Genetic analysis of remaining oil in thin and poor layers in Lamadian oilfield

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Abstract. Understanding the distribution of remaining oil and its genesis is the basic work of geological research. Lamadian oilfield has entered the late development stage of ultra-high water cut, the thick oil layer of water drive is decreasing gradually, and the thin and poor oil layer is becoming an important target of adjustment and tapping potential below 1.0m. In order to further improve the development effect of thin and poor reservoir, it is necessary to analyze the saturation field of the numerical model based on interpretation result, core analysis result of sealed coring well and water drive model. The remaining oil characteristics of thin and poor reservoir are studied by means of statistics, genetic analysis, dynamic analysis and static analysis.

1.Introduction
Taking the sedimentary facies as the research leader, this paper analyzes the sedimentary characteristics of the distributary plain subfacies and delta front subfacies, which are mainly developed in the thin and poor layers, and combines them with the permeability data of logging interpretation results. The reservoir with effective thickness less than 1.0 m is dominated by uniform water flooding, and the remaining oil in the thin and poor layers in Lamadian oilfield is mainly formed because of the influence of plane and interlayer heterogeneity, which leads to imperfect injection-production relationship. Through the analysis of remaining oil in thin and poor reservoirs under the sedimentary models of abandoned channels, interfluvial subfacies and branch-tuotransitional and sheet-sand subfacies in the delta front, the types and origin of remaining oil in the current facies-controlled model are clarified, in order to guide more effectively Lamadian oilfield extra-high water cut later on the remaining oil tapping program preparation.

2.Type of remaining oil in thin difference layer
After more than 40 years of development in Lamadian Oilfield, through fine adjustment of strata and infill well pattern, the control of well pattern on sand body is very high, and the proportion of effective sandstone producing thickness is 95.8%. Among them, the proportion of reservoir thickness below 1.0 m is only 10.1% , and there is some remaining oil.

Table 1. Statistical table of sand body producing degree

| Effective thickness level (meter) | Number of layers (Number) | Perforation condition | Effective thickness (meter) | Active proportion | Unused proportion |
|----------------------------------|---------------------------|-----------------------|-----------------------------|------------------|------------------|
|                                  |                           |                       |                             |                  |                  |
|                                  |                           |                       |                             |                  |                  |

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The sedimentary characteristics of the distributary plain and delta front subfacies are combined with the permeability data from logging interpretation results, and the sedimentary facies is taken as the research leader. Based on the analysis of the sedimentary characteristics of the distributary plain and delta front subfacies, which are mainly developed in the thin and poor layers. And the permeability data in the logging interpretation results, the reservoirs with effective thickness less than 1.0m are mainly flooded by uniform water. The remaining oil in the thin and poor layers in Lamadian oilfield is mainly caused by plane and interlayer heterogeneity, which leads to imperfect injection-production relationship. Through the analysis of remaining oil in thin and poor reservoirs under the sedimentary models of abandoned channels, interfluvial subfacies and branch-tuotransitional and sheet-sand subfacies in the delta front, the types and origin of remaining oil in the current facies-controlled model are clarified, in order to guide more effectively Lamadian oilfield extra-high water cut later on the remaining oil tapping program preparation.

2.1 Distribution characteristics of remaining oil in subfacies sedimentary environment of distributary plain
There are two types of remaining oil enrichment areas: one is that the remaining oil enrichment area is at the variation part of the river channel edge, the variation part of the crevasse sector edge, and the middle and upper part of the abandoned river channel. The second is the remaining oil enrichment area in the middle of two or more rivers in the marsh[1].

2.2 Distribution characteristics of remaining oil in delta front subfacies sedimentary environment
There are three situations in the remaining oil enrichment area: one is that the remaining oil enrichment area of the sheet sand in the delta is in the equivariant position at the side of the underwater channel[2]; The other is the remaining oil-rich area of delta-branch-tuotransitional subfacies in the sheet sand body between two or more channels, and the third is the isolated sheet sand body.

3. Static origin of remaining oil in thin difference layer

3.1 Analysis on the cause of formation of distributary plain subfacies control
The sub-facies of distributary plain is characterized by the deposition of each stage cutting down to the last stage. The middle part of the river has stronger ability to cut down than the side part. In the horizontal connecting section, the thin difference layers are mostly connected with the middle and upper parts of the channel body, and the thin difference layers formed by the variation of the channel side are of the same type as the contemporaneous deposits of the channel body. That is the thin difference layers sand bodies and the channel sand bodies are of the same origin. It is connected with the sand body in the middle of the channel. The remaining oil mainly exists in the middle and upper part of the channel sand body, and the thin and poor layers are formed after the physical properties of the sand body become worse.

