

Discussion on technical countermeasure of improving development effect of low permeability reservoir

Xiang Li

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

Abstract: Low PERMEABILITY RESERVOIR IS AN IMPORTANT MATERIAL FOUNDATION FOR STABLE PRODUCTION IN OLD AREAS, BUT DUE TO THE limitations OF reservoir physical properties, exploitation methods and other factors, the late production effect is poor, therefore, from the reservoir and development approach, the technical measures to improve oil recovery in low permeability reservoir are discussed. Based on the analysis of the factors influencing the development effect of double low reservoir and the geological characteristics of reservoir, from the viewpoint of seepage mechanics, this paper systematically classifies five indexes, such as main pipe radius, flow percentage, starting pressure gradient, clay mineral content and crude oil viscosity. The five-element combination evaluation method is used to optimize the low permeability point reservoir, and on this basis, favorable oil and gas accumulation areas are found. According TO THE DEVELOPMENT status of low permeability reservoir, reasonable injection-production network and well type are demonstrated to break the bottleneck of conventional low permeability water injection and improve the development benefit of low permeability reservoir.

Key words: low permeability reservoir; Reservoir grading evaluation; Reasonable well pattern; Natural gas flooding.

1. Introduction

In recent years, the development of low permeability reservoirs has become the main source of domestic oil resources, and the proportion of oil production is increasing year by year, its importance is increasingly prominent. With the development of low permeability oil field, China has already formed the situation of low recovery rate and low recovery rate at present. Combined WITH THE TYPICAL BLOCK, THE EXPLOITATION STATUS AND THE PROBLEM OF "DOUBLE LOW" OIL FIELD ARE IMPLEMENTED, THE TECHNICAL BOTTLENECK OF "DOUBLE LOW" OIL FIELD IS carried out, THE IN-DEPTH research IS carried out, THE practical AND feasible development methods are formulated, and THE injection and production well pattern is constantly improved. A set of technical means for economical and efficient utilization of low permeability and double low permeability reservoirs to improve ultimate recovery is established, and the development plan of low permeability and low efficiency blocks is guided and completed, which provides a reference for the efficient development of similar low permeability reservoirs.

2. An overview of low permeability reservoirs

2.1 Low permeability meaning

It turns out that "low permeability" refers to a reservoir with poor permeability and mainly refers to the concept of oil reservoir. At present, with the progress of industrial production technology, low permeability reservoirs have been widely used in low permeability reservoirs, low permeability reservoirs and so on. Because low permeability oil and gas fields have smaller Wells, weak fluid and permeability, reservoir void, low productivity and other problems, only through the reservoir transformation, to ensure the normal operation of oil and gas fields.

2.2 Division of low permeability reservoirs

At present, there is no clear definition and standard for low permeability oil field in the world, which is determined by each country according to its existing oil reserves and technical status, according to its existing crude oil reserves and technical status. In China, low permeability oil fields are divided into three types according to their average permeability according to the actual situation and production characteristics in China.

Generally, the permeability of low permeability oil field is the largest, and oil Wells can basically meet the production requirements, but the production is not high, so fracturing measures must be taken to achieve greater stimulation effect. The permeability of ultra-low permeability oil field is relatively normal, and the water content is also relatively high, but in order to achieve normal recovery effect, it must carry out large-scale fracturing transformation. Such fields generally have no natural yield because their reservoirs are so dense, their fluid volumes are small, and their bound water content is so high that they are generally not exploited.

2.3 Characteristics of low permeability reservoirs

Low permeability oil fields generally have the characteristics of low abundance, low permeability and low productivity of single well. Compared with medium and high permeability oil fields, low permeability oil fields have low permeability, poor fluid characteristics, small pore throat diameter, and "differential pressure for starting production", which requires a lot of flow resistance and pressure. The second characteristic is poor continuity, because the spacing between Wells is generally too large, the development scale of sand body is not large, and the water flooding control is difficult. The third problem is that after the discovery of water in the low-permeability reservoir, the indicators of crude oil extraction and oil production have fallen sharply, which seriously affects the stable production of the oilfield. Thirdly, for the enrichment degree of low permeability reservoirs, fracturing and other stimulation measures must be taken due to low oil saturation, low production capacity and insufficient production capacity.

3. The main problem of low permeability reservoir development

The effect of water injection in low permeability reservoir is not obvious, and the influence is great. It usually does not appear obvious change until half a year after water injection. It is an objective law that oil production decreases with water content increasing after water injection. Medium - and high-permeability reservoirs have a higher yield index after water injection, which can be stabilized or reduced by increasing production. However, the fluid production index of low permeability reservoir will decrease sharply after water injection, and the fluid production index is about 40% when the water content is above 60%. At the same time, low formation pressure makes production difficult, resulting in increasing production and decreasing production in low-permeability Wells after water discovery.

