Study on the mechanism of increasing oil by liquid extraction in offshore natural water drive reservoir

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Abstract

When oil field is in the middle and high water cut stage, increase production fluid is an effective way to delay the decline of oil production. Based on the microscopic mechanism of reservoir to carry out different injection times, different displacement pressure of rock under water flooding experiment, and proposed a new solution to increase the understanding of the mechanism of oil. Research shows: Increasing the injection times and water drive strength and increasing the washing strength can effectively overcome the influence of reservoir heterogeneity. The small pores of reservoir are constantly being spread, the range of remaining oil distribution becomes smaller, and the recovery ratio is greatly improved. For the micro structure of the core, that is increase production fluid can effectively improve the oil displacement efficiency.

Keywords

Injection Multiple; Water Drive Strength; Flushing Efficiency; Oil Extraction Mechanism.

1. Introduction

At home and abroad on the increase production fluid made a lot of research, such as Improve the production time, Improve the production rate, Improve the effect of liquid production, Factors influencing the effect of liquid production, the main method of core experiment[1] [2] [3] [4], numerical simulation[5] [6], waterflood curve method and field statistics [7], Has also made some achievements and understanding.But at present, the understanding of the mechanism of increase production fluid is still vague.This study based on the microscopic mechanism of reservoir to carry out different injection times, different displacement pressure of rock under water flooding experiment, and combined with the actual effect of liquid extraction, to analyzed systematically the mechanism of oil recovery by liquid extraction,It is clear that the large extraction of marine natural water drive reservoirs can effectively improve the recovery efficiency.

2. Research and new understanding on the mechanism of oil extraction

For the natural water drive oil reservoir in the sea, the middle and late stage of the oil field development is mainly to raise the liquid with large intensity and to replace the oil with liquid.The basic principle is to increase the water pressure by increasing the production pressure difference and water drive intensity,to extent of remaining oil in rock pores and the water drive swept volume in the plane and longitudinal direction,thus increasing the water flooding coefficient.With the increase of production pressure difference, it can effectively overcome the influence of reservoir heterogeneity, make the partial differential oil reservoir oil, the oil near the well zone is used, and the oil from the oil reservoir is obtained.

In the past, the traditional understanding of oil extraction can not improve the efficiency of oil displacement. In this paper, after a lot of research and practice of core displacement experiment,

through to the Wenchang A oil sealed coring experiment, based on the research on the factors from the micro pore structure of reservoir fluid, carry out different displacement ratio, displacement pressure under Naga Iwami, the short core flooding experiment, combined with comprehensive analysis magnetic resonance imaging data that: The oil recovery can be improved effectively by the liquid extraction, and the oil extraction efficiency can be improved effectively by the liquid extraction.Based on this study, the practice of large scale liquid extraction is carried out. The combination of theory and practice makes it clear that the large oil extraction in marine natural water drive reservoirs can effectively improve the recovery efficiency, it has certain guiding significance to the research of similar oil field.

2.1 Sensitivity of different pore types to displacement velocity

Based on the experiment of core displacement of the secondary pores and the primary pores under different displacement rates: Under different pore types, the oil displacement efficiency can be improved by increasing the displacement velocity and increasing the water flooding intensity, but the secondary pores are more sensitive to the oil recovery rate than the reservoir with the primary pores.The development of secondary pores in the reservoir in the high water cut stage to improve oil production rate of oil development effect is more obvious.By increasing the displacement velocity and increasing the displacement pressure difference, the residual oil saturation is obviously low, and the oil displacement efficiency is improved.According to the microscopic mechanism of the core, the oil recovery can be improved by increasing the production pressure difference and increasing the washing strength(See Figure 1, figure 2).

