Influencing factors and measures of water drive oilfield development effect

Hang Gao

Institute of Geology, No. 2 Oil Production Plant, Daqing Oilfield Co., LTD., Daqing, Heilongjiang 163000, China

Abstract: Oil field is a very important non-renewable resource in China, which plays a very important role in economic strategy. In the process of oil field development, water flooding technology can effectively improve the production quality, provide a strong technical support for our oil field exploitation, and help to promote the sustainable development of oil field enterprises. However, there are many influencing factors in the exploitation process of water flooding oilfield, so the workers need to deeply explore the root cause of the problem from different angles and all aspects, and take scientific and reasonable countermeasures to improve the exploitation effect of water flooding oilfield. This paper mainly introduces the factors affecting the development effect of water flooding oilfield and puts forward the corresponding solutions. At the same time, combined with practical cases, the measures to improve the development effect of water flooding oilfield are analyzed in detail.

Key words: Water drive oil field; Development effect.

1. Introduction

With the rapid development of petrochemical industry, the demand for oilfield development is also gradually increasing, which leads to the increasing pressure of oilfield development. For oilfield enterprises, how to improve the exploitation efficiency of oilfield has become one of the urgent problems to be solved. In order TO improve the quality and efficiency of oil field exploitation, oil field enterprises should set up a professional exploitation team, scientifically evaluate the results of water flooding oil field exploitation, try to find out every influencing factor and take solutions, so as to create more economic benefits for oil field enterprises.

2. Factors affecting the development effect of water drive oilfield

2.1 Liquid withdrawal rate

The quality of oilfield development is closely related to the rate of fluid production. In general, the faster the rate of fluid production, the higher the quality of the oilfield. But in the process of collecting liquid, sometimes it will be affected by the water cut stage. For example, in the stage of low water cut, the influence on the liquid collection speed is relatively small; However, if the water cut period enters the middle and high stage, the collection speed of liquid will be seriously affected [1]. Moreover, when the water-cut period enters the ultra-high stage, the liquid collection speed will gradually decrease on the basis of the liquid collection speed in the middle and high stage.

2.2 Permeability

When the rate of water cut rise is slowing down or remains constant, if the permeability increases, the development effect will be enhanced. It can be seen that if the development effect of water drive oilfield is not very ideal, it may also be caused by permeability. The staff should make an accurate judgment based on the actual situation.

2.3 Dip

The formation dip Angle has a great influence on the rise of water content. Generally, the smaller the dip Angle is, the lower the obstruction of water content will be, leading to an increase in the rise rate, and it is difficult to improve the rate of oilfield development. According to the research analysis, when the dip Angle of the local layer is around 1.8° to 4.8°, it is better to ensure that the oil can be more effective in the ultra-high water stage.

2.4 Heterogeneity

China's land area is broad and terrain conditions are very different, so the geological conditions and terrain conditions in the oil area are very different, even the geological conditions are the same, sometimes the oil quantity inconsistency will occur. At this time, for the area with serious heterogeneity problem, if the

permeability is not very strong, it will easily cause a lot of bad influence on the development effect of water drive oilfield.

3. Specific measures to solve the factors affecting the development effect of water drive oilfield

3.1 Improve the well pattern

Well pattern is one of the most important links in the development process of water flooding oil fields, which can better ensure the effectiveness of well pattern distribution and strive for more economic benefits for oil field development while ensuring the production efficiency [2]. Therefore, when using water flooding technology for oilfield development, workers should attach great importance to the perfection of well pattern. First of all, it is necessary to ensure that oil reservoirs of similar nature are combined in the same production layer as far as possible in the process of oilfield development, so as to ensure that the same results can be obtained after using water injection method. Secondly, it is necessary to ensure the stability of oil field production speed. At this time, it is necessary to ensure that each independent reservoir has the minimum reserves. By constantly improving the rationality of well pattern distribution, the exploitation area of the oil field is improved, so as to better guarantee the production quality of water flooding oil field. Finally, the staff should strengthen the statistical analysis of the original well pattern, encrypt the development of oil and water Wells whose economic benefits are not very obvious, improve the speed, and extend the service life of old oil Wells.

3.2 The old well is sidetracked

For the area with relatively high structure, it is very likely that the retention problem will occur. If effective methods are not taken in time to dredge, the later oilfield development work will not be smooth. At this time, the staff can sidetrack the old well, which can not only reduce the cost input, but also make reasonable use of resources. Sidetracking of old Wells is often used to reduce the impact of obsolete Wells on normal Wells. In particular, casing damage Wells and fallen Wells, which are difficult to be reused after repair, can be used as the main body of sidetracking, which can improve the production efficiency, enable them to be recycled, scientifically control oil reserves, and provide better service for people.

