Analysis of the causes of rising water content in the late stage of poly-drive in western block III of Area B and study of adjustment methods

Qiong Wu

Geological Research Institute of the Fourth Oil Production Plant, Daqing Oilfield Co., Ltd., Daqing, Heilongjiang 163000, China

Abstract: Seizing the main contradiction of fast water-bearing rebound in western block III, analyzing the reasons of fast water-bearing rebound in response to the contradiction, meanwhile, by understanding the mechanism of polymer oil drive and combining the development effect of three western injection and gathering blocks, finding out that the main problem of slowing down water-bearing rebound is the establishment of pressure system, and therefore the corresponding management measures at the injection and extraction ends respectively.

Key words: Late poly injection; control of water content rise rate; injection pressure; injection and extraction system

1. Introduction

With the time of poly injection, the western poly drive block III in area B has experienced blank water drive, water content decline period, water content low value period, water content rebound early stage, and is currently in the late stage of water content rebound, as can be seen from the proportion of oil production in different stages of the injected poly block, the stage of oil production in the early stage of water content rebound occupies a larger proportion in the whole process of poly drive due to the longer exploitation time, so the comprehensive adjustment of the water content rebound period plays an important role in the whole development of poly drive [1].

2. Block overview

The block is located in the western part of Area B of X Oilfield in City A, starting from the four rows of Area I in the north to the three rows of Area III in the south, bounded by Road S in the east and adjacent to the western transition zone in the west, with an oil-bearing area of 5.93km2.
The block was put into development in August 2011 and was injected with poly in August 2012. The geological reserves are 732.19×10^4 t. The exploited layer is Portuguese I $1^{\sim}3$, the thickness of sandstone is 11.28m, the effective thickness is 8.63m, the permeability is $494 \times 10^{-3}\mu m^2$, the degree of control of poly-drive is 75.4%, and the five-point method and 125m well spacing are used for well placement. As of June 2016, the average integrated water content of the block is 93.67%, which is in the late stage of water content rebound. There are currently 342 oil and water wells in the block, including 166 injection wells and 176 recovery wells.

3. Analysis of the current main problems and their causes

3.1 Rapid return of water content

The monthly water content of the block increased by 0.35 percentage points in the first half of 2016 and the number of wells with a monthly water content increase of greater than 0.5 percentage points was 28 wells, with a rapid rate of water content rebound.

Table 1 Rising water content of wells in Western Block III in the first half of the year

Classification	Number of wells (wells)	June 2016				Monthly water content uplift value (Percent)
		Daily fluid production (t)	Daily oil production (t)	Aqueous (%)	Sunkenness (m)	
≤0.3	49	35.2	2.4	92.84	342	-0.13
0.3~0.5	15	40.0	2.2	94.74	284	0.41
> 0.5	28	40.2	2.1	94.63	427	0.75
Set control area	62	15.4	1.2	90.92	187	0.68
Total	168	30.6	2.0	92.87	324	0.35

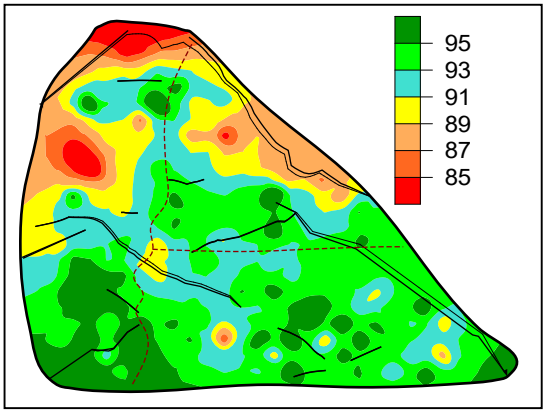

Figure 1 Water-bearing isopleth map of recovered wells in Western Block III

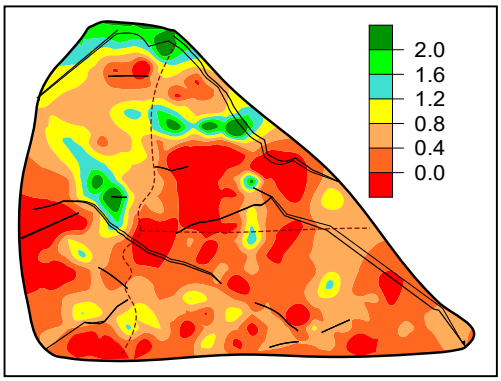

Figure 2 Water-bearing rise isogram for Block III West

3.2 Analysis of the causes of rising water content

The 28 wells with rising water content were analysed well by well for the reasons for rising water content into four categories: inefficient and ineffective circulation, insufficient fluid supply, insignificant profile improvement and high recovery [2].