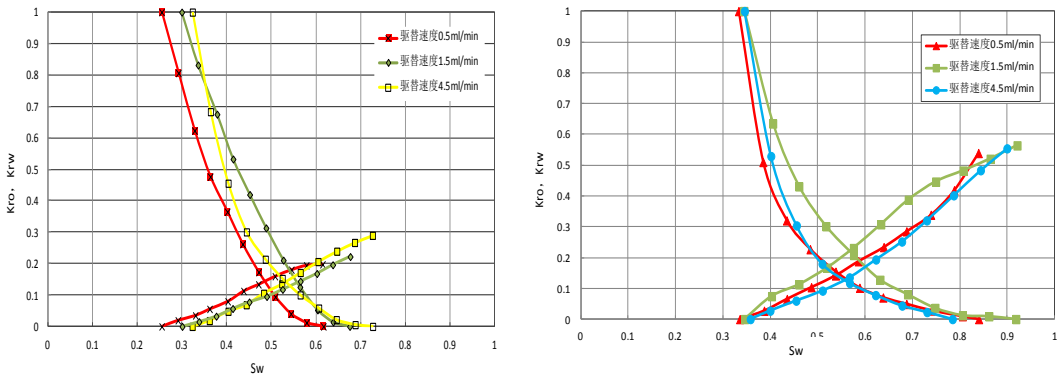

Figure 1. Sensitivity of different pore types to displacement velocity in X oilfield, Wenchang (left is the secondary pore, right is the primary intergranular pore)

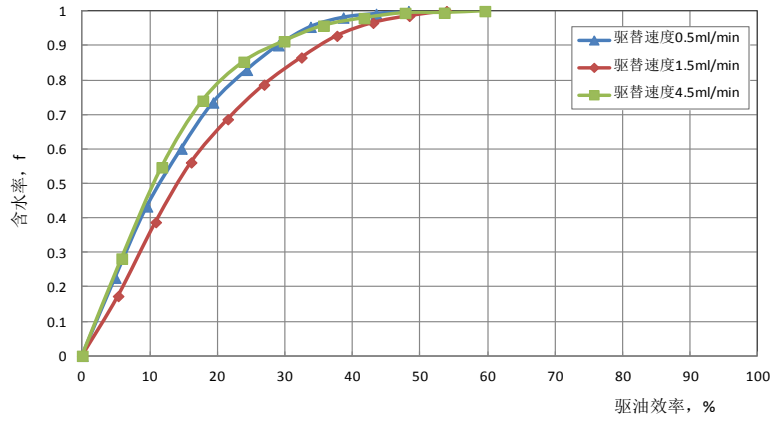

Figure 2. Relationship between oil displacement efficiency and water cut in a core of Wenchang X oilfield under different displacement rates

2.2 Analysis of the characteristics of rock pore distribution by nuclear magnetic resonance imaging

Analysis of the characteristics of rock pore distribution using core NMR imaging:The pore structure determines the direction and velocity of water line propulsion, the displacement efficiency and the distribution of residual oil.By increasing the water injection ratio and increasing the washing strength, the effect of reservoir heterogeneity can be effectively overcome. The small pores are constantly spread, the remaining oil distribution range is reduced, and the oil recovery is improved obviously(See Figure 3).By changing the pore pressure field, increasing pressure, making some small pores or pore water flooding area to overcome a sensitive effect, do not move the remaining oil into the movable oil out, until the pressure reached a new balance, improve the recovery rate(See Figure 4).

