EARTH SCIENCES
RESEARCH JOURNAL

Earth Sci. Res. J. Vol. 20, No. 2 (June, 2016) : A1 - A4

UNIVERSIDAD NACIONAL DE COLOMBIA
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HYDROCARBONS

Study of distribution of remaining oil in West Block of the Third District in North Saertu

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ABSTRACT

Identifying remaining oil distribution is an essential study at the Third District in North Saertu of the West Block in Daqing Oilfield. This field is known as a flooding fine potential tapping demonstration zone, characterized by a long-developing history and complex well history. Based on tectonic features and sedimentary characteristics of the study area, the methods of facies controlled reservoir 3D geological modeling and numerical simulation are used in the process of establishing the geological 3D static model. In this paper, we summarized the causes and distribution law of remaining oil in the study area by using the method of fine reservoir numerical simulation to provide a reliable basis for the development and adjustment of the oil field. In combination with fine exploration such as water drive fracturing, water plugging, reperforating and injection-production segment, the recoverable reserves recovery rate could be effectively increased.

Keywords: Remaining oil distribution, 3D geological modeling, Numerical reservoir simulation, Sedimentary microfacies, North Saertu.

Estudio de la distribución del remanente de petróleo en el bloque oriental del tercer distrito, en el norte de Sartu, China

RESUMEN

La identificación de la distribución del remanente de petróleo es un estudio esencial en el tercer distrito del norte de Sartu, que corresponde al bloque occidental del campo petrolífero de Daqing. Este campo es conocido como una zona ejemplar para aprovechar el potencial de explotación por inundación y que se caracteriza por una historia compleja y de largo desarrollo de sus pozos. Con base a las características tectónicas y sedimentarias del área de estudio se utlilizaron los métodos de modelado geológico 3D en depósitos con facies controladas y la simulación numérica en el proceso de establecer el modelo geológico 3D estático. En este artículo se establecen las causas y la ley distributiva del remanente de petróleo en el área de estudio a través del método de simulación numérica de depósitos de alta resolución que provea una base fiable para el desarrollo y ajuste del campo petrolero. Con la combinación de métodos de exploración como la fractura dirigida con agua, taponamiento acuático, reperforación y segmentos de inyección-producción, el índice de recuperación de reservas podría incrementar efectivamente.

Palabras clave: Distribución del remanente de petróleo, modelado geológico 3D, simulación numérica de depósitos, microfacies sedimentarias, norte de Sartu.

Record

Manuscript received: 10/04/2016
Accepted for publication: 29/07/2016

How to cite item
Wei, H., Zhu, H., Shi, S., Yang, X., Zhang, J., Wang, J., & Ashraf, M. A. (2016). Study of distribution of remaining oil in West Block of the Third District in North Saertu. *Earth Sciences Research Journal, 20(2)*, A1-A4. doi:http://dx.doi.org/10.15446/esrj.v20n2.55167

1. Introduction

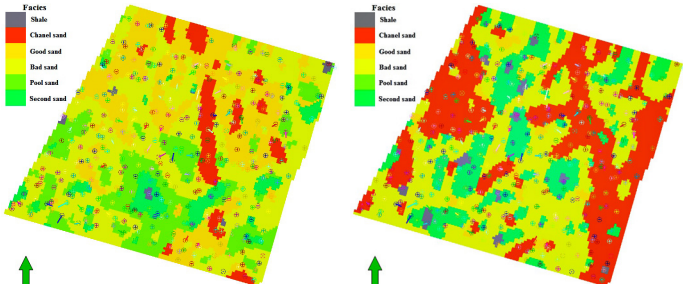
The West Block of the Third District in North Saertu water flooding fine potential tapping study area is located in the west of the pure oil of Saertu oilfield of Daqing placanticline and belongs to the delta facies lithologic-structural reservoir (Yang, 2004). Saertu, Putaohua, and Gaotaizi reservoirs developed in the study area (Tong et al., 2014). Since 1964, the District has experienced some major adjustments: the implementation of the fracturing, fill holes, water shutoff, subdivision injection production and other essential measures. Because of the long development time and complex well history conditions, it is not very clear for the remaining oil distribution law to find the appropriate area of remaining oil (Sun et al., 2011), the distribution of the remaining oil in the study area and the cause of formation. Those factors were quantitatively studied in this work.

