Optimization of Key Parameters of Tight Cut Fracturing Cracks for Horizontal Well Development of Tight Sandstone Gas Reservoirs

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Abstract. The permeability of dense sandstone gas deposit substation is very low, and it is often developed by horizontal well-tight cutting fracturing. The pressure crack network determines the production capacity of the gas well, so the optimization of the seam mesh parameters is the key problem in the efficient development of dense sandstone gas deposit. In order to solve the problem of multi-parameter comprehensive optimization of fracking horizontal wells, based on the principle of unstable seepage, a model for predicting the yield of fracking gas storage horizontal wells considering crack interference is established, and different crack conductivity, crack length, different crack patterns, crack spacing and number of crack clusters are designed in the model to simulate production, and the optimal fracking crack parameters are compared. Using numerical simulation method to analyze the main control factors of horizontal well fracturing effect, obtain the optimal parameters of fracking cracks, and provide ideas and reference for horizontal well fracturing construction in dense sandstone gas storage sites, which has certain theoretical guidance significance.

1. Introduction

Horizontal well hydro-fracturing technology is an important means to exploit low-permeable oil and gas reservoirs, which has been widely used in recent years. The theory and practice have proved that the parameters such as crack conductivity, crack length, crack pattern, crack spacing, number of crack clusters and horizontal segment length have a significant impact on the yield of dense sandstone gas storage horizontal wells, and the selection of these parameters is of great significance to the construction of dense sandstone gas storage fracturing and has important guiding significance for the efficient development of fracking horizontal wells. Zeng Fanhui et al. based on the theory of reset potential and potential overlay principle, established the fracking horizontal well production capacity prediction model, analyzed the impact factors of fracking horizontal well capacity, but most of them only discussed the change of horizontal well capacity when the parameters changed individually, rarely compared the sensitivity of each parameter to the impact of capacity, and did not carry out the preferred study of the fracturing parameters. Based on the gas properties and state equations, this paper establishes a numerical model of the work area, analyzes the influence of single factors such as horizontal segment length, crack conductivity, crack length, crack pattern, crack spacing, crack cluster number, etc. on fracturing horizontal well production capacity, and makes the construction parameters of each crack preferred, which is of
Theoretical guiding significance to site construction. It is also of great significance to the technique of horizontal well-cut fracturing of dense sandstone gas storage.

2. The establishment of oil storage numerical simulation model

The numerical simulation technology of oil storage is an important part of modern oil storage engineering, and it is a method and means to study and understand the oil storage. It uses computers to simulate and study the dynamic processes of the oil deposit. Compared with the traditional method of oil storage engineering, the oil storage simulation has many considerations, can design a variety of development programs and other advantages, is currently the most powerful prediction tool for oil storage engineers. Qiulin block Shaxi Temple gas collection is mainly composed of JS21, JS22, JS23, JS24, JS31 gas layer vertical stacking, JS22 layer as the main production layer. Using the work area data, the mathematical model is built using the Petrel tool, and on the basis of geological modeling, the coarse reservoir model is as follows: (Figure 1.)

![The coarse reservoir model](image)

a. The porosity model of the mathematical mode

b. The penetration model of the mathematical mode

**Figure 1.** The coarse reservoir model

The above model is roughed, and the settings of the coarse model include the flat grid and the hanging grid setting, depending on the requirements of the reservoir and reservoir distribution and the numerical simulation of the reservoir during the setup process. In order to make the results of the mathematical model as fine as possible, combined with the speed of the mathematical mode operation, the resolution of the flat mesh is 30×30, the vertical mesh accuracy is between 0-1m, and the mesh of the final coarse model is 130×63×20, for a total of 163,800. According to the requirements of the digital model, the grid and property model of the output work area provide parameters for the numerical simulation of the oil deposit.