3.3 Using water flooding method to drive water washing mining

The recovery factor formula of the reservoir produced by water flooding method is ER=ESEd, where ER is the recovery factor, ES is the sweep coefficient, and Ed is the oil displacement efficiency. It can be seen from the formula that the sweep coefficient and oil displacement efficiency are one of the two important factors affecting the water flooding recovery efficiency. The workers can improve the recovery efficiency through various measures. However, the recovery factor is not an immediate parameter. The recovery factor can only be determined after the reservoir has been developed, so the displacement process must be considered. At this time, R0=ESEfEd, where R0 refers to the degree of recovery and Ef is the degree of washing. According to the formula, the degree of water washing is 0 when the reservoir is put into production, and the degree of water washing also increases with the deepening of the waterflood development process. When all the movable oil in the formation is driven out, the degree of water washing reaches 100%. $E_f = \frac{S_w - S_{wc}}{1 - S_{wc} - S_{or}}$, According to the formula, the degree of water washing is 0 when the reservoir is put into production, and the degree of water washing also increases with the deepening of the waterflood development process. When all the movable oil in the formation is driven out, the degree of water washing reaches 100%. According to R0 formula, it can be judged that there are three main methods to improve the degree of oilfield recovery, which are expanding sweep, deepening water washing and improving oil displacement efficiency. In this case, the water drive reservoir can be divided into three areas, namely, unwashed, weak washed and strong washed, as shown in FIG. 1, where the outermost red part is unwashed, the middle pink part is weak washed, and the innermost side is strong washed.

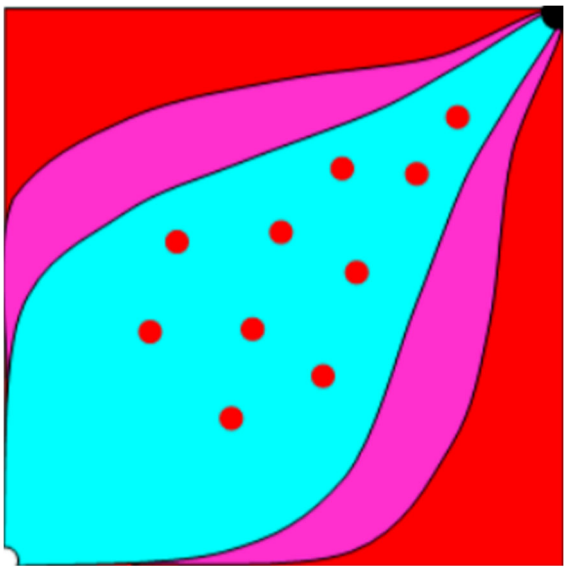

Fig. 1 Washing degree distribution diagram

The unwashed area refers to the area that has not been affected. The way to develop the remaining oil in this area is to expand the sweep and improve the sweep coefficient Es. In weak washing area, the water flooding time is relatively short, the degree of washing is also very low, and the remaining movable oil is more. The method of deepening washing can be used to develop the remaining oil and improve the degree of washing Ef. The water flooding time in the strong water washing area is long, the degree of water washing is high, and the amount of remaining oil is small, which is basically discrete oil. In this case, the recovery effect can be improved by

improving the water flooding efficiency, that is, improving the Ed. Waterflood development of oil fields is mainly to increase the sweep, so as to improve the recovery factor.

3.4 Strengthen the operation effect of liquid extraction

To strengthen liquid extraction operation, the electric pump is mainly used to regulate the reasonable control of the production pressure, so as to reduce the decline rate of the oilfield and improve the oilfield production efficiency. When using this method, attention should be paid to selecting a flat place as the liquid extraction site and selecting an electric pump with appropriate power [3]. In addition, water with different temperatures can be used to complete water flooding. As shown in Table 1, water with different temperatures can affect the original oil saturation and oil displacement efficiency, which can be selected according to the actual situation.

Table 1 Effects of different displacement modes

Displacement way	Original oil saturation (%)	Residual oil saturation (%)	Oil displacement efficiency (%)	The final displacement (PV)
55℃Water drive	63.9	28.3	55.7	6.427
120℃Water drive	61.8	24.1	61.1	5.475
200℃Water drive	55.8	19.2	65.6	4.441
270℃Water drive	54.1	16.4	69.7	3.481

3.5 Reinforced cement to block

Due to the large difference of geological environment and not very uniform, it is easy to encounter collapse and damage in the process of oilfield exploitation, which will inevitably increase the difficulty of exploitation and even lead to safety accidents. At this time, the staff can pass the refined level of cement blocking method, so as to avoid the waste of oil, damage to resources, reduce the quality and efficiency of oil production. There are three main ways of cement sealing, the first is the use of expansion agent, the ring welding in the horn position, and then filled with expansion agent, and quickly add water, so as to play a blocking role. However, this method has high cost and will increase the economic burden of oilfield enterprises. The second is to drill holes in the cement cake surface, with drilling tools to squeeze it, until the surface of the mud, the quality of the way is very good, the disadvantage is in the process of sealing need to use a large amount of cement as a basis, increase the strength of work. The third is to bridge in the table set, the staff in the table set under the ring, and then perfusion small stones, so that it forms a new cement cake surface, the cost is low, and the operation steps are simple, but also more commonly used.