2. Study area survey

West Block of the Third District in North Saertu Study zone is located at the west end of the anticlinal structures and having area of 18.5km2 and it is in the northern part of Saertu oil field. The structure is gentle, with a 2~3 degrees formation dip. The average altitude of the ground is about 150m. There are 625 water-drive oil & water wells in the study area. Well density is 33.8 well/km^2, the injection production ratio is 1.47, the average thickness of sandstone is 21.6m. So far, three types of subfacies developed in the study are have been seen: SI group, SII group, SIII group. PII group formation belongs to delta distributary plain subfacies and delta front subfacies sedimentary facies, and below GI9 oil layer in Gaotaizi, all belong to the sand body deposition in the outer edge of the delta front except GII1+2b, GII12+13 (Wang et al. 2007).

3. 3D facies controlled geological modeling

Due to the heterogeneity of Saertu, Putaohua, and Gaotaizi reservoirs at the West Block of the Third District in North Saertu (Han, 2010), it was established the use of the static three-dimensional geological model of the software PETREL 2009 to control the morphology of the geological body, ensuring the accuracy of modeling, the thickness of stratum and well pattern density (Guo et al., 2015). The plane grid spacing was set to be 20m×20m to characterize the reservoir plane distribution characteristics (Zhang et al., 2010). The vertical average is a grid for each 0.5m, and the minimum is 0.25m, which is used to meet the requirement of resolving the thinner layer (Fig. 1). The sedimentary facies modeling is based on construction model (Li et al., 2013), under the guidance of sedimentary model, using the theory of Assign to closest point to plane interpolation for phase data, and take the result of interpolation as constraints to establish sedimentary microfacies model (Chong et al., 2011).



SI4+5 small layer PII1 small layer

Figure 1. Microfacies model of reservoir sedimentary facies in the West Block of the Third District in North Saertu study zone

4. Numerical reservoir simulation

There is no visible crack in the study area, and the in-place oil is a conventional heavy oil. That is, the reservoir does not have an anti-coagulation phenomenon (Guo et al., 2013). It combines the actual situation in the study area to follow the first overall, after the local; the first principle of the block and single well numerical simulation to carry out the numerical simulation (Yang et al., 2011). Among 379 production wells in the region, the number of wells which have statistical production of single well fluid volume fitting relative error less than 20% is more than 65% of the total number of wells (Hu, 2012), the oil production fitting rate could reach to 100%, and the fitting accuracy of the study area is relatively high to meet the requirement of single well-fitting index (Fig. 2).

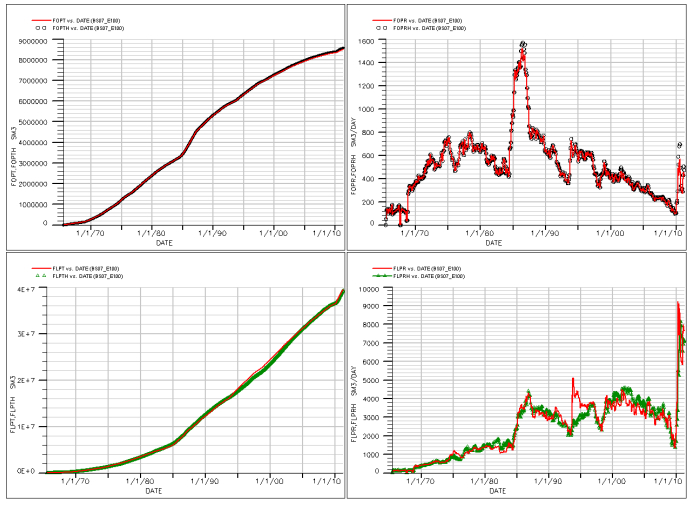


Figure 2. The fitting curve of generating oil and fluid in the West Block of the Third District in North Saertu Study zone

5 .Residual oil analysis

5.1 Remaining oil distribution law.

The numerical simulation results were carried out, the remaining oil saturation were subtracted from the residual oil saturation (Fu et al., 2010), and the residual oil reserves were calculated using the formula of reserves calculation (Fig. 3).

