Application Analysis of Integral Fracturing Measures in Oil Reservoir

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Abstract. With the continuous development of oil reservoir, integral fracturing has become an effective measure to improve production and efficiency. Therefore, starting from reservoir fracturing reform, effectively implement fracturing reform and promote the improvement of reservoir development index. This paper expounds the related contents of integral fracturing technology, and then probes into the application of integral fracturing measures in oil reservoir.

Keywords: Oil reservoir, Integral fracturing, Transformation measures.

1. Introduction

Fracturing technology is one of the important technologies in oilfield development. In terms of design, the optimization of single well stimulation in the past has gradually changed to the optimization of block fracturing plan. At present, the overall fracturing technology of the reservoir has been greatly developed, mainly starting from the whole reservoir, placing the fracturing fracture width, fracture length and conductivity and hydraulic fractures in specific reservoir conditions and feeding them back to the development plan, so as to promote the optimization of well pattern and number of wells, so as to achieve better results. Integral fracturing technology is not only the basis of oil production scheme preparation, but also an important part of development scheme. The transformation of integral fracturing plays a certain role in improving reservoir recovery.

2. Overview of overall fracturing

In oilfield development, the number of repeated fracturing wells is increasing, the conditions of potential wells are getting worse, and the oil recovery effect is decreasing. In this case, it is necessary to solve the problems of poor fracturing reservoir conditions, high water content before fracturing, and the increase of repeated fracturing wells. The integral fracturing reform of oil reservoir is mainly to solve seepage, improve fluid fluidity, and enhance oil field productivity and recovery ratio. Through comprehensive analysis of well pattern distribution and water injection, and optimized combination, the difficult-to-recover reserves can be effectively exploited. Overall reservoir fracturing is to make overall planning according to the present situation and requirements of reservoir geology and development, so as to optimize and guide single well fracturing. Its main purpose is to enhance the development value of oil reservoir and increase the recovery rate of oil reservoir, and it consists of four links, each of which is circularly deepened. First of all, before the overall design, we should know the geological conditions of the block, investigate the structure, and test and measure the in-situ stress core and hydraulic fracturing. Through reasonable analysis of the relationship between reservoir characteristics, parameters and development effect, select appropriate values to simulate fracturing. Secondly, fracturing construction technology, through studying the distribution characteristics of oil layers, reservoir types, etc., and according to the requirements of fractures, reservoir pressure, etc., selects the corresponding fracturing transformation methods. For those with good interlayer, separate layer fracturing is selected. When the interlayer is relatively thin and layered fracturing cannot be implemented, steering fracturing is used to effectively control the fracture height after fracturing. Finally, the overall fracturing reconstruction design is mainly based on fracturing simulation, with recovery as the goal, and the fracturing scheme is optimized. The overall fracturing optimization design should be comprehensively considered and configured in combination with the output, recovery ratio and economic benefits of a single well, and the best scheme should be selected, and the single well design scheme should be prepared according to the overall optimization scheme.

3. Application of integral fracturing measures in oil reservoir

3.1 Pre pressure comprehensive evaluation

The first step of integral fracturing reconstruction of oil reservoir is to comprehensively understand and analyze the geological conditions of oil reservoir, and build corresponding geological model, which is the basis to ensure the reliability of optimal design. After a comprehensive analysis of the reservoir geology, we can understand the corresponding reservoir background, and through the collection and confirmation of the parameters, we can prepare for the scheme transformation to ensure that all the characteristics of the reservoir can be covered. There are many evaluation methods for pre-fracturing reservoirs, such as conventional static analysis, unconventional special test, field test and core test. Take a block as an example, it is a monoclinic fault block, the oil layer is 3,100 meters deep, and the lithology is mainly fine sandstone. Physical properties of crude oil: it is easy to produce emulsification reaction with fracturing fluid, which blocks the reservoir and greatly reduces the fracturing effect. Sensitivity test: the reservoir belongs to weak water sensitivity, but as this block is an ultra-low permeability reservoir, we should pay attention to the influence of clay swelling on fracturing effect; Rock mechanics test: the reservoir rock has certain elasticity and plasticity, so it is easy to embed proppant. According to the above tests, the overall fracturing reform principle can be determined, that is, properly control the fracturing range and crack length. Before the priming fluid, in order to prevent the fracturing fluid and crude oil from emulsifying and have a great influence on production efficiency, viscosity reducing agent can be added. The fracturing reconstruction of medium-low permeability reservoir mainly aims at improving the conductivity, and choosing large-particle proppants or proppants of combination of large and medium-sized particles to solve the problem of proppant embedding and improve fracture conductivity. Adjust the concentration of guanidine gum without using filtrate reducer. The fracturing fluid should have good sand carrying capacity and low friction, so as to meet the construction requirements of large displacement. The fracturing fluid should also have the characteristics of low residue to minimize the damage to the fracture [1].

