

Fracturing method and application of low permeability reservoir

Huaiwen Zhang

No.3 Production Room, Geological Institute, No.2 Oil Production Plant, Daqing Oilfield Co., LTD, Heilongjiang Daqing, 163000 China

Abstract. Fracturing technology of low permeability reservoir is the key technology of reservoir recovery, and the key link of the key technology is fracturing layer selection. In the context of increasing production demand for low permeability reservoirs, the research and development of oilfield technology has carried out related research on low permeability reservoir fracturing method to ensure that the application of technology is more reasonable.

Key words: Low permeability reservoir; Fracturing layer selection method; Application research on.

1. Introduction

Low permeability reservoir is a special geological condition encountered in oilfield exploitation and is the main link of modern oilfield exploitation. The application of fracturing technology is very important in the production process of low permeability reservoir. But, in the process of modern low permeability oil field, as a result of the oil field geological condition is complicated, so part of the problem of low efficiency of fracturing technology implementation, and from the point of view, in order to achieve the efficient operation of fracturing process, it should be done quickly choose layer optimization of fracturing process, through the reasonable choice of layer and application effect of ascension fracturing process, It also ensures good recovery from low permeability reservoirs.

2. Low permeability reservoir analysis

Low permeability reservoir is an important part of modern petroleum resources exploitation in China, and it plays a very key role in modern petroleum resources exploitation. Low permeability reservoir is also a reservoir with characteristics. The permeability and abundance of oil fields in this reservoir area are relatively low, and the productivity of single well in low permeability reservoir is relatively low in oilfield exploitation.

At present, China's demand for oil resources continues to expand, but also attaches great importance to the exploitation of low permeability reservoirs. In addition, low permeability reservoir is the most abundant reservoir area in China. In the proved reserves, the proportion of low permeability reservoir reserves is very high, accounting for more than 2/3 of the national reserves, and the development potential is huge.

In China's current oil exploitation industry, the exploitation of low permeability reservoirs has been standardized, according to the different permeability of reservoirs, low permeability reservoirs are divided into three types of reservoirs.

- ① The first type is general low permeability oil field, the average permeability of oil layer is $(10.1 \sim 50) \times 10^{-3} \mu\text{m}^2$.
- (2) The second type is the ultra-low permeability oilfield, the average permeability of reservoir is $(1.1 \sim 10.0) \times 10^{-3} \mu\text{m}^2$.
- (3) The third type is ultra-low permeability oil field, with average permeability of $(0.1 \sim 1.0) \times 10^{-3} \mu\text{m}^2$.

In the actual oilfield exploitation, according to different reservoir exploitation needs, the completion of reservoir permeability well exploitation, to ensure more reasonable exploitation application, but also to maximize the efficiency of reservoir exploitation.

3. Fracturing and formation selection analysis of low permeability reservoir

The production of low permeability reservoir is different from that of conventional oilfield, and different technology needs to be applied in the production process. In the research and development of oil field production technology, relevant experts have proposed the fracturing technology of low permeability reservoir, which can solve the problem of low permeability of oil field and realize efficient reservoir production.

Low permeability reservoirs in the process of mining technology, the use of fracturing technology is to point to in the oil field, using the hydraulic outgoing forces, the underlying constant pressure to oilfield, let oil field stratum cracks, cracks appear after the internal flow of oil and gas resources environment, to improve oilfield within good fracturing oil field resources environment, the well production will also increase. Fracturing technology is

very suitable for low permeability reservoirs, because the permeability and flow rate of low permeability reservoirs are relatively low, so the two process principles are exactly compatible, so in the exploitation of modern low permeability reservoirs, began to widely promote the application of fracturing technology. The common fracturing techniques include packer stratified fracturing, flow-limiting stratified fracturing and fracture-controlled fracturing. In the actual fracturing process control, fracturing methods can be selected according to different pressure reservoir conditions, and fracturing process parameters can be designed to achieve good implementation of fracturing process.

