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Controlling The Reservoir Souring During Water Flooding

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Abstract: For increasing the production rate of the reservoir, water flooding is a traditional method that it is a main reason in increasing of H_2S level in the reservoir. In Movba reservoir because of the feasibility of SRB activity, several studies were performed on detection a treatment method for prevention and removing of biogenetic H_2S before water flooding. The best method was theapplication of scavenger and nitrate and nitrite injection.

Key words: H_2S, SRB, Biocide, Biocompetitive Exclusion, Scavenger.

INTRODUCTION

Enhance oil recovery (EOR) usually apply in petroleum industry to control production rate. EOR has been separated into 3 subdivisions primary, secondary and tertiary stages. Primary stage is associated to initial condition of the reservoir. Secondary stage is shown by the production decline in primary stage. The water flooding and gas injection are the useful methods in secondary stage of EOR. The tertiary stage is after secondary stage and use miscible gas or thermal energy for displacement oil (Tayfun, 2003).

In the both secondary and tertiary stages because of the changes that were created in the reservoir condition, must be performed by the specific considerations (Da-Kuang *et al*, 1999). For example, in the water flooding that is a widespread method in secondary stage of EOR; biogenetic sulfide production is a critical point. So identification and removing of biogenetic H_2S is a main matter in the enhance oil recovery with water flooding (Hitzman *et al*, 1995; Nemati *et al*, 2001).

In this study, an oil field was chosen for investigation and experiment. The water flooding operation was monitored and finally, an economical method was illustrated for prevention and removing the production of biogenetic sulfide after water flooding.

MATERIAL AND METHODS

The Movba field is a large petroleum sandstone reservoir. The initial condition of the reservoir is suitable for SRB activity and the amount of H_2S was too low. The reservoir condition was described below:

The reservoir temperature is 72°C, which is suitable for SRB bacteria.

The salinity of formation water is up to 5% wt and the amount of volatile fatty acids (VFA) is high (above 2400 mg/l).

The Movba water flooding was performed by injection rate of 420 k bwpd seawater at 180 bar pressure per day. The seawater was filtered before injection to the reservoir and the particle greater than 6 microns was separated by Multi Media Filters (MMF). For removing the oxygen of seawater, we apply a deoxygenator apparatus after MMF in injection line. Finally, nine were used for water injection.

RESULTS AND DISCUSSION

We used the up-flow fixed bioreactor (UFFBR) to understanding the SRB activity by measuring biogenetic sulfide. The fluid for experiments was a mix of seawater and separated production water. A column of reservoir core was cleaned by HCl solution and placed in the cylinder.

At first treatment method was based on injection tetrakis hydroxymethyl phosphonium sulfide (THPS) as a biocide and ammonium bisulphate (ABS) as a scavenger. Effect of this treatment showed a good ability in SRB inactivity and prevention of corrosion. After 4 months of treatment, the H_2S level increased to 210 ppm and water flooding was stopped. The main reason of disability was the reaction of the biocide and reservoir matrix instead of SRB (Okabe *et al*, 1992; Hitzman *et al*, 1995).

Next methods were based on bio-competitive exclusion the effects of nitrate and nitrite injection were tested the results showed the H_2S level for nitrate injection was a range between 30 – 180 ppm and most of the data were in a range between 50 – 100 that it showed the disability of nitrate injection. About the injection of nitrite, the results showed a range between 25- 160 ppm and most of data were in a range between 40 – 85 ppm. Another injection was tested based on a mix of nitrate and nitrate and results showed a perfect decline of H_2S

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level in a range between 10 - 40 ppm. So the final treatment for reservoir was performed by the injection of nitrate, nitrite and ABS for prevention and removing of biogenetic H_2S (Ehler and Hall, 1982; Hubert C *et al*, 2003; Nemati *et al*, 2001; Reinsel *et al*, 1996).