3.2 Optimization of fracturing materials

Fracturing fluid and proppant are the main materials for the implementation of integral fracturing technology in oil reservoir, and the fracturing materials should be suitable for the fractured formation. The optimization of fracturing fluid is mainly to balance the relationship between its rheology and fracturing fluid damage, minimize the corresponding damage and ensure the maximum net present value after fracturing. For the optimization of fracturing proppant, it is mainly to ensure the conductivity of the support. By using typical curves, the proppant and conductivity are determined by using economic models. Fracturing fluid has multiple functions, such as transferring pressure and bringing proppant into fractures, etc. The selection of fracturing fluid should fully combine the chemical and physical properties of reservoir, rock and construction technical requirements. According to the sequence and function of pump injection, fracturing fluid can be divided into different types. Including hole cleaning fluid, pre-priming fluid, priming fluid, sand-carrying fluid, etc. Sand-carrying fluid plays an important role in evaluating the performance of fracturing fluid and fracturing. According to the configured materials and the shape of the liquid, the fracturing fluid is divided into water-based fracturing fluid, emulsified fracturing fluid and foam fracturing fluid. Among them, water-based fracturing fluid belongs to a comprehensive fracturing fluid system and can be used in various types of reservoirs. The optimization of fracturing fluid is based on the geological conditions of the reservoir, fracturing process requirements, etc. The specific optimization method is to analyze the temperature, lithology and crude oil properties of the reservoir to determine the type of fracturing fluid. According to the technological requirements of fracturing, the formula of fracturing fluid is constantly improved. Carry out tests to check the damage of fracturing fluid formula to reservoir. According to the test results, select the optimal fracturing fluid, and improve it again in combination with field application until the overall fracturing task of the reservoir can be completed [2].

On the other hand, proppant. Proppant is mainly used to fill hydraulic fractures to prevent re-closure, thus forming corresponding flow channels in the middle of the reservoir. In the whole fracturing reconstruction, the properties, types and laying concentrations of proppants are very important, and they are also the key to increase production and efficiency. According to the mechanical properties, proppants are mainly divided into brittle proppants and ductile proppants, and the former mainly includes quartz sand, etc. Its main characteristics are high hardness and small deformation, and it is easy to break under the action of high closing pressure. The latter mainly includes aluminum balls, etc. Its main feature is that the pressure bearing area will gradually increase with the larger deformation, and it is not easy to break under the action of high closing pressure. At present, the commonly used proppants are natural sand and ceramsite. The selection of proppants should be based on the test results, combined with the reservoir conditions and technical requirements, to select proppants with greater fracturing benefits. As shown in Figure 1, it is the conductivity curve of medium density proppant, which is the test result of conductivity of different particle size proppant combinations. It can be seen that adding 10% of 0.4-0.7mm particle size composite proppant into 0.45-0.9mm particle size composite proppant has no significant influence on the conductivity. The more the additive amount, the greater the influence. However, when the addition amount reaches 20%, under the action of 50MPa closing pressure, the conductivity will decrease. Therefore, only by optimizing the particle size combination of proppant can the fracturing be successful. Designers should know the properties and limits of various proppants, and then select proppants that can be safely pumped and have high output after fracturing according to specific geological conditions. As proppant is a necessary expenditure item in overall fracturing, it should be carefully measured. After determining the type of proppant, it should be comprehensively evaluated and confirmed according to the corresponding output benefits [3].