The application of fracturing technology is very important in the implementation of low permeability fracturing technology. In its fracturing construction, mainly includes oil and gas well analysis, oil and gas layer selection, fracturing technology selection and implementation and so on. In the specific application process, oil and gas layer selection is the key link, the main purpose is through the effective permeability of oil and gas layer, porosity, oil saturation, effective thickness, reservoir parameters such as formation pressure, static temperature analysis, select the appropriate application of fracturing technology, mining the best effect of oil and gas layer, for subsequent fracturing techniques and oilfield exploitation. In summary, the most effective method of producing low permeability reservoirs is the fracturing process, and the good performance of the zone selection can ensure that the fracturing process is well implemented. Therefore, it can be inferred that the good application of layer selection method can realize scientific and reasonable fracturing of low permeability reservoir and improve oilfield production efficiency.

At present, the application of oil field layer selection method is mainly to analyze the parameters of each reservoir and the condition of reservoir, and to complete the application of fracturing technology of oil field reservoir. The main principle of fracturing layer selection is to analyze different oil layers according to reservoir characteristics and fracturing and exploitation technology, select the best fracturing layer, and improve the exploitation effect of low permeability oil fields.

4. Application of low permeability reservoir fracturing method in XX oilfield

XX oilfield is a low permeability reservoir oil field, which is also a key oil field in the exploitation of oil resources in XX region. It is of great significance to the development of oil production in the region and can also improve the effect of oil exploitation to the greatest extent. In XX oil field, there are 43 oil Wells in total, including 17 oil Wells with daily production of 2T, 20 oil Wells with daily production of 5T and 6 oil Wells with daily production of 6T. The average thickness of each oil layer is 1.2-2.5m and the average permeability is $0.1-3.0 \times 10^{-3} \mu\text{m}^2$. In the implementation of fracturing technology in this oilfield, a unique layer selection method has been designed. The following is a detailed analysis of the method. In the actual process of low permeability reservoir exploitation, the following layers are mainly selected.

(1) Select well zones that avoid water channeling

Water channeling should be strictly controlled during the exploitation of low permeability reservoir. Water channeling is the main problem that easily affects mining. For example, if there is no cement or less cement consolidation outside the casing of the adjacent oil layer and water layer, and there is good cement consolidation above, then the two oil layers and water layers flow together due to the difference of pressure. When perforated, even easy to flow can flow out, such as water is easier to flow than oil, after channeling it is easy to only water out of oil or a small amount of oil. Water channeling seriously affects the efficiency of oilfield exploitation. Therefore, in the actual oil field layer selection, the requirement of layer selection should avoid water channeling problem. In the oilfield reservoir, the well formations with small fracture direction Angle and difficult control of artificial fracture direction are prone to water channeling, and should not be selected. Judging the probability of water channeling in the reservoir is the main method module of layer selection in XX oilfield fracturing process [1].

(2) Do not repeat layer selection

In the implementation of fracturing technology, not only the bottom layer of fracturing is needed, but also the low fracturing is needed to support and control, so it is necessary to use fracturing fluid to support the pressure opening position to ensure the formation stability of the reservoir layer and facilitate the flow of oil and gas resources. However, in the implementation of oilfield fracturing, refracturing technology is often needed to realize the fracturing method and meet the flow demand of oilfield exploitation in low permeability area. As a result, the refracturing process is also prone to re-fracturing in the primary fracturing process. However, after repeated cracking, the original fracturing fluid support force is insufficient, which will cause the overall formation instability. In the actual process application, not only the second repeated fracturing is needed, but also the cracking control is needed to prevent repeated cracking. Therefore, it is necessary to avoid selecting well-fractured reservoirs, but to ensure that the fracturing intervals are

not repeated with the last fracturing; If it is determined that there is no undeveloped reservoir, the reservoir in the previous fracturing interval should be selected because of the length of the reservoir, the number of layers and the effective thickness of the reservoir. When there is no oil layer that has not been repeatedly exploited, XX low permeability oil field takes the thickness of oil layer as the basis for layer selection judgment. The thicker the thickness of oil layer, the greater the probability of avoiding repeated cracking. After practical operation, XX low permeability oil field was exploited, and the layer selection standard for re-fracturing oil field was determined as isolation layer thickness above 2.5m [2].

