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Analysis of Oil Displacement Effect of Ion Water Flooding Technology

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Abstract: The test area is a low porosity and low permeability reservoir. It was put into development in October 2005. The early effect was good, the later production decreased significantly, the ineffective water cycle was serious, the development layer series was few, and the main layer measures were difficult to increase production. In this paper, we carry out water quality analysis experiments of the produced fluid, and understood the change law of the main controlling factors $Cl^-$and Ca^{2+} for evaluating the effect of ion water flooding. Combined with the production dynamics, we evaluated the effect of the measures, guided the optimization of the measures, designed the scheme, and understood the law of oil displacement. Through this study, it can be clearly and intuitively seen that the replacement effect of ion water flooding has a good oil washing effect, which has important application value and certain academic significance for the development of low permeability oil fields.

Keywords: Ion Water Flooding Technology; Oil Displacement Effect; Development of Low Permeability Oil Fields.

1. Introduction

With the process of oil development, the development methods of different types of reservoirs are also constantly improving and developing, but the water flooding development technology is still the main technology of oilfield development [1]. Since the early 1920 s, water flooding technology has been developing and progressing, in which the transformation of water injection concept and the development of water injection process have played an important role, and the functionalization of water medium is the core and potential of future water flooding technology upgrading [2-3]. Since 2014, the international oil price has continued to be depressed, and the development and application of low-cost and efficient enhanced oil recovery technology is the company's top priority. Studies have shown that the cost of ion water flooding technology is more advantageous than other enhanced oil recovery technologies [4-5].

2. Determination of Evaluation Index

On the basis of the previous monitoring results, the main controlling factors for evaluating the effect of ion water flooding are recognized, the monitoring and detection analysis method of ion water flooding is improved, the monitoring and detection system of injection and production wells is optimized, and the later development effect analysis and injection parameters are optimized and adjusted.

Table 1. Monitoring and testing contents of injection-production wells

Production liquid detection		Production dynamic analysis		Injection-production status
Water quality analysis	Full analysis of crude oil	Injection well	Production well	Injection-production status
Ca^{2+}andCl^- were sampled and detected once a month.	The key wells are sampled and tested once a month. Conventional wells are sampled every 3 months. Encrypted detection before and after gas injection	Injection pressure, injection (water injection, gas injection), injection cycle, etc.	Liquid production, oil production, gas production, water content, dynamic liquid level, work diagram, etc.	Establish a normal communication mechanism with the oil production plant, closely track measures and formation pressure test monitoring

3. The Water Quality Analyzing Experiment

The water quality analysis experiment was carried out for the produced fluid of the ion water flooding field, and the variation law of Ca^{2+} and Cl^- concentration in each stage during the test was clarified.

3.1. Calcium Ion Concentration Analysis

First, filter the on-site produced liquid, add 3ml triethanolamine, 5ml sodium hydroxide, an appropriate amount of calcium indicator, add EDTA standard titration solution, record the amount of EDTA when the liquid changes from purple to bright blue, and calculate the calcium ion concentration.

The key nodes of the calcium ion concentration detection experiment are shown in Fig.1.

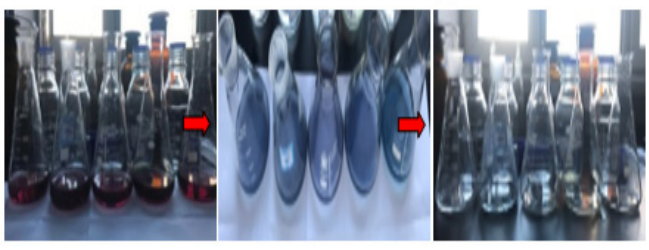

Fig 1. Calcium ion concentration detection experiment

Through Fig.2, we can clearly see the change of calcium

ion concentration in the block before and after the ion water flooding test. After ion water flooding, the calcium ion concentration showed a steady rise, rapid decline, smooth transition, and slow decline in four stages, indicating that ion water flooding has a good oil washing effect.

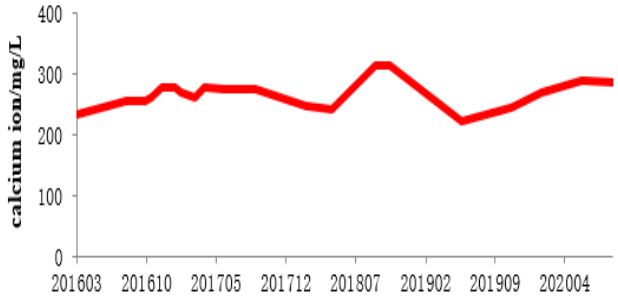

Fig 2. Variation curve of calcium ion concentration

3.2. Chloride Ion Concentration Analysis

First, the produced liquid was filtered and added to distilled water. Then 10 % potassium chromate indicator and 0.05 mol / L silver nitrate were added to the mixed solution in turn. When the mixed solution changed from bright yellow to brick red, the volume of silver nitrate consumed was recorded. At the same time, the blank experiment was carried out to record the consumption volume of silver nitrate standard solution, and the chloride ion concentration was finally calculated.