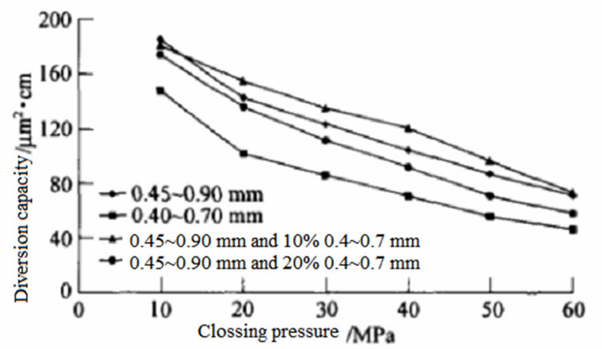

Figure 1 Flow conductivity curve of medium density proppant

3.3 Optimization of overall fracturing scheme

Combined with the pre-fracturing reservoir evaluation and the optimized results of fracturing materials, the overall fracturing scheme of the reservoir is designed, and the hydraulic fractures are placed in specific reservoir geology and well pattern. According to reservoir, hydraulic fracture and economic model, ensure the optimization of combination, and then take feasible technological measures to ensure the maximization of economic benefits after fracturing. First, design parameters. The reconstruction of the overall fracturing scheme of the reservoir depends on the complete design parameters, which can better comprehensively evaluate the reservoir productivity, technical indexes, development benefits after fracturing and so on. Oil and gas parameters are related to fracturing conditions; Gas reservoir parameters are related to the productivity of oil reservoir before and after reconstruction. Fracturing parameters are related to the conductivity and size of fractures; The economic parameters of fracturing are related to the production ratio. As shown in Table 1, it is the optimization result of fracture scale and conductivity under different well pattern conditions. Secondly, design criteria. For the new reservoir without injection-production well pattern, the well pattern layout should be optimized according to the extension orientation of hydraulic fractures, and the well spacing should be enlarged, the density should be reduced, and the economic benefits of development should be improved with the aid of the effect of fracture length. For the reservoir where injection-production well pattern has been deployed, if the location of hydraulic fractures has a positive effect on oil sweeping efficiency, the fracture length can be appropriately extended. If it is not conducive to the improvement of oil sweeping efficiency, the extension of cracks will reduce the efficiency, and the support of cracks should be less than a quarter of the well spacing, otherwise the oil sweeping efficiency will be reduced. If the orientation of the crack is between favorable and unfavorable, the unfavorable orientation should be optimized. For the primary oil recovery period, if the fracture direction has a certain positive effect, long fractures will be pressed out. If there is adverse effect, press out the wide seam. For the secondary oil recovery period, it is mainly to improve the swept volume and sweep efficiency of oil reservoir, and carry out corresponding fracturing to promote the improvement of oil recovery [4]. Finally, the scheme is optimized. The optimization of the overall reservoir fracturing scheme is to combine various factors for economic evaluation, and finally obtain an efficient design scheme.

Table 1 Optimization results of fracture scale and conductivity under different well pattern conditions

Well pattern	Optimize half length of crack (m)	Optimize fracture conductivity ($\mu m^2 \cdot cm$)
150m × 350m diamond well pattern	70-110	25-30
250m five point well pattern	50-70	20-40
250m inverted nine point well pattern	70	20-40
Horizontal well pattern	90	30

3.4 Diagnosis of hydraulic fracture

Hydraulic fracture mainly adopts a number of technologies to confirm the crack size, conductivity, extension orientation, etc. after the implementation of the scheme and the conformity of the scheme, with the purpose of evaluating the fracturing benefits. Although there are many fracture diagnosis technologies, different tests should be carried out in the same well layer to enhance the reliability. First, extend vertically. For the determination of fracture length and production after fracturing, the most important thing is the determination of fracture height. Isotope logging and well temperature logging are mainly adopted. Well temperature logging is widely used, and the method is simple and efficient. Secondly, test and analysis. In the process of fracturing construction, pressure monitoring can judge the extension of fractures in the reservoir, which is conducive to the smooth construction. For the relationship between pressure drop and time, the fitting pressure is obtained according to the pressure drop curve, and various fracturing parameters are solved. Then, according to the corresponding geological conditions, parameters such as elastic modulus of reservoir are obtained, which is the basis of post-fracturing evaluation. Real-time simulation technology is to fit the data collected from fracturing site with the data predicted by simulation. If the two are basically the same, it means that the fracture size is close to the actual one. The determination of hydraulic fracture orientation has a certain guiding role. At present, the fracture orientation and symmetry are mainly tested by means of fracturing monitoring, open hole test, laboratory test and other testing technologies [5].

3.5 Post compression evaluation

Post-evaluation is mainly to analyze the benefits after the implementation of the scheme, and compare the degree of agreement with the expected results. Therefore, it is best to get the same effect with low input and high benefit with the same input. If there is a big difference between the transformation plan and the actual situation, we should find out the existing problems one by one according to the comprehensive evaluation and improve them. There are many main methods for post-fracturing evaluation: fitting the post-fracturing well test data with the reservoir simulation production history, and obtaining the half length, conductivity, permeability and so on of the support fracture. According to the joint length and conductivity of the support joint, after the reservoir simulation, the dynamic evaluation is carried out effectively. Compare the prediction results, actual effects and simulation results, and then reasonably evaluate the economic benefits of fracturing [6].

4. Conclusions

The integral fracturing reform of reservoir is mainly aimed at improving the fracturing quality and efficiency, and constantly improving the fracturing project. Through the optimization scheme, process supervision and effect evaluation, the working standard can be standardized, the fracturing efficiency can be improved, and the reservoir development benefit and economic benefit can be promoted. In the research, design, implementation, evaluation and other links of reservoir fracturing scheme, through circulation deepening, the whole reservoir fracturing technology is improved, so as to better complete the development tasks of each stage.

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