Study on parameters limit of fracturing optimization process for thin and differential zone oil Wells

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Abstract: The potential target of water flooding measures has gradually changed to thin differential reservoir in three types of reservoirs. The fracturing proportion of thin differential reservoir in water flooding block oil well has reached more than 60%, and the existing fracturing design code can not fully meet the needs of thin differential reservoir fracturing. Through the effect evaluation of the technical parameters matching different types of thin differential reservoir, the field test is carried out to establish the limit of the optimal technological parameters for fracturing of thin differential reservoir oil well, which is of great significance for improving the fracturing effect and improving the technical level of fracturing in the future oilfield.

Key words: Thin differential zone, well fracturing, process parameter boundary.

1. There is a problem

In 2015, water flooding Wells contained 90.7% water before pressure, and the proportion of refracturing was 72%, and the proportion of fracturing in thin and differential reservoirs reached more than 60%. Due to the characteristics of poor development, small thickness, low permeability and longitudinal interaction distribution with high aquifer in thin and poor oil reservoir, it is difficult and ineffective to exploit potential. Meanwhile, the fracturing process parameters used in fracturing of water drive oil well are mainly for well-developed oil reservoir, and the existing fracturing design specifications cannot fully meet the needs of fracturing in thin and poor oil reservoir. According to statistics, the average oil increase of single well in thin and differential reservoir fracturing in recent three years can only reach 2.8t.

2. The main factors affecting the fracturing effect of thin and poor reservoir are studied

Through the analysis of 85 oil Wells previously fractured in the block, 40 oil Wells mainly fractured with thin and differential oil layers are selected as our research objects. By comparing the relationship between relevant influencing factors and fracturing effect, the influences of water cut before fracturing, strength of fluid produced before fracturing, thickness of target fracturing layer and amount of sand added in interval on fracturing effect are clarified:

Firstly, from the perspective of well selection conditions, the pre-pressure water cut and the strength of pre-pressure liquid production affect the fracturing effect. When the pre-pressure water cut is too high, there is a high-producing liquid layer in the well, and the contradictions between the layers are still prominent after fracturing. When the strength of pre-pressure fluid production is too low, the well is seriously short of liquid supply and the fracturing effect is poor due to the lack of formation energy. Therefore, the strength of pre-pressure water cut and pre-pressure liquid production are evaluated together. Based on the dispersion diagram of pre-pressure water cut and pre-pressure liquid production strength, it is clear that the fractured well should meet the requirement of pre-pressure water cut below 94% and pre-pressure liquid production strength greater than 2t/m at the same time when the oil increase is 3t as the standard.

Second, from the perspective of potential scale, the relationship between the effective thickness of the whole well fractured target layer and the oil increase volume is calculated. The greater the thickness of the whole well fractured target layer, the better the fracturing effect will be. With the gradual increase of the thickness, the oil increase range will be increased.

Thirdly, from the perspective of construction scale, the relationship between sand addition and oil increase in the fracturing interval of the whole well is calculated. The more sand addition in the fracturing interval, the better fracturing effect will be. However, with the increase of sand addition, the range of oil increase decreases.

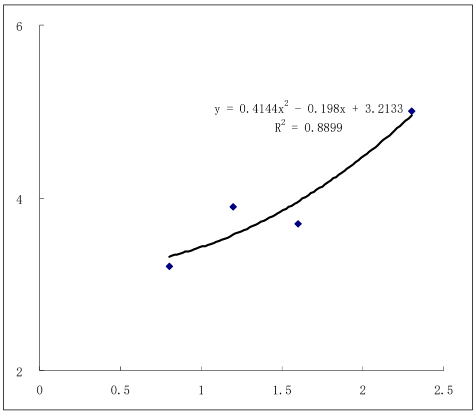

Fig. 1 Relation curve between effective thickness of target layer and oil increase

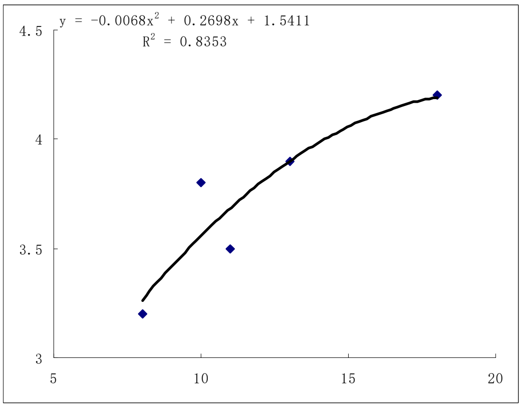

Fig. 2 Relation curve between sand addition and oil increase in fractured interval

3. Combined with the characteristics of reservoir development, the potential target of thin and differential reservoir is defined

According to the development of reservoir, the distribution form of sand body and the connection relationship between oil and water, the thin differential reservoir is subdivided into six types. Based on the evaluation of the effect of 106 thin differential intervals, it is concluded that the proportion of the three types of sand body in the implementation interval is 96.1%, and the oil increase intensity is 1.0t/m. The oil increase effect is obviously higher than that of the other three types, so three types of sand bodies, namely filling continuous piece type, edging bypass type (thin injection and thick production) and clumping distribution type, are regarded as the main potential objects for fracturing thin and differential Wells at present.

