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Widening fracturing potential in different kinds of oilfields

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Abstract: The old oilfields in our factory have entered the period of high water cut, the target of fracturing has changed from the main layer to the non-main layer, and the main layers have been fractured again and again. We have difficulty in choosing proper layers because good layers are in high-water-cut and there are not enough emerge in poor layers. As the oil quality of new oilfields deteriorates gradually, the effect of the fracturing gets worse and the effective period is short. The fracturing potential is gradually reducing. In this paper, according to the characteristics of different oilfields, the focus of potential exploitation will be shifted to the high aquifer where the remaining oil is enriched and thin differential layer in old oilfields, The new oilfields will carry out fracturing reconstruction corresponding to oil and water wells to shorten the displacement distance. By constantly quantifying and optimizing the principle of well selection and layer selection, perfecting the adjustment mode, optimizing the fracturing technology and scale, and taking the "three development", the fracturing potential is further released. The effect of the fracturing is guaranteed, and the development of the oilfield is improved.

Key words: well and layer selection; advanced adjustment; corresponding fracturing; optimization of fracturing technology and scale

1. Study on the measures of expanding and exploit potentialities space in different types of oilfields

In order to explore the potential exploiting methods of different oilfield measures, according to the characteristics of oilfield reservoir and development, we classified research, adhere to the "close combination of engineering and geology" and promote scheme design to the "fusion type", which makes sure reservoir engineering backward extension and the technology of petroleum production intervention in advance.

Although water has appeared in a lot of layers and from some directions in old high-water-cut oilfields, some oil is still enriched in the parts where sandstone gets thin affected by planar heterogeneity [1-2]. At the same time, there are some reservoirs with thin thickness and low resistivity due to the influence of the surrounding rock, which fail to meet the interpretation standard of sandstone, and these reservoirs can be regarded as the replacement potential for the next step [1-4].

2. Extend to the high aquifers with low-water-cut parts

In order to ensure sufficient energy for high aquifers with low-water-cut parts and avoid water exposure after fracturing, corresponding adjustments should be made to oil and water wells [5-6] first, so that liquid flow direction can be changed to release the potential of fracturing. In the low water flooding direction, water injection is strengthened by subdivision and recombination, test adjustment. And the oil well in the dominant direction of water flooding is blocked off, so that the liquid flow direction is diverted to the target well. In the direction of high water flooding, the injection well controls water injection in advance, and the fracturing layer of oil well in the weak direction of water flooding makes the fluid flow direction avoid the target well. According to the degree of water flooding in each direction of potential well layer, the adjustment mode and potential exploiting limit of high aquifer are established.

Table 1. High aquifers adjust method and exploit potentialities limit

the water flooded degree	Classification (cumulative water absorption strength)	water well injection		oil well
		control cycle	strengthen water limit	
high water floode	> 15000m³/m	> 2	/	fracture wak water
	≤15000m³/m	> 1		
low water floode	> 10000m³/m	/	>	plug the oil well in the
	≤10000m3/		>	

Secondly, the length of compression crack should be shortened. Using the formula of water drive border:

$$r_w = \{^{(Q_i - q_i) \times n}/_{[0.7\pi h\Phi(1 - S_{wi})]}\}^{1/2}$$

Among them $Q_i = Q \times \frac{\Delta SP_i \cdot h_i}{\sum_{i=1}^{N} \Delta SP_i \cdot h_i}$ $q_i = q \times \frac{\Delta SP_i \cdot h_i \cdot Q_i}{\sum_{i=1}^{k} \Delta SP_i \cdot h_i \cdot Q_i}$,

In the formula:Q—single layer cumulative water injection

Qi— cumulative water injection in single layer and single direction

q — cumulative water production in single layer of oil well

qi— cumulative water production of single layer in one direction

Finally, the influence of branch fracture on fracturing is quantitatively studied. Due to the influence of fracture branches, fracture length cannot meet the requirements of reservoir reconstruction according to the conventional single symmetrical model [7]. Therefore, according to the experiment data, the relationship curve between horizontal main stress difference and seam length loss degree is drawn, and the seam length loss degree under different stress difference is quantified. The fracture length loss degree was introduced into the fracturing optimization model, and the fracturing scale optimization method with low stress difference was established, and the fracturing sand and fluid parameters of each oilfield were revised to suit the reservoir design.

