CSCanada
Advances in Petroleum Exploration and Development
Vol. 10, No. 1, 2015, pp. 66-69
DOI:10.3968/7268

ISSN 1925-542X [Print]
ISSN 1925-5438 [Online]
www.cscanada.net
www.cscanada.org

The Research of Water Influx Law for Edge-Bottom Water Heavy Oil Reservoir

REN Wenjia[a],*

[a] 2th Oil Production Plant, Daqing Oilfield Company, Daqing, China.
*Corresponding author.

Received 1 June 2015; accepted 10 August 2015
Published online 28 September 2015

Abstract

The Liaohe Jin 91 block has entered the late period of steam huff and puff, the entire block is seriously water invaded. At this stage the water invasion regularity for edge-bottom water of heavy oil reservoir is not clear. In Jin 91 block two well group, for example, we model the fine geological with petrel soflware, application the CMG software throughput of history matching, and combined with homogeneous core model water influx the indoor physical model experiment,to research the water influx regulation of the edge-bottom water heavy oil reservoir. The results show that the water invasion form is given priority to with bottom water coning, the Edge water tonguing is secondary, and in accordance with the experimental data at the same time, fitting out the exponential function relationship of water influx with the differential pressure and temperature, which provides a theoretical basis for promoting the development of edge-bottom water steam flooding of heavy oil reservoir.

Key words: Heavy oil reservoir; Edge-bottom water intrusion; The water influx law; Jin 91 block

Ren, W. J. (2015). The research of water influx law for edge-bottom water heavy oil reservoir. *Advances in Petroleum Exploration and Development*, *10*(1), 66-69. Available from: URL: http://www.cscanada.net/index.php/aped/article/view/7268
DOI: http://dx.doi.org/10.3968/7268

INTRODUCTION

Since Jin 91 block is an active edge-bottom water reservoir, steam stimulation adopts depressurization mining method, leading edge-bottom water continue to invade the reservoir, as well as other strata of water invade along the fault. Resulting in reservoir utilized uneven, well is flooded, in a high moisture content, low oil state, which put forward new challenges for the switch to steam flooding from stimulation[1, 9]. To solve this problem, it is necessary to study this critical issue for the water influx law of edge-bottom water heavy oil reservoirs[2-3]. According to the results, recognizing edge-bottom water invasion characteristics in reservoir[4], grasp the control elements of edge-bottom water intrusion, to provide the theoretical basis of control edge-bottom water invasion of the mechanism of water production, control reservoir water influx, adjust the oil well oil production measures, growth in heavy oil reservoir development life[5].

1. NUMERICAL RESERVOIR SIMULATION

Water saturation field distribution obtained by numerical simulation:

Figure 1 gives out the water saturation distribution in each layer of Yu I group, it can be seen that edge-bottom water encroachment is generally at the production section at the bottom of the high permeability layer, bottom layer relative water invasion is more serious. The closer to the underlying, the increase of water saturation is more approximate to linear, in I_3^6 layer linear increase of water cut and the lag of the rest of the layer of water saturation increases, can determine that edge-bottom water intrusion is mainly bottom water coning[10]. In addition, from the field data we realize that south of well group always exit a lot of water, the numerical simulation[11] that the invasion of the edge water is not large, but invading reservoir in the type of finger and tongue along the large pressure drop gradient direction through the High permeability channels[12].