(3) Flow pressure layer selection method

In the exploitation process of XX low permeability area, flow-pressure layer selection is also a very important method. In the application of fracturing technology, flow pressure state has a very important influence on fracturing oil recovery. In the actual exploitation of oil resources, the flow pressure will affect the permeability of fractures. The lower the flow pressure is, the worse the permeability of the whole fractured layer will be, and the oil and gas resources will also appear colloid state, affecting the quality of oil and gas resources. In the production process of XX low permeability reservoir, the flow pressure and fracture permeability were analyzed. Through the practice analysis of the oilfield, it is found that when the fracturing flow pressure is below 2MPa, the fracture location has the lowest permeability and the fracturing effect is relatively poor. When the flow pressure is above 7.5MPa, the fracture location has the highest permeability and the fracturing effect is better. So, in the actual production process, low permeability zone reservoir XX low permeability zone oilfield exploitation of flowing pressure for judgment, and choose layer, reasonable flowing pressure 2 MPa to 7.5 MPa and 7.5 MPa above the reservoir as the exploitation of oil reservoir, can effectively improve reservoir development efficiency, to ensure that the oil reservoir more reasonable, can also improve the quality reservoir development [3].

(4) Select the reservoir with high development potential

In the process of cracking layer selection in XX low permeability area, the reservoir layer with relatively large development potential is mainly selected. And according to the oil reservoir situation, formulate the corresponding solution. In the process of cracking layer selection in XX low permeability area, it is required to conduct oil field reserve analysis for alternative oil layers. Priority is given to the exploitation of oil reservoirs with large reserves. In the actual analysis of oil and gas reserves, crude oil viscosity, permeability, buried depth, thickness, pure total ratio, porosity, saturation, edge and bottom water, heterogeneity, fracture situation and sensitivity are mainly used as analysis indexes. And according to the calculation formula of oil and gas geological reserves calculation comparison. The formula is $QN=A/N_0$, in which QN stands for reserve degree, the unit of which is 104T /km²; N stands for oil field geological reserve, the unit of which is 104T; and N₀ stands for oil-gas area, the unit of which is km². In addition, according to the comprehensive evaluation standard of oil and gas reserves, the richness of oil reservoirs is determined. Table 1 comprehensive

evaluation table of oil and gas reserves. In reservoir selection, naturally, the high-rich reservoir is the first choice for fracturing oil layer, and the oil reservoir selection is carried out by analogy [4].

Table 1 Comprehensive evaluation table of oil and gas reserves

Rating	Oil reserves
High abundance ratios	>300 Tons per square kilometer
Medium abundance	100~300 Tons per square kilometer
Low abundance	50~100 Tons per square kilometer
Very low abundance	<50 Tons per square kilometer

5. The effect of fracturing layer selection method in XX oil field low permeability reservoir is reflected in practice

To sum up, during the fracturing process of XX oilfield's low permeability reservoir, the fracturing layer selection method mainly completes the reserves analysis, flow pressure analysis, repeated exploitation analysis and water channeling problem analysis. Through the above analysis, reasonable fracturing layer selection can be completed to ensure the good exploitation of low permeability reservoir.

Since 2021, the fracturing process of XX oilfield's low permeability reservoir has begun to develop standardized layer selection methods, and standardized layer selection has been carried out in accordance with the above method scheme. After optimization of layer selection methods, good results have been achieved in the development of low permeability reservoirs in the oilfield. The average daily increase of oil production per well in the initial stage is 6.9 t/ d, which is 5.12 t/ d higher than that of the fractured well, and the stimulation multiple reaches 3.87. From this point of view, the fracturing method of XX oilfield's low permeability reservoir is worth popularizing [5].

6. Conclusion

In this paper, the author summarizes the methods of fracturing layer selection for XX oilfield's low permeability reservoir, hoping to be helpful to the optimization of fracturing layer selection technology for China's low permeability oilfield.

References

1. Su Liangyin, CHANG Du, QI Yin, et al. *Drilling & Production Technology*, 2020, 43(2):5-5
2. Liu Wang, XIAO Yongjun, Shi Kai, et al. Development and application of sand control agent for low permeability reservoir fracturing [J]. *Fine Petrochemical Industry*, 2021, 38(5):4-4
3. Zhang Dong. Optimization and application of horizontal well fracturing in ultra-low permeability reservoir [J]. *Chemical Engineering and Equipment*, 2020(3):2-2
4. Zhang Zhuxin, WU Jiapeng, Meng Wen, et al. Research on volumetric fracturing + imbibition recovery technology and its application to deep low permeability reservoirs in Cangdong Sag [J]. *Logging Engineering*, 2020, 31(S01):5-5
5. Liu Lu, Sun Qi, GUO Qinghua. *Petrochemical Technology*, 2020, 27(10):2-2. (in Chinese)