4. Actual case analysis

4.1 Geological situation

The fault block of an oilfield tends to the northwest. The western part is relatively open and the structure is very gentle with a dip Angle of 1.8°, while the eastern part is steep with a dip Angle of 4.8°. The main oil bearing zone of the oilfield is Sha3 to Sha2 member, with an area of 3.71 square kilometers and oil reserves of 1,808 *104 tons. The Wells range from -1765 m to -2120 m and can be divided into eight groups with an average thickness of 40 m.

4.2 Analysis of influencing factors of water flooding oil field

In this oilfield, there are four factors that affect the production effect. The first one is the influence of formation dip Angle. As shown in Figure 2, the smaller the formation dip is, the faster the water cut rises, the lower the recovery degree and the worse the recovery effect.

The second factor is the rate at which water is extracted. The faster the rate at which water is extracted, the faster the rise in water will be in a reservoir with a certain inclination Angle. However, for different water cut stages, the impact intensity also has certain differences. The impact is small in the period of low water cut, increases in the period of medium and high water cut, and decreases in the period of extra high water cut.

The third is the influence of permeability. Based on the actual situation of this oilfield, it can be concluded that the higher the permeability is, the higher the degree of recovery will be, the slower the rising rate of water cut will be, and the better the development effect will be [4].

The fourth is the influence of heterogeneity. This oilfield is seriously affected by heterogeneity, and the permeability of the same sandstone group can be tens of times different. Different sedimentary rhythm has a great influence on the effect of water flooding development. However, with the growth of time, the water flooding effect of medium permeability is the worst, while the water flooding effect of small permeability is very ordinary.

4.3 The measures

According to the analysis of reservoir distribution law in this oilfield, it is found that the remaining oil is mainly concentrated in the place with relatively stable structure, and there is a small amount of water-bearing remaining oil in the area without well control. In addition, there are no production Wells in the low level area of the western structure because of the shielding effect of cutting water injection.

The first point is to improve the well pattern. In the non-well control area in the west, a total of 5 Wells have been developed. The oil reservoirs are 37 meters deep in 12 layers, and the oil and water reservoirs are 76.5 meters deep in 23 layers. A total of 24,168 tons of oil was added.

The second point is that lateralization of old Wells can be used to restore reserve control by lateralization of

abandoned Wells in the stagnant flow area with high structure. For example, No. 61-58 well was scrapped previously due to casing changes and downhole falls. At this time, by using sidetracking, the workers encountered four oil layers with a total of 17.8 meters and seven low-flooded layers with a total of 32.1 meters. At the initial stage of production, 67 tons of oil could be pumped every day with a water content of 34%, resulting in a total oil increase of 16,384 tons.

The third point is to strengthen the liquid extraction. In the area with relatively gentle oilfield structure, the workers use the electric pump to extract liquid and reduce the pressure of the oil field to expand the sweep volume of water flooding. The initial oil production increased from 967 tons to 3,364 tons, with a cumulative increase of 17,462 tons, which effectively controlled the decline of the oilfield.

The fourth point is cement sealing. For the problem of water pipe channeling out of the fault block caused by the large number of oil bearing layers in the longitudinal direction and the low degree of low permeability thin layer, the workers can use ultra-fine cement to seal the borehole and then adopt heavy shooting measures [5]. A total of eight Wells were plugged in the field, with an initial oil gain of 56 tons per day for a cumulative oil gain of 7,452 tons.

4.4 Effect Analysis

In this oilfield, through the judgment and treatment of the factors affecting oilfield production, the daily oil production increased from 256 tons to 323 tons, the cumulative oil increase was 65,466 tons, the new geological reserves were 30*104 tons, the recoverable reserves were 47.3*104 tons, and the recovery rate increased from 49% to 52%.

5. Conclusion

The oil field is a very important resource for our country, in the oil field development process, water flooding is the very common and very effective way. The rational use of water flooding method can improve the oil exploitation efficiency and create more economic profits for the enterprise. However, in the use of water flooding technology, there are some factors that will affect the quality and efficiency of water flooding production fields. It is necessary for staff to conduct reasonable research and analysis on each factor and formulate corresponding measures to improve the production quality. According to the actual situation of the oilfield, the staff should make a comprehensive analysis and evaluation, put forward scientific solutions, and make more contributions to the steady development of the oilfield enterprises.

References

1. SUI Xin. Factors influencing development effect of water flooding oilfield and countermeasures [J]. Chemical Engineering and Equipment, 2021(04):80+70.
2. ZHAO Chongzhi, Tang Hai, Li Minglin, Yang Zhibin, Yi Fan. Analysis of influencing factors and treatment countermeasures of water flooding development effect in Block X [J]. Shandong Industrial Technology, 2019 (02) : 98-99:.
3. HUANG Rui. Principle and application condition analysis of periodic water injection to improve water flooding effect [J]. Yunnan Chemical Industry, 2019, 46(01):48-49.
4. Zhao Jun, Weng Dali, Chen Ping, et al. Laboratory experimental study on periodic water injection of heterogeneous reservoir in high water cut stage [J]. Applied Science and Technology, 2019, 46(06):92-95.
5. WANG Zenglin. Research and practice of stratified water injection technology in Shengli Oilfield [J]. Petroleum Geology and Recovery Efficiency, 2018, 25(06): 5-10.