DOI:10.21276/sjbr

Saudi Journal of Biomedical Research
Scholars Middle East Publishers
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

ISSN 2518-3214 (Print)
ISSN 2518-3222 (Online)

Original Research Article

The Indoor Optimization Experiment of Gel and Chemical Alternating Injection after Polymer Flooding

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Abstract: It is a kind of enhanced oil recovery technology with good use value and application prospect. It can obviously improve the oil recovery after flood drive. In order to investigate the effect of polymer flooding What kind of chemical agent alternately can make the best effect of flooding, the highest economic efficiency, carried out the gel and chemical agent into the indoor optimization experiment. Firstly, the effect of gelation of polymer and polymer, surfactant and binary compound system on the experiment was studied. The results showed that the gelation of the gel was similar to that of the binary composite system And the cost and economic benefits of the three chemicals were compared. The results showed that the ratio of gel to polymer was higher than that of the polymer, and the optimum pore volume was 0.35 ~ 0.5PV, to guide the scene of the remaining oil after the polymer to further tap the potential.

Keywords: gel, polymer flooding, oil displacement efficiency, economic benefit.

INTRODUCTION

Polymer flooding technology in the country most of the oil fields are oil production and stable production of important measures, but after the flood drive, there are still most of the remaining oil failed to be mined [1-3], so after the polymer to further enhance the recovery rate Has become the focus of research on polymer flooding field [4-7]. At present, gel and chemical agent into the oil flooding technology has been widely used in polymer flooding field, the technology can be further based on the polymer to increase the recovery rate of about 10% [8, 9], and can effectively avoid ternary during the process of oil displacement, there are serious problems such as severe alkali consumption, serious emulsification, scaling and other problems [10-13]. The use of the chemical agent in the technology of alternating injection of gel and chemical agent can achieve the optimal oil displacement effect, and the highest input-output ratio is an inevitable problem to be studied. At present, three kinds of chemical agents are used in China, which are polymer, surfactant and polymer binary system. These chemical systems have good use value and application prospect.

In this paper, the oil recovery effect of gel and different chemical systems was determined by indoor experiment. The results showed that the oil recovery efficiency of the gel and the different chemical systems was the same under the same slug volume and the same slug volume. By comparing the recovery rate and input-output ratio of the three schemes, The most suitable for polymer flooding after the remaining oil to further tap the potential of the chemical system, to guide the purpose of field testing.

LABORATORY TEST

Experimental materials

The experimental water is the conventional sewage of Daqing Oilfield Oil Production Plant, salinity 6000-7000mg/L , pH=9. Gel system is a molecular weight of 25 million, the polymer concentration of 1800mg / L, polymerization ratio of 40: 1 chromium ion gel system. Surfactant reinvented RMA-1, a new RMA-1 living agent system for daqing, which is 0.3 percent. The polymer is a high grade polymer with a concentration of 25million and a concentration of 1200mg/L. The composite system of the polymer and surfactant is 50% pure. Interlayer heterogeneous synthetic long-form core, (the core size is 45mm×90mm×300mm, the upper middle and lower permeability are $600\sim800\times10^{-3}\mu m^2$、$1200\times10^{-3}\mu m^2$、$2000\times10^{-3}\mu m^2$ respectively). Temperature is 45℃.

Experimental scheme

Table 1: Design of large-slab core oil displacement experiment

	Experimental scheme	pore volume (cm^3)	porosity (%)	initial oil saturation (%)	irreducible water saturation (%)
1	Polymer flooding+(gel 0.02PV+ surfactant 0.03PV total of 13 rounds)	4998	30.85	52.32	47.68
2	Polymer flooding +(gel 0.02PV+ binary system 0.03PV total of 13 rounds)	4730	29.19	50.03	49.97
3	Polymer flooding +(gel 0.02PV +polymer 0.03PV total of 13 rounds)	4850	29.93	52.31	47.69

Experimental procedure

(1) Saturated water and saturated oil treatment of three large slab cores;
(2) The water displacement rate of the water drive core is 98%, and Calculate the water flooding recovery rate;
(3) The polymer flooding is carried out, and when the injection reaches 0.65 PV, it calculates the recovery efficiency of the polymer flooding;
(4) Using 0.02 PV gel + 0.03 PV surfactant/binary system/oil displacement the alternating injection of polymer solution with different slug small slug alternating injection way rounds (gel gelling time is 24 h), injecting gel + chemical solution 13 rounds, 0.65 PV, subsequent water flooding to the moisture content of 90%.

EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results

Table 2: Experimental results of large-slab core oil displacement experiment

	Experimental scheme	recovery efficiency (%)				
		Water flooding	Polymer flooding (subsequent water flooding)	gel+ chemical solution	subsequent water flooding	overall recovery efficiency
1	Polymer flooding+(gel 0.02PV+ surfactant 0.03PV total of 13 rounds)	39.01	17.96	10.33 （0.65PV）	1.59	68.89
2	Polymer flooding +(gel 0.02PV+ binary system 0.03PV total of 13 rounds)	40.83	17.07	11.29 （0.65PV）	1.33	70.52
3	Polymer flooding +(gel 0.02PV +polymer 0.03PV total of 13 rounds)	40.16	17.02	7.51 （0.65PV）	1.27	65.96

Result correlation analysis

(1) Recovery contrast

Table 3: Gel+ chemical solution alternate injection results contrast after polymer flooding

	Experimental scheme after polymer flooding	residual oil saturation after polymer flooding	PV of composite system segment plug	recovery efficiency of composite system segment plug %	overall recovery efficiency %
1	Polymer flooding+(gel 0.02PV+ surfactant 0.03PV total of 13 rounds)	43.03	0.65	10.33	68.89
2	Polymer flooding +(gel 0.02PV+ binary system 0.03PV total of 13 rounds)	42.1	0.65	11.29	70.52
3	Polymer flooding +(gel 0.02PV +polymer 0.03PV total of 13 rounds)	42.82	0.65	7.51	65.96