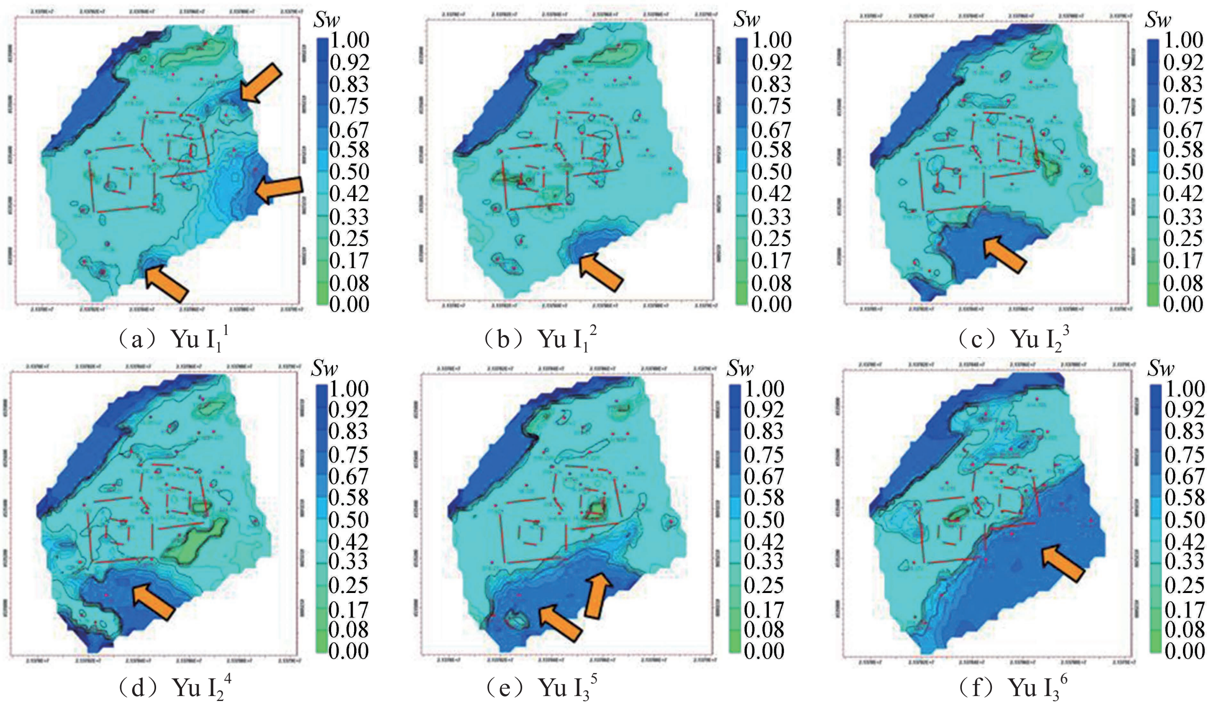

Figure 1
Water Saturation Distribution in Different Layers of Yu I Group

2. PHYSICAL MODEL EXPERIMENTS OF WATER INFLUX

The geological model is synthetic core physical model which adopt the quartz sand epoxy cement technology[6]. The size of homogeneous core is 30 cm × 30 cm×1.5 cm, and the gas permeability is about 1,500×10^{-3} μm^2. As is shown below, there are five production wells in the center, four Auxiliary production wells to form saturated oil at the periphery, four inlets to form a simulation of the edge of adequate water bodies, and a 2 cm-high hypertonic transition zone(its penetration is 16,000×10^{-3} μm^2) next to the edge of water bodies.

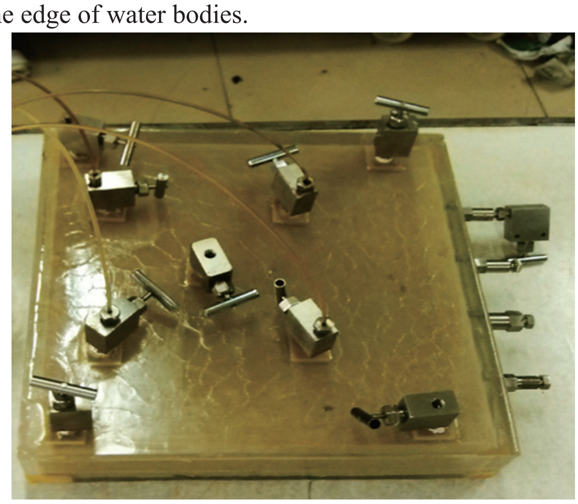

Figure2
Well Pattern Design

Experimental water is formation water that is configured: 2%KCl+5.5%NaCl+0.45MgCl$_2$ + 0.55%CaCl$_2$. Experimental oil are crude oil samples collected from Jinzhou Oil Production Plant.There are two experiments designed on the relationship between cumulative water influx and differential pressure, temperature: At the same temperature, the analysis on that the pressure differential impacts on water influx; under the same pressure difference, the analysis on that the temperature impacts on water influx[7-8].

