Research and exploration on acidizing fracturing technology in oilfield

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Abstract. At present, China's economic development has made unprecedented progress, all walks of life have also achieved fruitful results, and the development level of oil and gas fields has also been continuously improved. Various advanced development technologies have played an important positive role in it. Acid fracturing technology is one of the most representative technologies. In this paper, the principle of acid fracturing technology, the types of acid fracturing technology, include: acid fracturing technology of preflush, thickening acid fracturing technology, alternating application technology of fracturing fluid and acid fluid, closed acidizing technology, the last part is the application and prospect of new acid fracturing technology are studied, and the relevant conclusions are obtained for reference.

1. Introduction
The application significance of acid fracturing technology in the current oilfield development operation is to realize the increase of injection and production, especially for those carbonate oil fields, the application effect is very significant. Usually, in order to achieve all-round stimulation of the reservoir, the staff often combine the fracturing and acidizing technology with the matrix acidizing measures to ensure the stimulation effect. It should be noted that in the application of fracturing and acidizing measures, the staff should focus on mastering the relevant factors such as acid erosion rate, liquid injection intensity, rock mass type and fracture surface characteristics. After the formation is treated by fracturing and acidizing, it often forms fractures with strong permeability and conductivity. Therefore, the application of acid fracturing technology in oilfield is of great significance for improving oilfield productivity, increasing oilfield production and reducing oilfield development consumption. Compared with the common proppant fracturing technology, the oilfield acid fracturing technology has obvious advantages although its principle is similar. The application effect of acid fracturing technology in the oil reservoir with low permeability, low porosity and poor reservoir homogeneity is very significant. In the development of the oilfield under this condition, the application of acid fracturing technology can effectively ensure the development effect of the oilfield. The essential reason is that although acid fracturing technology is compared with proppant fracturing technology, its application purpose is to make the oilfield fracture wider and more flowable, so as to ensure the improvement of drainage capacity. Specifically, when the proppant fracturing technology is applied, the workers often fill the fractures with ceramsite and quartz sand, so as to avoid the problem of fracture closure due to pressure reduction, which effectively ensures the liquidity of fractures. However, in the application of
acid fracturing technology, the workers only use the uneven fracture surface effect, and do not need to use proppant. Based on the difference between acidizing pressure and proppant fracturing technology, the workers should know clearly that acidizing fracturing technology is more applicable when they are working in dolomite oilfield or limestone oilfield. In addition, because the acid fracturing technology does not need proppant in practical application, its application process is more simple and has strong applicability. However, the cost of acid required in the application process of acid fracturing technology is higher. Therefore, the application of acid fracturing technology in oilfield operation has not been popularized at present.

2. Principle of acid fracturing technology
In the actual oil and gas field development, we found that the application of acid fracturing technology in oil and gas field development can greatly improve the production of oil and gas fields. Specifically, the working principle of acid fracturing technology is to use acid as fracturing fluid to pour into the target layer, so as to replace other proppant. After the oil and gas reservoir is filled with acid, the acid will gradually fill every small joint, and then corrode the objects in the joint, and finally make the joint begin to increase and widen. After the acidizing fracturing is stopped, the formed joint can not be restored to the original state, the conductivity of the target layer will be improved naturally, and the permeability of the oil and gas field will be improved. At the same time, all kinds of minerals contained in the rock layer are usually alkaline. When contacting with acid solution, strong neutralization reaction will occur to generate water-soluble salts and some gases. In the process of acid solution continuously injected into the target layer, the dissolution rate of minerals will be faster and faster, and the cracking rate of oil-gas seam will also increase. Its permeability will continue to improve, and ultimately achieve the effect of enhancing oil and gas field production.

