Adjustment and tapping technology of water drive reservoir in late high water cut period

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Abstract: The implementation of oilfield development technology is closely related to geological conditions. Scientific and reasonable exploitation strategy is of great significance to improve oilfield economic benefits and technical utilization rate. At present, the development of oilfield is in the middle and late stage, and there are still many problems in technology, which need to be adjusted and innovated urgently. According to the geological conditions of oil fields and the current intensive exploitation technology, it is pointed out that in the late development of high water cut, it is an important method to improve the economic benefits of oil fields by using the potential tapping technology. In ORDER TO REALIZE THE TRANSFORMATION OF oil and gas exploration technology, THE key LIES in increasing research and development, accelerating technology innovation and application, and pushing oil field development into a new development track.

Key words: High water cut; Late water flooding oil; Adjust the latent technology

1. Introduction

With the increase of the number of Wells and the improvement of the extraction depth, the distribution of remaining oil is highly dispersed, and the potential benefit of each measure decreases year by year. The imbalance between storage and production is quite prominent, and the substitution ability of resources is poor. With the development of high water cut oilfield in late stage, the production decreases and the pressure of water cut increases gradually. The contradiction of large formation pressure difference is becoming more and more prominent, the structural adjustment is difficult, and the geological conditions involved in the development and analysis are becoming more and more complex, so the fine geological survey results and manual analysis can no longer meet the requirements. In this context, the oilfield put forward multidisciplinary integrated research, leading the field at home and abroad. Through research to guide practice, practice to transform knowledge, multidisciplinary research results reproduce history, quantify the distribution of remaining oil, and optimize the water drive adjustment program.

2. Study on geological characteristics of continental sandstone oil fields

First, continental sandstone oil fields are distributed in a wide range, mainly in fluvial sedimentary areas, delta areas and coastal areas. Based on known oil reserves, it is large, estimated to be several billion tons or more.

Secondly, the formation fluidity of continental sandstone reservoir is poor, the thickness of oil layer is larger, the number of sandstone layers in the reservoir is more, and its density characteristics are different. The oil in the reservoir is of great quality difference, but the overall viscosity is high, and its freezing point is low, the proportion is high, so it has great development value.

Thirdly, due to the low activity of the boundary water in the continental sandstone oil area, coupled with the lack of natural energy, the saturation pressure of the formation is low, which leads to the formation of the stingy cap.

Due to the improvement of oilfield development degree, the influence of regional environment, climate and other factors, its geological conditions have changed, and the sediment in the stratum has also changed, therefore, the analysis of the stratum of the oilfield, the adjustment of its technical program has a very important role.

3. Problems faced in the late stage of high water cut in waterflooding oilfield

Based on the analysis of the geological characteristics of the oil field and the actual production status of the oil field, it is proposed that the development of the oil field should be carried out in stages and layers, and the technical adjustment and improvement should be carried out in each stage. In the early stage of development, most of the basic well pattern is used, with large spacing between Wells and thick layers. With the development of oil field in the late stage, the water cut continues to increase, the water injection technology has been strengthened, and the

simple enhanced water injection technology in the development of oil field also encountered many problems. First, as the water injection oilfields at later stage of high water cut, water cut sharply increases, the demand for water also will increase, therefore, the water injection and waterflooding are increasing year by year trend, this phenomenon in many Wells in daqing oil field are reflected, while take the corresponding measures to curb, but with the deepening of the development, the problem also intensified [1].

Second, the continuous injection caused great damage to the equipment. In the stage of high water cut, high pressure water injection and complicated non-underground operation are required, resulting in a large number of casing damage. In the long-term high pressure and frequent use of oil well casing, casing damage is increasing, and many casing are nearly to the limit.

Third, oil fields are becoming more expensive to develop. The first is the loss of equipment, which must be continuously maintained and replaced, increasing the demand for funds; Secondly, in the late development of high water cut, not only the water injection pipeline but also the oil transmission pipeline should be adjusted. Therefore, it is necessary to carry out a lot of surface engineering transformation and introduce the corresponding equipment. Thirdly, since the operation cost of oil field is closely related to water content, the effective control of water content must be established when the cost control is carried out. With the increasing energy consumption of oil extraction, through the investigation of oil fields across the country, it is found that the energy consumption per ton of oil is increasing, and the energy consumption is also increasing.

4. Development technology adjustment strategy in high water cut late stage of waterflooding oilfield

This article aims at our country's oil field entering the late exploitation demand and the existing problem, proposes two countermeasures to the perfection of the development technology system of current oil field high water cut.