2.1 The Analysis of Pressure Drop in Water Flooded Rule

In the case of the temperature is 45℃, setting differential pressure is 0.035 MPa, 0.045 MPa and 0.045 MPa. The core model have been saturated fully, conduct the experiment of water displacing oil, respectively measuring each well fluid, the oil and water.The distance of edge water more far 3#, 4# have the less fluid production, 1#, 2#, 5# well have more liquid producing, the 1# have the most obvious outlet. From five wells produced liquid is visible, edge water is not uniform, the distance from the edge water near well formation water invasion channel first. In addition, compared the cumulative liquid production contrast curve under the pressure 0.035 MPa, 0.055 MPa, 0.075 MPa we can find along with the rising of the differential pressure, the cumulative liquid production curve. Gradually the linear growth.

The two function fitting to the accumulated water influx curve, the equation: Q = (143,433×$\triangle p^2$-12,340×$\triangle p$+283.46)×t. The cumulative water influx of exponential function fitting, we can get the relation expression: $Q = 4.7065 \times t \times e^{44.965\triangle p}$. The fitting curve as shown in Figure 3. For different pressure accumulated water influx fitting contrast visible exponential relationship is relatively good, the best two function. But when the pressure is zero, the flow should be smaller, two function does not conform to the actual situation.

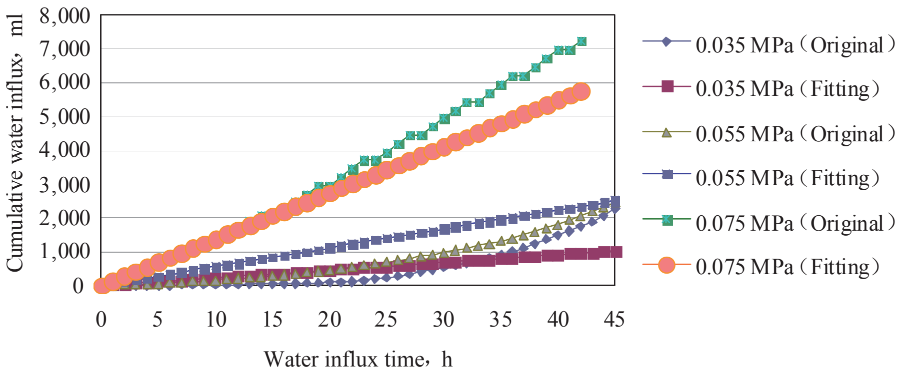

Figure 3
The Fitting Exponential Function of Cumulative Water Influx

2.2The Analysis of Temperature in Water Flooded Rule

In the case of pressure is 0.055 MPa, the temperature is setted respectively 45℃, 60℃, 75℃. The core model have been saturated fully Conduct the experiment of Water displacing oil. Respectively measuring the output yield of each well, Figure 4 for different temperatures of each well cumulative liquid production contrast curve As shown in Figure 11, 45℃, 60℃ instantaneous water influx curve, it close to exponential curve under 75℃.

