The discussion about comprehensive regulation and control methods of Low and non-effective circulation layers in ultra-high water cut stage

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Abstract: As the oilfield enters the ultra-high water cut stage, the development situation of water flooding is becoming increasingly severe, facing problems such as increasing natural decline, rapid water cut rise, and serious low and non-effective circulation. How to accurately identify low and non-effective circulation layers, effectively adjust them, and alleviate the interlayer contradiction, is an important subject of water control and efficiency improvement project. In recent years, in view of the difficulty in identifying low and non-effective circulation layers in water flooding and the unsatisfactory control effect, a platform of preferential seepage channels identification has been developed, to achieve accurate identification of low and non-effective circulation layers. A classification and evaluation of low and non-effective circulation layers use the recognition results combined with the dynamic and static data has been carried out. The personalized plan has been carried on the field application. It achieved good effect for improving producing reservoir effectively, controlling water cut rising, providing reference basis for determining control low and non-efficient circulation layers.

key word: Low and non-effective circulation.

1. Research Background

Block A, in the in ultra-high water cut stage, has determining developed nearly 60 years. Due to long perforating interval, many mining layers, and unevenness of the underground well pattern, interlayer contradiction is more outstanding. and long-term water flooding, sedimentary unit with better physical property is easy to appear preferential seepage channels.

In the injection side, monolayer breakthrough become seriously, worsen the interlayer contradiction, hard to produce in poor and thin layers. Once the preferential seepage channel is formed, the connected production oil Wells will soon be water breakthrough, and the water cut will rise faster, thus becoming high-water cut producer. The phenomenon of low and non-effective circulation between oil and water Wells seriously affects the efficient development of water drive blocks.

A lot of work has been done on this problem from the injection and production end, the low and non-effective circulation is still serious. How to accurately and effectively control the low and non-effective circulation layers is an important topic in the current water drive control.

2. Synthetically adjust and control methods of low and non-effective circulation layer.

In order to improve the accuracy of identification technology in low and non-effective circulation layers, we innovate the identification method of low and non-effective circulation layer based on dynamic and static data and using numerical simulation technology and multidisciplinary research results. With the application of this achievement, personalized synthetically adjust and control methods are adopted for different regions and different types of low and non-effective circulation layers. Using SimSim numerical simulation technology, a fine numerical simulation model is established. Tracer flow simulation calculation in multi-well group and large block quantitative shows the injection production and water cut of each well different displacement directions in the block. Based on this research results, the preferential seepage channel identification platform was researched, which developed the production status of single well and single layer from qualitative to quantitative, realizing the visualization of results and providing guidance for efficient oilfield development.

Figure 1. The profile of tracer flow with connected well

With the application of preferential seepage channel identification technology, the low and non-efficiency circulation layers of small well spacing pattern in experimental area were identified. 251 Wells and 1097 subzones were identified. 195 low and non-efficiency circulation Wells in G3 group accounted for 53.3%, and 639 low and non-efficiency circulation layers were identified, the thickness of sandstone reaches 1092.5m, and the phenomenon of low and none efficiency circulation is serious.

Table 1. The identification results of low and non-efficiency circulation layers in different thickness

effective thickness classification	Layers	sandstone thickness (m)	Low and non-efficiency circulation								
			Wells	Ratio(%)	Layers	Ratio of layers (%)	sandstone thickness (m)	Ratio of sandstone thickness (%)	Identify layers	Identify thickness of wells (m)	Identify thickness of layers (m)
≥2m	164	587.1	19	4.1	22	13.4	69.9	11.9	1.2	3.7	3.2
1m~2m	1237	2897.3	144	31.4	230	18.6	485.7	16.8	1.6	3.4	2.1
≤1m	5802	8979	232	50.7	796	13.7	1193.0	13.3	3.4	5.1	1.5
untabulation	5086	4841.5	35	7.6	49	1.0	68.4	1.4	1.4	2.0	1.4
total	12289	17304.9	251	54.8	1097	8.9	1817.0	10.5	4.4	7.2	1.7

Table 2. The identification results of low and non-efficiency circulation layers in different unit

Sedimentary units	Wells	Layers	Thickness (m)	Low and non-efficiency circulation					
				Wells	Ratio (%)	Layers	Ratio (%)	Thickness (m)	Ratio (%)
G1	56	856	1311.2	2	3.6	5	0.6	13.0	1.0
G2	446	5426	6107.0	174	39	421	7.8	635.6	10.4
G3	366	5033	7270.4	195	53.3	639	12.7	1092.5	15.0
G4	247	974	2616.3	16	6.5	32	3.3	75.9	2.9
Subtotal	458	12289	17304.9	251	54.8	1097	8.9	1817.0	10.5

Using the identification results of low and non-effective circulation layers, combined with the seismic interpretation of fine description and dynamic data, the adjust and control schemes are formulated from both ends of injection and production.

2.1 For the well group with interlayer contradiction, the injection end shall be comprehensively regulated.

Aiming at the well group with interlayer contradiction of injection end, targeted measures are taken to control the low and non-effective circulation layers, and at the same time, to improve the water injection of the poor production layers, which improved the producing situation

Taking well GROUP G36 as an example, the tracer simulation results show that the well has preferential seepage channel in THE G35 sedimentary unit.

