A Brief Talk on the Description Method of Residual Oil in Thick Reservoir

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Abstract: After years of development and adjustment, Xingnan Oilfield has entered the stage of high water-cut development. The main reservoirs are flooded seriously and the remaining oil distribution is complex. The main contradictions of reservoir development are transferred from interlayer and plane contradictions to intralayer contradictions. The heterogeneity of reservoir internal structure is the core geological factor that leads to the complicated watered-out form and residual oil distribution in the later stage of oilfield development. Taking the eastern pure oil area of Xingshi District as the research object, this paper determines the description method of residual oil in thick reservoirs, which provides technical support for the follow-up tapping potential of thick reservoirs.

1. Introduction
The interlayer in thick oil layer is one of the main factors controlling the distribution of remaining oil. Taking Pu I formation in Dongzhong block of Betyi district as an example, the distribution characteristics of interlayer in thick oil layer are analyzed, and the distribution characteristics of remaining oil under the control of interlayer are described. The results show that the smaller the water injection, horizontal spacing and dip angle are, the smaller the vertical displacement area of the sheltered area is, and the more the remaining oil is enriched; the more the number of horizontal interlayer is, and it is located on the opposite side of the oil and water wells, so it is easy to form the remaining oil enrichment area because of the barrier effect of the interlayer.

2. General Situation
2.1. Location and structural characteristics of the work area
The structure of the study area is gentle, slightly higher in the north, and the two wings are basically symmetrical. The trend of structural change is slightly different between the two wings, showing a pattern of steep in the West and gentle in the east. The dip angle of the western wing is 3°~5°and that of the eastern wing is 1.5°~3.0°respectively. (Figure 1) Location Map of Research Area.

The area of the study area is X km² and the geological reserves are T*10⁴t. There are X wells in the study area. It belongs to a large river-delta sedimentary system in the north of Songliao Basin. M, N and Z reservoirs, 39 sublayers and 72 sedimentary units are developed. Among them, 16 sublayers of M group are subdivided into 35 sedimentary units, 11 sublayers of N group are subdivided into 19 sedimentary units, 12 sublayers of Z group are subdivided into 18 sedimentary units.
3. Research process

3.1. Statistical Study on Reservoir Thickness and Physical Properties

3.1.1. Reservoir Thickness Characteristics
On the premise of considering both calculation efficiency and coarsening parameters of reservoir model, it is first necessary to consider whether vertical grid parameters can delineate the interface between reservoir and non-reservoir, and then the relationship between vertical sampling parameters and reservoir thickness should be considered; on this basis, further consideration should be given to whether vertical sampling parameters can delineate the changes of reservoir internal physical properties, and at this time reservoir should be considered. Thickness ratio characteristics of internal physical properties change and its relationship with vertical sampling thickness.

Statistical results show that the thickness of single sand body in M reservoir group varies from 0.2m to 5m, mostly from 0.4m to 1.6m, the number of sandstone layers with thickness over 1m accounts for 42.6% of the total number of layers, and the number of layers with thickness over 2m accounts for 7.4% of the total number of layers. The thickness of single sand body in N reservoir group varies from 0.2m to 3m, and most of them from 0.4m to 1.6m. The number of sandstone layers above 1m is 31% of the total number of layers, and the number of layers above 2m is 1.5% of the total number of layers. The thickness of single sand body in Z reservoir group is between 0.2m and 10m, mostly between 0.2m and 2m. The number of sandstone layers above 1m is 45.4% of the total number of layers, and the number of layers above 2m is 20% of the total number of layers (Figure 2).
3.1.2. Characteristics of water flooding ratio of reservoir

The percentage of reservoir watered-out thickness to the overall reservoir thickness can intuitively reflect the difference characteristics of reservoir internal physical properties to a certain extent [1]. According to the watered-out level (high watered-out, medium watered-out and low watered-out), the probability distribution of the percentage of watered-out thickness (Figure 3) and the watered-out and reservoir thickness maps (Figure 4) are calculated respectively. The statistical maps show that the high watered-out thickness accounts for the reservoir. The proportion of thickness is more than 60%, the proportion of main thickness is about 80%, and the proportion of Needle and low flooded thickness is about 50%.