The PROBLEMS existing in the development of water injection in oil field are that the formation pressure of injection well rises rapidly, the oil pressure and oil production decrease sharply, and finally the water injection, oil production, exploitation rate and recovery rate are all poor, resulting in no injection or production. In fact, these problems occur in all low permeability

reservoirs, some of which are particularly severe, causing production to grind to a halt.

4. Study on countermeasures to improve the development effect

4.1 Study the distribution of fractures and geostress field, and reasonably arrange well patterns

4.1.1 Study the direction of fracture formation extension

One is to track natural fractures, and the other is to create new fractures in the rock, which are parallel to the direction of the maximum principal stress in the current stress field. If a transverse fracture can be formed, it will help expand the oil spill area and further increase the production of the well.

4.1.2 Make full use of reservoir numerical simulation technology

Through the collection and analysis of a large number of data, the mathematical model of reservoir is established, and the dynamic of reservoir is corrected, and the historical fitting is carried out, so as to provide a new method for the future dynamic of reservoir, and improve the economic benefit of development.

4.2 Reservoir protection technology should be applied to reduce reservoir damage

In order to reduce the damage of drilling operations to the formation, polymer amine salt mud system, underbalanced pressure drilling technology and shielding temporary plugging technology are used in the drilling process. The construction technology mainly adopts various construction methods, such as negative pressure perforation, reasonable use of well washing fluid in different construction stages, lower oil and gas reservoir protector, etc., in order to reduce the damage to the reservoir during construction. In oil well exploitation, suitable auxiliaries should be selected according to reservoir characteristics. IN ORDER TO REDUCE RESERVOIR DAMAGE, VARIOUS MEASURES SHOULD BE TAKEN, SUCH as ANTI-SWELLING technology IN advance, fine treatment of water injection and modification of water injection.

4.3 Early water injection

Since the natural energy of low permeability oil fields is generally low, their elastic recovery and dissolution rates are also low, so early water injection and maintenance of formation pressure must be adopted to enhance the recovery. For fields with high elastic properties and abnormal pressure, recovery can be enhanced by delayed water injection and enhanced oil recovery. Through the investigation of low permeability oil fields in China, it is found that permeability coefficient and porosity decrease

with the increase of overburden pressure, and this change is an irreversible process. In order to maintain the low pressure of the low permeability reservoir, the porosity and permeability of the reservoir are avoided to decrease sharply, and the permeability of the reservoir is good.

Table 1 Basic parameters of water flooding core

NO	The length of the core (cm)	Core diameter (cm)	porosity (%)	Gas logging permeability (x 10 ⁻³ m ³) μ
1	3.20	2.49	11.94	0.263
2	4.10	2.50	12.50	0.500
3	4.10	2.49	13.20	1.560
4	4.15	2.49	12.70	7.500
5	3.16	2.48	13.70	10.80

4.4 Use fracturing technology to improve the productivity of low permeability reservoirs

Low permeability reservoirs have low natural productivity and usually cannot meet the requirements of industrial production. Therefore, fracturing is the core technology to develop low permeability reservoirs. The optimal design technology of "integral fracturing" has surpassed the conventional single-well oil augmentation and injection augmentation technology, which is a great development of hydraulic fracturing technology at home and abroad in recent years. It plays an important role in the whole oilfield development plan [1].

At present, the fracturing processes for low permeability reservoirs mainly include current limiting fracturing, ball-throwing multilayer fracturing, packer multilayer fracturing, CO₂ fracturing, high-energy gas fracturing, composite fracturing technology, etc. After fracturing technology modification, reservoir permeability is mainly caused by fracture forming mechanism, and a number of long and narrow sand filling fractures are formed in the bottom hole area. Due to the opening of reservoir, the formation permeability is increased, the pressure and direction of reservoir fluid are changed, the injection-production relationship of well pattern is optimized, and the production of oil Wells is greatly increased. Practice shows that there are three factors that can affect the fracture of sand-filled body [2]. Permeability mechanism of reservoir fluid: The formation of sandstone fractures changes the reservoir near the bottom of the well from radial flow to unidirectional flow, and flows downward to the borehole through the fractures. In particular sedimentary facies bands, the fractures extend from the middle to the high seepage phase, or to the deep pay zone and natural fractures. Due to the plugging effect, a variety of factors such as entering fluid will be encountered in all aspects of drilling, oil testing, production, etc., resulting in formation plugging, especially in low-permeability reservoirs, which will lead to the decrease of formation permeability and thus production. The occurrence of fracturing fractures can not only alleviate the plugging in the near-well area, but also improve the permeability of the reservoir, so that it has a better stimulation effect.