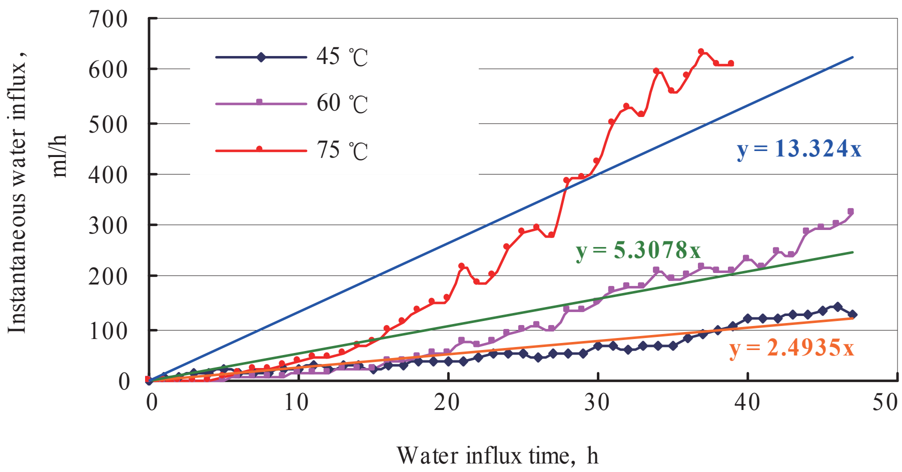

Figure 4
Tthe Linear Comparison of Instantaneous Water Influx

Three kinds of temperature instantaneous water influx of exponential function fitting to equation: $Q = 0.1964 \times e^{0.0559T} \times t$.

CONCLUSION

(a) Through the numerical simulation, results can be seen that the closer to the bottom, the increase of water saturation is more approximate to linear. By the linear increase of the I_1^6 water-bearing layer and the lag increase of the rest of the layer of water saturation, we can infer that the main form of the edge-bottom water into heavy oil reservoir is bottom water coning.

(b) From results of Yu I group historical simulation, we found that the invasion of the edge water reservoirs is not large, it flows through the high permeability channel along the bigger pressure drop gradient direction and then into reservoir in finger, tongue shape form.

(c) Through the regulation of differential pressure water invasion experiment data analysis, we know that accumulated water influx and fitting of the relationships between differential pressure is exponential function relationship $Q = 4.7065 \times t \times e^{44.965\triangle p}$ which can better describe the relationship between and in line with the actual situation.

(d) The experimental data shows that at low temperature, instantaneous water influx is approximate linear relationship with time, and at high temperature it is nonlinear relationship. Instantaneous water influx can be described by $Q = 0.1964 \times e^{0.0559\,T} \times t$.

REFERENCES

[1] Li, H. T., Zhang, L. H., Yang, S. Z., & Lu, L. (2004). J2x4 bottom water reservoir numerical simulation. *Southwest Petroleum Institute*, *26*(3), 25-27.

[2] Zhang, J. C., Zhang, Y., & Jiang, Y. W. (2007). Liaohe heavy oil reservoir with edge and bottom water control technology. *Special Reservoir*, *14*(2), 73-75.

[3] Jian, P. (2006). *Kam 45 floor*, *Xinglongtai oil fine reservoir description*. Daqing, China: Daqing Petroleum Institute.

[4] Wei, Z. L., & Huang, S. J. (2008). High water cut stage reservoir numerical simulation techniques and methods. *Southwest Petroleum University*, *30*(1), 103-105.

[5] Xu, H. Y., & Tan, Q. S. (2008). Heavy oil reservoir development flooding characteristics and remaining oil distribution. *Southwest Petroleum University*, *30*(3), 89-92.

[6] Zhang, W. (2007). *The fine reservoir geological model and its application* (Doctoral dissertation). China University of Petroleum, Beijing, China.

[7] Yang, J. B., Yang, Y. Z., & Dai, T. (2009). Reservoir geological modeling and numerical simulation of integrated application technology. *Petroleum Exploration and Development*, *16*(5), 72-75.

[8] Wang, H. F. (2004). *The water influx reservoir water influx to predict and injection-production ratio method* (Doctoral dissertation). Southwest Petroleum Institute, Chengdu, China.

[9] Cheng, Z. Y. (2010). Advances in numerical simulation of heavy oil thermal recovery of the Shengli oilfield. *Petroleum Exploration and Development*, *17*(6), 71-73.

[10] Zhu, L. (2012). Lengjia oilfield edge and bottom water heavy oil reservoir water influx law and Countermeasures. *Gansu Science and Technology*, *28*(2), 9-15.

[11] Li, Y. M., Chen, K. Y., & Zhao, Y. X. (2010). Countermeasures to improve the accuracy of numerical reservoir simulation. *Oil and Gas Technology*, *32*(3), 350-352.

[12] Li, D. (2012). Kam-91 side in Group I water heavy oil reservoirs in cyclic steam stimulation. *Inner Mongolia Petrochemical*, (14), 137-134.