Discussion on key points of underground fracturing technology in oil field

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Abstract: Oilfield underground fracturing technology is an important oilfield development technology, through the injection of fracturing fluid to make the rock fracture expansion, in order to improve the productivity of oil reservoir. In this paper, the selection and design of fracturing fluid, the selection of fracturing tools and devices, the control of fracturing parameters, the control and evaluation of fracturing fractures, and the adjustment and optimization after fracturing are discussed. Through the analysis of these points, it can provide guidance and reference for oilfield engineers and technicians in actual operation to improve the fracturing effect and oilfield development efficiency.

Key words: oil field; Fracturing technology; Crack control; Technical essentials.

1. Introduction

Oilfield development is an important part of modern energy industry, and downhole fracturing technology, as a common stimulation technology, plays an important role in increasing oilfield productivity and improving reservoir recovery. With the continuous evolution of oilfield development technology and the fluctuation of oil prices, the research and application of downhole fracturing technology in oilfield are constantly promoted and improved. The purpose of this paper is to analyze the key points of underground fracturing technology in oilfield, and provide practical guidance and reference for oilfield engineers and technicians, so as to better understand and apply underground fracturing technology and improve oilfield development efficiency and economic benefit.

2. Fracturing Technology Overview

Downhole fracturing technology is a commonly used stimulation technology in oil fields. By injecting high pressure fracturing fluid, rock fractures can be extended to increase the permeability and effective productivity of oil formations. This technology plays an important role in oilfield development, which can significantly increase the production capacity and recovery efficiency of oil Wells and improve the development efficiency of oil fields. The basic principle is to inject high pressure fracturing fluid into the oil well, so that the rock is subjected to great pressure, thus producing cracks or expanding existing cracks, so that the permeability of the reservoir increases. Fracturing fluids are usually composed of water, oil seals, colloidal particles, etc., and have certain viscosity and rheological properties in order to effectively transfer pressure and form cracks in the rock. By controlling the injection pressure, velocity and displacement of fracturing fluid, the fracture growth and morphology can be controlled to achieve the desired stimulation effect. Fracturing technology is widely used in oilfield development and can be used in different types of reservoirs and geological conditions [1]. Different fracturing processes are used according to the needs, including vertical well fracturing, horizontal well fracturing, multistage fracturing, etc. At the same time, fracturing technology can also be combined with other stimulation techniques, such as water flooding, polymer flooding, etc., to further improve oil recovery and economic efficiency.

3. The role of fracturing technology in oilfield development

Downhole fracturing technology is an important stimulation technology, which plays a key role in increasing oil well productivity and improving oil field development efficiency. The following are the main functions of fracturing technology in oilfield development: One is to improve the production capacity of oil Wells. Fracturing technology increases the permeability of the reservoir by enlarging the cracks in the rock, so that the production of oil can not be successfully restored. After fracturing, the permeability of the rock is improved, allowing crude oil from the reservoir to flow more easily into the wellbore, increasing the production of the well. The second is to improve oil recovery. Fractured fractures can expand the effective area of the reservoir, increase the

flow path of crude oil, so that more crude oil can be collected into the wellbore, which is conducive to enhanced recovery. The third is to expand the exploitation range, especially in the horizontal well development has an important role. Fracturing in horizontal Wells can effectively expand fractures, expand the mining area, and improve the mining efficiency of the oilfield [2]. Fourth, optimize the development plan. The fracturing technology can flexibly adjust the development plan according to the actual situation and development goals of the field. By selecting the composition of fracturing fluid reasonably and controlling the construction parameters, the development scheme is optimized to improve the mining effect and economic benefit. Fifth, enhance the profitability of oil fields. By increasing oil well productivity and recovery efficiency, fracturing technology can effectively increase oil field production and improve oil field profitability. Through rational investment and application of fracturing technology, oil fields can obtain higher returns and economic benefits.