4.1 Technical application of periodic water injection

In this paper, in the study of the late development technology of high water cut in foreign countries, a kind of technology, namely circulating water injection technology, is proposed, which can effectively improve the displacement effect and enhance the recovery efficiency. To adjust the reservoir fluid condition by periodic water injection is to inject water into the oil field according to the change of water content of oil Wells, so as to achieve the purpose of improving the recovery efficiency. Circulating water injection technology is the most effective method in the development of high water cut oil Wells, but it still needs further exploration and improvement. In addition, in the late development of high water cut, modern technological means should be reasonably used to improve the development process, such as gel and fracturing, so as to establish a supporting technical system suitable for the development of this region.

4.2 Adjustment of management mode focusing on single well management

In the early stage of oilfield development, we pay attention to the overall effect, so the technical scheme is based on blocks. This management way has a very good effect in the early stage. However, due to the scattered distribution of remaining oil in high water-cut oil Wells, and the remaining oil is mostly concentrated between Wells, it is necessary to pay more attention to the remaining oil reservoirs in the later development of high water-cut oil fields, and the well spacing will also change greatly, so it is necessary to focus on a single well. On the premise of improving the development effect of a single well, the technical scheme of a single well and well group should be adjusted to optimize the streamline of a single well and improve the recovery efficiency of a single well so as to improve the economic benefits of the whole block [2].

4.3 Research on technical limits of subdivided water injection

In order to effectively control high water-content invalid water injection, increasing the effective degree of water flooding, increasing the oilfield development, this paper segment segmentation boundary are studied, water injection and discusses the layer between the small number, thickness and interlayer inhomogeneity and development status, the connection between found in high water cut development stage, the permeability grade difference, the effect of Duan Youxiao thickness is reduced. Four indexes, including the number of oil layers, the coefficient of variation between layers and the thickness of sandstone, have significant influence on the utilization of oil and gas. Through analysis, the reasonable stratification parameters and various parameters within stratification are determined, which can be applied to different strata and blocks.

(1) In the longitudinal direction, reservoir injection conditions have the greatest influence on reservoir production. In THE WATER-INJECTION LAYER, THE LOWER THE NUMBER OF SHEETS IS, THE HIGHER THE USE DEGREE IS, AND THE FINER THE THEORY IS, BUT DUE TO THE LIMITATION OF THE WATER-INJECTION TECHNOLOGY, THE MORE REASONABLE NUMBER OF SHEETS CAN BE OBTAINED BY STATISTICS AND ANALYSIS. The linear regression method is used to study the relationship between water absorption of single sand body and single sandstone.

(2) On the plane, injection-production relationship is an important factor affecting reservoir production, and the role of reservoir can be fully played by increasing the number of interconnected Wells between Wells. In the design of the water-injection well area division scheme, the number of single reservoir, thickness of single reservoir and characteristics of reservoir should be optimized longitudinally, and the development of upper

reservoir, sand body contact relationship, water flooding control degree, and injection-production relationship of well group should be fully considered to determine the reservoir characteristics and water injection intensity reasonably.

4.4 Water drive adjustment in the late stage of high water cut

4.4.1 Develop block adjustment potential

According to the quantitative analysis and numerical simulation of remaining oil, the vertical stratification standard of each layer is determined. According to the relationship between the overall production of single layer and the comprehensive water content, each layer is divided into strengthening layer, control layer and equilibrium layer, and the existing water content and the degree of exploitation are taken as the reference. In the plane, according to the use of the situation is divided into strengthening parts, control parts and balance parts, and determine to meet the conditions. According to the clear injection and production conditions of the oilfield, combined with the relationship between water cut and formation pressure, numerical simulation method is adopted to formulate the regulation principle of water flooding in the late stage of high water cut, that is, according to the requirements of "three extraction, three control and one stability", the corresponding adjustment of oil and water Wells is carried out [3].

4.4.2 Developing individual well adjustment potential

(1) Reasonable determination of the range of water injection regulation. In order to protect the casing, the limits of water injection regulation can be reasonably determined by statistical analysis based on the measured data. According to the limit that the annual variation range of rock pressure is 0.5 MPa, water injection is adjusted for different types of sand bodies. The water extraction capacity of the outer edge facies sand body is not more than 20%, while that of the inner edge facies and distributive plain facies is not more than 30%, and the control water volume is 15% and 25%, respectively. (2) Reasonably determine the lower limit of flow pressure. In order to avoid the degassing of reservoir, the minimum allowable flow pressure under different water cut and different pressure is given based on the flow man dynamic equation of oil well. (3) Reasonable determination of the scope of adjustment measures. The numerical simulation method is used to find out the indicators of formation selection, such as fracturing, acidification and water plugging, when the output rate of each measure well exceeds 2. According to the above criteria, combined with the single well dynamic, static data and measured data, the single well was adjusted.

