Water injection performance analysis and fine potential tapping Countermeasures in heterogeneous reservoir

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Abstract: After the heterogeneous reservoir enters the middle and late stages of development, the problems due to water injection will become increasingly prominent. However, the requirements for water injection in reservoir development are also increasing. So how do we solve this big problem? And how to scientifically manage water injection wells, promote oil with water, improve water displacement efficiency, and make the reservoir enter a benign development state? First of all, we need to firmly remember the idea of "water well first, pay equal attention to oil and water", lock the key points of water injection, and comprehensively improve the water injection management level from the aspects of surface, wellbore and underground, so as to consolidate the foundation of stable oil reservoir production.

Keywords: Heterogeneous reservoir; Fine water injection; oil displacement; Profile control effect.

1. Introduction

The structure of heterogeneous oil reservoirs is characterized by complexity and reservoir physical properties. However, there is a huge difference between these two characteristics and fluid properties. The existence of this difference has a huge inhibitory effect on the management level of oilfield development and the improvement of oilfield recovery factor. Due to the traditional thought of "heavy oil and light water", the water injection management level is seriously lagging behind, which further affects the development effect of heterogeneous reservoir. Combined with a series of problems in water injection in heterogeneous reservoir, the author puts forward some methods to improve water injection management level and reservoir water displacement effect.

2. What are the main problems of water injection in heterogeneous reservoirs

2.1 The injection-production well pattern is not perfect for many times.

The distribution of oil layers in heterogeneous oil reservoirs is irregular, so it is impossible to arrange regular injection-production well patterns. Reservoir wells are often unidirectional water injection, and some even do not inject water, and are in the state of waterless development. In addition, when the reservoir development enters the middle and late stage, there are more and more downhole faults, so it has to be shut down. In this way, it will affect the layout of injection production well pattern and make it imperfect again. The remaining oil formed due to the imperfect injection production well pattern accounts for about 15% to 45% of the remaining oil reserves. In fact, no matter which well pattern is used for layout, there will be advantages and disadvantages.

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2.2 Under injected wells are becoming more and more.

The first reason is that under the influence of the traditional idea of "heavy water and light oil", there is no large capital invested in the maintenance of water wells, which makes the arrears of maintenance work gradually increase, so that the regular maintenance of water wells has to be reduced. . In addition, the maintenance personnel did not pay attention, and the sloppy work led to the worsening of the well condition, which eventually led to the problem of under-injection. Another reason is that when the reservoir development enters the middle and late stage, the medium and high permeability layer as the main layer enters the state of high water cut, and the low permeability layer replaces the main layer [1]. However, the water absorption capacity of low-permeability reservoir itself is very low, close to zero. Moreover, low-permeability reservoir is easy to cause reservoir blockage and under injection. Another reason is that due to continuous water injection, loose cementation of oil layer, easy sand production and sand burial of oil layer, etc., it is also likely to cause under injection.

2.3 The "three rates" of water injection wells need to be improved.

Today's water well distribution is mostly the use of hollow water distribution string and eccentric water distribution string, usually two to three layers. However, such a water distribution string cannot meet the requirement of subdivision water injection in the reservoir. The packer is the most important downhole tool in separate injection wells. However, it is also the most vulnerable to damage and failure. There are many reasons for its damage, such as excessive well flushing displacement, repeated shutdown of water wells due to ground reasons, etc. these reasons will lead to damage to the rubber of the packer. Some of them may also be due to the quality problems of the isolator itself, which shortens the effective period of packing and damages in less than one year, thus making the water injection unsuccessful. Comparatively speaking, separate injection wells have higher requirements on water quality. Because the water quality is generally poor, the downhole string is prone to corrosion and scaling, which is not conducive to relevant testing by testing instruments. Even if testing can be done, the results are inaccurate [2]. To sum up, the distribution rate of the injection wells, the qualified rate of layered water injection, and the test rate of the injection wells are all relatively low.

3. Effective methods for water injection management

3.1 Increase effective water injection well points. This can be achieved through the strengthening of betting efforts.

By perfecting the injection-production well pattern and continuously optimizing measures, water injection into heterogeneous oil reservoirs, which used to be effective for unidirectional water injection, will now become effective for multi-directional water injection. For those with imperfect secondary injection production well pattern, water well overhaul, supporting changguan to injection and other methods can be used to improve, so that the reservoir can be developed reasonably. Of course, it is also necessary to understand that the reasons for the imperfection of secondary injection-production well pattern are the overhaul of water wells, casing damage, etc. Only when the root cause of the problem is found out can we improve it better.

