Numerical Simulation Study on Optimized Cracks in Shale Gas

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Abstract

With the rapid development of the national economy, shale gas as an important non-conventional energy and clean energy in the national energy strategy plays a decisive role. Most of the shale must be fractured in order to carry out commercial exploitation, so the study of crack optimization, the use of numerical simulation of shale gas method, not only to study the shale gas seepage law, analysis of its production factors, and can And provide theoretical support for engineering theory and industrial development of shale reservoir fracturing.

Keywords

Shale Gas, Numerical Simulation, Crack Optimization.

1. Block overview

The target block for this design is Shale A block. The block is the hilly and mountainous area in the south of China, and it is subjected to the compressive stress from the northwest direction, and the positive structure is dominated by the oblique belt. Elevation up to 600m, the minimum 300m, more in the 300 ~ 500m between the target block in the figure marked in red, the inflection point coordinates as shown in Table 1.

Table 1. Regional inflection point coordinates

Inflection point	X coordinate	Y coordinate
1	17646600	3056000
2	17647600	3056000
3	17657400	3057400
4	17657400	3056200
5	17646600	3056200

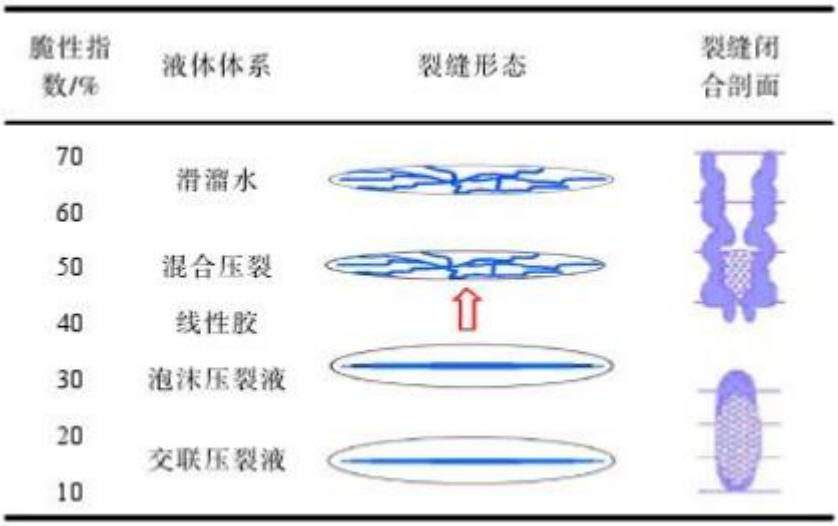

Fig.1 Relationship between brittleness and fracture morphology of rock mechanics

2. Shale gas fracturing fluid is preferred

Shale gas fracturing process, only continue to produce various forms of cracks, the formation of cracks network, fractured gas wells are likely to get industrial air. Rock mechanics experiments show that the brittle characteristics of rocks are the most important rock mechanics characteristic parameters of shale gas fracturing forming seam. According to the practical experience of the development of shale gas in North America, the relationship between rock brittleness index and post - press crack morphology is given. Fracturing fluid system is generally based on the rock brittleness index, generally with the brittleness index increases, the more fracturing fluid dosage, the lower the proppant concentration, the amount of proppant less[1].

The brittleness index of the shale is 55.3%. According to the relationship between brittleness and fracturing model, the fracturing fluid system is fractured, that is, slip water + glue system.

3. Optimization of Cracks by Numerical Simulation

Drilling of horizontal wells in shale gas reservoirs increases the contact area with the reservoir, but no fracturing is essentially free of natural capacity. In addition, due to the particularity of reservoir conditions, the general fracturing often formed a crack at the weak ground stress, still low after the pressure, only through the fracturing in the horizontal wells to form a number of cracks in order to significantly increase production. What types of fractures are needed to implement horizontal fracturing in horizontal wells, how many fractures are needed to be fractured, how to form cracks, how many fractures are formed, and whether the fracture parameters can meet the conditions of reservoirs Through the construction site to achieve, these parameters meet the economic requirements, to answer these questions, it is necessary to optimize the fracturing cracks [2].