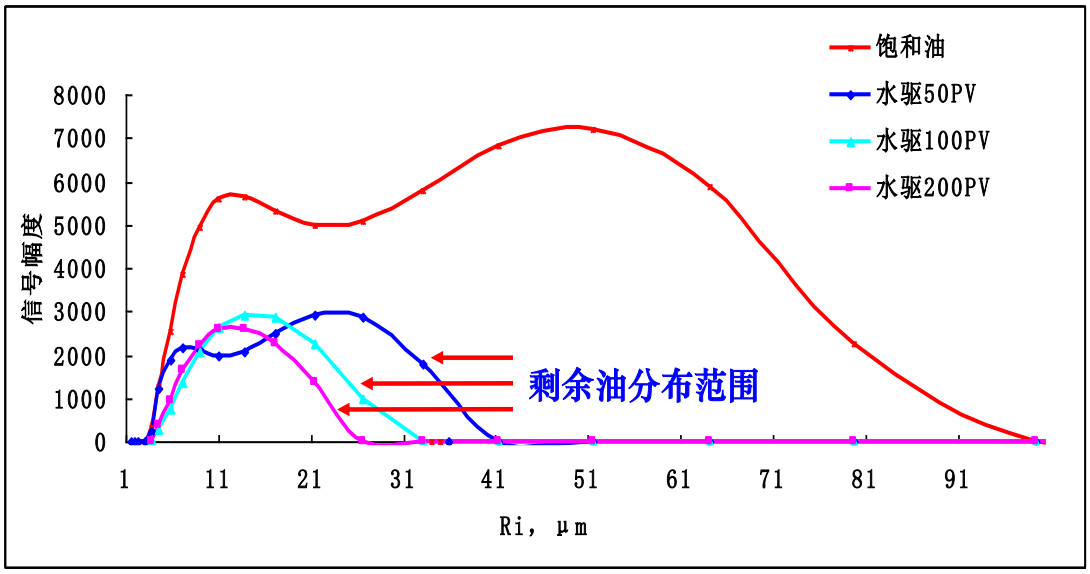

Figure 3. Porosity and permeability characteristics of rocks in different cores of X oil field in Wenchang

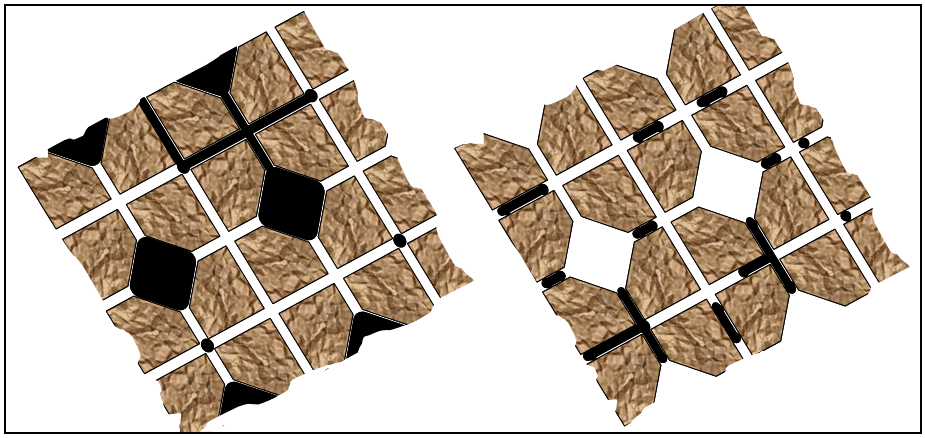

Figure 4. Distribution characteristics of remaining oil under different pressure fields

2.3 Naga Iwami, short core flooding experiment

From the single tube long core and short core displacement experiments, the oil recovery can be improved effectively by Increase production fluid.Taking the single tube long core displacement experiment as an example, two different displacement modes are simulated: The first one is the natural water invasion and artificial water flooding and the near well Depressurization(See Figure5a);The second one is the natural water invasion and near the well pressure drop liquid and natural water imbibition and imbibition water flooding(See Figure5b).

Experimental results show: Under different driving modes, the natural water flooding process is simulated. The water cut is obviously reduced and the recovery rate is obviously increased by reducing the pressure recovery to increase production pressure difference.The results show that increasing the water flooding intensity and the injection pressure difference can effectively improve the range of pore and increase the oil recovery.