Three experiments were carried out directly after polymer flooding with gel + surfactant, binary composite system, polymer multi-cycle alternating injection experiments, these three groups of

experiments are filled with 13 rounds of gel and chemical Solution, a total of 0.65PV was injected. Table 2 shows the results of the two cores of the oil displacement, can be seen from the table, the experimental 1 gel + surfactant plug plug oil phase recovery rate of 10.33%, experiment 2 gel + poly The recovery rate of the plugging stage was 11.29%, and the recovery rate was 7.51% in the plug oil phase of the gel + polymer system. When the total oil saturation (0.65PV) of the composite system solution was the same in the case of the residual oil saturation of the experiment 2 and the residual oil saturation in Experiment 1 and Experiment 3, the post-polymerized gel + poly The recoveries of the oil flooding of the binary binary system were 0.96% higher than that of the gel + surfactant and polymer flooding, indicating that the polymer + The effect of oil injection is better than that of the other two schemes.

After analysis, the main reason is that the polymer solution in the binary binary system can control the flow, but also can reduce the adsorption of surfactants in the near well area, so that the surfactant can reach the core deeper to give full play to its The effect of this effect is that the synergistic effect of the synergistic effect and the active agent in the formation of the active layer increases, making the gel + binary composite system alternate into the oil displacement effect is better.

(2) Cost comparison

Table 4: The price of each agent's solution during the experiment

	Gel system liquid price （yuan/m^3）	Polymer surfactant binary liquid system price （yuan/m^3）	Surfactant price （yuan/m^3）	1200mg/L polymer price （yuan/m^3）
Effective content	1800mg/L(P +180mg/L(Cr^{3+})	1200mg/L(P) +0.3%(S)	0.3%(S)	1200mg/L(P)
Gel price （yuan/m^3）	4.59			
Surface active agent price （yuan/m^3）		81.000	81.00	
Polymer price （yuan/m^3）	32.79	21.862		21.862
Total	37.38	102.862	81.00	21.862

It can be seen from Table 4 that the price of the polymer is much lower than that of the other two chemicals, which is about 59 yuan/m^3 lower than the price of the surfactant, which is about 81 yuan/m^3 higher than the price of the binary compound system, it can be seen, polymer flooding polymer + polymer intermittent injection into the cost of oil is relatively low.

(3) Economy benefit comparison

It can be seen from Fig. 1 that the input-output ratio of the polymer + polymer solution after the polymer flooding is much higher than that of the gel + polygene binary and the gel + surfactant. The input-output ratios of the three groups were 1: 3.64 (gel + polymer), 1: 2.25 (gel + surfactant) and 1: 1.96 (gel + binary system). Whether the gel + polymer, or gel + surfactant and gel + binary slug alternately into the oil displacement, the best slug injection as shown in Figure 1, in the injection pore volume 0.35 ~ 0.5PV interval , Relatively high input and output is relatively stable, after 11 rounds of input-output ratio than a downward trend. Significant economic benefits. From the economic point of view, the input and output ratios of the composite slugs were 13: 3.64 (gel + polymer), 1: 2.25 (gel + surfactant) and 1: 1.96 (gel + binary), indicating that the gel + polymer flooding although the recovery rate is low, but the input and output is relatively high, with a certain value and application prospects.

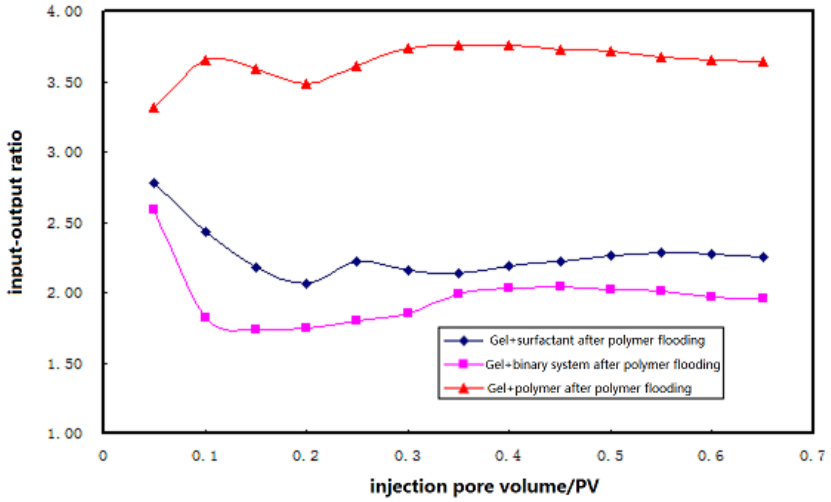

Fig-1: Each stage input and output contrast curve of gel + chemical alternate injection after polymer flooding

CONCLUSIONS

(1) Polymer gel after alternating with chemical agent injection technology to improve oil recovery effect is obvious, the injection pore volume is 0.35 ~ 0.5 PV interval, three kinds of chemical input and output ratio of high and relatively stable;

(2) When injected into complex system solution at the same time, the total number of PV phase polymer gel after + poly table binary compound system of alternating injection flooding effect is better than the gel + surfactant and polymer flooding after polymer flooding after polymer gel + two plans of oil displacement effect;

(3) Polymer flooding after ten after three rounds of the alternating injection of compound slug gel + although polymer flooding recovery efficiency is low, but compared with other two kinds of chemical input-output ratio is higher, have certain application prospect in the field.

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