First, explicitly optimize the object. In the established reservoir conditions, such as reservoir physical and other factors are objective existence, cannot man-made change, not to mention optimization. It is possible to optimize the elements that can be changed, such as the number of fractures, the number of segments per segment, the number of cracks, the length of the cracks, the location of the cracks, and so on, which affect the production parameters and construction of the crack parameters is the object of optimization. Second, we must clearly optimize the goal to be achieved. Fracture parameters to meet the requirements of the reservoir, to consider whether the realization in the field, the economy is effective, such as elastic mining conditions, the greater the number of cracks means that the higher the initial production, but also means that the construction capacity requirements The increase in construction risk and the increase in economy and investment, and ultimately the realization of efficiency development also need to conduct a specific evaluation. Therefore, the optimization of hydraulic fractures should take into account the factors of reservoir, construction and economy. The goal of optimization is to make the optimized fracture parameters and construction parameters meet the requirements of reservoir, construction and economy at the same time. Again, make sure to achieve the goal of optimizing your goals. For the optimization of the parameters of the fracturing parameters of the shale, the method is based on the numerical simulation of the reservoir to optimize the crack parameters and obtain the fracture parameters such as the number of cracks, the length of the crack, the capacity of the fracture and the crack location. On this basis, The construction parameters are optimized by crack simulation, and the construction parameters such as construction scale are obtained. The optimal parameters of cracks and construction parameters are evaluated economically, and finally the fracture parameters and construction parameters are determined.

(1) Using the reservoir numerical simulation software to establish a horizontal well fracturing model with multiple fractures,

Numerical simulations to study the effects of cracks, length and position on yield.

(2) On the basis of (1), the fracturing design software was used to establish the model,

Simulation, study the relationship between fracture geometry and fracturing scale,

(3) On the basis of (1) and (2), the economic evaluation model is used to input the evaluation parameters and evaluation. The effects of different fracture morphology, fracture number, fracture location and spacing, and economic efficiency under fracture length were studied. Benefit and construction risk, these parameters are economically optimized, so as to obtain the optimal fracture spacing, the number of cracks, Fracture location and crack length and other parameters.

3.1 The establishment of the model

In this paper, the optimization of the crack parameters using CMG shale gas module to carry out simulation studies, through the establishment of YY5 Well 5-layer dual-media model to simulate the number of cracks, crack spacing and crack length,Under the program gas production. Draw the yield change map under each factor, and finally get the optimization result[3].