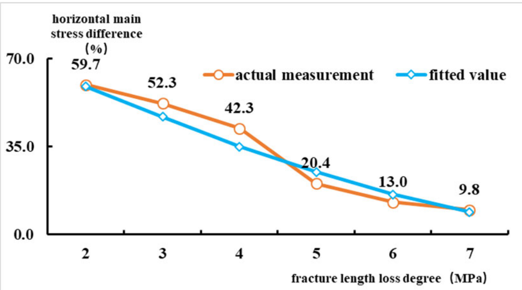

Figure 1. Curve of relation between fracture length loss and geostress difference

Table 2. Optimization table of fracturing scale parameters of each oilfield

oilfield	horizontal main stress difference(MPa)	fracture length loss (%)	single-layer sand amount(m^3)		single fracturing fluid volume(m^3)	
			before optimization	after optimization	before optimization	after optimization
L	2.4	54.2	9	18	53	89
Q	3.6	40.2	8	13	50	80
G	3.1	45.8	9	16	53	89
H	2.9	48.2	11	20	70	127

This layer is mainly argillaceous siltstone, with a small amount of calcium-bearing siltstone. The oil-bearing occurrence is oil spot. According to the core data of exploration well, evaluation well, oil test data and production dynamic data, the interpretation chart of mud and silt layer is established, the RLLD is lowered from 12 Ω.m to 8 Ω.m, the lower limit of physical property is lowered from 7mD to 1mD, and the geological reserves are increased by 1.28 million tons.

Table 3. Standard for interpretation of argillaceous silt layer

classification	coregraph	lithology	Permeability (mD)	electrical standard			
				micronormal-microinverse (Ω.m)	BHC (μs/m)	LLD (Ω.m)	Sp (mv)
effective layer		siltstone	10-50	≥1.0	≥255	≥12	≥6
argillaceous siltstone layer		argillaceous siltstone	<10	≥1.0	≥255	≥8	≥6

The argillaceous siltstone and aquifer layers are interactive distribution, so in order to achieve effective fracturing argillaceous siltstone layers, we break the interlayer standard of more than 4 metres thickness, establish the subdivided control fracture limit chart, adjust the interval division standard for interlayer difference of gamma value is greater than 40 API, effective barrier thickness more than 2.0 metres, which can realize the poor thin layers are fractured one by one, the fracture can be effectively extended and the remaining oil near the edge of sand body can be mined.

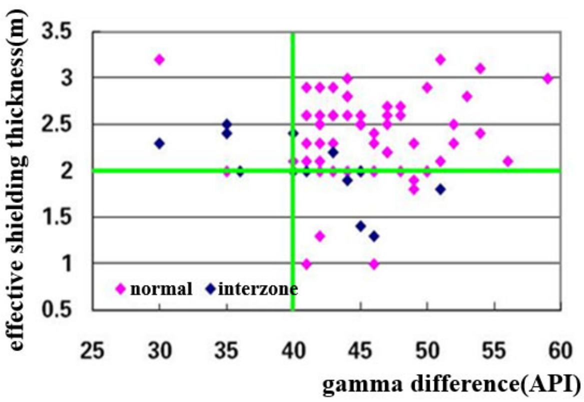

Figure 2. Subdivision control fracturing technology boundary plate

Due to the thin reservoir, fracturing is easy to communicate the upper and lower risk zones. Therefore, according to the isolation of layer stress shielding, the relationship chart of construction displacement and joint height was fitted, and the optimization standard of construction displacement was quantified, which effectively controlled the longitudinal extension of cracks,

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reduced the risk of communication between upper and lower risk layers, and transformed the reservoir with the minimum thickness of 0.6m sandstone. At the same time, considering the effective displacement distance of argillaceous siltstone layers 90-110m, the optimized fracture half-length is 160-180m, 40m more than conventional fracturing.

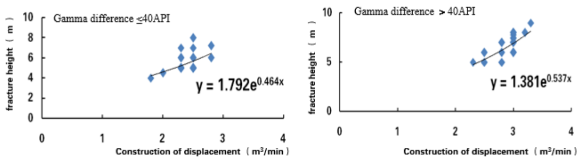

Figure 3. Construction displacement optimization chart

For the areas that can establish effective displacement, the corresponding fracturing technology of oil and water wells is studied [8-9]. Reservoir numerical simulation was used to optimize the timing of water injection. According to the formation pressure at the end of stage, the recovery percent of reserves at the end of low water cut stage and the recovery percent of reserves at the end of medium water cut stage, the timing of leading water injection in corresponding fracture wells was determined to be 6 months. On the basis of water injection, the relationship between well pattern and fracture is determined according to existing injection-production well pattern and in-situ stress direction, and the displacement distance is shortened.

