Complementary Practice and Effect Analysis of A Transition Zone

Guoyi Li[1]

[1] No.3 Oil Production Plant of Daqing Oilfield Company Ltd, 163113, China

* Corresponding Author: Guoyi Li; email: lgy-19830421@163.com; phone: +86 15846185101

Abstract: At present, the A-transition belt water drive has a common foundation, encryption, and four sets of three well networks. The base layer and the encryption layer are very close to each other, and the room for structural adjustment is small. In order to improve the development effect of the encryption layer system, the layer is complemented by the infill hole. This paper expounds the specific practices and effects of layer complementation, through the complementation of layer system to reduce the well spacing and improve the injection and production relationship of narrow river channels, increase the connection direction, and broaden the adjustment space of reservoir and mining structure. It can fundamentally improve the mining and encryption layer mining effects, meet the needs of the development of one or two water flooding development, and achieve better development results by complementing the layers.
Block overview; 2. The problem of the encryption layer; 3. The idea of complementing the layers; 4. Evaluation of the practice and effect of layer complementation; 5. Conclusions; References.

1. Block overview

At present, A transition zone water drive has a total of 749 oil and water wells (459 oil production wells, 290 water injection wells), and the well network density is 22.1 ports/Km^2. As of December 2013, the average daily production of single wells was 68.9 tons, the daily output of wellheads was 2.7 tons, and the comprehensive water content was 96.08%. The formation pressure was 11.23 MPa, the total pressure difference was -0.23 MPa, the average single well daily water injection was 136 m^3, the rupture pressure was 14.52 MPa, and the water injection pressure was 13.02 MPa.

2. The problem of the encryption layer

2.1. The transition zone has a low level of daily oil production per well

At present, the encryption layer has a total of 155 production wells, 142 wells, with an average daily production of 37.8t of single well, 1.8t of daily oil production, 95.24% of integrated water, 11.22MPa of formation pressure, and a total pressure difference of -0.38MPa. This layer was put into development in 1996. The initial average daily production of single well was 4.5t. In 1999, the average daily production of single well was 2.7t. From 2001 to the present, the average daily production of single well was about 1.8t. It is lower than the regional average of 0.9t, which is lower than the average level of the basic well network by 2.5t.

2.2. The comprehensive water content is high, the water content rises faster, and the room for structural adjustment is small

The layer had a comprehensive water content of 27.07% at the initial stage of production, and the comprehensive water content increased to 80.57% in 1999. In 2002, the comprehensive water content increased to 90.92%. At present, the integrated layer of the encryption layer is already 95.24%, and the water content rise value is 0.69 percentage points in recent years, thus the water content rises faster. In addition, the basic layer system has a comprehensive water content of 96.50%, which has little difference in water content compared with the base layer system, and the room for structural adjustment between the layers is small.

3. The idea of complementing the layers

When the first and second bands have been adjusted in the encryption layer system in 1996, the infill well was laid in the position of the shunt line between the foundation wells, and a complete four-point area well network could be formed with the foundation well. At present, the two sets of layers are very close to each other, and the layers are complemented by the infill holes. The foundation layer system can reduce the well spacing and improve the injection and production relationship of the narrow river channels, increase the connection direction, widen the adjustment space of the storage and recovery structure, and increase the thickness and effect direction of the encryption layer system, which is beneficial to improve the development status due to small thickness and low output. By complementing the layers, the mining effects of basic and encrypted layer can be fundamentally improved, and the requirements for the development and adjustment of one or two water drives can be met. In the later stage, the comprehensive utilization of the well pattern is implemented according to the actual development situation, and at the same time, it is considered to be connected with the third-stage oil well three-stage oil well network.

According to the development characteristics of the first and second oil layers in the north and the distribution of the interlayer. Based on the principle of "reducing the well spacing, perfecting the injection and production, and facilitating the adjustment", the design and optimization of the layered complementary scheme was carried out with the aim of maximizing oil recovery.

