E3S Web of Conferences **375**, 01017 (2023) https://doi.org/10.1051/e3sconf/202337501017
ESAT 2023

Technology and effect of small well spacing control decline in close well network

Senlin Gan

The Third operation area of No.1 Oil Production Plant of Daqing Oilfield Co., LTD； heilongjiang daqing 163000, China

Abstract: In order to further improve oil recovery, water flooding was adjusted for three times from 2009 to 2012. The spacing of injection-production Wells was shortened from 250 meters to 106 meters, and the density of well pattern increased from 90.7 to 196 per square kilometer. This leads to the problems of "rapid rise of water cut, large difference in oil formation production, and large production decline in block u". In recent years, we by fine geologic research, to improve the poor thin oil layer use condition, controlling water cut rising velocity, as the key point, the energy recovery network continuously grope for dense well spacing control regulation technology, gradually formed dense well network from decreasing "three-excellent" control technology, through the effective implementation, improved the block development effect, achieve the goal of stabilizing oil water control.

Key words: small well spacing; Natural decline; Stable oil and water control; Control technology

1. Introduction

After three encryption adjustments, the number of small Wells accounted for 85%. On the longitudinal, average interval is 198 meters long, single well interval number is 5.8, and a big difference between layers, check with the percent of pass is 10% lower than conventional well, lead to a use of sandstone percentage is only 25%, after rising water cut, inefficient invalid circulation to further expand, injection-production in the development of dynamic high speed, low degree of use, water cut rises quickly, the characteristics of big production decline, Water injection adjustment and on-site management is more difficult.

Stabilize in order to further extend the production period, to achieve the goal of stabilizing oil water control, through the comprehensive analysis of dynamic and static data, first looking for remaining oil, and at the same time for different sedimentary microfacies in the reservoir and the status of the use of the single sand body, water flooded, optimization measures, aimed at the prominent contradiction development problems in production process, summarizes the mining practice of the process of recognition, To solve the influencing factors, to find out the potential of a single well, to promote the fine analysis, fine potential exploration, fine measurement and adjustment, according to this development idea, gradually developed and formed the "three best" regulation technology of tight well network and small well spacing control decline.

2. "Three optimal" control technology for tight well network and small well spacing

In the double extra-high development stage, in view of the contradictions such as low use degree of small well spacing, difficult well selection measures, and rapid water cut rise, the precision water injection and water control are deeply promoted, and the "three-best" water control and efficiency improvement technology is developed

2.1 Water injection program optimization and adjustment technology

One is the combination of fine geological research results, do fine water allocation scheme. Adhering to the concept of "precision is potential, precision is potential", we have carried out solid precision mapping work, deepened the digital and modeling understanding of the research and development block modeling, and the research object has changed from oil formation to sedimentary unit and then to the internal configuration of single sand body, so as to realize the progress of remaining oil characterization from precision to precision. The distribution characteristics of remaining oil in the late stage of ultra-high water cut are revealed, and the main potential objects are identified precisely.

Second, it is combined with the use of refined layer segment, do fine water injection stratification scheme. Considering the long distance from the well to the well and the number of layers, the analysis method combining dynamic and static data was used to introduce the coefficient of permeability variation based on the "7788" subdivision limit standard adjustment technology, and the layers with similar coefficient of variation were combined. Through the reorganization, the water absorption difference between the layers was significantly reduced.

Thirdly, the optimal stop-control and recovery plan is made based on the numerical well test research results. With the decrease of pressure and the redistribution of oil and water, it has become a potential reservoir for the recovery of water injection. The numerical well test simulation method is used to study the variation law of bottom hole pressure and guide the design of injection distribution scheme for long stop zone. On the basis of theoretical understanding, comprehensive analysis of well pressure level, injection-production connectivity, remaining oil distribution characteristics, effectively adjust the small layer injection.

Fourth, the combination of round - round inspection and intelligent test and adjustment, do accurate water injection program implementation. The polling inspection and adjustment technology was adopted: a two-month cycle was carried out to optimize the test cycle, so as to ensure the encryption and adjustment of key Wells and stable Wells as required, and effectively improve the qualified rate of inspection and distribution on the basis of reducing the workload. Adopting intelligent measurement and adjustment technology: In 2016, the field test was first carried out in the narrow well spacing area. Based on the understanding of the results obtained, the intelligent measurement and adjustment technology was comprehensively promoted in the area, which achieved a good effect of remote real-time monitoring and adjustment of stratified water quantity, a leap in the quality of water injection, greatly reducing the test workload and reducing labor cost.

2.2 Measure scheme optimization design technology

For fracturing, the difficulty of selecting well, clear "potential match technology, combination of conventional and unconventional" working train of thought, on the basis of analysis of remaining oil potential, the potential for different types of targeted measures tapping technology, by doing conventional technology, do best unconventional technology, realize all kinds of effective measures to potential release. Especially for small well spacing block action potential, potential in alignment with low water cut Wells, on the basis of the conventional fracturing, by summing up, widen the fracturing optimization design, the wall pressure combined with exploration technology, smaller size fracturing technology, coiled tubing fracturing process four potential direction, in terms of unconventional fracturing, reverse pressure, displacement process, Through the detailed design and individual design of fracturing schemes according to different reservoir development conditions and development conditions, the potential space is effectively broadened by applying various process combinations.

