPa · m; 48 wells with pressure 7-9mpa, accounting for 41.7% of the total number of wells, and the specific suction index is 0.62m3/d · MPa · m; 35 wells with pressure 9-11mpa, accounting for 30.4% of the total number of wells, and the specific suction index is 0.43m3/d · MPa · m; 8 wells with pressure greater than 10MPa The specific suction index is 0.38 m3 / D · MPa · M.
1.2. There are differences in oil layer suction conditions of each sedimentary unit
According to the statistics of isotopic suction profiles of 42 injection wells in the whole area, the effective thickness suction ratio of the block is 58.7%. According to the statistical results of the suction profiles of the sedimentary units, the suction conditions of each sedimentary unit are quite different. Among them, the relative inhalations of A, B, C, D and E reach 56.5%.

According to the statistical results of the suction profile of permeability classification, the higher the permeability is, the larger the suction ratio is. The suction thickness ratio of oil layers with permeability greater than $500 \times 10^{-3} \text{μm}^2$ is 73.7%, which is 28.2% higher than that of low permeability layers with permeability less than $300 \times 10^{-3} \text{μm}^2$. The injected water advances along the high permeability layers.

1.3. Some wells have high liquid production and water cut
There are 114 production wells, 111 of which are currently open, with a daily fluid production capacity of 7550t. The daily oil production is 250t, and the comprehensive water cut is 96.69%. From the water content level, there are 4 wells with water cut below 90%, accounting for 3.6% of the total number of wells; there are 8 wells with water cut between 90% and 95%, accounting for 7.2% of the total number of wells; there are 37 wells with water cut between 95% and 97%, accounting for 33.3% of the total number of wells; there are 62 wells with water cut more than 97%, accounting for 55.9% of the total number of wells, and the overall water cut of the block is high.

To sum up, due to the existence of low efficiency and invalid circulation zones in the block, the injection pressure of some injection wells is low, the suction profile is uneven, and the comprehensive water cut of the block is high. It is necessary to take deep profile control measures to ensure the development effect of chemical injection in the block.

2. Principle of well and layer selection for profile control and dynamic characteristics of well group

2.1. Principle of profile control and well selection
According to the mechanism of profile control, we determined the following four well selection principles:

(1) The reservoir connectivity of the well group is good, and the first-class connectivity thickness ratio of channel sand is more than 40%;
(2) The injection pressure is less than 7 MPa;
(3) High permeability layer has large proportion of suction thickness, large relative suction volume and strong suction capacity;
(4) The liquid production of the whole or part of the surrounding oil wells is high, and the water cut is more than 95%.

According to the above well selection principles, 10 injection wells are selected in this block for deep profile control.

2.2. Principle of profile control and layer selection
(1) The thick reservoir with single effective thickness greater than 3.0m and large channel is selected;
(2) The channel sand with more than two connected directions, high permeability and medium high water flooded zones are selected;
(3) Select the layer whose relative suction volume of single layer is more than 30%;
(4) The layer with high water absorption is selected, and the suction intensity is greater than that of the whole area.

According to the above method, we determined the profile control horizon and thickness of 10 profile control wells.
2.3. profile control well group characteristics
First, the oil layer is thick and has good permeability. The average thickness of 10 profile control wells is 22.6m, the effective thickness is 16.2M, which is 4.6m higher than the block, the permeability is $384 \times 10^{-3} \mu \text{m}^2$, which is $37 \times 10^{-3} \mu \text{M}^2$ higher than the whole area; the thickness ratio of high permeability layer with permeability greater than $500 \times 10^{-3} \mu \text{M}^2$ is 25.9%, which is 3.9 percentage points higher than the block level.

Second, the injection well has strong suction capacity and uneven suction profile. The average actual injection volume of 10 profile control wells is 86m$^3$/D, and the average injection pressure is 6.6mpa. The injection pressure is 1.8MPa lower than the average level of the block, and the specific suction index is 0.8m$^3$/d · MPa · m, which is 0.2m$^3$/d · MPa · m higher than the whole area.

The third is the high liquid production of production wells around profile control wells. 28 production wells around 10 profile control wells have an average daily liquid production of 96.9t, daily oil production of 3.1t, comprehensive water cut of 96.85%, flowing pressure of 4.38mpa and dynamic liquid level of 431m. The daily liquid production is 27.9t higher than the average level of the whole region.

It is necessary to take profile control measures to ensure the development effect of the block.

3. Analysis of field implementation and effect of profile control

3.1. site implementation
According to the previous field experiments, the profile control radius should be about 1 / 3 of the injection production well spacing, and the average well spacing of the second class oil layers in the A, the second and the East is 125m, so the profile control radius is determined as 45m. The profile control system is composed of copolyamide and polymer gel. The particle size of bulky particles is 0.1-4.0 mm, the injection concentration of bulky particles is 5000-5500 mg / L, the concentration of polymer solution is 800 mg / L, the total injection volume of profile control fluid is $4.31 \times 10^4$ m$^3$, and the total injection volume of solid particle profile control agent is 227.3 t.

3.2. effect analysis after profile control

3.2.1. profile control can effectively improve injection condition
By comparing the weak alkali ternary compound area of the second class reservoir in the A oilfield before and after profile control, it can be seen that the injection pressure of the whole area has increased by 1.4mpa compared with that before polymer injection, while that of the profile control block has only increased by 1.1MPa; after profile control, the injection pressure of the whole area has only increased by 0.6MPa, while that of the profile control block has increased by 2.2MPa.

3.2.2. profile control can effectively improve the suction profile of injection wells
According to the comparison of suction profile before and after profile control, the suction intensity of high permeability reservoir ($> 500 \times 10^{-3} \mu \text{m}^2$) was obviously controlled, the relative suction volume decreased from 36.5% before profile control to 24.3%, decreased by 12.2%, the suction intensity of low permeability reservoir ($< 300 \times 10^{-3} \mu \text{m}^2$) was enhanced, and the relative suction volume increased from 33.6% before profile control to 44.3% after profile control 7 percentage points.

It can be seen that: after deep profile control, the suction profile of injection well has been effectively improved, the swept volume of injected water has been expanded, more middle and low permeability layers have been used, the contradiction between layer and plane has been alleviated, and the foundation has been laid for the production of middle and low permeability potential layers after injection.

3.2.3. the production well achieves the effect of increasing oil production and reducing water
The profile control can control the injection of high permeability layer, strengthen the suction of low
permeability layer, improve the degree of chemical drive, control the low efficiency and invalid circulation, and significantly reduce the water cut of production wells. The average water cut per day of non profile control wells decreased by 0.7% after 11 months. It shows that the profile control well has achieved a good effect of increasing oil and reducing water, used new reservoirs, and improved the development effect.

4. Conclusion and understanding
(1) The injection wells with good connectivity, uneven suction profile and serious vertical heterogeneity should be selected for deep profile control, and the profile control horizon should be above the medium and high water flooded level, which improves the production status of oil reservoir.
(2) The deep profile control of injection well can effectively expand swept volume, improve injection condition, effectively alleviate the contradiction in the formation, make chemical agents play a greater potential for oil increase and enhance oil recovery.

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