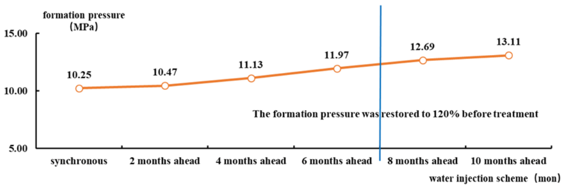

Figure 4. Formation pressure change curve at the end of each set of water injection schemes

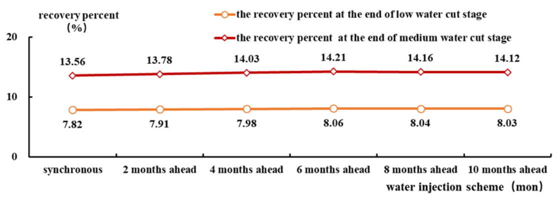

Figure 5. Curve of recovery percent of reserves of each set of water injection schemes

3. Application effect

Recent years, on the basis of fractured well and layer development, adhere to the "adjustment before fracturing, combination of measures, protection after fracturing", adopt integration scheme design, although the condition of effective fracturing thickness decreases, the fracturing scale doesn't decrease.We implement all kinds of fracturing 210 wells, and the average daily oil increase per well is more than 2t, accumulation of oil are 7.15×104t during the period of validity.

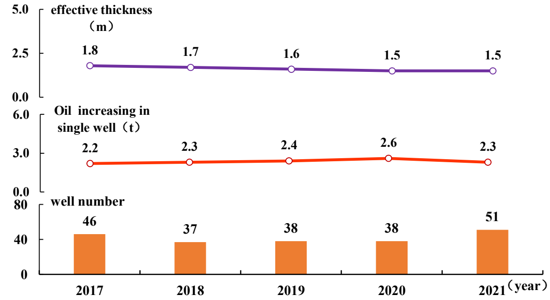

Figure 6. Fracturing effect curves of oil wells in recent years

4. Conclusions

(1)For the main oil reservoir with high water cut, according to the practice of "advanced systematic adjustment, long-term dynamic tracking, optimizing mature well layer, appropriately shortening the length of pressure fracture and optimizing the fracturing scale", the space for measures of high water content wells is released.
(2)For the argillaceous siltstone layer with thin reservoir thickness and poor physical property, according to the technical practice of "deepening geological understanding, implementing single clamping and single pressure, reducing the boundary of single layer thickness, and increasing the scale of fracturing", the measures are effectively realized.
(3)For the ultra-low permeability reservoirs, according to the principle of treating water before treating oil, the fracturing of injection well first, increasing pressure and increasing injection, corresponding fracturing between oil and water, fracture net fracturing and multi-branch fracture fracturing carried out in oil wells improve production, which effectively improves the stimulation effect.
(4)The fusion scheme design is adopted to adhere to the key practice of "close integration of engineering and geology". The reservoir engineering is backward extension and the technology of petroleum production intervention in advance.

References

1. Xu Jianjun, Huang Lida, Yan Limei, Yi Na. Insulator Self-Explosion Defect Detection Based on Hierarchical Multi-Task Deep Learning[J]. Transactions of China Electrotechnical Society, 2021,36(07):1407-1415.
2. Limei,LIU Yongqiang,XU Jianjun,et al.Broken string diagnosis of composite insulator based on Grabcut segmentation and filler area discrimination[J].Power System Protection and Control,2021,49(22):114-119
3. Yi, Q. Wang, L. Yan, et al., A multi-stage game model for the false data injection attack from attacker's perspective. Sustainable Energy Grids & Networks 28 (2021).

https://doi.org/10.1051/e3sconf/202235201071

4. Na Yi,Jianjun Xu,Limei Yan,Lin Huang. Task Optimization and Scheduling of Distributed Cyber-physical System Based on Improved Ant Colony Algorithm. Future Generation Computer Systems, 109(Aug. 2020),134-148.
5. Yang Zhao, Jianjun Xu, Jingchun Wu. A New Method for Bad Data Identification of Oilfield Power System Based on Enhanced Gravitational Search-Fuzzy C-Means Algorithm. IEEE Transactions on Industrial Informatics. VOL. 15, NO. 11, NOVEMBER 2019 5963-5970
6. Jing Han,Xi Wang,LiMei Yan, Aida Dahlak, et al. Modelling the performance of an SOEC by optimization of neural network with MPSO algorithm. International Journal of Hydrogen Energy, Volume 44, Issue 51, 22 October 2019, Pages 27947-27957.
7. Yang X S. A new metaheuristic bat-inspired algorithm[M]. Nature inspired cooperative strategies for optimization (NICSO 2010). Springer Berlin Heidelberg, 2010: 65-74.