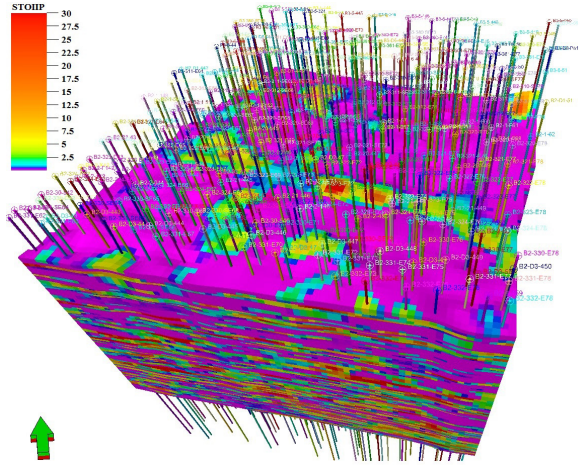


Figure 3. Movable remaining oil abundance distribution in West Block of the Third District in North Saertu Study zone

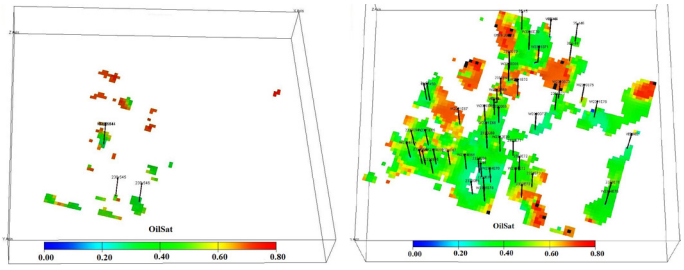
The distribution of remaining oil in the reservoir of Saertu oil layer is relatively uniform, and the remaining oil reserves are moderate, in the 20~50×10⁴t/km², which are distributed in the North and South area. Putaohua reservoir movable remaining oil reserves abundance high-value area is not relatively wealthy, with the moving remaining oil reserves abundance between 10~50×10⁴t/km². The high-value areas are in south and northeast. Gaotaizi reservoir remaining oil reserves plenty are between 5~50×10⁴t/km²; the high-value area concentrated in the southern half of area. The potential of the remaining oil is mainly accumulated in the non- principal parts of <1.0m, by using the existing well nets to do the injection-production relationship, adjust layer, water blocking and other measures, the estimated total remaining recoverable reserves are expected to reach 113.1×10⁴ tons, the ultimate recovery rate could be 49.8%.

5.2 Analysis of the causes of the remaining oil.

The formation of the remaining oil is influenced by the reservoir heterogeneity and the mining condition (Li et al., 2011; Wei et al., 2008). In this paper, the structure of the remaining oil in the block are affected by the following factors:

The pattern can not control it.

This kind of remaining oil is in the original well network, while drilling but not perforated, or original well pattern not being drilled and new infill wells drilled encountered reservoir is formed. Alternatively, is due to the relatively narrow oil-bearing sand body, passes through the middle of the two wells, due to well away from the Ohara pattern did not hold and the formation of remaining oil (Fig. 4).

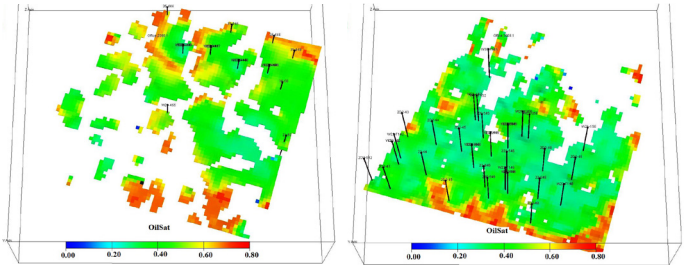


SIII9b GII9

Figure 4. Remaining oil formation (well pattern can not control)

The type whose injection production is not perfect.

Such residual oil is only well drilling encountered or only wells drilled, or oil wells drilling met for interlayer, the cementing quality and the same layer and water control, water and other aspects of the reasons and no perforation of remaining oil (Fig. 5). Injection production system adjustment can improve this potential, well network encryption and hole filling and so on, which are used to raise the level of use.