2.3 2Ineffective injection and production optimization control technology

For a dramatic increase in late high water cut oil liquid ratio, invalid injection-production contradictions prominent problems, such as using tracer flow simulation software and the mathematical model research, preliminary screening invalid injector-producer layer, combination and utilization of water saturation, injection-production ratio parameter identification standard preliminary judgment may be ineffective circulation well layer, analysing the injection-production relationship, sandbody connecting relations, injection-production profile, Judge invalid loop identification result.

3. Practical application effect

Through the implementation of "three excellent" regulation technology, the oilfield development effect has been significantly improved

It is output, decrease get effective control

From the five - year production changes, the annual oil decline significantly reduced.

Table 1 Production of water flooding in recent five years

year	20 17	20 18	20 19	20 20	20 21
Annual oil production (ten thousand tons)	44. 02	37. 73	33. 73	30. 21	28. 12
Production decline (%)	18. 8	14. 3	10. 6	10. 4	6.9

Table 2. Natural decline of water drive in recent five years

year	201 7	201 8	201 9	202 0	202 1
Natural decline (%)	15. 1	12. 8	12. 7	10. 9	10. 8

Table 3. Natural decline of stratified systems

year	20 17	20 18	20 19	20 20	20 21
MrPortuguese formation (%)	15. 0	11. 8	10. 2	8.5	8.4
High platform sub-layer system (%)	20. 0	16. 7	15. 6	12. 0	11. 7

Second, the rise rate of water cut is effectively slowed down

The regional water cut is stable as a whole, and the rising rate of water cut is controlled.

Table 4. Variation of water cut in water drive year

year	2017	2018	2019	2020	2021
In aqueous（%）	96.31	96.59	96.86	97.11	97.35
Rise in water content（%）	0.37	0.3	0.3	0.25	0.24

Table 6. Variation of appreciation over water in stratified systems

Year	2017	2018	2019	2020	2021
Mr Portuguese formation（%）	0.32	0.25	0.23	0.22	0.21
High platform sub-layer system（%）	0.41	0.36	0.31	0.28	0.27

Third, the injection-production capacity is balanced and the formation pressure is stable

The formation pressure is stable, and the overall submergence decreases by 51m, but the overall structure tends to be reasonable.

Table 7. Formation pressure variation

Year	2017	2018	2019	2020	2021
Injection-production ratio	1.17	1.2	1.2	1.14	1.16
Formation pressure（MPa）	9.45	9.57	9.62	9.68	9.66

Table 8. Variation of Wells with different levels of water flooding

classification	Number of Wells in 2020 (Wells)	Number of Wells in 2021 (Wells)	difference
submergence <100m	0	1	1
100m≤submergence < 300m	421	541	120
300m≤submergence < 500m	189	78	-111
submergence≥500 m	71	48	-23

Fourth, the use of oil reservoirs has been effectively improved

The water absorption ratio of off-sheet sandstone increased by 11.59 percentage points.

Table 9. Triennial water absorption ratio change

year	2017	2018	2019	2020	2021
Water absorption ratio once every three years（%）	62.18	69.85	70.14	72.86	75.08

4. Conclusion

(1) The late stage of extra high water cut is still an important stage to tap potential. Accurate characterization of structure, reservoir and remaining oil is an important basis to ensure the release of small-scale potential.

(2) Through the integration and application of conventional technologies and the demonstration and application of new technologies, the potential space of narrow well spacing is broadened, and the supporting technology and model of tight well network and small well spacing in the late stage of extra high water cut is formed.

(3) Based on the fine anatomy of tight well pattern reservoir, through the optimization and adjustment of water injection, the qualified rate of water injection is improved and the quality of injection is improved by making full use of intelligent separate injection and round check and adjustment, and the comprehensive potential mining adjustment of small well spacing is formed to improve the water injection efficiency.

(4) The combination of dynamic and static is used to establish the automatic identification of invalid circulation and the potential exploitation measures of the combination of dredging and blocking in the aspect of injection and production, forming the integrated adjustment technology of identification of inefficient invalid circulation and water control and potential exploitation.

References

1. Wang Lixia. Improvement method of water flooding technology in high water cut stage of complex fault block reservoir in Huabei Oilfield [J]. Petroleum Knowledge, 2019(4):2-3.
2. Zhao Beichen. Coupling mechanism and parameter optimization of water flooding in fault block reservoir [D]. China University of Geosciences (Beijing), 2020.
3. Wang Nian-ming, GUO Hua-gu, JIANG Ming-sen. Research on oil stability and water control technology in middle and high water cut stage of complex fault block reservoirs: A case study of Yuejin No.2 Donggao Oilfield [J]. China Petroleum and Chemical Standards and Quality, 2013(11):1-3.
4. Wu Gang. Water flooding enhanced Oil recovery technology of fault-block reservoir in Shengli Oilfield [J]. China Chemical Trade, 2015(9)23-24.

https://doi.org/10.1051/e3sconf/202337501017

5. Liu Xishun. Research on remaining oil distribution and potential exploitation strategies of extremely complex fault block reservoirs in high water cut development period [J]. Xinjiang Oil and Gas, 2008, 4(4):4-5.