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Fracture Height Control Analysis of Different Reservoir Interval Thickness in HangJinqi Shiguhao Block

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Abstract

The relationship between gas and water in in Shiguhao block of HangJinqi is complicated, some areas show the characteristics of upper gas reservoir and lower water reservoir, and the interlayer between gas and water layer is not developed, so the blocking effect is poor, how to control water and increase gas has become the key to the effective development of horizontal wells in Hanggin Block, in this paper, stress ratio method, empirical formula method and comprehensive analysis method are used to analyze the controlling factors of different reservoir thickness on fracture height after pressure, and the range of different reservoir thickness controlling fracture height is obtained, it provides certain technical support for water control and gas enrichment in the later period.

Keywords

Shiguhao Block L; In Your Paper Reservoir Interval Thickness; Crack Height Control.

1. Introduction

He 1 in the target area of HangJinqi Shiguhao block is generally water-bearing, and the lithology and thickness of the interlayer between He 2 and He 3 are quite different, as shown in figure 1. Through early research and field test, a small scale plug removal and fracturing technology has been preliminarily formed for the multi-stage external sealing and segmented fracturing technology, and the results of plug removal have been obtained, however, some horizontal wells in He 2 and He 3 have the possibility of artificial fracture communication with He 1 Aquifer, which increases the liquid-gas ratio of single well and affects the productivity of single well, as shown in Table 1.

In the process of hydraulic fracturing, when the oil and gas layer is very thin or the stress difference between the producing layer and the upper and lower interlayer is small, the fracture often breaks through the interlayer and extends in the direction of fracture height, which not only causes the waste of fracturing fluid resources, and will cause the crack height to be too big and the crack length to be too small to achieve the design request. Based on the investigation of the literature on controlled fracture and high-pressure fracturing at home and abroad, Hu Yongquan, Li Yongming, Hu Yangming and others have established the mathematical model of fracture three-dimensional extension to study the law of fracture longitudinal extension, determination of stress difference, thickness and construction parameters (fluid filtrate loss, viscosity, etc.) are the main parameters affecting fracture height extension. Based on the understanding of reservoir geology in target area of Shiguhao and the effect of pre-reformation, the relationship between the effect of reformation and the thickness of reservoirs and barriers is analyzed, and the critical value of effective reformation of reservoirs and barriers in HE2 and HE3 in target area is determined.

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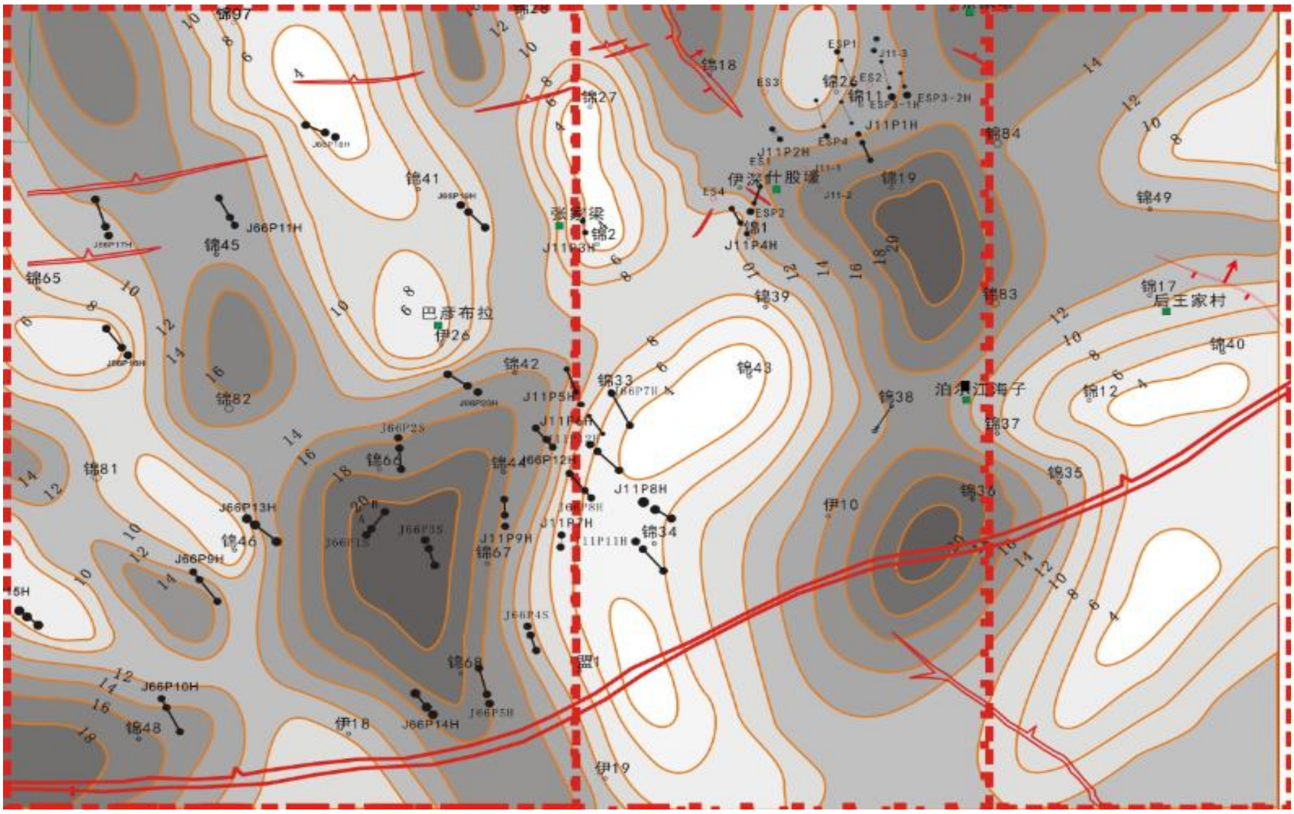