4. Establish fracturing technical specification of thin and differential reservoir

On the basis of the previous fracturing effect of thin and differential oil well, through the comparison of various parameters of sand body types in thin and differential oil reservoir, the technical limits of various fracturing parameters were studied with the target of 3.5t fracturing oil increase.

4.1 Establish the optimal selection criteria of measure well formation

Under the premise that the pre-pressure water cut is lower than 94%, the influence of formation liquid supply capacity on the oil increase effect of fractured well is considered. The low strength of pre-pressure liquid production indicates insufficient liquid supply capacity, while the high strength of pre-pressure liquid production indicates that multiple small layers of the well have been well used. Therefore, the relationship between the strength of pre-pressure liquid production and the amount of oil increase of three types of sand bodies is calculated respectively, and the limit of the strength of pre-pressure liquid production of classified sand bodies is clearly defined. The filling contiguous sand body is between 2-7t/m, the edging bridge sand body is between 2-6t/m, and the turd distribution sand body is between 2-4t/m.

Combined with the analysis results of factors affecting the fracturing effect of thin and differential formations, the larger the fracturing thickness of the whole well is, the better the oil increase effect will be. By establishing the matching relationship between the converted thickness of the fractured interval and the oil increase amount of the whole well, it is concluded that the converted thickness of the fractured interval aiming at the measured oil increase of 3.5t needs to be more than 3.0m. Meanwhile, the fracture thickness limit is further subdivided into three potential objects. The filling contiguous sand body shall be at least 3.0m, the edging bridge sand body shall be at least 3.5m, and the turd distribution sand body shall be at least 3.3m.

4.2 Define the boundary of process parameters

According to the theoretical chart of fracture parameter optimization in thin differential zone, the penetration ratio requirements of different types of sand bodies at the highest recovery degree after fracturing are defined. Under the condition of 175m injection-production well spacing in thin differential zone, the penetration ratio formula is as follows: The penetration ratio = fracture half-length/well spacing *100%, the minimum fracture half-length is calculated, and then the maximum fracturing sand addition amount of classified sand body is obtained according to the relationship curve between fracture half-length and sand addition amount. According to the regression relationship between the sand addition amount and the effect of different sand body types, the minimum sand addition amount is obtained. Thus, the sand addition limit range of classified sand body is obtained.

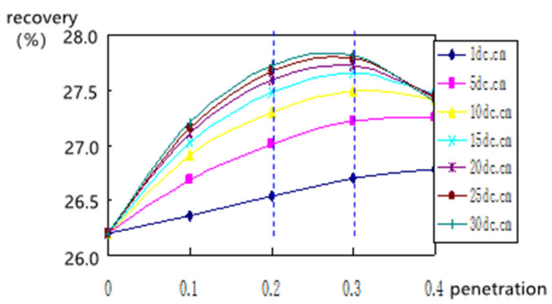

Fig. 3 Fracture parameter optimization diagram of thin differential layer

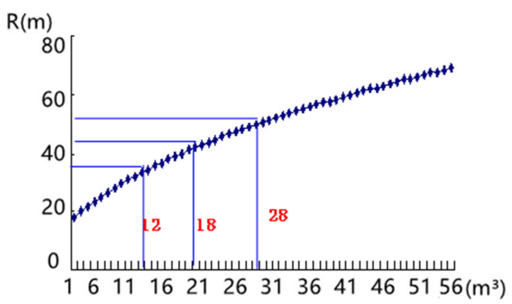

Fig. 4 Relation curve between fracture half-length and sand addition amount

Based on the above analysis, considering the factors affecting the fracturing of classified sand bodies, the fracturing well selection standard of thin differential reservoir is clearly defined, the construction parameter design is optimized to increase the reconstruction scale of thin differential reservoir, and the technical parameter specification that best matches the classified sand bodies of thin differential reservoir is established.

Table 1 Fracturing technical parameters boundary table of classified thin differential reservoir

Sand body type	Preferred well zone criteria			Optimization parameter design
	Water cut before pressure (%)	Strength of liquid production before pressing (t/d·m)	Fracturing is converted to thickness (m)	Amount of sand added in interval (m³)
Filling continuous type	< 94	2-7	≥3.0	9-12
Border bypass type	< 94	2-6	≥ 3.5	14-18
Turd distribution type	< 94	2-4	≥ 3.3	16-28

The fracturing technology specification of thin and differential zone oil well was used to select 30 Wells in the block for verification. After the implementation, the oil increase per well was 4.2t per day. Compared with the previous fracturing effect of thin and differential zone oil well, the fracturing effect of thin and differential zone oil well was significantly improved.

5. Conclusion

1. After water flooding development enters the ultra-high water cut stage, the remaining oil distribution is scattered, and well fracturing has become an important means to improve the utilization degree of sand body and explore potential of local remaining oil.

2. The difficulty of oil well fracturing is gradually increasing, and the existing standards of oil well fracturing measures cannot meet the requirements of the current situation. Therefore, it is of great significance to establish the parameter boundary for thin and differential oil reservoir fracturing. 3. Establish fracturing technical specifications for different types of thin differential reservoirs. On the basis of fine remaining oil analysis and combined with the matching adjustment of Wells, the fracturing technical specifications for thin differential reservoirs have seen a better oil increase effect.

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