

Evaluation of the Effect of Microbial Combination Flooding

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Abstract

The microbial combination flooding is a method of microbial enhanced oil recovery, which use the composite system produced by biopolymers and bio-surfactants to drive oil. In this paper, we chose B2/DJ composite system through the stability test, and study the experimental of indoor flooding with the B2/DJ composite, it drew a conclusion that the oil recovery was improved obviously after water flooding. The oil recovery was enhanced 13%.

Key words: Microbial combination flooding; Bio-surfactant; Biopolymers; Enhanced oil recovery

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INTRODUCTION

Due to the synergistic effect of biological polymers and biological surface active agent, which makes the characteristics of microbial flooding have a trait of

microbial oil flooding, and also have a merit of binary compound flooding, so the effect of the microbial combination flooding is more obvious than that of ordinary microbial flooding, which is more safety than chemical binary compound flooding in environmental protection. However, the study of microbial compound flooding technology is less. Aiming at the weakness of microbial flooding, we take core flooding displacement experiments, and comprehensively evaluate the effect of complex system which improves recovery efficiency.

1. COMPARED THE METHOD OF OTHER MICROBIAL FLOODING WITH MICROBIAL COMBINATION FLOODING

Take four pieces of small core that permeability is approximately 300 mD, compared the capacity of the other microbial flooding with microbial combination flooding. Among them, the microbial combination flooding uses the B2/DJ system solution, the injection volume is 0.3 PV; the microbial polymer flooding uses DJ fermentation liquid, the injection volume is 0.3 PV; bio-surfactant flooding chooses B2 fermentation liquid, the injection volume is 0.3 PV; biological polymer and bio surfactant slug are injected the injection volume of 0.15 PV DJ fermented liquid to core, then the injection volume of 0.15 PV B2 fermented liquid, totally amount of injection of microbial is 0.3 PV. In addition, before the injection of microorganism, water flooding water rate should reach 98%. The experimental results are shown in Table 1.

From Table 1, microbial combination flooding has more advantages than other microbial oil displacement method, when B2/DJ composite system is injected 0.3 PV, the recovery rate enhanced by 13.89%.

Table 1
Test Results of Different Microbial Oil Displacement Method

Microbial displacement	Water flooding recovery (%)	Microbial combination flooding and subsequent water flooding recovery (%)	Ultimate recovery (%)
B2/DJ compound flooding	41.67	13.89	55.56
DJ flooding	41.89	10.81	52.70
B2 flooding	39.73	6.16	45.89
DJ+B2 Slug flooding	40.28	9.03	49.31

2. THE OIL DISPLACEMENT EFFECTS OF MICROBIAL COMBINATION FLOODING INJECTION VOLUME

Take three pieces of small core which permeability is approximately 300 mD make biological binary compound

flooding. After the aqueous water flooding rate reach 98%, respectively injected by 0.1 PV, 0.3 PV and 0.5 PV into the core with the B2/DJ system, we study the oil displacement effects of the different microbial combination flooding injection volume. The experimental results are shown in Figure 1 to Figure 3.