The key nodes of the chloride ion concentration detection experiment are shown in Fig.3.

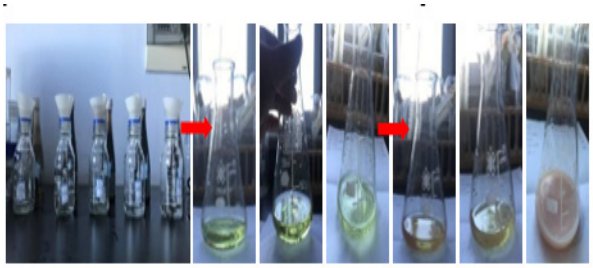

Fig 3. Chloride ion concentration detection experiment

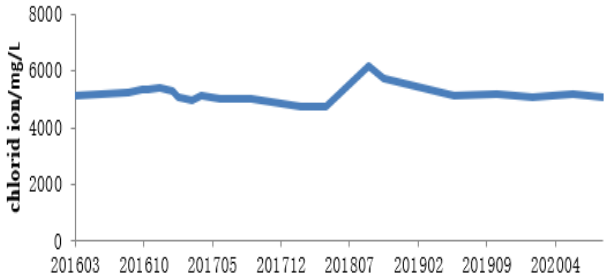

Fig 4. Variation curve of chloride ion concentration

Through Fig.4, the change of chloride ion concentration before and after ion water flooding test can be clearly seen. During the whole test stage, the chloride ion concentration of the produced fluid in the test area did not change much, indicating that although the ion water flooding technology had a good oil washing effect, it could not expand the swept volume.

4. Production Dynamic Analysis

The ionized water test area 5 injection 15 mining, since June 2016 began to inject ionized water, to August 2020, a total of more than 1500 days of injection, cumulative injection volume of 114,800 cubic meters; the injection pressure before the test was 12.43 MPa, and the injection pressure in August 2020 was 16.33 MPa, an increase of 3.9 MPa.

It can be seen from Fig.5 that the effect of increasing oil in the early stage of ion water test is obvious. In the middle stage, due to the insufficient injection amount, the energy supplement is not enough. It has experienced a long stable period. In the later stage, the injection amount is adjusted, and the effective period appears again, and the oil increase is obvious. In the end, due to the increase of injection pressure, some injection wells are under-injected and shut down, resulting in insufficient formation energy supplement and decreased oil production.

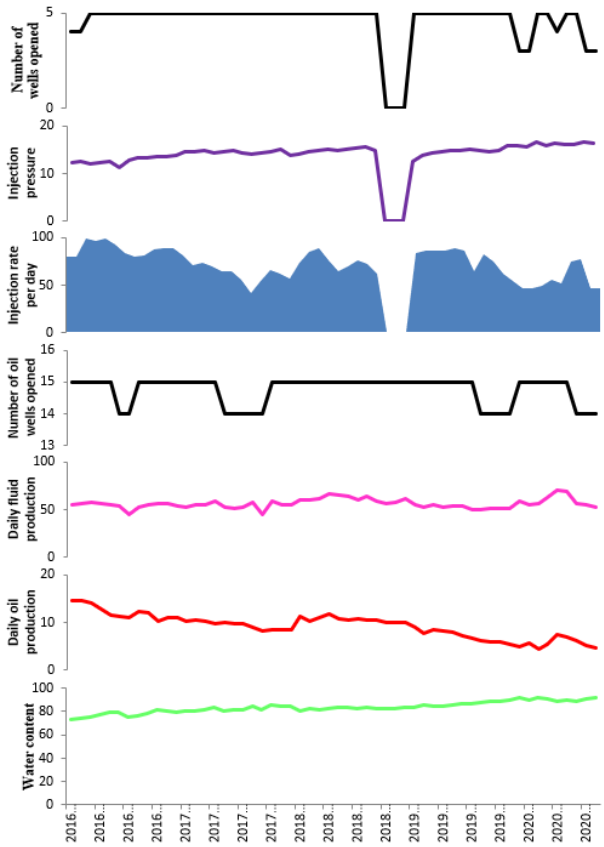

Fig 5. Production dynamic analysis curve of ion water test area

5. Conclusion

On the basis of the previous monitoring results, the variation law of the main control factors for evaluating the effect of ion water flooding is recognized. Through the ion water flooding test, the law of ion water flooding is further understood, which can effectively desorb the crude oil from the rock surface, control the decline, and have a good oil increase effect, providing technical support for the low-cost and efficient development of low-permeability reservoirs.

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