Study on Injection Parameters of ASG Composite Foam in Low Permeability Reservoir

Jian Wang [1, a], Mengyu Wang [2], Zhaoyu Liu [3]

[1] Northeast Petroleum University Daqing, Heilongjiang Province 163318, China

[2] Daqing Oil Field Co fifth Production Plant Daqing, Heilongjiang Province 163513, China

[3] Daqing Oil Field Co fourth Production Plant Daqing, Heilongjiang Province 163511, China

[a]2760913691@qq.com

Abstract

The enhanced oil recovery technology of ASG (alkali, surfactant and nitrogen) composite foam and water alternating injection was studied in high temperature and high salinity low permeability reservoir. The results show that the enhanced oil recovery of the method adopted by this study is 16.61%, 10.26% and 9.21%, relative to water flooding, nitrogen flooding and surfactant flooding technology. The parameters such as slug size, injection rate and gas fluid ratio of ASG composite foam were optimized by bench scale displacement test. Laboratory findings shows, under the condition of the same foam injection volume (1.2 times the pore volume), when the size of the foam slug is 0.4 times the pore volume, the effect of alternating injection is better; The foam injection rate has an optimum value of 1.5 ml / min. when the injection rate is too low, resulting in less foam, and prone to gas and liquid separation, blocking effect is poor. When the injection rate is too high, the size of the bubble is different, prone to bubble merger, causing the bubble burst, and is likely to cause the foam cut defoaming; When the gas fluid ratio is 3: 1, 2: 1 and 1.5: 1, the recovery rate is 2.04% higher than that of the single gas fluid ratio, and the better development effect is obtained..

Keywords

Low permeability reservoirs; Alternating injection; ASG composite foam ; Injection parameters.

1. Introduction

Most of our landfield oil fields have entered the era of high water development, and the development of contradictions has become increasingly prominent. At present, polymer flooding, binary flooding and ternary flooding are considered to be more mature tertiary oil recovery techniques[1-2], but their reservoir conditions Also received a strict limit, the bubble due to its unique characteristics of the oil displacement and seepage law and more and more people receive attention, is considered a very promising three times the way oil production[3-4]. The gas foam has the dual effect of profile control and flooding, which can significantly improve the oil volume and increase the oil washing efficiency, and can greatly improve the oil recovery. For high temperature and high salinity low permeability reservoirs, polymer flooding and ASP flooding (ASP) are greatly restricted. The reason is that the polymer is difficult to be injected into the low permeability reservoir, and the degradation is serious. Poor stability is one of the important reasons.

In view of the above development, it is found that the use of nitrogen and surfactant to form a bubble, in cooperation with the alkali, ASG foam and water into the injection can be highly efficient development of high temperature and high salinity low permeability reservoir. At the same time, the parameters were optimized for the size of the slug, the injection velocity and the gas-liquid ratio.

2. ASG Foam Applicability Evaluation

2.1 Experimental drugs and methods

The experimental drug consisted of simulated oil with a viscosity of 5.5 mPa•s, simulated formation water with a salinity of 50000 mg / L, blowing agent HY-3, alkali Na_2CO_3 and nitrogen. Using artificial core, gas permeability of 50× 10-3μm2, porosity 0.12, the appearance of the size of 60cm×60cm×4.5cm or so. Experimental temperature of 110℃, injection method for the blowing agent, alkali and nitrogen mixed injection.

2.2 Evaluation of Foam Plugging Performance

The blocking ability of the foaming agent is determined by measuring the resistance factor at both ends of the core, and the significant increase in the resistance factor after injection of the foam indicates that the foam has been effectively blocked. The experimental results show that the ASG foam can greatly increase the resistance factor and form a good blocking effect on the dominant seepage channel.

3. Comparison of recovery ratio of different displacement methods

Experimental steps：①water flooding to integrated water 90%, water injection speed 2ml / min; ② after the water drive, nitrogen flooding, surfactant flooding, SG flooding and ASG foam drive; ③ flooding to no oil so far, the statistical comparison of different displacement recovery. The experimental results show that the ASG foam flooding in the high permeability and low salinity reservoir has a higher degree of recovery than other displacement methods, and it has a certain application prospect in the practical application of oilfield.

Tab.1 Comparison of recovery ratio of different displacement methods

Flooding system	Injection volume(PV)	Total recovery(%)	Improve oil recovery(%)
Water drive	---	43.89	---
Nitrogen flooding	---	50.24	6.35
Active agent flooding	1.2	51.29	7.40
SG drive	1.2	54.27	10.38
ASG foam drive	1.2	60.50	16.61

4. ASG Foam Alternate Injection Parameter Optimization

4.1 ASG Foam Slug Size Optimization

Water drive to 90% of water to the bubble after the drive. (1.2PV), the foam injection rate of 1.5ml / min: ①1.2PV foam; ②0.6PV foam and water into the injection; ③0.4PV foam (4P), the same time, And water into the injection; ④0.3PV foam and water into the injection; ⑤ follow-up water drive to no oil so far. Measure the injection pressure at both ends of the core of the flooding process, monitor the breakthrough time of the tracer, and calculate the core recovery.

Tab.2 Comparison of parameters of different slugs

Program	injection pressure (MPa)	Sodium bromide detection time(min)	Recovery rate(%)
1	—	—	—
2	2.8	481	58.96%
3	2.3	422	60.50%
4	1.4	225	55.69%

From the experimental results, it can be seen that for the low permeability oil layer, the large slug is directly injected into the foam, which is difficult to be injected. The injection pressure exceeds the rock fracture pressure, and the practical application is not feasible. When the first stage plug size changes from 0.6PV to 0.4PV , The detection time of sodium bromide was only decreased by 59 min, indicating that there was no significant change in the plugging capacity of the first stage plug. When the first stage plug size changed from 0.4PV to 0.3PV, the detection time decreased to 197min, the blocking effect was worse, Easy to break. After the segmentation, the recovery rate reached 60.50% and the recovery rate was 16.61%, but with the increase of the foam segment, the foam recovery was The effect is weakened and the recovery rate is reduced.

The viscosity increases as the gas-liquid ratio increases. In the process of bubble flooding, the foam slug has different effects: the role of the first stage plugging mainly for the closure of the advantages of seepage channel, this time should choose a higher gas-liquid ratio to form an effective plug; second and third The role of the stage is mainly to expand the spread of the volume, should choose a relatively low gas-liquid foam slugs, thereby expanding the scope of the bubble to improve recovery. According to the experimental results, it can be seen that the recovery rate of the slugs is 2.04% when the nodules of 3: 1, 2: 1 and 1.5: 1 decrease.

5. Conclusion

(1) For the high temperature and high salinity low permeability reservoir, ASG foam and water injection can achieve better development effect. The recoveries were 16.61%, 10.26% and 9.21%, respectively, compared with water flooding and nitrogen flooding.

(2) When the slug size is 1.2 times the pore volume, the effect of alternating injection is better when the pore size is 0.4 times the pore volume.

(3) the bubble injection rate of the optimal value of 1.5ml / min, when the injection rate is too low, resulting in less foam, and prone to gas-liquid separation, blocking effect is poor, when the injection rate is too high, the bubble size is not First, prone to bubble merging, causing the bubble burst, and is likely to cause the foam cut defoaming.

(4) the gas-liquid ratio of the single gas-liquid ratio is 2.04% when the gas-liquid ratio is 1.5: 1 when the gas-liquid ratio is 3: 1 and the gas-liquid ratio is 2: , Take the better development effect.

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