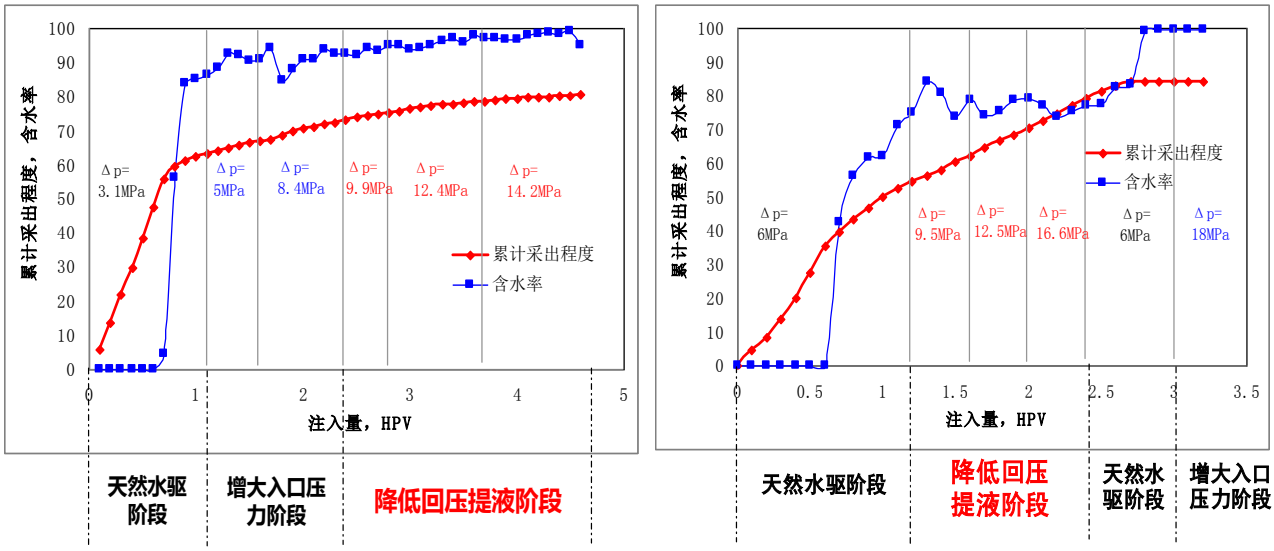

Figure 5. The single long core flooding experiment

At the same time, from the reservoir pore throat structure, compared with the early stages of development, after years of water flooding, reservoir physical property, increase the proportion of high permeability reservoirs, illite smectite content decreased, increased the content of illite in the pore throat, high cement particles were dispersed, after water flooding with high pore throat the radius of the main.

2.4 Numerical simulation study

From the numerical simulation analysis, the liquid extraction can effectively improve the output of the oil reservoir with different oil layers and the physical properties.By increasing the production pressure difference, can effectively overcome the influence of heterogeneity, a part of poor reservoir oil, at the same time by physical layers can be obtained using sandwich block to a certain extent, to extract water falling instead of rising, the effect of oil increase significantly(See Figure 6).

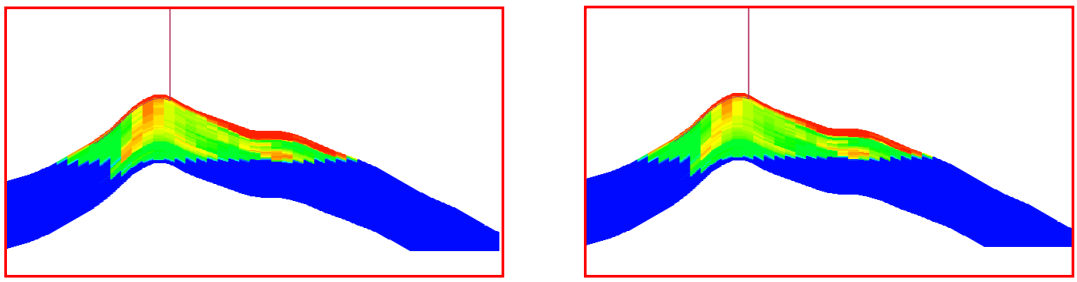

Figure 6. Saturation variation of water reservoir before and after development of interlayer reservoir(Left for the before increase production fluid, right for the after increase production fluid)

