

Study on Reinjection Technology of Sewage With SO_4^{2-} in Oilfield

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Abstract

SO_4^{2-} rich in reinjection sewage combined with Ca^{2+} , Mg^{2+} in formation water to form precipitate which results clogging in the formation pore. Ion exchange method was chosen to remove SO_4^{2-} in reinjection sewage and the anion exchange resin with OH^- is selected as the exchange medium. It is necessary to evaluate alkali sensitivity of the formation rock due to the reinjection of sewage containing excess OH^- . The results indicate that ion exchange method can remove more than 90% of the SO_4^{2-} and the rate of formation damage is negligible when the pH below the critical of 9.8.

Key words: SO_4^{2-} ; Ion exchange method; Scaling; Alkali sensitivity

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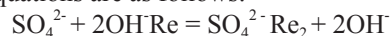
INTRODUCTION

The present stage of oil exploration in China, water flooding is usually adopted as the main development. Produced fluid containing 70%-95% of the water which is needed to be the oil phase and water phase separation. If the sewage is discharged that it will cause environmental pollution and waste of resources. It must be carried out through several processing steps to reinjection into the reservoir, such as broken emulsification, sedimentation, filtration, and so forth.

Reinjection technology can not only protect the environment, but also solve the problem of water injection to bring economic and social benefits^[1]. But the sewage contains large amounts of sulfate ions which will be combined with magnesium and barium to form precipitation. It results in clogging in the formation pore. The best way to solve the scaling problem is the sub-mining dispensation, but pipeline design of most oilfields unable to meet this requirement^[2]. In the oilfield existing conditions, the optimal scheme for removing sulfate ions is dealing sewage with the alkaline water to prevent fouling of low permeability reservoirs and enhanced oil recovery^[3].

1. METHODOLOGY

Ion exchange is defined as excluding the inorganic ion dissolved in the water by ion exchange resin which is a kind of polymer material having an ion exchange function. According to the different nature of the exchange groups, the ion exchange resin can be divided into cation exchange resin and anion exchange resin. Anion exchange resin with OH^- in exchange for SO_4^{2-} in reinjection sewage, the reaction equations are as follows:



2. RESULTS AND DISCUSSION

2.1 Ion Exchange Method to Remove SO_4^{2-}

The Adsorbing characteristics of anion exchange for anions are differences, the strength of adsorption as follows:



Anion ion exchange resin will give priority to be combined with SO_4^{2-} and release OH^- . The sewage from Henan Oilfield in China is used for the experiment which removes SO_4^{2-} by ion exchange resin.

Sewage containing SO_4^{2-} are implanted into the replacement tower filled with anion exchange resin. The content of the sulfate varies with time are shown in Table 1.

Table 1
 SO_4^{2-} Concentration Varies With Time

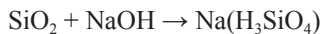
Sewage samples	Time (min)	Concentration of SO_4^{2-} (mg/L)	pH
Untreated sewage	0	2,243.39	6-7
Sample 1 in resin tower	15	1,503.65	7-8
Sample 2 in resin tower	30	1,195.38	8-9
Sample 3 in resin tower	45	902.29	8-9
Sample 4 in resin tower	60	743.97	8-9
Sample 5 in resin tower	75	605.67	8-9
Sample 6 in resin tower	90	506.57	8-9
Sample 7 in resin tower	105	398.21	8-9
Sample 8 in resin tower	120	280.33	8-9
Sample 9 in resin tower	150	195.73	8-9

As can be seen from Table 2, the concentration of SO_4^{2-} in the wastewater was decreasing with the increase of the sampling time. Compared to the initial solution, the concentration decreased from 2,243.39 mg/L to 195.73 mg/L, the decrease range was 91.2%. Anion ion exchange resin will give priority to be combined with SO_4^{2-} and release OH^- . The pH value of the solution is weakly alkaline by acid conversion. The experimental results show that the anion exchange resin can remove the SO_4^{2-} effectively. But it is necessary to carry out the experiment of alkali damage to prove its feasibility.

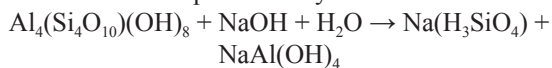
2.2 Reservoir Alkali Sensitivity

2.2.1 Mechanism of Alkali Damage

In the reservoir, alkaline fluid is reacted with quartz to form a variety of silicate minerals which can be adsorbed on the solid to form a new precipitate and cause formation plugging^[4].



In clay component, the main mineral is affected by the alkaline fluid are kaolinite and montmorillonite. Kaolinite is in the strong base effect to generate sodium silicate which will affect the permeability of the formation.



2.2.2 Experiment of Alkali Damage

The permeability of rock sample which is remembered as K_1 by injected KCl solution below the critical velocity of speed. According to the volume of 10-15 times of the core pore, injecting the test fluid with a certain pH value and then still more than 12 h to measure the rock sample permeability K_2 of the alkaline solution. Alkali sensitivity index (S_b) calculated by the following formula:

$$S_b = \frac{K_1 - K_2}{K_1}$$

When $S_b \geq 0.3$, the alkali sensitivity degree is defined as a medium above.

After removing the SO_4^{2-} by anion exchange resin method, the pH of the sewage is 8-9 belongs to the weak alkaline. This needs to select reservoir a few natural core of reservoir for alkali sensitivity evaluation.

In condition of 75 °C, the impact of different alkalinity fluid on the permeability of the core was evaluated. Experimental results show that: When the pH value is higher than 10.0, with the increases of the pH the permeability decreased greatly. The critical pH value of alkali sensitivity is a 10.0-10.5.

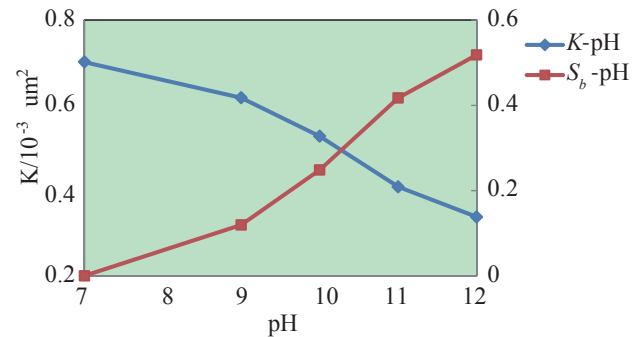


Figure 1
 K and S_b varies with pH

After removing the SO_4^{2-} by anion exchange resin method, the pH of the sewage is 8-9 belongs to the weak alkaline. The value of pH is lower than the critical value, so it meets the demand of injection.

CONCLUSION

- (a) SO_4^{2-} can be effectively removed by using anion exchange resin.
- (b) When the pH up to 10, the formation permeability decreased rapidly and the damage of the formation increased significantly, the critical pH is 9-10.
- (c) Ion exchange method is feasible.

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