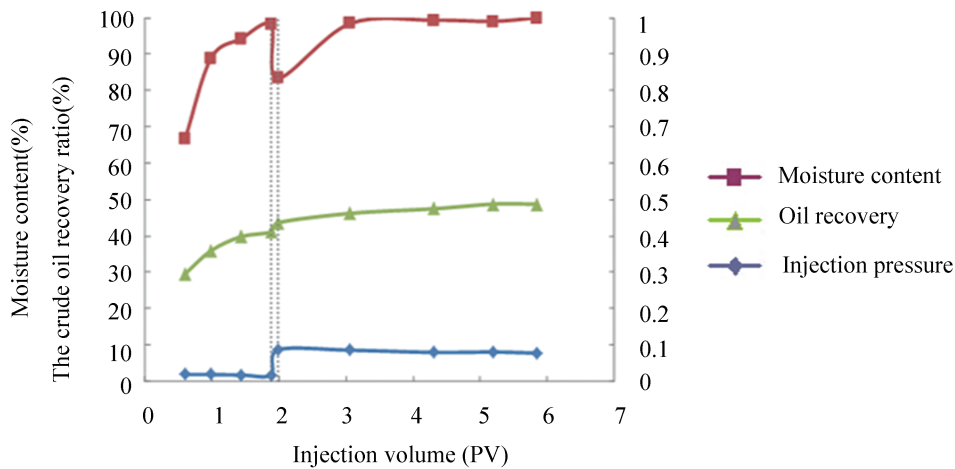


Figure 1
0.1 PV B2/DJ Oil Displacement Process Curve Drawing

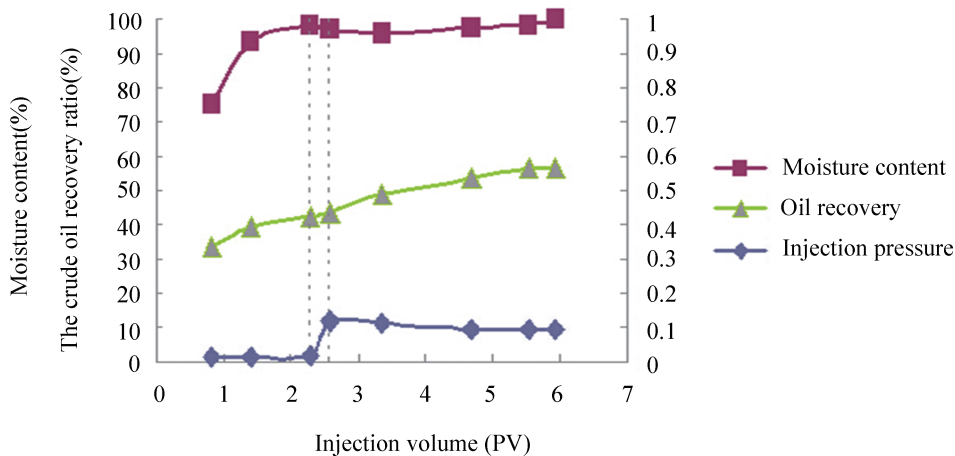


Figure 2
0.3 PV B2/DJ Oil Displacement Process Curve Drawing

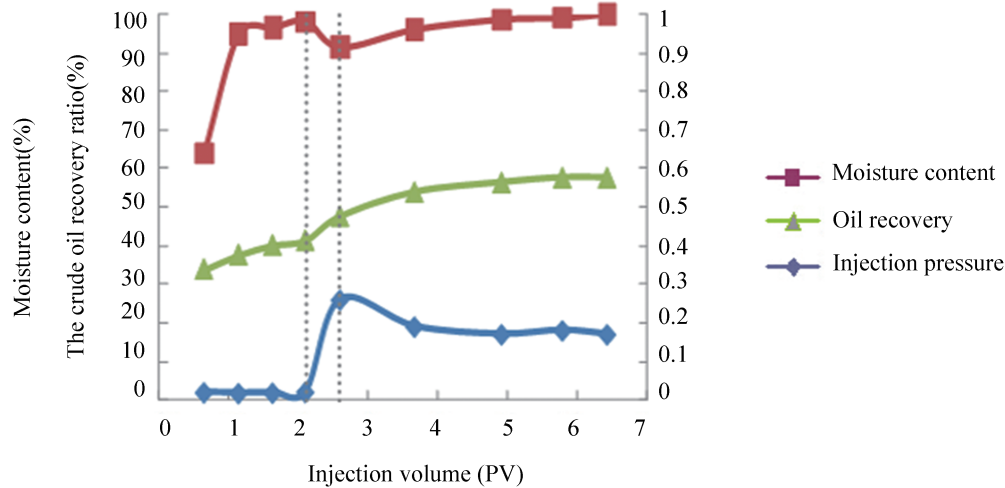


Figure 3
0.5 PV B2/DJ Oil Displacement Process Curve Drawing

The experimental results are shown that, under the same permeability and the same injection period, along with the injection rate of B2/DJ system increases, pressure's increasing amplitude of follow-up water flooding becomes larger, and the B2/DJ flooding recovery and subsequent water flooding's recovery also increase, so that, as the injection of composite system increases, strains amount, biopolymer and biological surfactants increase, which enlarge the sweep volume effectively and improve the oil cleaning efficiency. Therefore, the injection of composite system is more, the recovery rate improve much more. The cores which permeability is 300 mD cores, are injected B2/DJ complex solution of 0.5 PV, the recovery rate can increase by 16.25%, it is 2.56% higher than that of 0.3 PV, 8.56% higher than that of 0.1 PV.

3. THE MICROBIAL FLOODING PERIOD IMPACT ON COMPOSITE FLOODING

Take three pieces of small core which permeability is about 300 mD, are injected into the composite microbial system in the water rate of 80%, 90%, 98% in flooding water, injection volume is 0.3 PV, the experimental results are shown in Table 2.

