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Research Article

Study on Distribution Law of Remaining Oil in X Block of Niuxintuo Oilfield

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Abstract: Niuhuangtuo Oilfield X block after years of water injection development has been in the stage of high water extraction. In order to improve the oil field development effect and improve the recovery rate, it is necessary to find the remaining oil exploitation potential. Based on the characteristics of reservoirs and the combination of geological modeling and numerical simulation, the remaining oil distribution in the study area is studied. Based on the analysis of drilling, earthquake and logging, the petrel modeling software is used to complete the geological model And the development of the block geological reserves, water content and single well production history, have reached a high precision, can be more realistic to restore the oil field development. The results show that the residual oil in the study area is mainly affected by the factors such as sedimentary microfacies, microstructural high point, fault occlusion and blocking. From the longitudinal point of view, the remaining oil is mainly concentrated in N12, N21 and N31 layers; the plane is mainly distributed in the fault edge, micro-amplitude construction high point, the river sand.
Keywords: Sedimentary microfacies; Shielding; Sealing; Remaining oil.

INTRODUCTION

Mining entered high water cut stage, It is the key to the development of the reservoir to describe the inherent heterogeneity of the reservoir and to find out the remaining oil distribution controlled by it, so as to adjust the injection and development system and scheme and improve the final recovery rate of the oilfield. The X-block of Niuxintuo Oilfield has a total oil production of 97.52×10^4t, a recovery rate of 14.93%, a comprehensive water content of 72.6%, and a low degree of water drive. In order to improve the development effect, on the basis of fine geological modeling and reservoir numerical simulation, provided the study on the remaining oil distribution in the area, which provides a theoretical basis for the structural adjustment of X-block well pattern in Niuxintuo oilfield.

WORK AREA OVERVIEW AND DEVELOPMENT PROCESS

The Niuxintuo Oilfield is located in the north of the western depression of the Liaohe fault basin. It has three distinct characteristics: the depth of the foundation, the complexity of the lithology and the change of the times. In the study area, the structure of the oil is simple, and there are three normal faults. The development location of the well is shown in Figure1.

The depth of the reservoir buried 1500-2200m, the use of oil-bearing area of 5.4km^2, oil geological reserves of 658.32 × 10^4t.

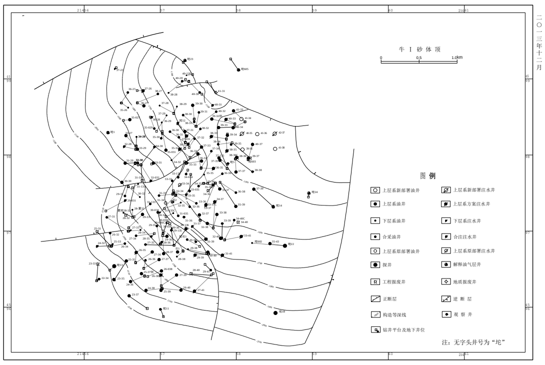

Fig-1: Niuxintuo Reservoir development location map

The development process of X-Block in Niuxintuo Oilfield can be divided into the following two stages:

Phase I: Natural Energy Mining Stage (May 1988 – Dec.1990). Due to lack of natural energy, the initial production and formation pressure decreased rapidly. As of December 1990, the formation pressure was 68% of the original pressure, and the daily oil production was only 36% of the initial production. The stage is 2.55% and the accumulated oil is 33.9 × 108t.

Phase II: Waterflood Development Phase (Jan.1991 - present). In order to supple the formation energy, improve the oil field development effect and improve the oil recovery rate, the well pattern of the study area is constantly adjusted and perfected, and the water injection is carried out with the anti - nine point well pattern of 210 m well distance. After 1 year of water development, reservoir energy is basically added, the output remained stable. Up to now, the cumulative oil production 97.52 × 104t, the degree of recovery 14.93%, integrated water 72.6%.