![Fracturing Diagram](image-url)

Figure 1. Acidizing fracturing operation and effect drawing

3. Types of acid fracturing technology
The application of acid fracturing technology in oilfield production mainly includes matrix acidizing, acidizing and acid fracturing. Therefore, when applying acid fracturing technology in oilfield operation,
the staff should pay attention to the reaction speed of acid rock, the actual length of acid corrosion fracture and the acid pressure control. Specifically, acid fracturing technology includes thickening acid fracturing and combined closed acidizing, and pre fluid technology and multi-stage alternate injection technology.

3.1. Acid fracturing technology of preflush
Because the pre fluid involved in acid fracturing process has strong viscosity, through its full application, it can realize the formation fracturing. This is because the application of acid fracturing technology in oilfield operation can not only effectively reduce the temperature of surface rock mass, but also effectively limit the fracture size. The staff can effectively control the application distance of the preflush between the rock and the acid to ensure that it can enter the longest fracture. At the same time, the acid fracturing treatment of the oilfield by using the pre fluid has a strong viscous effect, which is helpful to form uneven grooves of the acid fluid, so as to achieve the goal of improving the fracture conductivity. The staff should also pay attention to the effective control of the viscosity ratio of acid liquid and preflush to ensure the viscosity effect. At this time, because once the viscosity ratio is too small, viscosity is not high, it will greatly increase the flow rate of acid. In addition, the staff should also strengthen the control of the filter cake speed, once the filter cake and the crack surface appear the phenomenon of adhesion, the acid will quickly penetrate the filter cake, and finally form holes. Therefore, the staff must control the acid loss rate to ensure the acid fracturing effect.

3.2. Thickening acid fracturing technology
In thickening acid fracturing technology, thickening acid is mainly composed of additives, thickeners and acid solution, and hydrochloric acid is a common component in the configuration of acid solution. Therefore, the significance of thickening acid is to effectively improve the viscosity of acid system by adding water-soluble polymer in the acid. The thickening acid fracturing technology is divided into two categories according to type, including crosslinking gel acid and thickening agent. In the practical application of oilfield operation, it is often necessary for the staff to divide it according to the type, so as to distinguish the acid concentration and type. Usually, in those reservoirs with ordinary permeability for oilfield production, the staff can ensure the formation of acid corrosion fractures of about 30 meters through the use of thickened acid. It should be noted that the application effect of thickened acid is not ideal in those formations with enhanced or poor permeability. At the same time, the staff should also pay attention to the reverse drainage problem in the practical application of thickened acid to avoid the adverse effect of high viscosity of thickened acid. In addition, the application of thickened acid in oilfield development can not only improve the conductivity of acid, make it better penetrate the formation, but also avoid the damage to the environment caused by secondary acidification.

3.3. Alternating application technology of fracturing fluid and acid fluid
In some special cases, the alternative application of fracturing fluid and acid fluid can be used to ensure the effect. It refers to a method of alternately injecting fracturing fluid and acid into target layer respectively. The advantage is that it can expand larger area of gap faster in a short time, and the amount of acid and fracturing fluid required will also be reduced. In addition, we must consider the alternating order between the two when applying this technology, and we cannot carry out it at will, otherwise the final development effect will be affected by adverse effects. Usually, the prepositive solution is used first and then the acid is injected into it. Only in this way can the loss rate be controlled to avoid unnecessary waste. At the same time, we should inject acid solution in batches and times, so as to improve the number of gaps produced by acidizing.

3.4. Closed Acidizing technology
Usually, when facing the closed fracture in the oilfield, the staff can fill a small amount of acid into it appropriately to ensure that the fractures between the wellbore and the borehole can be kept open. It is important to note that when filling the closed fracture with acid liquid, the ratio of acid liquid should be
strictly controlled to ensure that the proportion of acid liquid injected is in a suitable state so that the bottom hole and upper air flow can be closely combined. Once the conditions are found, the workers can combine closed acidizing with multi-stage alternating technology in the process of oilfield operation. This requires that the staff should inject acid and prepositive fluid into the fracture in alternate order in order to improve the effect of acid pressure, and greatly reduce the loss of filtrate, and effectively widen the fracture in the oilfield and improve the corrosion effect of acid solution. Because of the strong erosion of fracture opening by closed acid, the application of closed acid can not only achieve the purpose of acidizing and increasing production, but also greatly improve the conductivity. Therefore, compared with other technologies, the combined closed acidizing technology has better effect in acidizing construction with large displacement.