Fig. 1 Sketch of interval thickness between target zone box 2 and Box 1

Table 1 Statistical table of high fluid production of single well in target area of Shiguhao

Well	formation	Horizontal length (m)	fracturing segments	Single stage sand addition m3	Total sand addition m3	Top Sand m3	Construction Displacement m3/min	Ground inflow m3	Daily gas production 104m3/d	Daily production m3/d	Open flow 104m3/d
J11P9H	He3	582	6	21.8	130.5	25	3.7-4.0	1155.1	0	7.9	0
J66P7H	He3	989	6	11	65.5	11.5	2.9-3.1	555.7	0	16	0
J11P11H	He2	1050	9	16.7	150.4	18.3	3.2-3.5	1061	2.1951	35	3.4297
J66P1S	He2	774	6	21.4	128.3	22	3.0-3.5	984.7	0.447	8.5	0
J66P10H	He2	1000	9	10.9	98.4	11.5	3.0-3.1	752.8	0	12.6	0

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2. Ratio method of net pressure to reservoir stress difference

The formation stress difference is the main factor controlling the growth of fracture height. D. M. Talbot believes that 1.4-4.8 MPA formation stress barrier can effectively slow down or stop the growth of fracture height. With the increase of the ratio of net pressure to in-situ stress difference, the fracture height shows an accelerating trend, because the smaller the in-situ stress difference is, the smaller the closing pressure is to restrain the fracture extension, which increases the net opening pressure acting on the fracture wall, this inevitably leads to an increase in the crack height, as shown in figure 2.

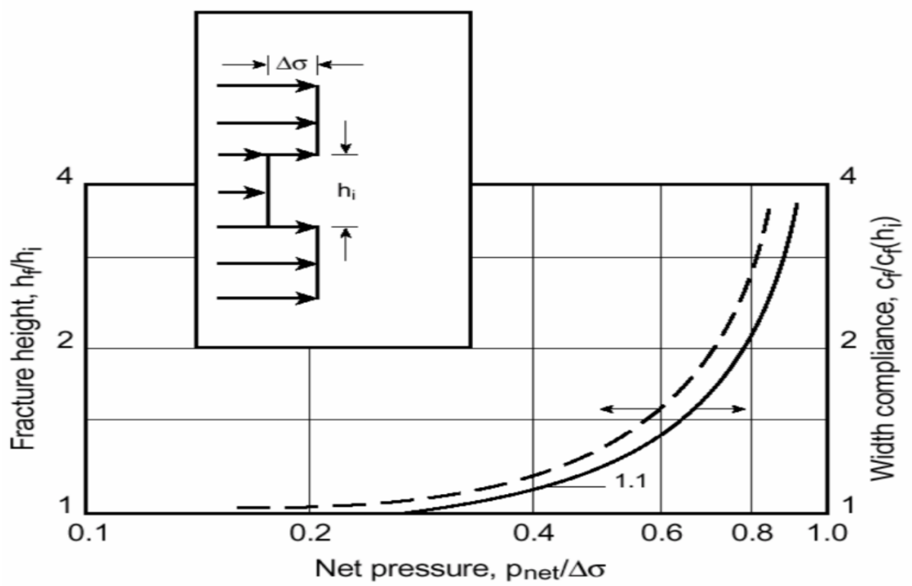

Fig. 2 The relationship between the ratio of net fracture pressure to the stress difference of the reservoir and the fracture height and width

1. If the ratio of net fracture pressure (Pnet) to reservoir-barrier stress difference (△) and Pnet/△≤0.65, the fracture height is completely controlled, and the thickness of bottom cap is not required;

2. If 0.65≤ PNET/△≤0.85, the fracture height can be controlled, but the thickness of the bottom cap must be at least half of the thickness of the production layer;

3. If Pnet /△≥0.85, the crack is out of control.

Statistical target area horizontal well construction pressure, and use fracturing construction string friction software to calculate string friction, the results show that the net pressure in the joint is 35MPa, the hydrostatic pressure is 24MPa, the friction resistance of the pipe is 8.2 MPA, the friction resistance of the sliding sleeve is 5MPa, the minimum horizontal principal stress is 42mpa, and the stress difference of the reservoir is 4MPa.