3.2 Analysis of the controlling causes of delta front subfacies
Intertidal zone exists in the sub-facies sedimentary environment of delta sheet sand, that is the sand body thickness decreases under the same conditions as that of fluvial sand body. Because it is washed and reformed by the lake tide. The lateral development range of sand bodies is enlarged, and the sand bodies extension distance along the river flow direction is reduced. In particular, injection-production
wells are easily formed in the branch-tuo transitional subfacies in the underwater channel and sheet sand. Respectively the reservoir physical properties of underwater channel sand body and sheet sand body are quite different. The effective porosity and permeability of underwater channel sand body are much larger than that of sheet sand body.

4. Dynamic origin of remaining oil in thin differential layer

4.1 Genetic analysis of plane contradiction remaining oil
According to the development data, the initial permeability of channel sand body is 0.5-0.8 darcy, and some reservoirs even reach 1.0 darcy. The thin differential layer is affected by the permeability range, which results in low degree of production and almost no production of the off-balance sheet reservoir. Taking the abandoned channel subfacies as an example, the remaining oil is enriched in the middle and upper part of the reservoir sand body, especially in the meandering river sedimentary environment, the abandoned channel subfacies develops more, and the well logging curves show bell or pagoda type. The lithology and physical property difference in the upper part of the middle part is mainly the thin difference layer in the plane. Although it is connected with the river channel, but before the permeability difference is 3.3-6, and before the effective measures such as fracturing are taken to improve the permeability of the reservoir. Because of the phase change, the poor and poor layers interacted with the channel on the plane, and the control of the original well pattern on the sand body decreased. Finally the incomplete residual oil was formed in the sand body of the thin and poor layers.

4.2 Genetic analysis of remaining oil in interlayer contradiction
Because of different sedimentary environments and hydrodynamic characteristics, the lithology and physical properties of the sedimentary sand bodies are different vertically, and the physical properties are good when multiple reservoirs with different perforations are simultaneously developed. The reservoir with good porosity and permeability is used preferentially, and the reservoir with low permeability can not be used when the range of permeability between different reservoirs is more than 5[3]. In the fluvial sedimentary environment, the porosity and permeability of the sand bodies in the middle part of the channel is good, the initial permeability can reach 0.8-1.0 darcy, and the initial permeability of the thin difference layer is generally not more than 0.15 darcy. The permeability of off-balance sheet reservoirs is lower, almost all of them are less than 0.05 darcy, even less than 0.015 darcy. Individual layers can be up to 10 or more. According to the field experimental data, interlayer interference will be formed when the permeability range reaches more than 2.5, the interlayer interference is serious. Which leads to the low degree of production of thin and poor layers, and the reservoir outside the table is hardly used. Finally the incomplete residual oil is formed in the sand body of the thin and poor layer.

5. Conclusion
The remaining oil in distributary plain subfacies is mainly distributed in channel margin, crevasse fan margin, interchannel subfacies and abandoned channel subfacies. So there is no injection-production relationship between thin difference layer and channel sand body. The remaining oil in delta front subfacies is mainly distributed in sheet sand subfacies with different porosity and permeability characteristics, intermittent underwater channel sand body and isolated sand bar sand body. There is no perfect relationship between the thin difference layer and the underwater channel sand body or sand bar sand body.

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References

[1] Zhao Wei, Zhao Yunfei, Wang Liming, et al. Reservoir production and comprehensive adjustment direction of Lamadian Oilfield [a]. Daqing Petroleum Geology and development, 2002, 21 (2): 26-28

[2] Han Weidong, Huang Fusheng, AI Ying, et al. Methods for tapping the remaining oil potential of Lamadian Oilfield [a]. Daqing Petroleum Geology and development, 2002, 21 (3): 41-43

[3] Zhang Baosheng, Zhang Shujie, Zhong Ling, et al. Water washing conditions of various oil layers in LaSaXing oilfield [a]. Daqing Petroleum Geology and development, 2002, 21 (6): 40-43