Pressure system adjustment technology before polymer injection in XX block

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Abstract. There are two problems in the upward-return block: one is the insufficient testing and fracturing pockets; the other is the complex comprehensive adjustment. According to the pocket depth of test and fracturing requirements, combined with plugging cost, casing size of oil and water wells, development status of lower layers and length requirements of plugging intervals, the plugging mode is determined. According to permeability, effective thickness, injection-production perfection, injection pressure and subsidence, the comprehensive adjustment method is determined.

Keywords: Blank Water Flooding, Perforation and Plugging, Comprehensive Adjustment.

1. Introduction
XX oilfield has a large vertical development thickness, and a set of well pattern is used for segmented development. When a section of reservoir is exploited, it is plugged and the upper section is opened at the same time, which is called Upward Return. After years of research and field experiments, the plugging technology is becoming more and more perfect [1-3]. But the cost of different plugging methods varies greatly. In the second type reservoir block of XX development zone, the original well pattern is successively used to carry out the second upper layer reverting. Because of the small interlayer between the new undeveloped strata and the developed strata, there are no enough test and fracturing pockets left in the blocks that have already returned to the upper strata. Therefore, the plugging scheme is redesigned. At present, although polymer flooding technology is relatively mature, there is no clear basis and process for the adjustment of blank water flooding stage [4] [5] [6]. During this period, the relationship between injection and production was changeable and imperfect, which brought great difficulties to comprehensive adjustment. Therefore, a comprehensive adjustment method for blank water flooding stage has been formed to prepare for polymer injection.

Aiming at the above two problems, this article is divided into two parts. The first part is the plugging technology. The second part is comprehensive adjustment.

Field application results show that the optimized plugging technology standard effectively solves the problems of test and fracturing pocket. The fracturing thickness of oil and water wells is increased by 606.7 meters, which maximizes the potential of the measures. Meanwhile, by means of combination of shutdown and control, fine stratification and optimization of injection-production structure, casing pipe damage rate is effectively reduced and production effect is guaranteed. The average daily increase of oil
per well is 2.1 tons, and water cut is reduced by 3.2%. At the same time, suitable injection speed and pressure space are provided for polymer injection.

2. Design of Plugging Technology

According to the pocket depth of testing and fracturing requirements, combined with the casing size of oil wells and water wells, the development status of the next extension layer and the length requirements of the plugging interval, the plugging mode is determined to maximize the potential of measures.

At present, the requirement of injection well test pocket is more than 13.5m, and the fracturing pocket of injection well and production well is more than 10m. Therefore, the design of injection well pocket is greater than or equal to 13.5 m, and the production well pocket is greater than or equal to 10 m.

Mechanical plugging is a kind of plugging method which separates the exploited and untapped reservoirs vertically with drillable packers. Its advantages are: low cost, unlimited length of plugging interval, and shortcomings: need to keep pockets, only suitable for ordinary casing size. Blasthole plugging is a method of sealing perforated holes with special chemical materials. Its advantages are: no need to keep pockets, medium cost; the disadvantages are: the length of the plugging section is required, only suitable for conventional size casing. Cement plugging is a kind of plugging method which uses cement slurry to plug the strata that have been exploited and then drill the cement plug. Its advantages are that it does not need to keep pockets, the length of plugging interval is unlimited, and the casing size is not limited; the disadvantage is high cost. Contrast of different plugging modes: mechanical plugging is preferred, Blasthole plugging is preferred, and cement plugging is preferred when the barrier between untapped and untapped reservoirs can keep enough pockets.

![Fig.1. Standard Flow Chart for Plugging Design](image)

The tubing depth of injection wells is below the target formation, and that of production wells is above the target formation. Therefore, the injection well seal can be plugged by tubing, which becomes simple. The results are shown in Figure 1.
3. Design of Injection-production Related Parameters

According to the construction progress, it can be divided into two stages: centralized operation stage and completion of operation to pre-polymer injection stage.

