The practice and understanding of reconstructing the flow field by the homogenization-flowline method

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Abstract After a long period of unstable injection and production, the reservoir is distributed within different levels of the advantage seepage area and the weak seepage area. With the continuous development, especially gradually into the high water content, high recovery degree of the double-high reservoir, saturation field is basically in an almost stable state. For the reservoir of large porous channel and serious flooding, the use of the homogenization field technology can achieve the purpose of adjusting the yield and suction profile, strengthening the balanced utilization, and reconstructing the underground seepage field. Before the reconstruction of the flow field, the flow line was densely distributed in the advantage seepage area, and after the reconstruction of the flow field, the flow line in the well area was evenly distributed. The water injection utilization rate was greatly improved, and the remaining oil was used effectively. On-site examples show that by adjusting the strength of the flat water drive, the daily injection of Gang 5-30 Well was raised from 30 m³ to 100 m³, the distribution of seepage field changed significantly, and the degree of control and utilization of the oil layer was greatly increased.

1. Introduction
After years of development, the water development reservoir has entered the “double high” stage, influenced by reservoir materiality, the evolution of well network and injection dynamics. The residual oil in this stage is characterized by the distribution characteristics of “whole dispersion, local enrichment”, and its scattered enrichment characteristics not only show the macro distribution status, at the same time, the injection control area also shows the micro-dispersion and enrichment condition of the pore level. The key to the study of residual oil in the “double-high” stage and the implementation of the EOR technique is to identify the well mesh injection and seepage field under the control of geological factors. At the macro level, under the influence of the relative fixed and long-term injection of well network, the seepage field has basically solidified and formed a relatively stable advantage injection channel; Microscopic, affected by the size of the pore throat, the microscale seepage field still has the solidification characteristics. “Double high” stage, the injection of water impact range is small; “injection water ineffective – inefficient cycle” phenomenon is prominent, water injection utilization rate decreases, oil field stable production, and production difficulty
increased dramatically. It is urgent from the perspective of seepage field reconstruction, the ineffective movement of reservoir fluid into an effective and orderly flow, to achieve the reservoir plane and vertical balanced replacement. The seepage field is transformed in the direction of improving the recovery rate, so as to improve the development effect.

2. The concept and ideas of the homogeneous field

Under the influence of different development stages, different development methods, and different well network perfection levels, the flow density shows obvious differences. Micro-performance on the water drive, the small pore internal micro-residual oil is approximately locked, the residual oil in the large pore channel is replaced, carried, extracted, reduces the oil drive efficiency, reduces the final recovery rate. For the reservoir of relatively perfect injection well network, relatively high degree of water drive control, relatively good water drive development effect, in order to make full use of the remaining oil, further improve the oil and gas recovery rate, carrying out the overall work for the purpose of the homogenization line. The measures of adjustment and water injection were adopted for wells to improve the volume of water diversion; water blocking measures were adopted for oil wells to inhibit high-yielding water production. Therefore, in view of the problem of large hole channel, flooded reservoir, formed a special technology homogenization field to adjust the yield and suction profile and strengthen the balance.

In the middle and late stage of oil field development, affected by the non-homogeneous reservoir, the difference in flow between the reusable medium and the displaced medium, the imperfect well network and other factors, the medium and high-permeable reservoir has been injected into the oil for a long time, and the development of the development advantage spout area and the weak seepage area in the well area (Figures 1). In the advantage seepage area, the spatial flow field distribution is concentrated, which shows that the strength of plane and upward water drive is seriously uneven, and the macro-impact efficiency decreases. Dagang oil field to improve the inter-layer, in-layer, plane macro-flow field distribution for the purpose, through injection of well skewed, fine layered water injection, production well blocking water and other measures, expand the degree of water drive and block the large hole, to avoid the advantage of the region flow field too concentrated problem, forming a relatively balanced displacement of the homogeneous field reconstruction mode (Figure 2).

Figure 1. Flow line distribution before and after seepage field reconstruction, respectively
Before the reconstruction, the flow line was concentrated in the advantage seepage area, and the flow field was sparse in the weak seepage area, and after the reconstruction, the phenomenon of ineffective water injection circulation was curbed, the flow field in the well area was evenly distributed, the control degree of the well network was significantly improved, and the water injection utilization rate was greatly improved (Figure 3).

3. Target reservoir overview and homogeneous field design

The porosity of the Yang 3 blocks is 12.3%~41.9%. The average porosity is 32.5%, the permeability is 20~16565×10^{-3} μm², and the average permeability is 2259.4×10^{-3} μm². Influenced by the strong heterogeneity of the reservoir, the oil layer has a higher degree of launching, but the degree of water flooding control is low. The overall performance of the block is that the reservoir has a high degree of flooding, the production wells have high water cut, and the remaining oil is difficult to tap, and the annual oil production has dropped significantly.

The average comprehensive water content of the YangG1 fault block is 97.79%; the high-collecting liquid well is flooded, and the comprehensive water content of the Yang 5-22 well is 99.25% (Figure 4). Oil well transfer was carried out in the strong liquid well area to change the direction of liquid flow. The Nmx6-2 sand body was taken as the research object, and the 5-22 well in the high production liquid well area was transferred to achieve an effective uniform displacement (Figure 5).
Figure 4. Production Comprehensive Curve of Yang 5-22 well

Figure 5. Streamline Distribution
(a before adjustment, b after adjustment, c one year after adjustment)

4. Conclusion
(1) For the relatively perfect injection well network, the relatively high degree of water drive control, the water drive development effect is relatively good reservoir, to carry out the overall work for the purpose of the homogenization line, can further improve the recovery rate.

(2) The re-engineering of the seepage field for the purpose of the homogenization line includes measures such as water well tuning drive, sub-injection and pulse injection, and water blocking of oil wells.

(3) Oil well transfer was carried out in the strong liquid well area to change the direction of liquid flow. The Nmx6-2 sand body was taken as the research object, and the 5-22 well in the high production liquid well area was transferred to achieve an effective uniform displacement.

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