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Original article

The effect of physical property change on the water flooding development in Changqing oilfield Jurassic low permeability reservoir

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ABSTRACT

Changqing old oilfield Jurassic reservoir's average calibration recovery is 24.7%, with geological reserves recovery of 16.6%, water cut of 65.2%. And most of Jurassic reservoirs are in the middle and later field life, part of them has entered the high water cut and high recovery stage. Traditional water flooding way for improving oil recovery becomes more difficult, and new method has to be considered. Maling oilfield BS district is a typical representative, with high water cut of 90.8%, high recovery percent of 26.1% and low oil recovery rate of 0.25%. To explore the new way to improve oil recovery, the polymer and surfactant (SP for short) important pilot test has been developed. The low permeability reservoir indoor core data in high water cut stage and inspection well results indicate that the reservoir permeability, pore combination characteristics and pore type changed greatly after long-term water flooding development. These changes bring more difficulties to the continue development, especially the high injection pressure, which can cause other problems for well pattern infilling and EOR. This paper takes the high injection pressure problem of Maling BS district Jurassic reservoir for example, analyzes the physical property change law on the following aspects: the development mode in the past, core analysis, formation sensitivity, interstitial matter, well test interpretation results, in order to help to further effective development and provide important parameters for tertiary oil recovery technique for similar reservoirs and others.

1. Introduction

At present, there are three types of developed main reservoirs in Changqing oilfield: Jurassic reservoir, Triassic low and extra-low permeability reservoir [1], which account for the producing geological reserves of 17%, 51% and 32% respectively.

Jurassic reservoir's average calibration recovery is 24.7%, with geological reserves recovery of 16.6%, water cut of 65.2%. For many years of water flooding, Changqing oilfield Jurassic media-low permeability reservoir has entered the media-high water cut phase, the water-cut rate has been over 75% and the ratio of total oil produced to the OOIP has been less than 30%.The two main factors that influence the oil recovery are displacement efficiency and volumetric sweep efficiency, therefore well pattern infilling and EOR become effective methods to improve oil development. However, the water flooding development way that we used in the past and the physical property change will frequently bring more difficulties to the well pattern infilling and EOR, so analyzing the physical property change will not only help to effective development, but also provide important parameters for tertiary oil recovery technique.

According to the water flooding problems that we faced in the well pattern infilling of Maling oilfield BS district, this paper analyzes the effect of physical property change to the oilfield water flooding and EOR, and provides the basis of oil development decision.

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2. Test area general situation

Changqing Jurassic old oilfield, represented by Maling oilfield, has high water cut, high recovery percent, low oil recovery rate and low water flooding recovery. To explore the new way to improve the oil recovery of Jurassic reservoir, we developed polymer and surfactant important test in the remaining oil area of the Maling oilfield BS district.

BS district located at Huan county of Gansu province, exploration started in the mid-1970s, development started in1998, main production horizon is Yan'an Formation Y-10, calibration recovery is 27.7%, with the average porosity of 13.3%, the average permeability of 110mD, the original oil saturation of 62%, the formation water salinity of 23800 mg/L, the initial formation pressure of 13.48 MPa, the initial reservoir temperature of 50 °C.

Test area was selected in the north abundant remaining oil area, in the test area 14 new wells were drilled and 2 old wells were utilized, and irregular inverted seven-spot well pattern has been adjusted to five-spot, producer-injector spacing changes from 250–350 m to 150 m (Fig. 1).

In the water flooding stage, the injection pressure reaches to 17 MPa in the early production stage, consequently, two rounds acidification and stop injection, three rounds injection-production adjustment have been conducted to reduce injection pressure. The measures result is obvious, but the overall effective time is very short (average 68 days. At present, the water injection pressure still remains at 17 MPa, there is no pressure rise space for subsequent polymer and surfactant flooding. The high injection pressure caused serious problems to the water flooding and polymer and surfactant flooding. After the failure of these measures, it is crucial and urgent for us to make clear why the injection pressure is higher than before when the producer-injector spacing is shorter, some researches were carried out to study the reason of high injection pressure (Fig. 2).

