Research and adjustment methods in the mid-term of injection of salt-resistant polymer flooding

Yongchao Li
No.1 Oil Production Plant, Daqing Oilfield Co., Ltd., Heilongjiang 163000, China

Abstract. In order to maximize the ultimate recovery of the salt-resistant polymer flooding block, this paper analyzes the problems existing in the mid-phase of the polymer injection in the salt-resistant block and combines the dynamic data research to formulate the main methods for adjusting the salt-resistant polymer flooding stage. Suggestions for the next adjustment are provided, which provide reference for future adjustment of the same type of block.

Keywords: Salt resistance, polymer flooding, medium-term, staged adjustment.

1. Basic situation of the block
In order to explore the technology of polymer flooding to improve the recovery rate under the sewage system, to solve the problems of excessive output sewage, large dry powder consumption, and low economic benefits, through the combination of production reality, the development of salt-resistant polymers in this block experiment.

The block is located in the central development zone of Changyuan in Daqing area. It began to be exploited in SaⅡ1 ~ 9 oil layers in March 2013. It began to bet on salt-resistant polymers in August 2016. It uses a 175m well spacing five-point method well pattern for injection and production. The entire block is divided into three types of sedimentary units, of which the type ⅡA sedimentary units are the main ones. The development of oil layers among the units is quite different. Units 1-4 of SaⅡ are well developed and the thickness of the ejection is large. Above, but because the development of interlayer shale is in the casing damage sensitive section, it is necessary to make adjustments for casing damage prevention.

2. Development status and existing problems
From the perspective of development status, the injection end is adjusted through the system, the overall injection volume is basically stable, and the injection viscosity is maintained at a reasonable level. Through adjustment at the production end, the production status gradually improved, and the water content showed a second downward trend. Compared with the numerical model of the oil displacement scheme, the scheme has predicted that the minimum water content of the block will drop to 85.7%, the degree of recovery in the polymer injection stage will reach 15.82%, and the final recovery ratio will reach 59.12%. Through this scheme, the recovery ratio has been improved by 13.15 Percentage points. However, at the current stage of the block, the enhanced recovery factor is only 2.18 percentage points,
and the effect of polymer injection is not as expected. It is found through analysis that it is mainly affected by the following four factors.

First, betting that the sewage indicators exceeded the initial standard and the injection quality was poor. In the early stage of betting, due to the serious bacteria exceeding the standard and the poor sewage water quality, the viscosity retention rate dropped significantly, only reaching 29.32% of the plan. The plugging effect of the system in the deep part of the oil layer was weakened, and the injection pressure rose slowly.

The second is the loss prevention and control of the main layer of prevention and control sets, with low utilization. Block mining Sa Ⅱ 1 ～ 9 layer system, of which, Sa Ⅱ 1-4 oil layer is well developed and is the main oil-producing layer. However, after the injection is controlled according to the casing damage prevention and control requirements, the use of Sa Ⅱ 1 ～ 4 and Sa Ⅱ 5 ～ 9 intervals Unbalance, injection speed difference becomes larger, and pressure difference becomes larger.

The third is that the pressure of the air drive injection before the investment is high, and the adjustment space is small. Due to the high level of fluid production in the early stage of betting, the injection-production ratio is low, the formation pressure has dropped, and the pressure system is not reasonable. At the same time, the over-exploitation during the blank water flooding stage resulted in a pressure space of only 2.4MPa before the betting of the block. The adjustment space is small.

The fourth is the impact of two-wheel drive interference. There are three sets of well pattern mining zones in the area. The number of water flooding wells is 2.5 times the number of poly flooding wells. The relationship of the well pattern is very complicated. Before betting, the relevant target intervals of water flooding have been blocked. For reasons such as plugging failure, channeling, and unsealed thin layer, there are still interference problems during the implementation process, and the effectiveness of water flooding oil wells is still obvious.

![Figure 1. Polymer flooding in sewage system treatment system](image)

3. Method and effect of stage adjustment

In view of the problems existing in the mid-term of block injection, in order to ensure the effect of displacement, through the working ideas of "guarantee system, promote use, promote efficiency, reduce interference", strengthen the four combinations to improve the development effect.
3.1. Combining above and below ground to ensure the quality of injection
Aiming at the problem that water quality has a great influence on the injection system, around the idea of "reducing viscosity loss, improving viscosity stability, and optimizing solutions", we strengthened on-site management, optimized injection solutions and improved injection quality.

By means of pipeline flushing and equipment maintenance, the degradation of mechanical shear is reduced, water quality is adjusted from the source, and block stickiness is reduced. In the process, it is further optimized by adding oxygen aerators and pharmaceutical formulas to reduce bacterial content and increase viscosity retention. At the same time, in order to ensure that the working viscosity in the oil layer meets the standard, the viscosity of the wellhead is dynamically adjusted and adjusted according to the viscosity stability index, so that the retention rate of the underground viscosity reaches the requirements of the plan, and the effect of the system plugging is guaranteed.

3.2. Combining prevention and control and release to improve the utilization
Aiming at the problem that the control injection of Sa Ⅱ1 ~ 4 affects the utilization degree, I continuously summarize the understanding of the law, and dynamically track and evaluate, on the premise of effectively preventing and controlling the casing damage, explore the reasonable injection intensity of the balanced application of the interval, forming Sa Ⅱ1 ~ 4 sets of methods for optimizing the injection strength of damage sensitive sections.