According to the ratio method, PNET/△ = 0.75, between 0.65 and 0.85, that is, the artificial fracture height in the target area is controllable, but the thickness of the bottom cap layer is at least half of the thickness of the production layer.

3. Empirical Formula Method of construction parameters and crack height (amendment)

In order to control the unfavorable propagation of crack height, the controllable and uncontrollable factors of crack height should be analyzed and studied. It is found that formation parameters are uncontrollable factors affecting fracture height, fracturing fluid properties and construction parameters are controllable factors, and weakening the influence of uncontrollable factors on fracture height is an effective means to reduce the unfavorable propagation of fracture height. Wang Hongxun

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in "hydraulic fracturing design numerical calculation method, " a study shows that: Construction Displacement and fracture height of the exponential change, statistics Hanggin Banner block early construction well construction parameters and well temperature logging interpretation results [2], the relationship between the construction displacement and the fracture height measured by well temperature is obtained as follows: h = 3.02E0.77Q.

In the early stage, the small scale plugging and fracturing was used, and the construction displacement was controlled at about 2.5 m 3/min. According to the revised empirical formula method, the fracture height was calculated to be 20.7 m, that is, the reservoir thickness and the thickness of the overlying interval under 2 times were more than or equal to 20.7 M, the crack height can be controlled within this layer.

4. Empirical Formula Method of construction parameters and crack height (amendment)

The above two methods are relatively single to control the crack height by means of geological and engineering parameters, and have some limitations. Combining the advantages of the above two methods, using the implicit formula of the conclusions and the boundary conditions of the reservoir and compartment, the following inequality equations are obtained:

$$\text{Inequality system:} \begin{cases} Y \leq 2X \\ Y + 2X \geq 20.7 \end{cases} \tag{1}$$

$$\text{Boundary Condition:} \begin{cases} Y > 0 \\ X \geq 0 \end{cases} \tag{2}$$

In the formula, Y is the thickness of reservoir sand body and x is the barrier layer under the reservoir. It is assumed that the barrier layer above is equal to the barrier layer below.

By solving the inequality equations, as shown in figure 3, the following conclusions can be drawn:

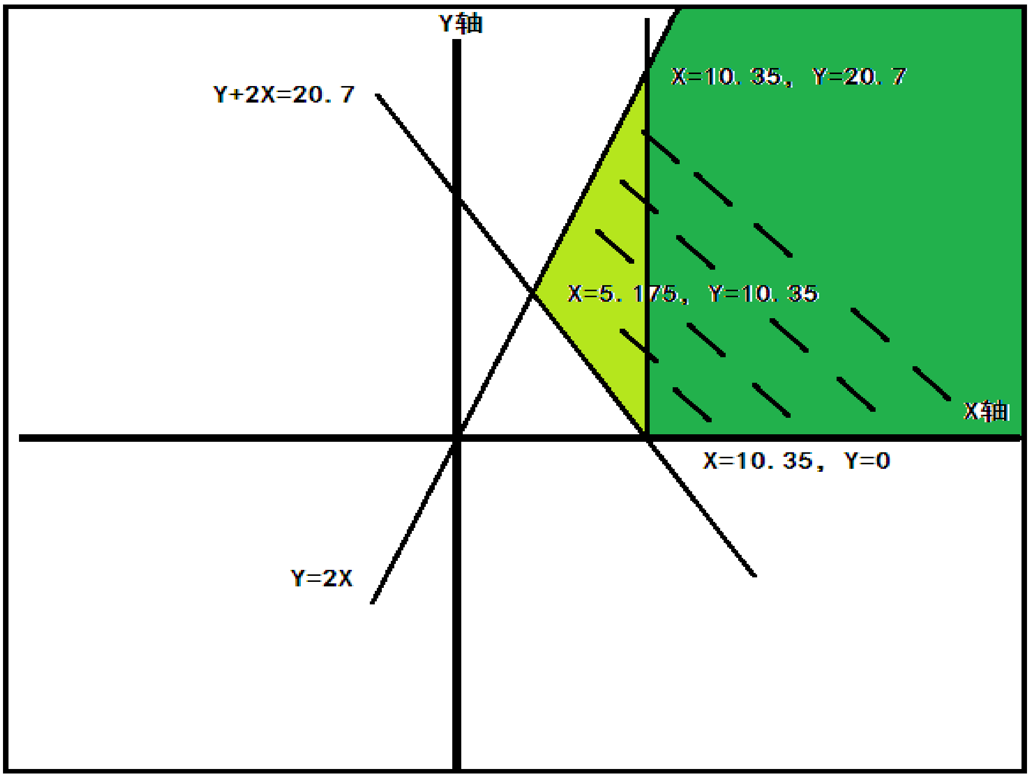

Fig. 3 Solution of inequality equations

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1. If the interlayer thickness is less than 5.2 m, the height of the artificial fracture can not be controlled effectively;

2. If the interval thickness is between 5.2 m and 10.4 M, there are two cases: if the reservoir sand body thickness is more than 10.4 m, the interval thickness should be more than half of the reservoir sand body thickness; otherwise less than 10.4 m, the sum of 2 times interval thickness and reservoir thickness is more than 20.7 M;

3. If the interval thickness is more than 10.4 m, the interval thickness should be more than half of the reservoir sand body thickness.

Up to now, 14 horizontal wells in the target area of Shiguhao have been used in small-scale plug removal and fracturing. The statistical analysis shows that 11 out of 14 horizontal wells accord with the above-mentioned characteristics.

Table 2 Statistical table of small scale unplugging and fracturing horizontal wells in Shiguhao target area

Well	formation	Thickness m	Interlayer thickness m	Construction Displacement m3/min	Average sand addition m3	Maximum sand addition in a single section m3	Ground inflow m3	Daily gas production 104m3/d	Open flow 104m3/d	Daily production m3/d	Classification	fits the pattern
J66P7H	He3	12	4	2.9-3.1	11	11.5	555.7	0	0	16	I	√
J66P18H	He2	16	2	2.4-2.5	13.4	15.2	816.2	3.7733	10.0868	1.9	I	×
J11P4H	He2	10	10	2.8-3.0	12.7	13.8	684.2	5.3447	10.0888	4.2	II	√
J11P8H	He2	12	6	2.8-3.1	12	14.5	705	2.547	3.9281	3.4	II	√
J11P11H	He2	14	6	3.2-3.5	16.7	18.3	1061	2.1951	3.4297	35	II	√
J66P12H	He2	8	8	2.4-2.5	10.2	10.3	461.4	0.848	1.1585	27.3	II	√
J66P16H	He2	15	6	2.4-2.5	9.1	9.7	605.4	0	0	23.4	II	√
J66P19H	He2	12	10	2.4-2.5	15.1	16.5	1051	3.1795	5.1182	8.4	II	×
J11P12H	He2	13	14	2.9-3.0	16	18.1	1343.4	6.6485	9.3145	1.7	III	√
J66P1S	He2	14	20	3.0-3.5	21.4	22	984.7	0.447	/	8.5	III	√
J66P5H	He2	14	15	3.0-4.1	12.4	12.9	1117.4	4.3643	10.8388	1.8	III	√
J66P9H	He2	22	12	3.0-3.1	11	11.6	801.1	4.7531	10.8966	4.2	III	√
J66P10H	He2	18	14	3.0-3.1	10.9	11.5	752.8	0	0	12.6	III	×
J66P11H	He2	22	12	3-3.5	14.2	15.1	841.6	2.9491	11.453	2.4	III	√
J66P13H	He2	10	12	2.6-2.8	9.4	9.9	688.2	2.2579	2.3282	7.5	III	√

Note: Type I reservoir interval: Interval thickness is less than 5.2 m; type II reservoir interval: Interval thickness is between 5.2 m and 10.4 m; type III RESERVOIR INTERVAL: Interval thickness is more than 10.4 m.

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5. Summary

(1) the estimation and determination of fracture height has become one of the most important factors in the process of fracturing, and different reservoir thickness and characteristics have different effects on the gas-water relationship.

(2) by ratio method, Pnet is between 0.65 and 0.85, the artificial fracture height in the target area can be effectively controlled when the thickness of the caprock is at least half of the thickness of the productive layer.

(3) if the interval thickness is less than 10.4 m, the artificial fracture height in the target area can be effectively controlled by the synthetic analysis method of the formation parameters and engineering parameters, 2 times the interval thickness and reservoir thickness must be more than 20.7 M.

(4) according to the actual data of statistical analysis, the results of the target area show that the characteristics of the above laws are in line with the results, and the coincidence rate is high, it can provide some theoretical support for the analysis of the influence of different reservoir-barrier thickness on the post-pressure water production in the later stage of the HangJinqi Shiguhao block.

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