4. Analysis of key points of underground fracturing technology in oil field

(1) Selection and design of fracturing fluid

First, fracturing fluid composition selection. Fracturing fluid usually consists of water, oil seal, colloidal particles, etc. Reservoir characteristics and rock properties, as well as downhole environmental conditions, should be considered in the selection of fracturing fluid composition. The commonly used fracturing fluid components include water base, oil base and emulsion base, etc. The appropriate components are selected according to the actual situation. Second, fracturing fluid viscosity and density control. The viscosity and density of fracturing fluid are important parameters affecting fracture propagation and rock fracture. The choice of viscosity and density takes into account factors such as the nature of the rock, well depth and construction conditions. Polymer additives, colloidal particles, etc. are usually used to increase the viscosity and density of the fracturing fluid to achieve better fracture expansion. Third, fracturing fluid pH control. The pH value of fracturing fluid has a great influence on rock acidity and alkalinity, which will affect rock fracture and fracture propagation effect. According to different rock types and reservoir characteristics, the pH value of the fracturing fluid is reasonably controlled to ensure the best fracturing results. Fourth, fracturing fluid and formation compatibility. Compatibility with the formation should be considered when selecting fracturing fluid. The fracturing fluid should have good compatibility and not adversely affect formation rock and reservoir in order to avoid damaging reservoir permeability and productivity [3]. Fifth, the volume and injection rate of fracturing fluid have an important effect on fracture growth and rock fracture. According to rock properties and downhole environmental conditions, the volume and injection rate of fracturing fluid are reasonably designed to ensure adequate fracture propagation and fracturing effect.

(2) Selection of fracturing tools and devices

One is the choice of fracturing tools. Commonly used fracturing tools include fracturing tubes, perforators, expanders, etc. Factors such as reservoir characteristics, hole size and operating conditions should be considered when selecting fracturing tools. At the same time, it is necessary to select the right tool to complete the fracturing operation based on the requirements of hole diameter, fracturing fluid volume and fracturing parameters. The second is the choice of fracturing device. Fracturing device includes fracturing pump, stirring tank, flowmeter and other equipment. Factors such as construction scale, construction conditions and equipment reliability should be considered when selecting fracturing equipment. At the same time, ensure that the fracturing device can provide sufficient injection pressure and flow rate to meet the requirements of the fracturing process. Third, the reliability of fracturing tools and devices. The selection of reliable fracturing tools and devices is critical to ensure the safety and stability of the construction. Select a proven supplier and brand, and perform rigorous equipment inspections and maintenance to ensure the proper operation of fracturing tools and units. The fourth is to select supporting equipment and auxiliary tools, such as concrete mixers, high-pressure pipelines, mixing trucks, etc. [4]. These equipment and tools play an important supporting role in fracturing operations and should be selected and configured according to the construction needs. Fifth, technical support and training. The choice of fracturing tools and devices also takes into account the technical support and training capabilities of the supplier. The supplier should have extensive experience and expertise in fracturing technology and be able to provide relevant training and technical support to ensure smooth construction.

(3) Control of fracturing construction parameters

First, control the fracturing fluid concentration. Fracturing fluid concentration refers to the content of additives in fracturing fluid, including colloidal particles, polymers, sand control agents, etc. Reasonable control of fracturing fluid concentration can affect the formation and propagation of fracturing fractures. The increase of fracturing fluid concentration is positively correlated with the increase of fracture length and width, as shown in Table 1. Excessive concentration will increase the liquid viscosity, reduce the liquid permeability, resulting in the crack can not expand; Too low a concentration will not form enough cracks. The concentration of fracturing fluid should be controlled reasonably according to different geological conditions and reservoir characteristics to achieve the best fracturing effect. Secondly, focus on pressure control. The expansion and morphology of cracks can be controlled by controlling injection pressure. In general, the pressure should be gradually increased to a predetermined value and then kept stable. Excessive pressure may lead to excessive rock damage and even fracture of well walls; Too low a pressure and not enough cracks can form. Therefore, reasonable control of pressure is the key to ensure the fracturing effect. Thirdly, the injection speed and injection amount are controlled. Injection rate and injection amount have important influence on fracture propagation and fracturing effect. If the injection speed is too fast, the liquid flow will be

unstable, and the crack cannot expand fully. If the injection rate is too slow, the fracturing effect is not satisfactory. At the same time, injection volume control should also be determined according to hole diameter, fracture expansion needs and rock properties to ensure full fracture expansion and optimal fracturing effect [5]. Finally, the control of fracturing construction time is the key to ensure the construction quality. Too long construction time leads to the degradation and loss of additives in fracturing fluid, which affects the fracturing effect. Too short construction time will lead to cracks can not fully expand.

