Study on Reasonable Secondary Infilling Method of Well Pattern in Low Permeability Reservoir Based on Computer

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Abstract. With the details of low permeability reservoir exposed, the overall development effect of the oilfield will continue to deteriorate. Scholars have been looking for a solution to this problem. With the passage of time, it has been found that the secondary infilling of well pattern can improve the development effect of oil field. In this paper, through the analysis of the practical behavior of well pattern infilling and the use of computer numerical simulation, the infilling form of well pattern in low permeability reservoir is studied. This paper also puts forward a reasonable densification form of reservoir well pattern.

Keywords: Computer, Reservoir, Well pattern, Densification form

1. Introduction

The problems involved in low permeability reservoir are complex. In recent years, the problems of many oilfields in China have gradually exposed. These problems include: the increase of fracture pressure, the increase of injection production ratio, the rapid increase of water cut and the increase of low efficiency wells. These problems lead to the poor development effect of many oilfields. Scholars found that under the actual conditions of the existing well pattern, it is difficult to fundamentally improve the development effect of the oilfield. This is a puzzle[1].

Since then, people began to study the feasibility analysis of well pattern infilling. In order to avoid the contingency of the experiment, the test area of well pattern infilling has been established. Gradually, people have formulated the general principles of well pattern encryption and proposed the encryption forms of different well patterns. These achievements have made important contributions to the development of oil fields.

2. Main principles of well pattern infilling in low permeability reservoir

According to the investigation of literature, the principle of well pattern encryption should include three
parts. First, it is necessary to reduce the reservoir seepage resistance and establish a proper driving system\(^2\). Second, we can use the combination of well pattern encryption and injection production system to achieve the goal of linear water injection. Third, we should make clear the difference of water injection mode in different blocks.

2.1. Low permeability reservoir

Due to the low permeability of the oilfield, in order to ensure the development effect of the oilfield, the fracturing design should be carried out. Fracturing programs can increase production in early fields. However, the influence of low permeability is still great. In the absence of solutions, only through the infilling of well pattern can further improve the oilfield development effect.

2.2. Block reservoir with prominent contradiction

The fracture development of non-main reservoir can make the water absorption capacity of oil field stronger. The poor water absorption capacity of the main reservoir results in the lower pressure of the reservoir. The poor connectivity effect of non-main reservoirs leads to the increase of inter layer contradictions of the reservoirs in the block. Moreover, the way of layered water injection can’t avoid the influence of interlayer contradiction\(^3\). This contradiction can be effectively solved by using infill well pattern infill technology to shoot oil layer.

2.3. Blocks with large remaining oil

As we all know, dead oil area is a necessary part of well pattern. Although linear water injection can improve the development effect of phlegm, the remaining oil in the dead oil area can only be extracted by densification.

2.4. Local areas with imperfect injection production system

The common problems in many oilfields are poor fault development and narrow fault block. This phenomenon makes it difficult to form a complete injection production system. The improvement of injection production system can only be completed by encryption\(^4\).

2.5. Application of oil recovery method by dialysis

The permeability of matrix in fracture developed reservoir is very low. The imbibition condition of oil layer is general. The success rate of well to well conversion is very high. Therefore, the well pattern infilling can be improved to the greatest extent by using the well with strong permeability.

2.6. The lower limit of thickness that can be encrypted

At present, the water injection effect of the block with high oil production rate is better. Its economic effect is also accepted by people. This kind of block may not consider encryption. Not all oil fields need to be encrypted to improve their development effect. Sometimes the cost of infilling is very high. This is something enterprises should pay attention to. There are many and complex forms of encryption. However, the lower limit of the thickness of the encryption is the same. The range is between 7m and 10m.
3. Analysis of reasonable well pattern secondary infilling form in low permeability reservoir based on computer

3.1. In conventional sandstone reservoir, uniform infilling well should be selected first

The physical properties of reservoirs with poor fracture development are very low. For it, the purpose of well pattern infilling is to reduce well spacing. In the form of uniform infilling, under the same well pattern density, the maximum water drive ability can be obtained.

3.2. The well pattern with an angle of 11.5 degrees between side-by-side direction and fracture trend should be densified side by side

The permeability of the main block in some oilfields is very high. The angle between the side-by-side direction and fracture trend is 11.5 degrees\(^\text{[5]}\). In this case, linear water injection can be realized. According to the computer numerical simulation, we can find that the remaining oil is mainly concentrated in the middle of the oil well row after the linear water injection. The side-by-side densification of oil wells can help people to exploit the remaining oil to the maximum extent. This way can also greatly save money consumption.

3.3. The well pattern with an angle of 22.5 degrees between the side-by-side direction and fracture trend should be densified unevenly

It is difficult to realize linear water injection by side-by-side encryption. The well pattern with an angle of 22.5 degrees between the side-by-side strike and fracture strike should be densified unevenly(see Table 1).

| Table 1. Different infilling methods of well pattern with an included angle of 22.5 degrees |
|---------------------------------|--------|---------|
| Well pattern                    | Row spacing | Recovery ratio |
| Square                          | 300m     | 21.9%    |
| Side by side encryption         | 300m     | 24.5%    |
| Well row infilling              | 150m     | 26.2%    |
| Heterogeneous infilling well    | 134m     | 27%      |
| Uneven infilling well           | 134m     | 30.3%    |
| Encryption test area            | 134m     | 29.9%    |

3.4. Reasonable infilling form should be adopted for well pattern with 45 degree parallel direction and fracture strike

Generally speaking, there are three conditions that must be satisfied for the densification form of well pattern. First, the densification form can not hinder the linear water injection. Second, the infilling form should reduce the row spacing and the seepage resistance. Third, the oil wells with high water cut should
be fully used in the form of encryption.

3.5. Keep encryption flexible

The internal structure of different well pattern is different. Therefore, different well pattern encryption methods are different. Some well pattern encryption methods are only applicable in theory. In practice, the infilling form of well pattern should be flexible. In this way, the development of different oilfields can be guaranteed.

4. Application of computer in the study of reasonable secondary infilling pattern in low permeability reservoir

The reasonable infilling method of reservoir well pattern can increase the production and development effect of oil wells. We can't directly put the theoretical encryption method in the undeveloped oil wells. This is unreasonable. This way of use will only increase the cost consumption in the process of infilling and arranging well pattern. The consumption of experimental oil field will also be a great cost. Therefore, we can use some computer technology to carry out simulation experiment and motion analysis in advance before arranging well pattern encryption[6].

Designers can use MATLAB software to simulate the data. Designers can convert well pattern infilling into mathematical formula calculation. We can get the result of computer simulation by putting the formula calculation method in the computer simulation software. It can help us to find the main problems in theoretical design. In addition, the designer can also use the motion simulation technology of UG to carry out the pre experiment of well pattern encryption. We can use the technology of motion simulation to explore the movement form and arrangement position of liquid in oil well and water well. The best design method is to use the combination of dynamic simulation and computational simulation to design well pattern encryption.

5. Conclusion

In this paper, according to the different characteristics of the reservoir in the oil field, the infilling form of different well pattern is determined by computer numerical simulation technology. We can find that different densification forms can make different low-permeability reservoirs better.

Acknowledgments

Study on the encryption and adjustment method of low permeability reservoir.

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