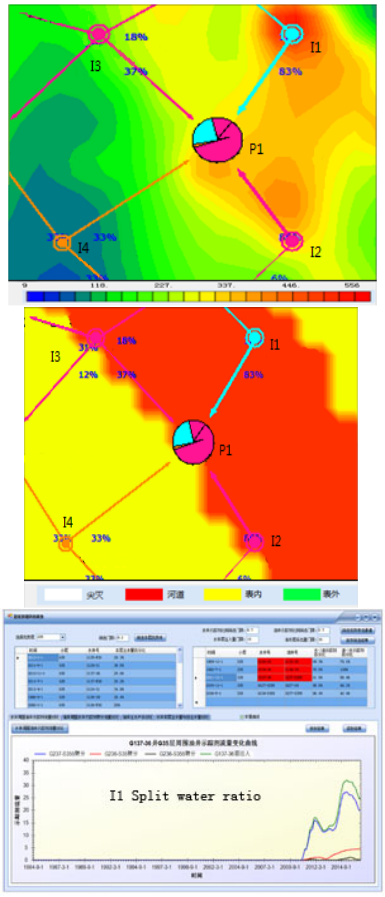

Figure 2. I1 well group tracer flow simulation results

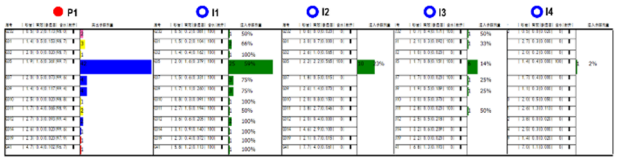

Figure 3. I1 The profile of tracer flow with I1 well group

Combined with the analysis of the isotope test data, it was determined that the G35 sedimentary unit had low and non-effective circulation. The layer adjustment of G36 well was carried out, and the injection of G35 layer was stopped by single blockage, and the injection allocation was added to the layer with poor water absorption to improve the production of thin and poor layer.

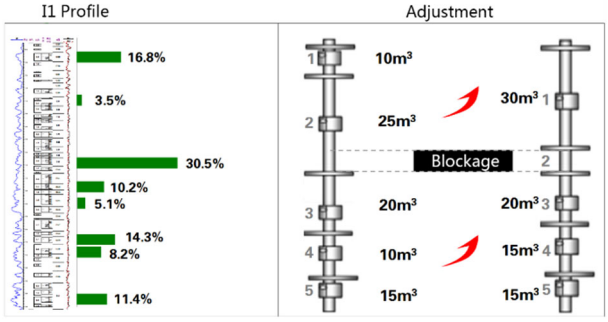

Figure 4. The tracer simulation results of G36 well group

83 injection Wells were adjusted and 11 profile control measures were taken in the small well spacing block to achieve good results.

The producing condition of reservoir has been improved. Compared with the same Wells in 2021 and 2020, the proportion of water-absorbing layers, sandstone thickness and effective thickness increases by 4.4%, 5.4 % and 5.9% respectively.

The surrounding connected oil well is obvious effectiveness. Daily production of liquid decreased by 1,231t, daily production of oil increased by 41t, and water cut decreased by 0.2%.

2.2 For well groups with plane contradictions, synthetically adjust and control methods should be adopted at the production end.

Aiming at the well groups with plane contradictions, based on the identification results of d preferential seepage channels, combined with the fluid production of single well and the water cut difference in the plane, the synthetically adjust and control boundary standard of production end was established.

2.2.1 Accurate water blocking scheme

For oil Wells with little plane difference, daily fluid production of single well is more than 50t, water cut is more than 98%, flow pressure is more than 3.0Mpa, and the number of low and non-efficient circulation layers is less than 5, mechanical water blocking is adopted to control low and non-effective circulation layers, so as to alleviate the contradictions between layers and control low and non-effective circulation.

Accurate water blocking was carried out in 34 Wells, with daily fluid production reduced 20.1t per well, stable oil production and reduced water cut 0.5%.

2.2.2 Cycle shut and control scheme

In view of the surrounding injection-production complete, daily fluid production of single well is more than 50t, water cut is more than 98.5%, the number of low and non-efficient circulation layers is more than 5, Cycle shut and control method is adopted, to adjust the relations of the injection-production well group, change the direction of fluid flow, expand swept volume, so as to eventually achieve the goal of improving regional overall development effect.

31 Wells with high water cut were closed and controlled for 176,300 square meters, affecting oil production of 1,100t and controlling liquid moisture content of 99.35%.

3. Conclusion

Based on dynamic and static data, with the fine numerical simulation, it can greatly improve the accuracy of identifying low and non-effective circulation layers, and provide a reliable basis for controlling low and non-effective circulation layers in ultra-high water cut period.

The control of low and non-effective circulation layers in the ultra-high water cut stage is characterized by complexity and diversity. It is quantified and classified according to the identification results, and comprehensive control measures are formulated from both ends of injection-production according to the differences of contradictions between layers and planes, so as to achieve the purpose of controlling the low and non-effective circulation layers.

Comprehensive control techniques of the low and non-effective circulation layers still need further perfect and mature, although it has obtained the phased development effect, but with the change of the injection-production relationship, remaining oil distribution will also change, how to develop continuity with low and non-effective circulation layers change the comprehensive control methods will be the future research direction.

References

1. Li xilian, zhao xiaoping et al. Analysis and evaluation of influencing factors of water injection development [J]. Tuha petroleum,2004,9(1): 34-35.
2. Li Daoxuan. Development technology of thin interbedded low permeability reservoir [M]. Dongying: China University of Petroleum Press, 2007, 62-65
3. Tan Fengqi, Li Hongqi, Meng Zhaoxu. Application of data mining in petroleum exploration [J]. Oil Geophysical Prospecting,2010, (1): 36-39.
4. Yang Qiurong, Study on determination method and formation condition of low efficiency circulation well layer [D]. Daqing Petroleum Institute, 2007.
5. Li Jiawen. Study on distribution and treatment measures of inefficient and ineffective circulation field in subsequent water flooding in Qingjia Block[J]. Inner Mongolia map replication of ancient petrochemical industry, 2014, (5): 2.