Reservoirs with 100% watered-out thickness are mostly thin reservoirs with average thickness of about 0.5m (thickness of 0.2m-1m). Logging curves are finger-shaped, and the physical properties of reservoirs vary little. Reservoirs with 100% watered-out thickness are mostly about 1.6m (thickness of 0.6m-6.7m). Logging curves are mainly finger-shaped and box-shaped.
3.1.3. Spatial Development Location Characteristics of Sandstone
The probability statistic results of sandstone spacing of each sedimentary unit show that 80% of the reservoirs of M oil formation are located in 14 sedimentary units in the upper part of sedimentary unit, 13 sedimentary units in the lower part of sedimentary unit, and the reservoir development difference between upper and lower parts of 8 sedimentary units is not obvious; 80% of the reservoirs of N oil formation are located in 4 sedimentary units in the upper part of sedimentary unit, and 80% in 6 units in the lower part of sedimentary unit. In sedimentary units, the development of reservoirs in 9 sedimentary units is not distinct; 80% of the reservoirs in Z reservoir are located in the upper part of the sedimentary unit with 3 sedimentary units, 80% are located in the lower part of the sedimentary unit with 2 sedimentary units, and the development of reservoirs in 12 sedimentary units is not distinct[2].

3.2. Determination of vertical parameter assignment principle
(1) The physical properties of thin reservoirs below 0.8m with finger-shaped curves are not different. A set of thin reservoirs can be represented by a grid when establishing the model. The basic sampling thickness parameter to accurately characterize the thickness information of thin reservoirs is the same sampling thickness as the thickness of thin reservoirs.

(2) Curve characteristics are funnel-shaped and bell-shaped reservoirs with thickness over 0.8m. There are obvious differences in internal physical properties and water washing characteristics. At least 1/2 thickness of reservoir thickness is required as vertical mesh parameters to establish the model, which can characterize the difference between upper and lower physical properties of reservoirs. If the accurate location of difference demarcation points is needed, vertical mesh parameters can be selected as 1/5 of reservoir thickness.

(3) Curve characteristics are bell-shaped and funnel-shaped reservoirs. There are differences in internal physical properties, physical properties of reservoir top and bottom are poor, and there are differences in water washing characteristics. At least 1/3 thickness of reservoir thickness is required as vertical grid parameters to establish the model, which can characterize the difference of reservoir physical properties. If the accurate location of difference demarcation points is needed, vertical grid parameters can be selected as 1/5 of reservoir thickness.

The selection of vertical parameters not only considers the accurate characterization of reservoir thickness and reservoir physical properties, but also considers the relationship and influence between vertical sampling and reservoir spacing. With the increase of sampling parameters, the recognition ability of spacing between two sets of sandstones decreases gradually.

3.3. Carry out numerical simulation research
Two conditions should be satisfied for the geological model to be coarsened by the fine geological model. One is that after coarsening, the total mesh nodes of the model are controlled within the requirements of numerical simulation[3]. The other is that the distribution characteristics of attribute values in the coarsened mesh are as close as possible to the description of reservoir characteristics by the fine geological model. Accordingly, according to the above-mentioned model coarsening method, combined with the current application of computer software and hardware constraints, the size of mesh coarsening is optimized[4].
From the curves of cumulative oil production and recovery degree, it can be seen that when the fine model is coarsened to 20m *20m and 30m *30m, the cumulative oil production and recovery degree decrease with the increase of grid step. After the grid step is larger than 40m *40m, the decreasing trend of oil production is obvious[5].

4. Conclusion
Firstly, based on the statistical data of reservoir thickness, physical properties, location, spacing and the proportion of washed thickness of each sedimentary unit, the vertical sampling standard of each sedimentary unit is established according to the principle of vertical parameter division.
Secondly, the model coarsening algorithm is determined by applying different algorithms and comparing the results of coarsening.
Thirdly, through numerical simulation of geological models with different mesh steps, the differences between the models are determined.
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