Table 1 Relationship between fracture fluid concentration increase and fracture length and width

Fracturing fluid concentration (%)	Fracture length (m)	Crack width (mm)
1	10	5
2	15	7
3	20	9
4	25	11
5	30	13

(4) Fracturing fracture control and evaluation

Firstly, fracture control technology is an important means to ensure fracturing effect. By controlling the composition and properties of the fracturing fluid, the formation, propagation and orientation of fractures can be controlled. Some common crack control techniques include the use of sand control agents, colloidal particles, and cellulose to prevent excessive crack expansion and instability. Second, the evaluation of the fracture formation after fracturing can help determine the fracturing effect and the nature of the fracture. Commonly used fracture evaluation techniques include pressure testing, resistivity logging, seismic monitoring, etc. These techniques provide information about fracture length, width, and direction to assess the effectiveness of fracturing and provide reference for subsequent well production and development. Thirdly, through numerical simulation and optimization technology, fracturing fractures are simulated and optimized to improve the fracturing effect. Numerical simulation can simulate the interaction between fluid and rock during fracturing and predict the formation and expansion of fractures. Through the simulation and optimization of different parameters and processes, the best fracturing design scheme is found. Fourth, on-site monitoring and real-time feedback during fracturing can help control fracture formation and growth. By monitoring parameters such as pressure, flow, injection speed and injection volume, the construction parameters can be adjusted in real time to achieve the desired fracturing effect. At the same time, real-time evaluation and adjustment should be made according to real-time monitoring results to improve the success rate of fracturing.

(5) Repair and plugging of fractures after fracturing

The repair and plugging of fractures after fracturing is an important step to ensure the lasting fracturing effect and the normal production of oil Wells. First, according to the characteristics of the reservoir and fracture conditions, choose the appropriate fracture repair agent. A crack repair agent is usually a curing agent or filler that can fill and seal cracks to prevent leakage and loss of fluid. Common crack repair agents include polymers, cement, resins, etc. Second, according to the crack situation and the effect evaluation after fracturing, choose the appropriate construction method and process. Crack repair can be carried out by injecting repair agents, and the location and method of injection need to be determined according to the location and size of the crack. Third, when performing crack repair, it is necessary to control the injection pressure and speed. Reasonable injection pressure and speed can ensure that the repair agent fully fills the crack, avoid too high pressure causing the crack to expand again or too low pressure causing the repair agent to not completely fill the crack. Fourth, the repair effect of cracks should be evaluated after the repair is completed. The filling condition and sealing effect of the repair agent were evaluated by monitoring injection pressure and liquid recovery rate. According to the evaluation results, the repair process was further adjusted and the repair effect was optimized. Fifth, continuous monitoring and maintenance. Post-fracture repair and plugging is not a one-time process, but requires continuous monitoring and maintenance. Through regular inspection and monitoring, possible problems can be found and repaired in time to ensure the lasting sealing effect of cracks.

(vi) Adjustment and optimization after fracturing

By evaluating the fracturing effect, adjusting the injection-production relationship, optimizing the fracturing parameters, fracture encryption and propagation, we can optimize the production capacity of the field to the maximum extent possible. First, it is necessary to evaluate the effect of fracturing after the completion of fracturing construction. By monitoring well production, pressure changes, fluid recovery and other indicators, you can assess the success of fracturing and fracture effectiveness. Based on the evaluation results, the advantages and disadvantages of fracturing are understood to provide a basis for subsequent adjustment and optimization. The second is to adjust the injection-production relationship of the well after fracturing to maximize the production capacity of the oilfield. By adjusting the wellhead valve, adjusting the pump speed and pressure, the oil and gas production and water injection volume are optimized. At the same time, it is necessary to monitor and adjust the injection-production relationship in real time to maintain a good fracturing effect. The third is to optimize and adjust the fracturing parameters according to the fracturing effect evaluation results. For example, adjusting the formula and concentration of the fracturing fluid, changing the injection speed and injection volume, etc. By optimizing parameters, the formation and propagation of fractures can be controlled better, and the effect of fracturing can be improved. Fourth, in some cases, it is necessary to further encrypt and expand the fracture after fracturing. By re-fracturing or enhanced fracturing in a fractured well, fracture connectivity and extension can be improved to increase the productivity of the well. The fifth is to develop a comprehensive optimization plan considering

the fracturing effect evaluation, injection-production relationship adjustment and parameter optimization. According to the characteristics and actual situation of the oilfield, a set of systematic optimization strategies and schemes are formulated to improve the production capacity and economic benefits of the oilfield.

5. Conclusion

As an important technology for increasing oil production, underground fracturing is of great significance for increasing oil production capacity and economic benefit. The success of downhole fracturing technology depends on the reasonable grasp of several key points. It includes the selection and design of fracturing fluid, the selection of fracturing tools and devices, the control of construction parameters, the fracture control and evaluation, and the adjustment and optimization after fracturing. These key points are related to each other, only reasonable grasp and application of them, in order to maximize the role of fracturing technology. Through the rational application of technical points, the advantages of fracturing technology can be fully utilized, the efficient development and utilization of oil fields can be achieved, and the sustainable development of energy industry can be promoted.

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