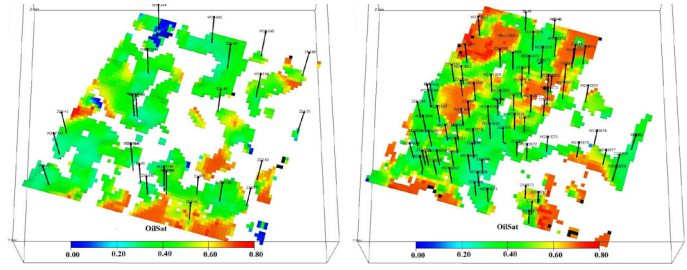


SI2 GII1+2a

Figure 5. Remaining oil formation (the type whose injection production is not perfect)

The kind of detention area.

The remaining oil is formed by the pressure balance between adjacent wells, which is a certain proportion in the thick layer and thin layer, but its distribution area is relatively small. The encryption can be used to improve the injection production relationship (Fig. 6).



GI4+5 SIII10

Figure 6. Remaining oil formation (the type of detention area)

The kind of poor reservoir.

The of this kind of residual oil is mainly due to the thin reservoir, poor physical properties, the original well pattern and well spacing conditions not established an effective drive system or the plane and inter layer interference. One is a thin layer with large distribution area, and the other is the area with poor physical properties in the side of the river. The remaining oil must be adjusted by the well network encryption and fracturing and other measures to improve the use of the situation (Fig. 7).

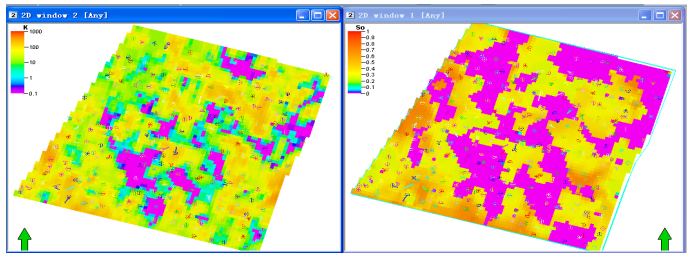


Figure 7. GI11+12 Comparison of permeability and residual oil saturation of the type of poor reservoir

The Relationship between residual oil and sedimentary microfacies.

With good physical properties of the channel sand reservoir, in the case of injection production, the water channeling occurred along the high permeability channel in the injection-production well, the water flooded in the first place, the formation of high permeability channel, and its adjacent non-main channel sand, front sand and other physical properties of the reservoir with low oil saturation, low level of reserves, the formation of the remaining oil enrichment (Fig. 8).

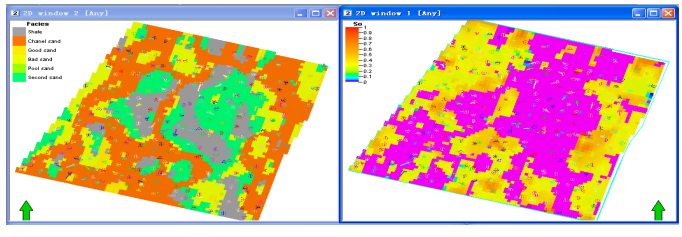


Figure 8. SII12 The contrast between sedimentary microfacies and remaining oil saturation

No water flooded type in the layer.

This kind of remaining oil mainly exists in the thick oil layer. Because of the good heterogeneity of the layers, good physical properties, high permeability of the site development effect is good, while the physical properties of poor, low permeability of the part because of the high permeability of the impact of the use of poor or non-use of the remaining oil, the use of the well network encryption and injection production system adjustment can be improved. The remaining oil is mainly the third times such polymer flooding oil potential object.

6. Conclusion

(1) Based on the geological modeling and numerical simulation, it was stablished that the remaining oil potential in West Block of the Third District in North Saertu Study zone is large, and Saertu oil reservoir remaining oil is mainly distributed in the area to the north and south; relatively few in the center. Residual oil of Putaohua reservoir is in the South and Northeast area. Gaotaizi reservoir remaining oil is concentrated in the southern half of area.

(2) The remaining oil potential in West Block of the Third District in North Saertu Study zone is concentrated in the non-main parts below 1.0m, the residual oil potential distribution is not balanced, and the local area has the encryption adjustment condition. It needs to use the existing well pattern and make the injection production relationship, adjustment layer, water shutoff and so on. The final recovery rate can reach 49.8%. Combined with water flooding fine exploration the recoverable reserves recovery rate could increase 1.1%.