GEOLOGICAL MODELING AND HISTORICAL FITTING

Reservoir geological modeling is the application of geological, geophysical, logging and production dynamics and other information to carry out reservoir description research, Through the modeling means, the understanding of the reservoir will be reflected in the "mathematical model", and estabing the "three-dimensional digital reservoir", which would help the reservoir engineer to carry out the relevant numerical simulation and other research. Based on the collection of basic data (including well data, stratified data, fault data, logging interpretation data, etc.) of Niuxintuo oilfield. Geological modeling of the X - block of Niuxintuo Oilfield was carried out by Petrel geological modeling software. The working area was determined by the fault. In order to accurately describe the relationship between the fault and the horizon, the modeling uses a corner grid system, the plane grid with 25m × 25m and in the vertical a total of 43 deposition units, each single layer between the existence of a stable Layer, the total number of nodes to reach 491619. In order to describe the heterogeneity of the reservoir accurately during the establishment of the attribute model, the establishment of the study area attribute model is completed by the combination of the Gaussian simulation algorithm and Kerry. The study area permeability model is shown in Figure2.

In order to determine the variation of residual oil distribution and oil saturation in the study area, it is necessary to carry out historical fitting to reproduce the development of oil field. The first step in historical fitting is to carry out geological reserves fitting, Petrel is used to calculate the volume of geological reserves law, while Eclipse is performed using hydrodynamic balance model initialization, solution gas-oil ratio is varies with the pressure, and considering rock compressibility in Eclipse. Thus, the results of their calculation of reserves are different [5]. The actual geological reserves in the study area are 658.32 × 104t, the calculated reserves in the petrel are 641.61 × 104t, and the geological reserves in the eclipse are 649.57 × 104t. Taking into account the requirements of numerical simulation, the final eclipse in the calculation of reserves as a benchmark, the error of 1.12%, higher precision fitting.

Followed by the development of the region and single well development indicators of the fitting. Up to now, the actual accumulated oil production in the study area is 97.52 × 104 t, the cumulative oil production is 96.98 × 104t, the relative error is 0.558%; the actual water content is 72.4%, the water content is 72.6% and the relative error is 0.276%. There were 112 oil wells and 32 water wells in the study area. The water well fitting error of the single well was 1.6% and the fitting rate was 79%,which have achieved high fitting accuracy. The region's daily oil fit and the regional water content fit shown in Figure 3,4.

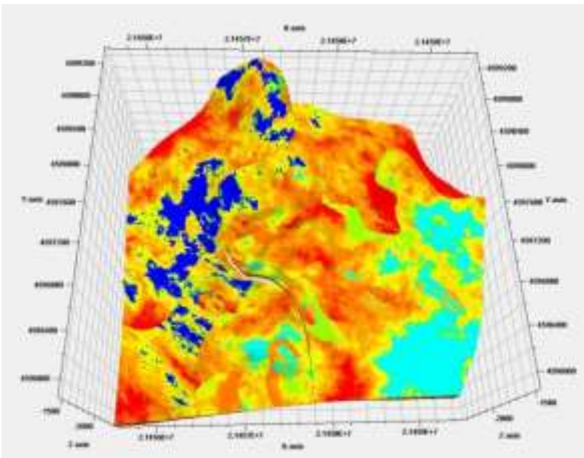

Fig-2: Permeability model in the study area


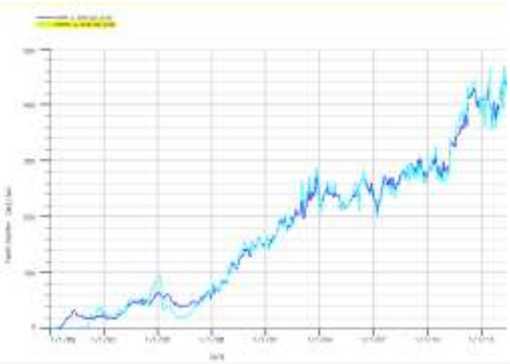

Fig-3: The whole area of daily product oil fit Figure 4 The whole area of water content fit

STUDY ON DISTRIBUTION LAW OF REMAINING OIL

Analysis of influencing factors

The factors that affect the distribution of residual oil are mainly geology and development. The main factors include reservoir heterogeneity, physical properties, tectonics, fault and sand body distribution. The development factors mainly refer to the improvement of injection and production system, the relationship between injection and production and the well layout and production dynamics. These factors are interdependent and mutually restrictive [6, 7].