4.4.3 Optimize the adjustment scheme and improve the development benefit

After the implementation of the potential, the production decline and water cut increase were strictly controlled from the adjustment of injection-production system and injection-production structure. In order to complement the difference between the measured conventional capacity and the preset index, the scheme is optimized.
(1) Optimization of injection and production system. Its main objective is to optimize the injection and production relationship of a single sand body, reorganize the well pattern under the existing well pattern conditions, and use the numerical simulation method to select the scheme with the best, maximum exploitation degree, the lowest water cut and the highest input-output ratio [4]. (2) Optimization of injection and production structure. The adjustment and economic effect of different schemes are analyzed, and the best economic effect is obtained, which is optimized and optimized.

5. Evaluation method

In the late stage of high water cut, due to the influence of many factors and the complex relationship between them, the effect of each factor can not be accurately judged, and the overall effect can not be expressed by a single factor. On the basis of "fuzziness", the fuzzy comprehensive evaluation method is used to evaluate it.
(1) Mine statistical analysis. According to the recent statistics of oilfield, at present, many reservoirs in the eastern area of our country have entered the high water cut later period, and at present, the natural decline rate of composite fault block reservoir is about 11.7%. Based on the above data and the current industry norms, the criteria for the natural decline rate of the integrated reservoir and fault block reservoir in the late stage of high water cut are obtained (see Table 1).

Table 1 Evaluation criteria of natural decline rate in the late stage of high water cut

Reservoir types	Natural decline rate %		
	Excellent	Good	bad
ready	≤10	10~20	>20
block	≤15	15~25	>25

(2) Establish the index. If m indices are selected for evaluation, then these indices can be constructed as a set of indices. F={F1， F2, Fm}.
(3) Establish evaluation set. The evaluation set represents the final evaluation of several levels, such as A={A1,A,... Ak}, indicating that there are k evaluation levels [5]. If the rating is good, medium, or poor, k=3. The three levels were standardized, among which the positive score was 1, the bad score was 0, and the medium score was 0-1.
(4) Establish the weight set. There are many ways to determine the weight set, such as statistical method, analytic hierarchy process and so on. The AHP method is used to stratify the problem, establish a stratified model, and gradually distribute the weight from top to bottom. The weighted assignment vector for this set of factors is W = {W1, W2... Wm).
(5) Establish fuzzy matrix. Due to the numerous influencing factors, a single evaluation index can only reflect the local effect but not completely represent the

overall situation. If there are n evaluation indexes, whose index set is F and evaluation set is A, then the evaluation matrix P=(rij) mxn, then (F, A, P) is the judgment space. If there are 12 evaluation indicators, then n=12.

6. Effect evaluation

(1) The water injection structure is improved. The WELL pattern DEVELOPED IN THE early STAGE HAS good utilization conditions, high water content and good water injection effect, which can be reduced by 7.83 percentage points. In ADDITION TO THE WELL PATTERN AFFECTED BY DRILLING PIPELINE, THE WELL PATTERN IMPLEMENTED IN RECENT YEARS CAN ALSO INCREASE THE WATER INJECTION BY 7.83 PERCENTAGE POINTS, SO THAT THE UTILIZATION RATE OF RESERVOIRS IS IMPROVED AND THE development BENEFIT IS OBVIOUSLY improved. In the pumping profile of the injection well, it is found that the stratum utilization thickness increases by 0.88 percentage points, the proportion of water-absorbing sand body increases by 0.88 percentage points, and the outer layer and inner layer increase the most [6]. (2) The liquid production structure was adjusted. According TO THE METHODS OF profile CONTROL, subDIVISION, periodic water INJECTION, WATER SHUtoff and fluid drawDOWN, THE CONTROL of profile control, SUBdivision, periodic water injection, WATER SHUtoff and fluid DRAWdown were carried out for more than 92% WATER-bearing reservoirs. For Wells with low water cut, fluid production can be increased by increasing water injection and taking measures to increase production, so as to effectively adjust fluid production.

7. Conclusion:

In the stage of high water cut, strengthening multidisciplinary research and promotion can provide reliable technical support for water injection regulation. The results can quantitatively evaluate the occurrence state of remaining oil in the late stage of high water cut, so as to determine the idea of water flooding control. It is a prerequisite for the optimal measure scheme to study the adjustment boundary suitable for water flooding measures in the late stage of high water cut. Multidisciplinary numerical simulation technology is an effective method to optimize water flooding adjustment scheme and improve mining efficiency.

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