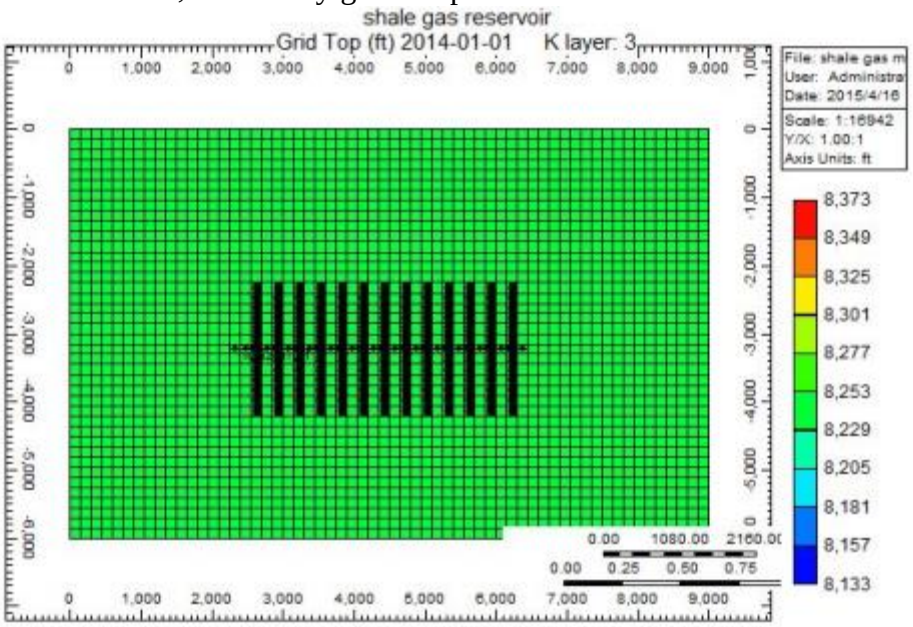

Figure 2. Schematic diagram of the purpose of the geological model

The above figure is the geological model established. The model is 150mm × 150ft × 60ft grid, horizontal, vertical grid number of 60,40, respectively, divided into five vertical; input competition to the data, create a horizontal horizontal length of about 1500m; And then perforation, adding fracturing cracks; in order to ensure the accuracy of fracture simulation, for each added cracks for local mesh encryption. The figure shows that the 13 fractures of the model map.

1.2 Optimization of crack length

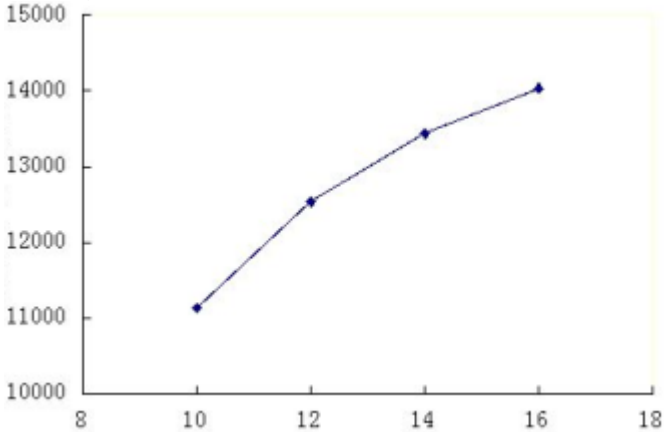

Figure 3. Cumulative output and the number of cracks segment diagram

It can be seen from the above figure that when the number of cracks is less than 12, the cumulative output increases rapidly in 5 years. When the number of segments is more than 12, the yield increases obviously with the increase of the number of cracks, so the optimal number of cracks is 12 Segment (the above figure for the segment spacing 90m, crack half-length 280m simulation results).

1.3 Crack half-length optimization

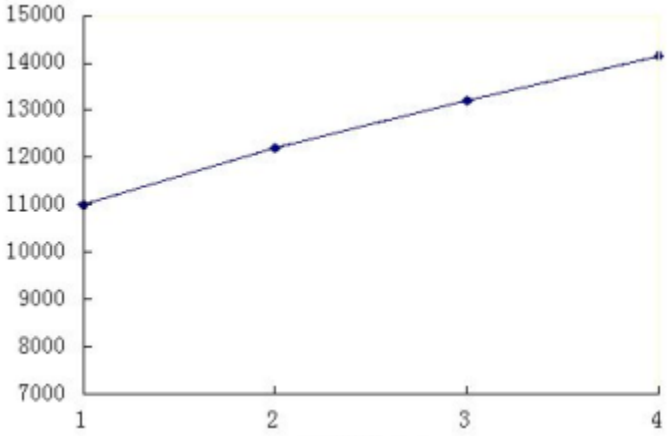

Figure 4. Cumulative yield and fracture half-length relationship diagram

It can be seen from the above figure that when the crack length is less than 250m, the accumulated output increases rapidly in 5 years. When the crack is more than 300m, with the increase of the crack, the yield is obviously weakened, so the optimal half length is 250 ~ 300m The above figure for the segment spacing 90m, crack segment number 12 simulation results).

4. Conclusion

(1) Fracturing fluid system is generally based on the rock brittleness index, generally with the brittleness index increases, the more fracturing fluid dosage, the lower the proppant concentration, the less the amount of proppant.

(2) General fractures are often weak in the ground to form a crack, still low after the pressure, only through the fracturing in the horizontal wells to form a number of cracks in order to significantly increase production.

(3) Using the economic evaluation model, the evaluation parameters and evaluation indexes are input, and the economic benefits and construction risks of different fractures, fractures, cracks and spacing, fracture length are analyzed and analyzed, and the optimal parameters are optimized. Fracture spacing, number of cracks, fracture location and crack length and other parameters.

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