Acknowledgments

The authors would like to thank Shi Shangming for supporting the publication of this work and Zhu Huanlai for supporting the shale-gas reservoir modeling studies. The authors would also like to acknowledge Yang Xinliang, Zhang Jingjun and Wang Jian for his many contributions to shale-gas reservoir modeling that were instrumental in this work. This paper is supported by the state key laboratory breeding base co-constructed by unconventional oil and gas accumulation & development province department, and it is funded by the National Natural Science Foundation of China (Fund number: 41302210) and the Research Fund for young teachers of Northeast Petroleum University (Fund number: 2013NQ136).

References

Chong, R.J., & YU, X.H. (2011). The Keys to Quality Control of 3D Reservoir Modelling. Marine Geology Frontiers, pp. 64-69.

Fu, Y.X, Feng, M.F., Liu, H. Bi, X.F. & Wang, S.Q. (2010). Analysis of Residual Oil Distribution Rules and Controlling Factors in Kumkol Oilfield. Drilling & Production Technology, pp. 61-63, 77.

Guo, X., Wang X.B., Guo M., Liu P., & Zhou X.M. (2013). Application of 3D Geological Modeling in Reservoir Description - A Case Study of Block T in Daqing Oilfield. Sino-Global Energy, pp.48-52.

Guo, Z., Sun, L.D., Jia A.l. & Lu T. (2015). 3D Geological Modeling for Tight Sand Gas Reservoir of Braided River Facies. Petroleum Exploration and Development, pp. 76-83.

Han, M. (2010). Research on Three-dimensional Modeling and Numerical Simulation in Shuyi District Du 84 Block SAGD. Petroleum Geology and Engineering, pp. 43-45.

Hu, H.F. (2012). Quality Evaluation Method on History Matching of Reservoir Numerical Simulation. Fault-Block Oil & Gas Field, pp. 354-358.

Li, S.H., Liu, X.T., Wang, J., Gong, W.Q., & Lu, W.T. (2013). Improvement of the Alluvsim Algorithm Modeling Based on Depositional Processes. Acta Petrolei Sinica, pp. 140-144.

Li, Y., Wang, X.H., Jin, S.S., Cai, S. Y., & Wang S. Q. (2011). The Rules of Remaining Oil Distribution and Measures for Potential Tapping in Wangji Oilfield. Journal of Oil and Gas Technology (J.JPI), pp. 294-296.

Sun, Y. Ma, S.Z., Jiang, H.F., Liu, Y.Y., Liu, Z.B., & Yu, L.M. (2011). Distribution Characteristics and Controlling Factors for Reservoirs of Putaohua Oil Layer in Sanzhao Sag of Songliao Basin. Journal of Central South University (Science and Technology), pp. 2387-2393□

Tong, S.Q., Li, B., Luo, Q. & Wang, H.J. (2014). Single-sandstone-layer Sedimentary Microfacies and Favorable Sandbody Prediction of Putaohua Reservoir in South Gulong Sag, Songliao Basin. Oil & Gas Geology, pp. 517-525.

Wang, J.G., Wang, T.Q., Wei, P.S., Liang, S.J., & Han, X.Q. (2007). Sedimentary Mode of Shallow Lacustrine Delta of Large Continental Basin - An Example From Putaohua Formation in Northern Songliao Basin. Lithologic Reservoirs, pp. 28-34□

Wei, Z.L., & Huang, S.J. (2008). Reservoir Numerical Simulation Technology and Methods in High Water Cut Period. Journal of Southwest Petroleum University (Science & Technology Edition), pp. 103-106.

Yang, F. Wang, X.H. & Liu, H. (2011). Evaluation on Remaining Oil Distribution Law and Adjustment at High Water-cut Stage - An Example from Gasikule Gas Reservoir. Journal of Oil and Gas Technology (J.JPI), pp. 129-132.

Yang, Y.F (2004). Formation Conditions and Distribution of Lithologic Pools in Songilao Basin. Oil & Gas Geology, pp. 393-399.

Zhang, Y., Zheng, Z.J., Lu, G.X., Wang, H.X. & Pu, H.Q. (2010). Application of Three-dimensional Geological Modeling and Numerical Simulation in Exploitation of Fractured Water-Gas Reservoir. Natural Gas Geoscience, 21(5), pp. 863-867.