In the table, injected Equal B2/D system solution in different injection period, it has different EOR degree. After injected the composite microbial system with 0.3PV when water content is 80%, the recovery rate increases by 24.30%, 3.49% higher than the injection when the moisture content is 90%, 9.96% higher than the moisture content is 98%. The results show that, B2/DJ composite microbial system implantation in earlier time, which has the better the effect to improve the recovery after injection, the less injection quantity of displacement fluid, the smaller workload of flooding.

Table 2
The Results of Different Injection Period of B2/DJ Composite System During the Oil Displacement

Water content of water flooding (%)	Water flooding recovery (%)	Recovery of B2/DJ flooding + follow-up water flooding (%)	Ultimate recovery (%)
80	30.56	24.30	54.86
90	34.03	20.81	54.84
98	40.56	14.34	54.90

4. OIL DISPLACEMENT EFFECT OF COMPOSITE MICROBIAL SYSTEM IN THE HETEROGENEOUS MODEL

Take three pieces of small core that of permeability are 100 mD, 300 mD, 500 mD which are saturated with

formation water and crude oil, in parallel, then water flooding to the outlet water rate of 98%, and then injected into the B2/DJ system solution for oil displacement, placed it for one day, proceed follow-up water flooding. The experimental results are shown in Figure 4 to Figure 7.