4. Application of new acid fracturing process

Compared with developed countries, the application and development of acid fracturing technology in China's oilfields is not perfect, and there is still room for progress. At present, when applying acid fracturing technology in the oilfield, the staff should comprehensively consider the lithologic characteristics and stress characteristics of the oilfield layer, and then select the best construction technology to improve the oilfield productivity. This requires the relevant staff to accurately investigate the local geological conditions of the oilfield in advance before the actual construction, so as to avoid that the application effect of acid fracturing technology is greatly reduced due to unclear understanding of the geological conditions. Through the application of acid fracturing technology in oilfield, the purpose of increasing production can be achieved, which is very important for the development of oilfield. Therefore, in the future, the staff should also focus on the more complex special block reservoir, in order to realize the effective optimization and improvement of ultra deep well and deep well fracturing technology, and lay a solid foundation for the improvement of oilfield productivity. At the same time, the staff should also focus on the application of acid liquid composite system in oil and gas reservoirs, which plays a positive role in improving oilfield productivity and improving production efficiency.

4.1. Technology of toe sliding sleeve

The basic component consists of three parts, one is fracturing control device, the other is delay control system and inner piston. When the pressure test reaches the standard time, the inner piston moves in place, the sliding sleeve is fully opened, and the wellbore formation circulation channel is established. It is mainly used for the integrity pressure test before the target formation is opened and the flow channel is constructed, which can replace the first section perforation.

![Figure 2. Schematic diagram of toe sliding sleeve structure](image_url)

After the first successful application of toe sliding sleeve technology in Shengye 20-2HF well, the technology has been widely used in many oilfield.
4.2. Technology of infinite sliding sleeve
The basic part consists of three parts, the main body of sliding sleeve; Opening tools; Seal the ball. After the completion of the infinite sliding sleeve drilling, the casing string will be run into the target layer, so it is not necessary to perforate during the fracturing operation. The jacket and the soluble ball will be put in to open the sliding sleeve channel, and the fracturing operation will be carried out directly. The application of infinite sliding sleeve staged fracturing has unlimited stages, full bore after fracturing, uniform hierarchical reconstruction, small construction scale, low cost, fast and efficient, and can achieve rapid production and completion.

![Figure 3. Structure diagram of infinite sliding sleeve](image)

In November 2020, the infinite sliding sleeve technology was applied in Longye 1-2HF well, creating the highest number of fracturing operation sections in single 24 hours per day in "single well eight sections per day".

In March 2021, the infinite sliding sleeve fracturing technology was applied in Shengye 2-11HF well, and 12 fracturing sections were successfully completed in one day, setting the highest number of fracturing sections in a single well group in a single day for domestic shale gas horizontal wells.

5. Conclusion
The application of acid fracturing technology in the development of oil and gas fields can effectively improve the production of oil and gas fields, but also improve the speed of oil and gas field development, and make an important contribution to the development of China's oil and gas development. At present, closed acid fracturing technology, preflush acid fracturing technology, alternative application of fracturing technology and so on are relatively common and the application effect is outstanding. In the future work, we need to further study the acid fracturing technology, strive to find an effective development direction, and seek more efficient development technology.

At present, acid fracturing technology is mainly used in the development of those large-scale Low-permeability Oilfields, and its purpose is to improve the productivity of oilfields. The application effect of this technology is particularly obvious in those more complex oilfield development operations. Therefore, the staff should pay attention to the mastery of acid fracturing technology, and will improve its application effect.

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