Deposition phase distribution

The sedimentary facies of the study area are mainly streamway, between inner and outer interfluve. Because the distribution of the sedimentary facies affects the oil and water movement laws, it is the main influencing factor of the difference of the remaining oil distribution [8]. On the plane, the injected water first protrudes along the better physical path and then gradually spreads to both sides. Up to now, the river is the largest, 18.26%. River level within the table to produce 10.36%, the river between the basic do not use. At the same time, the river is good physical properties, large thickness, large reserves, the remaining oil is more, accounting for 66.1% of the total remaining oil. The remaining reserves and the amount of deposited microfacies are shown in Table 1 and Figure 5.

Table 1: Statistical tables for remaining sediments of different sedimentary microfacies

Microphase	Raw geological reserves /10^4t	Residual geological reserves /10^4t	Current accumulated reserves /10^4t	The degree of recovery /%
Streamway	446.83	365.23	81.60	18.26
Inner interfluve	138.33	124.00	14.33	10.36
Outer nterfluve	64.41	63.36	1.05	1.63
Grand total	649.57	552.59	96.98	14.93

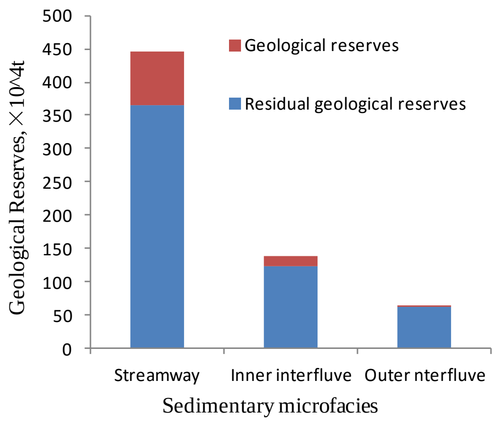

Fig-5: The amount of sedimentary microfacies and the remaining geological reserves

Constructive awareness of the impact

The overall tectonic trend has a great influence on the injection and production system. Through the deepening of the understanding of the structure of the study area, the following two types of residual oil distribution are obtained.

(1)Micro-amplitude construction of high-point residual type

According to the Niuxintuo NI-NIII sand top slightly structural analysis of the study area, the presence of a plurality of micro amplitude broken nasal structural high, the height difference is usually 6-7 meters in length less than 400 m, a width of 200 -400 m, and between different groups of groups with inheritance. After years of water injection development, the law of oil and water has changed with the recovery degree. According to the principle of oil and water migration, it is easy to form non-movable residual oil in the high part of microstructure, which is an advantageous zone for tapping potential in the later stage of development. It is suggested to adjust the injection-production relationship reasonably.

(2)Fault edge mining imperfect type

The remaining oil in the edge of the fault is mainly affected by the occlusion and sealing of the fault. The following three types of residual oil are due to the formation of fault caused by the formation of imperfect formation: ① between the wells and fault formation between the retention zone: the type of residual oil is mainly concentrated in the 8 # fault and 10 # fault, The fault distance is 120 meters. ②The fault is partially absent from the edge of the fault. The damage of the well pattern is reduced due to the influence of the fault, and the control of the well pattern is reduced. ③The area is formed with no injection.

At the same time, some oil traps are considered to be ineffective due to the influence of fault sealing at the beginning of the development. The area of the well has a low density, so the remaining oil is enriched and it is proposed to deploy the new oil recovery well. Figure 6 and Figure 7 show the structure of the N1 layer in the study area and the remaining oil distribution.