The first stage: the method of comprehensive adjustment in the stage of centralized operation, which is divided into four aspects. The first aspect is to ensure the perfection of injection and production by zoning and batching, first oil and then water operation. According to the distribution of water cut and oil production, it is divided into four working areas, each working area is constructed first by oil wells and then by water wells, and the zoning is completed in turn to ensure perfect injection and production. The second aspect is fine stratification, accurate score, to ensure the effective use of each layer. With the effective thickness of the interval greater than 0.8m as the standard fine stratification, the layered injection rate reaches 94.6%, of which the proportion of three or more intervals reaches 78.3%. The injection intensity is designed according to permeability and effective thickness. The average injection intensity of the whole region is 5.3m3/d.m. Take Well 1# as an Example. The whole well is divided into four intervals for injection. Because S II 1-4 horizon is shale developed horizon and easy to casing damage, the design strength is less than 4. The effective thickness of S II 2a horizon is 2.7m, multiplied by 4 m3/d.m, is approximately equal to 11 m3. The permeability of S II 5+6a horizon is 0.054 µm2, less than 0.6µm2, the effective thickness is 1.3 m and less than 2.5 m, so the designed injection strength is 6.5 m3/d.m. 1.3m multiplied by 6.5m3/d.m is about 83m. Similarly, other horizons are designed in the same way. After the completion of the design, the injection volume of the whole well is 53 m3 and the injection intensity is 5.4 m3/d.m, which is equivalent to the injection intensity of the whole area. The results are shown in Figure 2. The third aspect is the combination of shut-in and injection control of imperfect well groups to prevent casing damage. If there are 0 connected oil wells open, the water wells close; if there is one connected oil well open, the water wells control injection 30 m3; if there are 2 connected oil wells open, then the water wells control injection 50 m3. Through the implementation of this method, the casing damage rate of plugging and sealing operation is controlled at 6.8%. The fourth aspect is to adjust the injection-production structure and balance the pressure distribution. Oil well design: For the submergence degree of pumps less than 300 m, the parameters of mechanical production are lowered, a total of 87 wells are implemented, and the average well submergence degree is restored to 250m; For the submergence degree of pumps above 600 m, the parameters of mechanical are increased, 46 wells are implemented, and the average well submergence degree is decreased by 230m. Water well design: For wells with pressure space less than 0.5 MPa, 26 wells were implemented with down-regulation of injection rate, the average injection pressure of a single well decreased by 1.1 MPa; For wells with pressure space greater than 5 MPa, 10 wells are implemented by increasing injection rate, and the average injection pressure of a single well rises by 2.1 MPa. In the first stage, the effect of comprehensive adjustment is remarkable: wells with water cut below 94% account for 30.9% of the whole area. In the first stage, the effect of comprehensive adjustment is remarkable: wells with water cut below 94% account for 30.9% of the whole area. There are 42 wells with water cut less than 90%, and the average water cut is only 81.3%.
The second stage: comprehensive adjustment method from completion of construction work to pre-polymer injection. It is divided into three aspects. The first aspect is the adjustment of injection-production structure to meet the injection speed and pressure space required by oil displacement scheme. By adjusting, the pressure space gradually reaches 3-5 MPa and the injection rate reaches 0.16-0.18 pv/a. Specific methods are as follows: for wells with high current pressure, high injection-production ratio and small pressure space, the injection rate should be lowered; for wells with low flow pressure, low injection-production ratio and small pressure space, the injection rate should be lowered after adjusting the production parameters of the down-regulator; the whole area should be adjusted gradually for six months. The second aspect is to reform the non-suction wells in time to ensure the injection capacity. Surfactant plugging removal is carried out for developed reservoirs well and fracturing is carried out for poor developed reservoirs well. The third aspect is to repair casing damaged wells in time and improve the injection-production relationship. A total of 26 injection wells were repaired, increasing daily water injection by 1432 m3; 18 oil wells were repaired, recovering daily fluid production by 843 t and oil production by 41 t.

Comprehensive adjustment effect: At present, the average daily injection volume of single well is 68 m3, injection pressure is 8.4 MPa, pressure space is 3.5 MPa, injection speed is 0.17 pv/a. Compared with that before plugging, the daily increase of oil is 431t, the comprehensive water cut is reduced by 3.2%, and the flow pressure is maintained at a higher level.

4. Conclusion
Field test results show that: Firstly, optimizing the standard of sealing technology effectively solves the problems of testing and fracturing pockets and maximizes the potential of measures. Secondly, the comprehensive adjustment method from filling and plugging process to pre-polymer injection can effectively reduce casing damage rate, ensure production effect, and provide suitable injection speed and pressure space for pre-polymer injection.

(a) Classification Criteria
(b) Practical Example of a Well

**Fig.2.** Classification Criteria for Injection Strength of Subdivision Segments
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