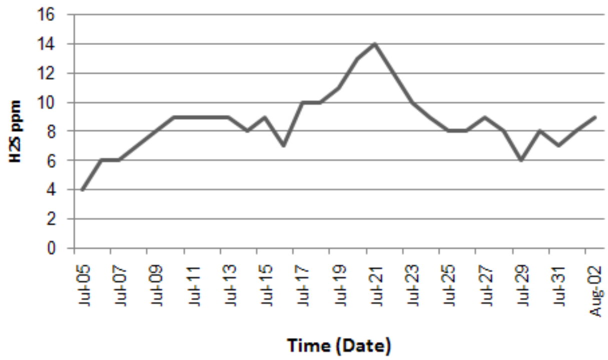

Fig. 1: Effect of ABS and THPS on biogenetic sulfide production.

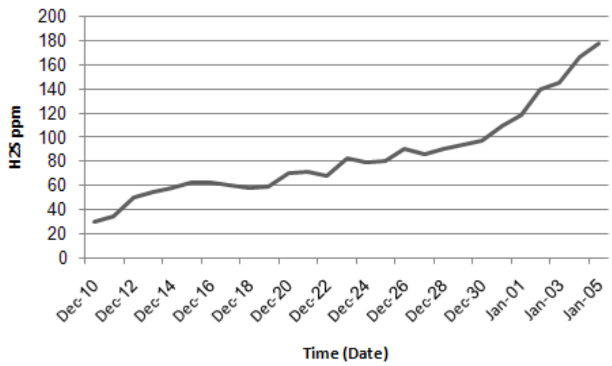

Fig. 2: Effect of nitrate injection on biogenetic sulfide production.

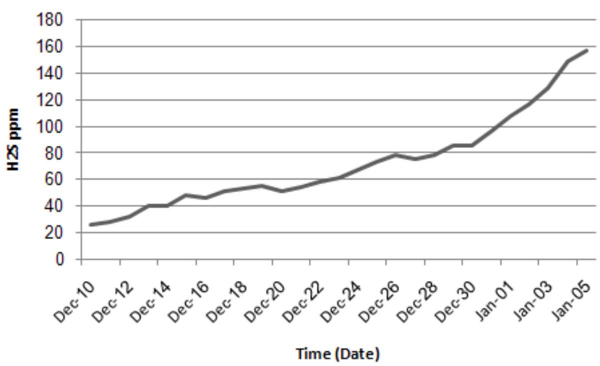

Fig. 3: Effect of nitrite injection on biogenetic sulfide production.

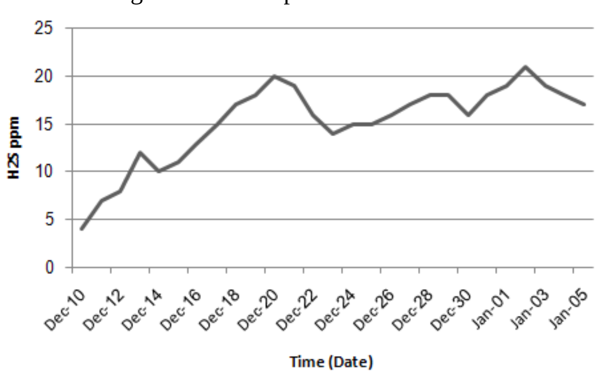

Fig. 4: Effect of nitrite and nitrate injection and ABS on biogenetic sulfide production.

Conclusions:

The Movba reservoir has a suitable condition for SRB activity and reservoir souring. Before enhance oil recovery (water flooding), several studies were performed for finding a success method in prevention and removing the biogenetic sulfide.

Several methods were investigated base on using biocide and scavenger and biocompetitive exclusion. Finally, injection of nitrite and nitrate with the scavenger was successful.

In biocompetitive exclusion part, the composition of injection was 55 mg/l nitrate and 80 mg/l nitrite for activation of local nitrate reduced bacteria in the reservoir. For controlling the condition of seawater injection, we used 8o mg/l ABS scavenger and laboratory and field examinations did not show any negative effects upon the inactivation of beneficial bacteria such as NRB.

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