For example, a group of oil in the A oilfield of Wenchang is divided into 1U, 1L and 2U, with a total of 3 sets of oil-bearing layers, including the development of the interlayer, including the top calcareous layer, middle calcareous layer and bottom calcareous layer,and the unstable distribution of the mud interlayer.From the production dynamic and core experiments, the calcareous layer is not separated, but has a certain percolation capacity.The mean value of the minimum starting pressure difference of the bottom calcareous water drive is 1.65MPa, and the average value of the middle calcareous layer is 0.07MPa, and the average value of the calcareous layer is 0.03MPa. From the reservoir analysis, the oil group from high to low part of the construction site, and the calcareous

argillaceous interbed reservoir increased, vertical heterogeneity, interlayer is not separated, but has a certain percolation capacity,to some extent inhibited the water coning caused by interlayer shielding layer has low producing degree.Therefore, in the vicinity of the mezzanine prone roof oil and roof oil distribution.By increasing the pressure difference of production implementation extracts, which can effectively overcome the effects of heterogeneity, part of reservoir interlayer occlusion has been effectively utilized, thereby increasing the efficiency of water flooding, the production performance for the extract oil increasing effect is obvious, the water remained unchanged or decreased, increased oil effect(See Figure 7).Since 2008, the annual oil extracts of 3 ~ 5 times, a total of 21 wells, annual increase of oil (3.4 ~ 7.3) * 10^4m^3, the prediction can be extended 36.5 * 10^4m^3 oil tired, oil effect is very significant.

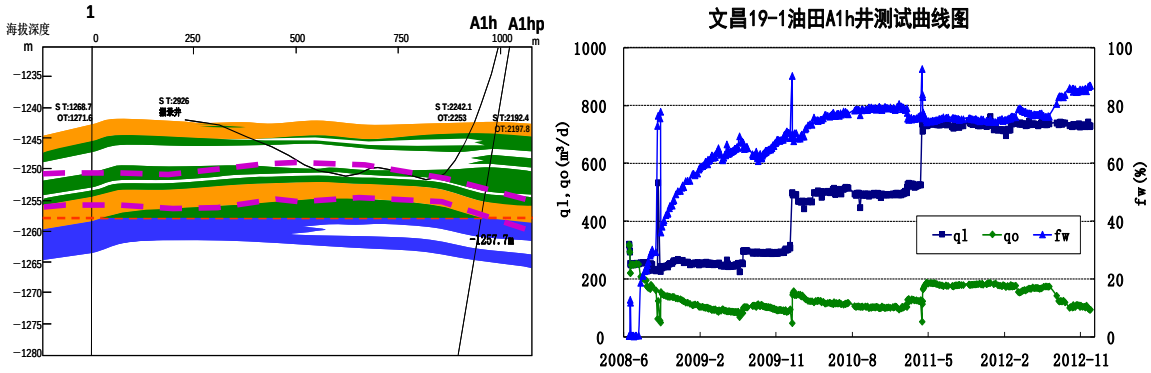

Figure 7. Reservoir profile and production curve of well A* in Wenchang A Oilfield

3. Field practice of large lift test

From the west of the South China Sea Oilfield Group over the field practice of water extract, the low water content period rate increased greatly with the extract rate changes, Suitable for small amplitude liquid extraction, high water cut period rate and extract the magnitude of change is small, suitable for large scale extraction production.Offshore oil field due to sea pipe infusion volume limit, over the years through the continuous expansion of extract, cyclone dewatering and other means to improve the fluid handling capacity after the implementation of several rounds of extract, can delay the decline of oilfields yield, Increase production capacity has become an important means of old oilfield in late development stage of increasing oil.