4.5 Use acidification technology to improve the productivity of low permeability reservoirs

As an adjunct technology, acidification can increase the production of a well at a specific well location. The improvement of reservoir permeability by acidification technology can be divided into three types: conventional acidification, pickling and fracturing acidification. Acidification is through acid chemical dissolution and extrusion formation of certain minerals in the dung and formation, formation seam hole to expand, extension, communication or in formation with diversion ability of crack formation, so as to restore and improve the formation permeability, reduce the resistance of formation, increase the power of the injection Wells, achieve the goal of increasing oil and water Wells [3].

4.6 Pressurized water injection profile control technology to improve reservoir permeability

The causes of water injection difficulty in medium and low permeability reservoirs are very complex. In addition to the pollution and water quality in deep drilling, there are mainly two reasons: first, the formation condition is poor, the formation permeability is low, the porosity is small, and the pipe diameter is small; Second, for reservoirs with special high-pressure characteristics, the energy and pressure released in the process of opening the reservoir will lead to formation "plastic change", which is very unfavorable to water injection. In VIEW OF THE UNDERINJECTION WELL CAUSED BY THE ABOVE MENTIONED CAUSES, IT is difficult to obtain good results by adopting chemical transformation measures. After investigation, a new technology suitable for high-pressure water injection and profile control technology is put forward. The pressure can be directly raised to 40 MPa according to the requirement of 30 MPa water supply.

4.7 Using aerodynamic deep penetration augmentation technology to improve reservoir permeability

4.7.1 Mechanism of action

Put various reagents in the well bottom, will mix together all sorts of different drugs, the formation of strong chemical reaction, high temperature and high pressure gas formation, formed a huge crack in the strata, under the effect of repeatedly, the fracture will extend to the deeper, so as to improve the permeability of formation, to eliminate formation pollution [4].

4.7.2 Improve formation characteristics

This method is suitable for medium and low permeability reservoirs, and is also suitable for oil and gas production decrease due to the blockage of impurities such as asphalt gel and insoluble organic salt, and water injection pressure increase resulting in the reduction of water injection. The technology has a variety of functions such

as fracturing, pyrolysis plugging, acid plugging, etc., which can eliminate the pollution of the reservoir near the bottom of the well, increase water injection and volume, increase production, improve formation permeability, and thus enhance recovery efficiency.

4.8 Well spacing test is carried out to explore reasonable development mode of low permeability reservoir

At present, the phenomenon that the water injection well does not inject water and the high-pressure zone is formed is common in low permeability oil fields. Because the oil well is in the low pressure area, it cannot be exploited, resulting in the production of the oil field into a passive, even into paralysis. To solve this contradiction, the key lies in the appropriate reduction of well spacing and the reasonable increase of well pattern density. Only in this way, can a set of effective driving force system be formed to ensure the effect of water injection in the oilfield, ensure its stable production, and increase the oil recovery. When laying the development well pattern, it is necessary to take the whole reservoir as the research object, fully consider the match between in-situ stress direction and hydraulic fracture, and make full use of the potential of hydraulic fracture to achieve the purpose of efficient well pattern mining [5].

4.9 Main Application Technologies

In the early stages of development, the formation pressure is high and the production can be elastic, so the traditional method can achieve better production. During the middle and late stages of development, as the formation pressure decreases and the average fluid level of the well decreases, the application of deep pumping technology can increase the recovery efficiency, thereby increasing the economic value of the reservoir.

4.9.1 Supporting technology of deep well pump

Rod PUMP DEEP PUMPING technology, equipped with speed regulating motor, can be IN the production process, according to the change of moving liquid level to adjust the flushing, determine a reasonable working mode, coordinate the relationship between oil supply. The use of long stroke pump deep pumping process, can increase stroke, reduce stroke, so that the production pressure difference is stable.

5. Conclusion

Reservoir protection is very important to improve the early productivity of low permeability oil Wells. Reasonable well pattern design is the premise of achieving good results, and appropriate supporting technology is also the key to ensure the stability of low permeability oil fields. Integrated fracturing, acidification and other techniques are the main means of developing low and medium permeability reservoirs. In oilfield DEVELOPMENT, IT IS NECESSARY TO comprehensively CONSIDER FRACTURING,

acidification, injection addition, aerodynamic deep penetration injection, AND well pattern and water injection, so as to realize the comprehensive utilization of the oilfield. In medium and low permeability reservoirs, high pressure water injection and fine water quality treatment should be strengthened to ensure the normal operation of injection Wells, timely replenish formation energy, and increase the formation pressure of the block. No matter in low permeability oil reservoir or using aerodynamic deep pressure technology, the plugging of oil well can be realized.

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