3.2 Effective management of under-injected wells.

Under-injection of water wells can easily reduce the development effect of reservoirs. Therefore, to control the problem of under-injection of water wells, we should first start from the reasons for under-injection, and target the under-injection to increase injection to ensure that the reservoir can be injected with enough water. The treatment of under injected wells also needs to be combined with defense to ensure the effectiveness and long-term effectiveness of treatment through reservoir development surface integration and management of water quality and water injection pressure [3]. Establish a relevant early warning system and do a good job in relevant early warning work. We should pay more attention to the variation of water injection pressure and water quantity in water injection wells. When the above two changes greatly, it is necessary to take immediate action, and it is best to fundamentally reduce under-injection wells.

3.3 Reconcile the contradictions between planes and layers.

Under the premise of the existing injection-production well pattern, the injection-production adjustment method is no longer a single plane perfection, it has gradually become a method of subdivision and reorganization. Water well injection plays a key role in exploiting the potential of poor oil layers, controlling water and stabilizing oil, and developing reservoirs with water injection. Firstly, according to the reservoir characteristics, do a good job of separate injection, so as to improve the separate injection rate of water wells; Secondly, improve the scheme according to the surface wellbore technology, focus on solving the problems such as isolator, and strive to prolong the effective time unit of isolator; furthermore, the stratified test of separate injection wells also needs to be done well. Before and after the test, the well should be washed with large displacement. Then, the data acquisition of separate injection wells needs to be greatly enhanced, especially for wellhead casing pressure data, this can timely find and deal with problems, integrate a series of changes in oil well performance, timely allocate water wells and improve the water injection effect of distribution wells. The last thing to do is to strengthen the maintenance work such as daily well cleaning, pipe replacement and seal replacement, and strive to control the well flushing displacement within 30 cubic meters per hour.

3.4 Enhancement of dynamic cycle allocation of wells.

When the water injection pressure increases continuously, the fluid in fractures and high permeability zones will be driven to production wells. In addition, the imbibition pressure of the low permeability zone will also be increased. When the pressure in the high permeability zone is lower than that in the low permeability zone, part of the fluid in the low permeability zone will flow to the production well through the high permeability zone and fractures, which mainly occurs during the injection stop stage. In practical applications, the increase in the number of interim injections will lead to a decrease in the interim injection effect. The main factors causing this result are: First, the increase in the number of interim injections will reduce the amount of remaining oil between the high and low permeability zones. The difference in oil saturation is one of the key conditions for cyclical water injection to enhance oil recovery. After multiple cycles, the water saturation difference between permeable layers decreases gradually, and the water injection effect will also decrease. Second, for some well areas with high recovery degree and comprehensive water cut, because of their high reservoir water saturation, the reservoir may have spontaneously formed a dominant permeability channel, so that the water injection pressure remains basically unchanged, and the low-permeability reservoir cannot be used [4]. Therefore, on the premise that the driving force does not change, the residual oil in the replaceable range is continuously reduced, which leads to the continuous reduction of the effect of the indirect injection. The performance in dynamic development is: the water cut of the injection well group decreases rapidly and obviously in the initial period, and the oil production keeps rising, and the effectiveness of the medium and high water cut wells is also very clear. However, due to the increasing number of inter-injection times, both liquid and oil production will decrease sharply, and the effect of inter-injection will also decrease. For example, after long-term electric pump well mining, the water content of No. 1 well group can reach 98% or more. After a long period of water injection in No. 2 well, the corresponding No. The water content of the oil well No. 2 will also decrease in a short period of time, and after several cycles, it is basically the same as the production capacity before the inter-injection.

3.5 Profile control of wells.

In the late stage of ultra-high water cut development, the contradiction between injection and production becomes more and more obvious. In this way, the contradiction can be resolved through comprehensive methods such as profile control.The principle of this method is to reduce the permeability in the high permeability area, increase the injected water wave and volume, and enhance the imbibition between the fluid and the low permeability area through profile control, so as to replace the unswept reserves. This method mainly has two working principles: first, it reduces the permeability of high permeability areas and increases the water absorption of some low permeability areas; Secondly, it can expand the scope of imbibition and replace the remaining oil by periodic water injection, thus improving the utilization of reserves [5].

4. Conclusions

The dynamic analysis of water injection in heterogeneous oil reservoirs is a systematic project, which needs to be carried out seriously. Of course, in order to enhance oil recovery, in addition to reasonable water injection, what needs to be done is to excavate the remaining oil. The formation of remaining oil is mainly related to the corresponding relationship between injection and production, large pore channel, cumulative injection multiple and so on. When excavating the remaining oil, it must be carried out under the guidance of its distribution law, and effective measures should be taken to expand the swept volume of water flooding and improve the utilization degree of reserves. Only in this way can the recovery efficiency be finally improved.

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