In order to further implement the late development of the comprehensive effect of liquid extraction, combined with the results of the study, 1 wells were selected to carry out the practice of large-scale liquid (Figure 8).The amount of liquid is raised from 1600m^3/d to 2500m^3/d, the liquid extraction amplitude is 900m^3/d, the water content is basically the same, the oil content is increased from 145m^3/d to 220m^3/d, the oil is increased by 75m^3/d, the effect is remarkable, and the prediction can be achieved by adding about 42 thousand oil.

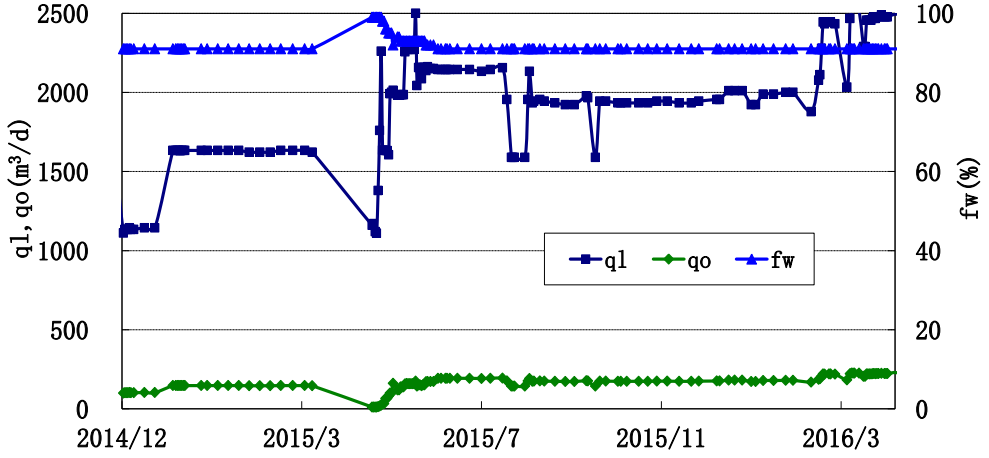

Figure 8. Test curve of A* fluid extraction test well in Wenchang A Oilfield

4. Conclusion

(1) In this paper, through the study of reservoir microscopic mechanism, the sealed coring experiment of water displacing oil, greatly improve the fluid field test, that the marine natural water drive sandstone reservoir in high water cut period by increasing production pressure difference, increase the intensity of water washing, can effectively improve the oil displacement efficiency and recovery rate, the main means of the future will continue to greatly improve the solution as the increasing oil.

(2) As the first-hand data, experiment is the main means to obtain more cognition. It is very important to study the microscopic mechanism of reservoir and establish the microscopic mechanism research process.

References

[1] Lan yu bo.Analysis of oil displacement efficiency in mine closed coring and laboratory simulation, Journal of Daqing Petroleum Institute,2005,p. 43-45

[2] Jian Bo.Study on the relationship between water injection efficiency and oil displacement efficiency,value engineering,2012,p.9-11

[3] Jishuhong.Re understanding of water flooding efficiency in high water cut stage,Petroleum exploration and development,2012,p.338-344

[4] Xuyang Zhang.Evaluation of water flooding efficiency of sandstone reservoirs with different pore structures,Journal of Chongqing University of Science and Technology,2011,p.47-51

[5] Zhang SD.Characteristics of reservoir microstructure and its effect on oil displacement efficiency in Gudao Oilfield,Journal of University of petroleum,2002,p.47-53

[6] Zheng qiang.Study on liquid extraction in sandstone reservoir with high water cut and high recovery, Xinjiang Oil & Gas,2013,p.24-27

[7] Shishubin.Study on Influencing Factors of oil extraction in high water cut stage,Petroleum Geology and Engineering,2012,p.83-85

[8] Chen Lin.Study on stability of liquid extraction in late stage of water flooding reservoir,Petroleum Geology and Engineering,2007,p.47-50