3. Reason analysis of high injection pressure

Historical data of water injection well indicates that high injection pressure was relatively high in the early production stage because of water-sensitivity and acid sensitivity.

There were 16 water injection wells during 1999.8–2010.9 in the development of Maling oilfield BS district. According to the water injection data statistics over the past years, 9 water wells injection pressure were above 14 MPa, the rest well's injection pressure is below 10 MPa, but successively rise above 15 MPa in the later period.

Under the original reservoir condition, 56% injection well's injection pressure was at 14.5–16 MPa which is a relatively high value for Jurassic reservoir, the injection water and formation are incompatible; but the injection pressure can be reduced to 10–12 MPa if acidification has obvious effects, but it still rise to

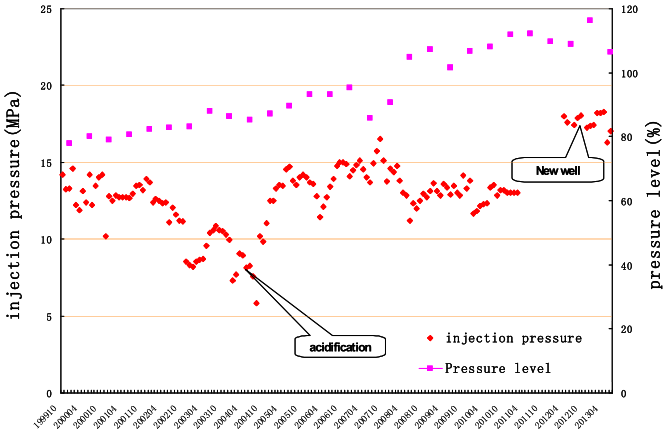

Fig. 2. BS district injection pressure historical data.

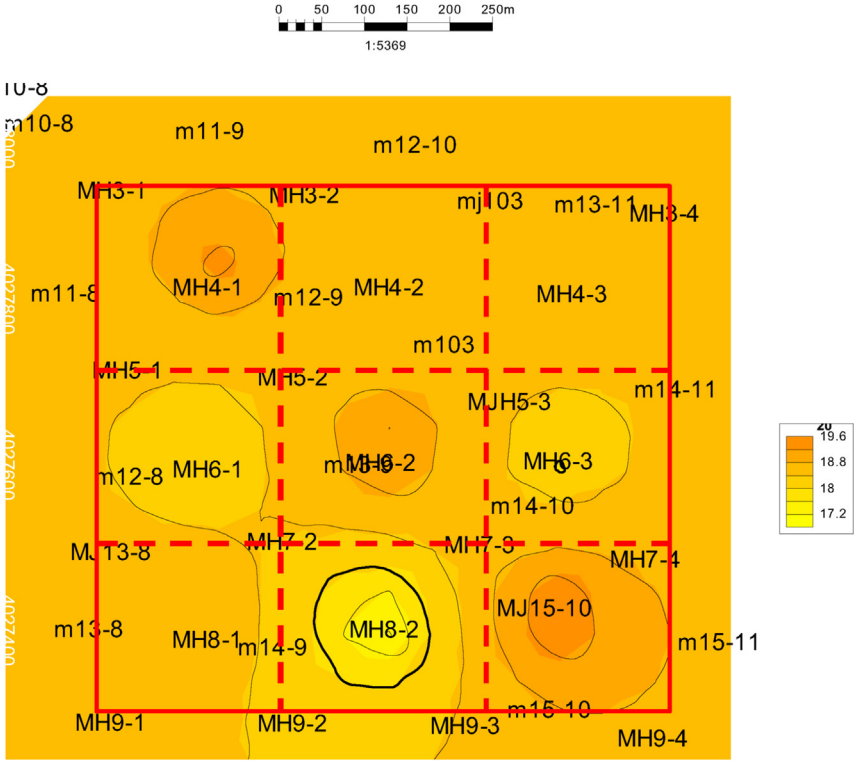

Fig. 1. Injection pressure distribution map.