After the layer of the base layer is replenished for the full layer of the encryption layer, the new 202m four-point area well network is reconstructed with the base layer, which will increase the contradiction between the production wells and increase the water-bearing rate, but not conducive to the adjustment of the well in the later period. To this end, the selective hole-filling scheme of the cross-layer system of the oil wells in the infill well network is adopted. The scheme mainly uses the infill holes to supplement the holes, and improves the relationship between the injection and the mining of single sand bodies. The infill well network production well uses the basic well net injection well as the perfect object to selectively replenish the oil layer with relatively rich remaining oil. The infill well water injection well uses the basic well network production well and the new oil recovery layer of the well production well as the perfect object to selectively replenish the relatively rich oil layer or direction of the remaining oil. In the replenishing well area, the well spacing of the well layer remains unchanged, and the well spacing of the foundation layer is reduced from 350m to 202m four-point area well network.

The study area was selected in the B team. The north side was bounded by a well and b well line, the south side is bounded by c and d well lines, the west side is bounded by lines of a well and c well, and the east side is bounded by lines of b well and d well. The test area is 1.3km^2.

4. Evaluation of the practice and effect of layer complementation

After the layer of the base layer is added to the full layer of the encryption layer system. Reconstructing the new 202m four-point area well network with the foundation layer will increase the contradiction between the production wells and accelerate the water-bearing rise rate, which is not conducive to the adjustment of the wells in the later stage. To this end, the selective hole-filling scheme of the cross-layer system of the oil wells in the infill well network is adopted. The scheme mainly uses the infill holes to supplement the holes, and improves the relationship between the injection and the mining of single sand bodies. The infill well network production well uses the basic well net injection well as the perfect object to selectively replenish the oil layer with relatively rich remaining oil. The infill well water injection well uses the basic well network production well and the new oil recovery layer of the well production well as the perfect object to selectively replenish the relatively rich oil layer or direction of the remaining oil. In the replenishing well area, the well spacing of the well layer remains unchanged, and the well spacing of the foundation layer is reduced from 350m to the 202m four-point area well network.

4.1. Carry out fine anatomy of the reservoirs in the complementary wells of the strata, laying the foundation for the complementarity of the strata

In order to clarify the reservoir development and sand body distribution characteristics of the A-transition zone system in the existing well pattern, the well-seismic combined reservoir fine anatomy of the A-transition zone system was studied.

4.1.1. Research on sedimentary microfacies based on well data

The coordinates, logging curves, sedimentary facies, and stratification boundaries of 484 wells in the study area were collated, and GPT work areas were established, and 4 vertical and 6 horizontal main sections were established. The fine layer comparison of the 33 deposition unit 14875 was completed, and the boundary modification rate was 1.31%. The 14 microphases of the 2 subphases were identified by the core data and the corresponding logging microfacies mode was established. Completed the drawing of the Saartu oil layer based on the well data plane deposition microphase diagram 33 sheets.

4.1.2. Seismic horizon calibration

Establish Landmark work area, carry out seismic data quality evaluation, make synthetic seismic record of well 107, and carry out seismic section calibration and seismic horizon interpretation of Sa Iding and Sa II top.

4.1.3. Seismic horizon calibration

Seismic properties such as total amplitude, RMS, and average amplitude were extracted, and it was preferable to determine the instantaneous amplitude along the layer as the best attribute reflecting the distribution of sandstone mudstone in the sedimentary unit. For each small layer, the seismic layer of the top and bottom of the oil layer group was equally divided, and the small layer attribute slice was preferred according to the principle of pre-determination and post-quantification. Through the analysis of the spatial evolution of the well-seismic combination, it was determined that the stratigraphic slice reflected the reliability of the channel sand body information, and further clarified the river layer vesting. Finally, 33 small-layer instantaneous amplitude attribute slices and coherent attribute slices were extracted.

4.1.4. Well seismic combined with fine reservoir inversion study

The inversion calculation was carried out by post-stack geostatistical inversion, the inversion parameters were optimized, the inversion quality was improved, and the inversion quality control was performed by using the residual method, pseudo-well curve method and post-test well precision analysis method. Finally, 12 pieces of fine 3D wave impedance inversion body were obtained in the entire work area; 33 inversion plans of 11.63 km2 were produced.`

4.1.5. Seismic combined sedimentary microfacies study

According to the optimal seismic attributes and inversion results, combined with the logging sedimentary microfacies map, the sedimentary microfacies maps of 33 sedimentary units in the Sa-1, Sa II and Sa III reservoirs were completed.

