Adjustment method and understanding of water-cut recovery period in polymer injection block

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Abstract: Taking an injection station in polymer injection block (BLOCK A) as an example, this paper proposed a series of measures such as stratification polymer injection and regional overall profile control to improve the development effect and further enhance the final recovery factor of the block in view of the problems of low injection pressure in individual areas, profile in thrust and high comprehensive water cut of produced Wells in the block. It provides some basis and reference for production and development of other polymer injection blocks.

Key words: Polymer injection water recovery stage stratified profile control.

1. Introduction

Petroleum is an important energy source in China, and it is also an indispensable resource in the process of rapid economic development in China. With the improvement of science and technology in China, the technical level of petroleum exploitation is also improved rapidly, which improves the efficiency and quality of petroleum exploitation to a large extent. Water flooding is generally used in oil exploitation in China, and the water content in oil is relatively high, which requires the state to encourage enterprises to carry out technological innovation through policies.

2. Characteristics of high water cut later stage stratified oil recovery technology

2.1 Complexity

In the process of oil exploitation, it is necessary to adopt the method of stratified oil recovery in the late stage of high water cut to improve the oil exploitation efficiency. However, the mining environment is also complicated, which has a great impact on the improvement of exploitation efficiency to a large extent. Therefore, the technology of stratified oil recovery is relatively complicated [1]. With the increase of oil drilling time is not short in our country, oil resource state have bigger difference, some technology cannot meet the actual demand in a large extent, result in the late exploitation in the process of water content are relatively serious, this needs in the process of mining should be fully aware of the complexity of the mining, in order to find out the effective processing method, so that greatly reduce the process of mining, Lay a good foundation for the smooth implementation of oil exploitation.

2.2 High technical

In the process of using stratified oil recovery technology to exploit high water-cut oil, there are high requirements on the exploitation technology. In order to improve the economic benefits, it is necessary to adopt stratified technology, and only in this way can the petroleum engineering better adapt to the future development. However, the location and environmental conditions of different oil fields are quite different, and the performance of mining equipment and the skills of personnel are also quite different, which will affect the efficiency of oil exploitation to a large extent.

2.3 Professional

Oil is an important characteristic is professional, and in the process of mining technical conditions and variables relatively more, this needs at the same time of mining and mining environment for effective combination, in order to make the determination of technical solutions to implement effective comprehensive improve their professional technology level, only in this way can better enhance their professional, So as to maximize the benefit [2]. Therefore, it is necessary to improve its professional ability, make all aspects more perfect and professional, so as to improve its professional level to the maximum extent, ensure the efficiency and quality of petroleum exploitation process, and lay a good foundation for the future development of petroleum engineering.

In block A, a five-point area well pattern is adopted with a distance of 125m between injection and production Wells. There are 102 oil and water Wells in total, including 45 injection Wells and 57 production Wells. The geological reserves of 511 station in the middle block are 346.7396× 104T and pore volume is 567.118×104m3. In December 2005, 250m well spacing blank water flooding was put into the block. In June 2011, well pattern was encrypted, and 125m well spacing was used for blank water flooding. In January 2013, polymer injection began. As of May 2016, 460.3176×10m3 polymer solution, 0.81PV underground pore volume, 5424.46 T dry powder, polymer dosage reached 1416.28mg/L.PV.

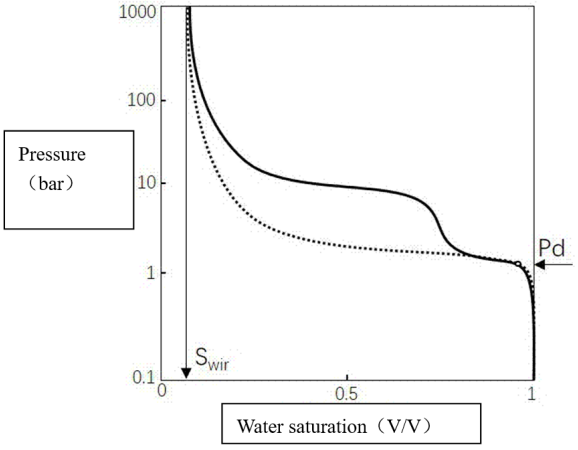

Fig.1 Water saturation

3. There are three major contradictions in block development

3.1 Plane injection pressure is unbalanced

In June 2021, the average injection pressure was 9.0MPa and the pressure space was 2.4MPa. There were 40 Wells with a pressure space greater than 1.0MPa, accounting for 89% of the total number of Wells.

3.2 The longitudinal upper section is unbalanced and protruding seriously

With the extension of polymer injection time, the number of water-absorbing layers and the proportion of water-absorbing sandstone and effective thickness of layers with effective thickness greater than 2m are relatively high, and the proportion of activated thickness is more than 90%, while the proportion of activated thickness of thin and poor layers with effective thickness less than 2m is less than 70%. Visible, the layer with bigger thickness uses thickness scale bigger.