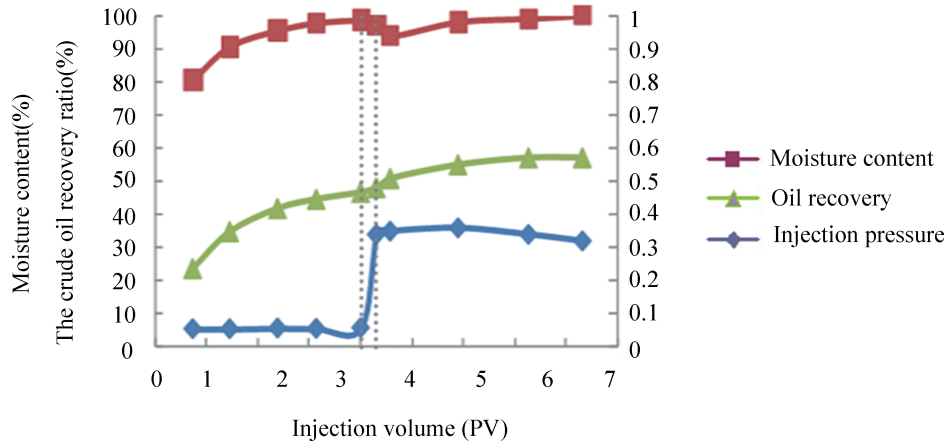


Figure 4
Change Curve of Oil Flooding Parameters of High Permeable Layer

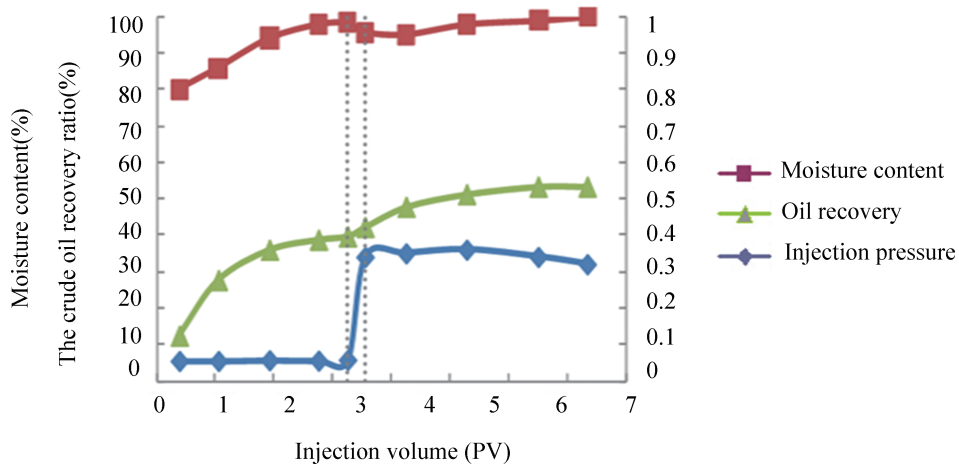


Figure 5
Change Curve of Oil Flooding Parameters of Middle Permeable Layer

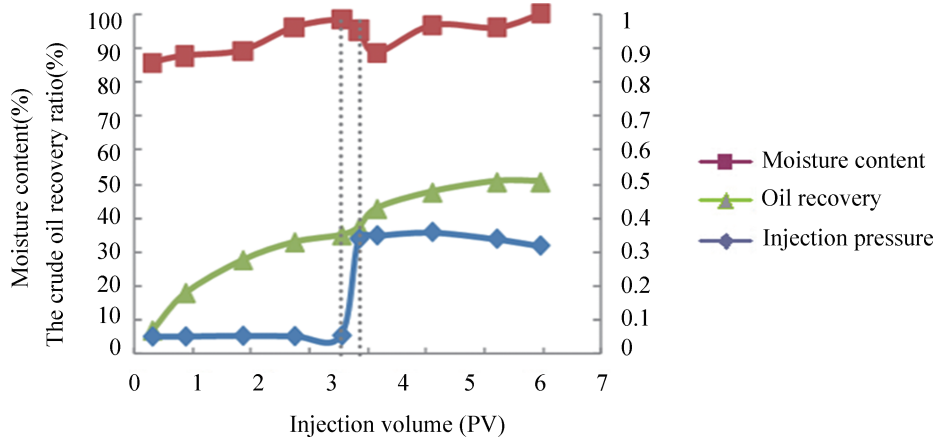


Figure 6
Change Curve of Oil Flooding Parameters of Low Permeable Layer

In the figure, we can know that the speed of water rate increases quicker in high permeability layer, water flooding recovery is max before the combination flooding. When the water content reaches 98%, high permeability layer's water flooding recovery is 46.53%.

Injected B2/DJ composite system with 0.3 PV, the

recovery rate is improved, the low permeability layer of enhanced oil recovery rate can reach 15.69%, 2.02% higher than it in the middle permeable layer, and 5.27 % higher than it in high permeability layer. It shows that the compound system can plug big pore effectively, thus changing the flow direction of succeeding water flooding,

middle and low permeability layer became the main circulation place of follow-up water flooding, effectively enlarge the sweep volume of middle and low permeability

layer, the final recovery after subsequent water flooding of high and low permeable layer are 56.94%, 53.47%, 50.83%.

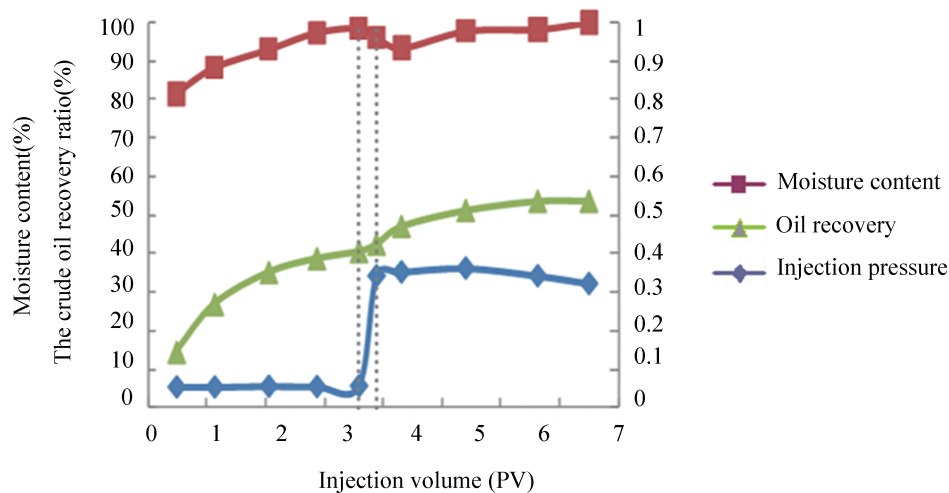


Figure 7
Change Curve of Oil Flooding Parameters of the Model

From Figure 7, in the model that average permeability is 300 mD, after water rate of water flooding reaches 98%, injected B2/DJ composite microbial system with of 0.3 PV, the ultimate recovery rate can reach 53.75%, the recovery rate increases 13.10%, the effect of displacing oil is obvious.

CONCLUSION

(a) The amount of microbial compound system has a significant effect on the oil displacement effect, the greater the amount, the better the oil displacement effect. In the permeability of 300 mD in the heart of the heart, the injection of B2/DJ 0.5 PV, the recovery rate is increased by 16.25%, higher than the note 0.3 PV 2.56%, higher than the note 0.1 PV 8.56%.

(b) In the injection period, the oil displacement effect of B2/DJ microbial composite system is affected, the early injection period, the better the recovery efficiency, the less the total injection volume, the smaller the displacement of oil displacement.

(c) Microbial flooding has more advantage than other microbial oil displacement method. In the heterogeneous model which average permeability is 300 mD, injected B2/DJ composite microbial system with 0.3 PV, the recovery rate increases 13.10%, the effect of displacing oil is obvious.

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