4.2. Identify the remaining oil enrichment sites and guide the selection of the replenishment horizon

First, the closed coring data indicates that all the waters in the Saertu oil layer in the test area have all seen water, but the proportion of weak unwashed water is 39.21%, and there is residual oil potential. The second is the analysis of water flooding data from the new well. The effective thickness of the test area is less than 1.0m. The flooding degree of the oil layer is relatively low, and the ratio of low and unflooded thickness is 23.9%. There is potential for further adjustment. The third is the analysis of the remaining oil potential of each small layer. From the numerical simulation results, the current mining degree of the water drive stratum in the eastern part of the test area is 35.3%, and the remaining reserves of the SII and SIII oil layers respectively account for 48.02% and 25.05% of the remaining total reserves, which are the main targets for the next step.

4.2.1. Residual oil distribution type in the test area

According to the analysis of dynamic and static data, there are four types of remaining oil in the test area: the remaining oil in the abandoned river channel, the remaining oil in the riverside type, the remaining oil in the poorly distributed oil layer, and the remaining oil in the well network. It is the main direction of the next step.

4.2.2. Microscopic residual oil potential in the test area

According to the parameters of mercury intrusion data permeability and porosity, the experimental area is divided into four types of reservoirs, namely, I to IV reservoirs. Class I is mainly free-form residual oil, and the other three types are mainly bound.

4.2.3. Evaluation of the complementation effect of the layer system

Based on the results of fine geological research, flooding data of new wells, and monitoring data of remaining oils, the research on complementarity of layers was carried out, and 26 wells for oil wells were prepared. At present, the filling work of 24 oil and water wells has been completed. The average single well fill sandstone has a thickness of 12.8m, an effective thickness of 9m, an average daily oil increase of 3.8t, a comprehensive water cut of 4.56 percentage points, and a cumulative oil increase of 21,900 tons. Increased oil recovery by 1.35 percentage points (*Fig. 1*). The average single well fill sandstone of the injection well has a thickness of 15.1m, an effective thickness of 12.2m, and a daily water injection of 158m^3, which has achieved good results. At the same time, in terms of water injection wells, in order to ensure the effectiveness of the measures and extend the effective period of the measures, combined with the comprehensive adjustment plan, the water quantity matching between the basic wells and the infill wells in the complementary well areas of the strata is carried out. A total of 10 wells of the water injection well adjustment plan for the foundation layer were prepared and all were implemented. The surrounding base oil wells have increased the direction of new incoming water. Seeing the effect of increasing oil and precipitation, the initial average daily oil increase of single well is 0.6t, and the water cut is 0.48 percentage points.

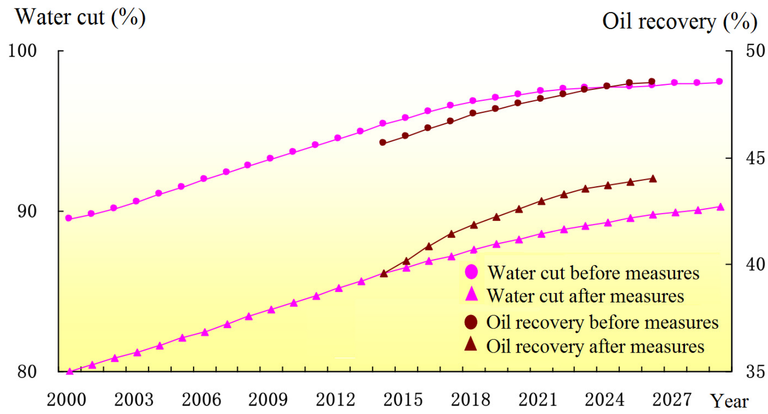

Figure 1. Predicted curve of complementary comprehensive water and recovery factors.

5. Conclusion

1. By implementing the complementation of the layer system, the development effect of the encryption layer system is effectively improved, and the water-containing rising speed is effectively controlled, which is an effective means for enhancing the oil recovery in the ultra-high water-bearing oil field.

2. After filling the hole, the basic layer and the encryption layer match the water injection relationship in time, which can extend the effective period of the measure and ensure the development effect.

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