3.3 The distribution of water cut and mining concentration is unbalanced, and the inefficient and ineffective circulation is serious

After 10 months of polymer injection, the comprehensive water cut drops to the lowest point, reaches the peak of effect, and then enters the comprehensive water cut recovery stage. At present, the water cut in the block has recovered 15.9 percentage points, reaching 95.73%. In the plane, there is a large difference in water content between Wells. In June 2014, 23% of the Wells with water content greater than 95% accounted for the total number of Wells, and 29 Wells with concentration greater than 1000mg/L accounted for 51% of the total number of Wells. This phenomenon of high water content and concentration of production and accumulation indicates that there is a certain inefficient and ineffective circulation.

4. The comprehensive adjustment method can be adopted in view of the three major contradictions

4.1 Reduce injection speed and optimize injection concentration

By tracking injection-production changes and response status of well group in time, individualized design and adjustment of injection parameters of single well can slow down the recovery rate of water cut. After adjusting the scheme of liquid extraction and concentration reduction, the liquid volume decreased by 295m3 and the concentration increased by 300mg/L.

4.2 The combination of zonal injection and plugging reduces interzonal contradictions

According to the principle of separate injection, 43 stratified Wells were determined, the separate injection rate reached 96%, and 10 Wells were combined with separate injection and plugging. In the process of stratification test, in order to fully use the potential layer, the injection plan was re-formulated and re-tested according to the injection pressure standard of 0.5MPa lower than the overlying rock pressure for the Wells with pressure space and pressure drop after stratification. The injection pressure of 43 stratified Wells increased by 0.35 MPa before and after the test. After stratification, the ratio of producing layers and thickness of injection Wells increases by 13.6 and 22.7 percentage points, respectively, and the monthly water cut recovery decreases by 0.99 percentage points.

4.3 The production parameters of the produced well are lowered, the production speed is reduced, and the flow pressure is restored

From January to December 2021, a total of 91 Wells were down-regulated. The fluid production of the down-regulated Wells showed a downward trend, with the oil decreasing by 5.5t and the flow pressure increasing, which remained above 3.4mpa for 7 consecutive months.

4.4 Water shutoff is combined with fracturing to reduce inefficient circulation and recover remaining oil

In order to increase the development effect of polymer flooding, 16 Wells were fractured and water plugging measures were taken (fracturing 7 Wells and water plugging 9 Wells). After fracturing, the average daily oil production per well increases by 2.8t and water cut decreases by 0.8%. After water plugging measures, the average daily oil production per well increases by 0.5t and water cut decreases by 0.7%

4.5 Synchronous profile control of oil and water well can alleviate the contradiction between layers and control water cut rise

According to the profile control principle, 23 profile control Wells were determined in February 2015, including 15 injection Wells and 8 produced Wells. Four injection Wells adopted composite ion profile control technology, and 11 injection Wells adopted modified asphalt particle profile control technology. Positive electrogel profile control technology was adopted in 8 produced Wells.

Up to now, the average injection pressure of profile control Wells has increased by 0.3Mpa, and the water cut in 6 months has increased by 0.28%, which effectively controls the water cut rise rate.

5. Analysis of adjustment effect

5.1 The comprehensive water cut is well controlled

Since the layered polymer injection, the water cut rising rate has been well controlled, with the monthly water cut rising rate of 0.87% in the first half of 2014 and 0.28% since the second half of 2014, slowing down by 0.59 percentage points.

5.2 The working thickness of thin layer is improved

Fro enter two years to use a situation to look, thin poor layer's use degree all has the rise of different degree. The number of water-absorbing layers and the proportion of sandstone with effective thickness less than 2 meters increased by 14% and 10% respectively, while the proportion of water-absorbing layers and sandstone with effective thickness less than 1 meter increased by 8% and 6% respectively.

5.3 Recovery efficiency is improved

The recovery factor is 13.8%, up 6.7 percentage points from 2020.

5.4 The pressure in the block tends to balance

Through adjustment, the pressure in the block was rationalized, both in terms of injection and production.

The average injection pressure increased by 0.8Mpa, and the number of Wells with a pressure space greater than 3.0Mpa decreased to 1. The narrowing of the pressure space indicates that the production degree of low permeability reservoirs has improved.

The number of Wells with high and low sinking degrees is decreasing and tends to reasonable sinking degrees. Compared to June 2014, the number of low-sunken Wells decreased from 18 to 12, the number of high-sunken Wells decreased from 17 to 12, and the number of 100-500 m sunk Wells increased from 19 to 30.

6. Cognition and Conclusions:

In the stage of water-cut recovery, there is still a certain amount of remaining oil due to the influence of interlayer, intralayer and plane difference

In the water-cut recovery stage, the liquid production index can be reduced by reducing parameters, plugging water, stratification, profile control and other measures to control the liquid production capacity of high permeability layer and reduce the water-cut recovery rate

During the adjustment process, the pressure change should be stable and balanced to avoid the occurrence of casing damage

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