The data of the study area are collated, and the data of high-pressure material PVT and the relative permeability curve of oil and water are shown in the figure below:
The horizontal well length is optimized

The horizontal well length is one of the important factors affecting the development effect of horizontal well, so the choice of horizontal well horizontal segment length is also very important. The horizontal segments of different lengths are designed for simulation, 720m, 840m, 950m, 1080m and 1200m, respectively. The simulation results are as follows (Figure 4.):

![Figure 4. Different length of horizontal well diagrams](image-url)

Figure 4. Different length of horizontal well diagrams

Depending on the length of the horizontal segment of the design, the simulation results are as follows(Figure 5.-Figure 8.):
The longer the horizontal segment length, the greater the seepage area of the gas, the higher the output of the gas well. Generally speaking, the longer the horizontal segment length, the greater the cumulative output of the gas well, but the increase in the horizontal segment length will lead to a significant increase in the drilling costs of the well. Therefore, the choice of horizontal well horizontal segment length should be combined with economic costs, preferably the largest economic benefits of the flat segment length. According to the results of numerical simulation, the horizontal well yield is best when the length of the horizontal segment is about 900m.

4. The construction parameters of dense cutting fracturing are optimized
The yield after horizontal well fracturing has a great relationship with the flow conduction capacity of cracks, so it is necessary to select different crack conduction capabilities. There are five types of crack conduction capabilities for analog designs: 10mD · m, 100 mD · m, 200 mD · m, 500 mD · m, and 1000 mD · m. The results of the calculation simulation are as follows (Figure 9.-Figure 10.):
According to the calculation results, it can be seen that with the increase of the crack conductivity, the cumulative yield is also increasing, but in general, the crack conductivity has little effect on the gas well yield, and the optimal conductivity is about 100mD.m according to the relationship curve between the conduction capacity and the cumulative yield.

The different parameters of horizontal well fracturing construction process will lead to differences in the length of cracks generated by fracking, different crack lengths have a greater impact on the development effect of gas wells, using Eclipse software to simulate the different seam lengths of horizontal wells to study the effect of seam length on yield, setting different crack lengths of 35m, 45m, 55m, 70m, 80m, the simulation results are shown in Figure 11:

According to the simulation results, the cumulative yield increases with the length of the fracking crack. However, on the whole, the length of the crack has little effect on the yield, that is, as the length of the crack increases, the yield increment decreases.

According to the experience of on-site construction, the production effect of the pressure cracks in the following forms is better, so the three different forms of cracks are simulated, respectively, interleaved cracks, iso-long cracks, U-shaped cracks, W-shaped cracks, crack pattern schematics are as follows:
The simulation results are as follows (Figure 16.):

From the simulation results, under the condition that the total seam length is unchanged, the pattern of the crack has less effect on the yield, but in general, the production effect of the W-shaped crack is slightly better.

Crack spacing also affects the capacity of gas wells, so crack spacing needs to be preferred.

The set crack spacing is 90m, 100m, 120m, 200m, and the software simulation results are as follows (Figure 17.- Figure 18.).
With the increase of crack spacing, the cumulative yield of gas wells decreases, which is due to the interaction between cracks. Depending on the relationship between the cumulative yield and the crack spacing, the optimal seam spacing is 108m.

The number of crack clusters is an important parameter in the process of increasing production and transformation of dense reservoirs, and the number of different crack clusters has a great influence on the production capacity of horizontal wells. Here, the following types of crack clusters are simulated, namely 2 clusters, 3 clusters, 4 clusters, 5 clusters, to study the impact of different crack clusters on the production capacity of horizontal wells. The simulation results are as follows (Figure 19.- Figure 20.):

As can be seen from Figures 19. and Figures 20., the larger the number of crack clusters, the higher the capacity of the gas well, but when the number of crack clusters is greater than 6, with the increase of the number of clusters, the cumulative yield of the gas well changes, the optimal number of crack clusters selected is 6-8, that is, when the number of crack clusters is 6-8, the development effect of horizontal wells is the best.

5. Conclusion

(1) Combining the gas properties and state equations, a numerical model of the work area is established, and the influence of single factors such as horizontal segment length, crack conductivity, crack length, crack pattern, crack spacing, crack cluster number and so on is analyzed.

(2) According to the results of numerical simulation, it can be seen that the horizontal well yield is best when the length of the horizontal segment is about 900m. The optimal crack conductivity is about
100mD.m, the pattern of the crack has less effect on the yield, but overall, the production effect of the W-shaped crack is slightly better, the optimal crack spacing is 108m, and the optimal number of crack clusters is 6-8, i.e. when the number of crack clusters is 6-8, the horizontal well development effect is the best.

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