According to statistics, there are 151 Sa Ⅱ sets of 4 damaged wells in water flooding. The damage points are mainly mat-shaped sand, accounting for 80.8%; the damage points of the channel sand casing are layers with poor connectivity and injection strength greater than 6m³ / d • m. the Lord. According to the statistical results, based on the dynamic monitoring indicators of the interval pressure system, through the multi-parameter boundary analysis, the criteria for judging the pressure status are clarified, and the dynamic optimization adjustment of the injection intensity is guided. After the optimization, the injection pressure rose steadily, no new casing damage wells were added, and the casing damage risk was controllable; the difference in utilization between the layers was significantly reduced, and the development effect was gradually improved.

3.3. Combination of adjustments and measures to promote the overall effectiveness of the block
In view of the contradictions such as high injection pressure, small adjustment space, and unreasonable pressure system at the initial stage of betting, based on the idea of "combining adjustment and measures", on the basis of deepening geological understanding, strengthening injection-production balance adjustment, fine measures to tap potential, and promote block effect.

A total of 232 wells were matched and adjusted at both ends of injection and production. The injection-production ratio increased to 1.11, the formation pressure value returned to close to the original pressure value, and the plane pressure difference was significantly reduced. At the same time, aiming at the problems of large differences in utilization, slow results, and imperfect injection and production in the fault area, the adjustment target of "improving utilization, promoting effectiveness, and digging potential" is improved to improve the utilization status, increase injection and production capacity, promote water cut, and tap remaining potential.
3.4. Combining water flooding and polymer flooding to comprehensively prevent interference from two flooding

In response to the problem of two-wheel drive interference, strengthen the cooperative management of water-polymer two-wheel drive, optimize the management mode, support the monitoring system, clarify the analysis method, and optimize the governance measures.

One is to establish a two-drive integrated management operation mode, collaborative design, coordinated operation, and coordinated adjustment to improve operational efficiency and improve prevention and control effects. Comprehensive analysis of the well location relationship and co-firing situation, clarify the interference well identification and plugging standards, and plug all the determined waterflood interference wells before commissioning.

The second is to check the interference wells by means of laboratory monitoring and dynamic analysis, implement three-level linkage monitoring, clarify management responsibilities, optimize the monitoring plan, improve the monitoring method, and ensure the monitoring effect. For the confirmed interference wells, comprehensive consideration shall be given to factors such as injection and production conditions, co-injection thickness, cementing quality, etc., and treatment measures shall be optimized to ensure the best treatment effect.

In view of the development contradictions currently faced by the block, according to the four combined working ideas, various workloads of 3310 wells have been implemented. Through careful management, the block development situation has gradually improved. The injection pressure rose steadily, the injection and production capacity tended to be stable, the comprehensive water cut continued to decline, the ratio of effective wells increased to 91.7%, and the difference in effectiveness among well groups gradually narrowed. The development form gradually improved.
At present, the block is in the stage of water stability, referring to the trend of similar blocks, in order to promote the full effect of the block at an early date, it is necessary to strengthen tracking and management in the following aspects:

One is to optimize the injection intensity and improve the utilization situation; according to the utilization situation of each layer, optimize the injection volume of the small layer to ensure balanced injection between the layers and alleviate vertical contradictions.

The second is to strengthen measures to improve the injection and production capacity; implement measures for wells with large water cuts and low submergence; and implement liquid lifting measures for wells with large production drops and wells with sufficient fluid supply.

The third is to improve the injection-production relationship and promote the effect of measures; for the thin-difference interval between injection-production well groups corresponding to fill holes, improve the injection-production relationship and tap the remaining potential.

The fourth is to control the interference of two drives and improve the development effect; establish a perfect interference investigation system, and analyze and control the interference wells according to the production status of the produced wells and the changes of the water drive well group.

4. Conclusion

(1) In the stage of chemical flooding, qualified injection water quality is the basis of block adjustment. Only by ensuring a reasonable thick viscosity can chemical flooding achieve the desired effect.

(2) For the layers 1-4 in Sa Ⅱ with relatively large geological reserves, the optimized design of injection strength can effectively improve the utilization of the oil layer and improve the development effect.

(3) Injection-production balance and measures optimization are important tracking adjustment methods for anti-salt polymer flooding, and grasping the opportunity can achieve the most ideal measures.

(4) Establish a reasonable two-drive interference well investigation system, which can detect the interfering well layers in time, so as to ensure the development effect of the two drives.
References

[1] Hu Bozhong. Polymer flooding engineering. Beijing: Petroleum Industry Press, (1997).
[2] Kang Wanli. Introduction to tertiary oil recovery. Beijing: Petroleum Industry Press, (2000).
[3] Xu Qinglian. Study on tertiary oil recovery method in heterogeneous reservoirs. Petroleum Geology and Recovery Efficiency, (2003), pp. 56-57.
[4] Wang Qimin, Qi Baofa, Qi Jun, et al. Practice and understanding of tertiary oil recovery technology in Daqing Oilfield. Daqing Petroleum Geology and Development, (2001), pp.1-6.
[5] Yang Zhenyu, Chen Guangyu. Research Status and Development Direction of Composite Flooding Technology at Home and Abroad. Daqing Petroleum Geology and Development, (2004), pp. 94-96.
[6] LU Xiangguo, HU Jianbo, ZHANG Jichang. Technical countermeasures and methods for expanding composite flooding volume and coefficient. Daqing Petroleum Geology and Development, (2010), pp. 139-144.