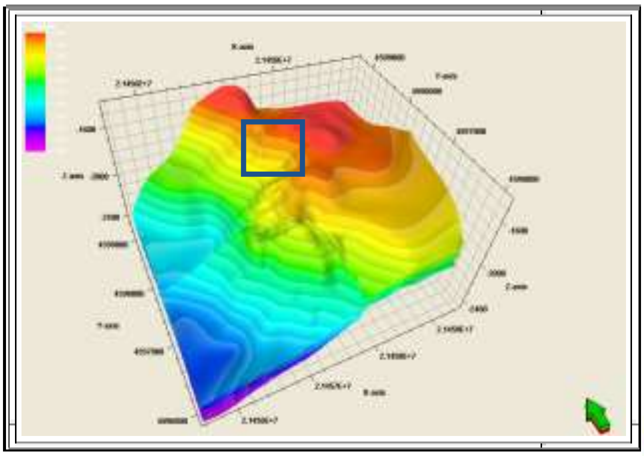

Fig-6: N1 layer structure diagram

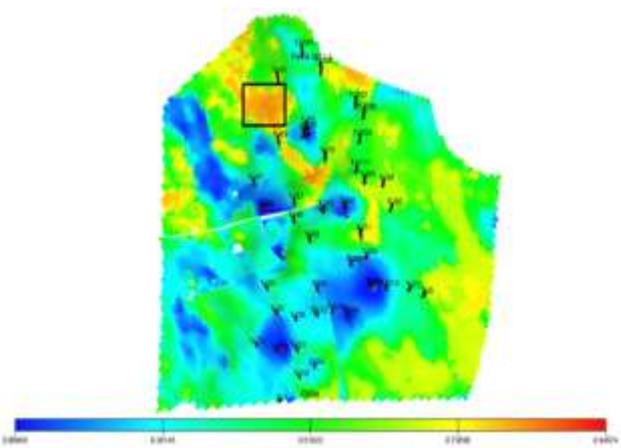

Fig-7 N1 layer remaining oil distribution map

The remaining oil distribution of each oil group

According to the numerical simulation results, the remaining reserves of each deposition unit are calculated, as shown in Fig. 8 and Table 2, respectively.

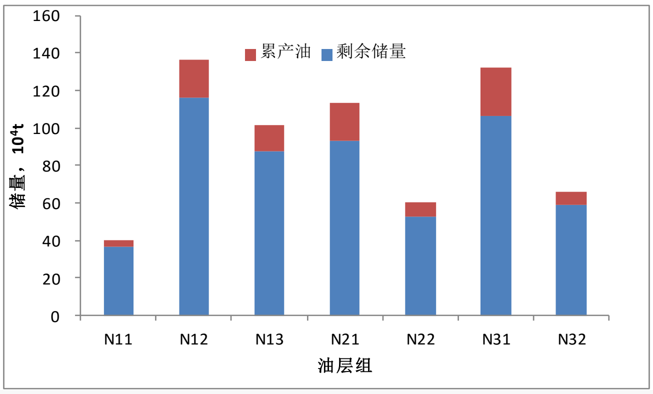

Fig-8: The amount of oil collected and the remaining geological reserves

Table 2: List of remaining reserves in different reservoirs

Reservoir group	Layer	Remaining reserves /10^4t	Tired oil/10^4t	The degree of recovery/%	Geological reserves/10^4t
N1	N11	36.68	3.24	8.32	38.92
	N12	116.16	20.99	16.29	128.86
	N13	87.38	14.17	14.48	97.83
	Total	240.22	38.40	14.46	265.61
N2	N21	93.49	19.69	17.69	111.28
	N22	52.99	6.48	9.74	66.52
	Total	146.48	26.17	14.72	177.80
N3	N31	106.39	26.07	19.97	130.54
	N32	59.35	6.35	8.40	75.62
	Total	165.74	32.42	15.72	206.16
Total		552.44	96.98	14.93	649.57

It can be seen from Fig. 8 and Table 2 that the total oil production of Niuxin Tuo Oilfield is 96.98×10^4 t and the comprehensive recovery rate is 14.93%. The difference between the N1, N2 and N3 reservoirs in the study area is small, but due to the uneven development of the layers, the degree of utilization of the small layers is quite different. Which N11, N21, N32 recovery degree of less than 10%. N12, N21, N31 three layers of the degree of recovery is higher than 15%.

N12, N21, N31 three layers of higher level of recovery, the oil production accounted for 69% of the total oil production, but the remaining oil reserves are relatively large, accounting for 57.2% of the total remaining oil reserves, still has a large remaining oil potential.

CONCLUSIONS

1) In the process of establishing the attribute model of the study area, the reservoir heterogeneity can be described very well by the method of Gaussian simulation and Kriging, which can lay a solid foundation for the numerical simulation of reservoir.
2) The numerical simulation results show that the geological reserves and water content in the study area are basically consistent with the actual situation, and the single well fit rate is 79%, which satisfies the precision requirement and can reflect the underground condition more truly, and the remaining oil distribution Research to provide a reliable basis.
3) The difference between the N1, N2 and N3 reservoirs in the study area is small, but the degree of N31 is 19.97% due to the uneven development of the layers.

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