The development of inefficient and ineffective circulation is characterized by high water content and prominent inter-stratigraphic conflicts, the solution focuses on controlling ineffective circulation and stopping high seepage; the development of undersupplied wells is characterized by low well sinkage, which is manifested by insufficient fluid supply, the solution focuses on enhancing fluid supply by increasing the injection volume; the development of insignificantly improved profiles is characterized by a lack of significant improvement in the ratio of layer activation and thickness activation, the solution focuses on stopping high seepage, adjusting dissection and increasing injection concentration; the development of high recovery is characterized by high cumulative oil production per unit thickness and a large maximum drop in water content, the solution focuses on reducing the injection of high seepage layers to improve the activation of low seepage layers.

4. Adjustment methods

Polymers act as oil repellents in two main ways. Firstly, due to the nature of polymers, they can be adsorbed into capillaries in the rock to seal the water pathway without any significant effect on the permeability of the oil phase, which is due to the hydrophilic and oleophobic characteristics of the phthalimide and completion acid groups. In addition, the high viscosity of the polymer increases the viscosity of the water phase, which can play a role in reducing the flow rate of the water phase, thus playing a role in reducing the water-oil flow rate ratio [3]. The change to high polymer concentration at the end of the injection period improves the viscosity of the polymer, changes the fluid properties and movement within the formation and improves the intra- and inter-formation conflicts in the injector well.

After we understood the oil drive principle of polymer, by comparing the development effect of the three western injection and gathering blocks, the injection and gathering process, the western block III injection pressure is always higher than the other two blocks, the pressure space is kept smaller, it is found that the wells with higher injection pressure, the succession layer is continuously moved during the injection and gathering process, the injection profile is improved, it is recognized that the pressure system has a greater impact on the development effect, for this reason, the pressure system is reasonably adjusted as the focus to establish an effective drive system.

The main means of adjustment for this is to adjust the injection and extraction parameters and increase the injection pressure.

Table 2 Rate of water content rise in each block of Zone B during the aggregation injection phase

Block	Initial water content (%)	Duration of low value period(month)	Maximum water content reduction (Percent)	Monthly water content uplift value (Percent)	
				Early stage of rebound	Late rebound
West I Block	97.26	5	15.37	0.88	0.45
West II Block	95.23	8	13.55	0.55	0.43
West III Block	93.43	13	14.45	0.45	0.35

4.1 Injection side

For the 53 wells with small injection pressure space, we focus on the work idea of ensuring injection and system, firstly, for the 18 wells with pressure space less than 0.2MPa, we implement the reduction of concentration and quantity 17 times to ensure continuous injection; secondly, we strengthen the sticky loss management for wells with pressure space between 0.2~0.5MPa to ensure the injection system, ensure the system fluctuation to the site, pressure change to the site, troubleshooting The "three to the site" principle, at the same time to implement a clear viscous loss of each node, to identify the two major factors affecting viscous loss: the impact of machine pumps and pipeline impact, to this end we actively repair all kinds of pump failure in the first half of the year more than 1,000 times, and at the same time to solve the pipeline viscous loss of high-temperature water cast ball 21 wells, through the above work, the western III Through the above work, the qualification rate of the western III block system was maintained at over 90%.

For the 58 wells with a large injection pressure space, we focused on the idea of increasing the injection pressure and reducing the pressure space, firstly, we implemented 10 wells with a thicker volume for wells with a pressure space between 0.5 and 1.0MPa according to the injection strength, and the average injection pressure per well increased by 0.2MPa after adjustment; for wells with a pressure space greater than 1.0MPa, we implemented 11 wells with a large thicker volume and 11 times, and stopped 2 wells with high seepage, and the average injection pressure per well increased by 0.6MPa after adjustment. The average single well injection pressure increased by 0.6MPa after the adjustment.

4.2 Extraction end

In view of the contradiction between the current development of the western block III, where the water content is rising rapidly and the recovery concentration is rising rapidly, we refined the classification of the extraction wells to explore the potential; at the same time, based on the relationship between the flow pressure and the water content and recovery concentration, we established a chart and concluded that the current reasonable flow pressure limit is 3.0~5.0MPa, for which we made targeted adjustments in conjunction with the injection and extraction conditions.

For the 4 wells with high water content and high concentration of poly, 9 wells were adjusted to control the inefficient and ineffective cycle, and 4 wells were plugged with water from the extraction wells, after which the average daily oil production per well increased by 1.3t and the water content decreased by 3.05 percentage points. For low water-content high poly wells to strengthen the injection and extraction structure adjustment, the implementation plan was adjusted 10 times, and 8 wells were transferred to small reference, after which the water content decreased by 1.50 percentage points and the sinkage increased by 46 m. For low water-content high poly wells to extend the low value of water content to maintain the effect of poly drive, the implementation plan was adjusted 12 times, and 4 wells were transferred to large reference, after which the daily oil production increased by 0.3 t and the sinkage decreased by 39 m.

5. Conclusion

A reasonable injection plan is a prerequisite to ensure the effect of injection, and timely adjustment of the plan is a guarantee to prolong the effect of injection; for the characteristics of late injection should reduce the injection rate, increase the injection concentration, expand the wave volume, and maximize the remaining oil. At the same time,

in order to control the rate of water content recovery to control the pressure system as a key element.

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