Effect of pressure systems on the development effectiveness of 125m polymer blocks

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Abstract: Since the industrial polymer drive development in the oilfield, eight blocks have experienced poly-drive development successively. With the extension of the development time, the extraction well spacing of polymer drive blocks has been reduced. After the reduction of well spacing, the influence of whether an effective pressure system can be established on the development effect gradually increases, and the minimum value of pressure space rises from about 0.5 MPa to 1.5 MPa, and the value of improved recovery rate is nearly 3 percentage points less with the same subsurface pore volume PV number injected. In this paper, we study the pressure system to find out the influence of pressure system on the development effect of 125m polymer block, and take adjustment measures to improve the development effect of poly-drive.

Keywords: Polymer drive, 125m well spacing, pressure system.

1. Introduction

Comparing the development effect of eight different well spacing poly-drive blocks, the extraction well spacing of polymer drive blocks keeps decreasing, from 200 meters to 150 meters to 125 meters, after the well spacing decreases, the pressure transmission distance decreases, and it becomes more difficult to establish an effective driving differential pressure, and the influence of whether an effective pressure system can be established on the development effect gradually increases, and the development effect of 125 meters spacing has a tendency to become worse. Therefore, it is necessary to study the influence of the pressure system on the development effect of agglomeration drive at 125m well spacing, and to improve the development effect of agglomeration drive by changing the unfavorable side of the pressure system through corresponding adjustment measures.

2. Effect of pressure on the effectiveness of polymer drive development

For the pressure system that affects the effect of poly-drive development focus on four aspects. First, the influence of the gravity of the liquid column, the influence of low injection and high extraction or high injection and low extraction caused by different structural positions after the injection and extraction wells are drilled and drilled; second, the influence of the start-up pressure, after the well distance is reduced, the loss pressure in the formation is reduced and the start-up pressure has a tendency to decrease; third, the influence of formation pressure, with the reduction of well spacing, formation pressure transfer is faster, and there is a large change in the number of years required for the block formation pressure to recover to the original formation pressure; fourth, the influence of driving pressure difference, mainly from the production of large pressure difference, injection and extraction wells in the middle of the driving pressure difference, injection and extraction wells in the middle of the formation pressure gradient three levels to analyze the influence of driving pressure difference on the development effect.

2.1 The effect of gravity on the liquid column

The results from tracer monitoring showed that the average tracer advancement velocity on the left side, bounded by the center well, was 1.42 m/day, while the average advancement velocity on the right side was 2.34 m/day. Analysis of the reason is mainly due to the influence of the structure, the average depth on the left side is 837.1 meters, the average depth at the center well is 845.6 meters, the average depth on the right side is 854.6 meters, the right-side structure is lower than the left side, in the case of similar oil formation development, the right side see agent time earlier than the left side.

The maximum tectonic drop between injection and extraction wells is 12.4m, and the distance between injection and extraction wells is 125m. The maximum formation inclination between injection and extraction wells is calculated to be 5.7 degrees, and the minimum inclination is 0.6 degrees. According to the recovery fluid tracer detection data, the inter-well drop is less than 8 m

and the formation inclination is less than 4 degrees. A=acttg(12.4/125)=5.70, A=acttg(12.4/150)=4.70, A=acttg (12.4/200)=3.50.

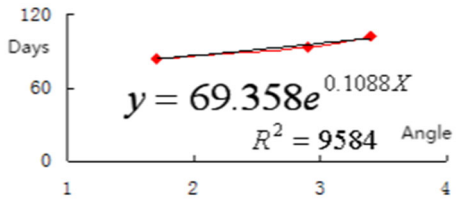

Fig.1 Exponential relationship between angle and time between low injection and high extraction wells

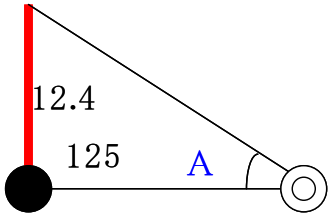

Fig.2 Diagram of the dip angle of 125m well from the formation

The large production pressure difference between low injection and high recovery type wells gradually decreases, and the formation-driven pressure difference between water and oil wells may be reversed by other inter-well interference situations, resulting in no actual driving capacity between water and oil wells.

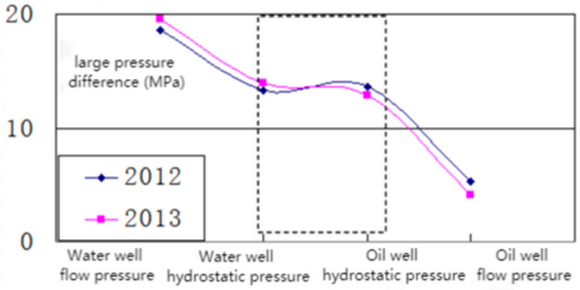

Fig.3 Large pressure difference between wells at the same height

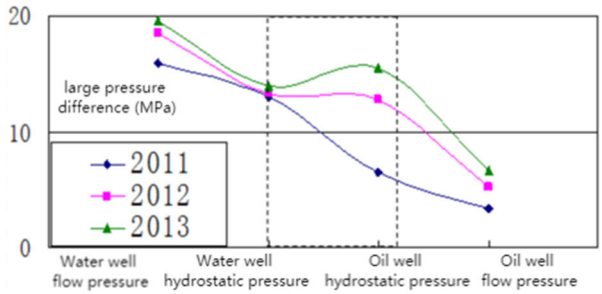

Fig.4 Large pressure difference between low injection and high extraction wells

2.2 Start-up pressure influence

The measured PI (90) values under different well spacing conditions show that as well spacing decreases, the loss pressure in the formation decreases, the number of wells with start-up pressures greater than 7.0 MPa decreases proportionally, and the average start-up pressure in the block tends to decrease, making it easier for the injected polymer solution to enter the formation and more difficult to establish an effective driving differential pressure.

The injection well indication curves are normally linear increasing, inflection point upward and inflection point flat, which represent different formation characteristics, while the injection well indication curve of the 125-meter well distance poly-drive block is a typical linear increasing type, indicating that the injection pressure increases linearly with the rise of the injection solution, and the pressure conduction is faster after the formation is injected with the solution.

2.3 Influence of stratigraphic pressure

As well spacing decreases, formation pressure is transferred faster and the block formation pressure takes less years to return to the original formation pressure. As the injection and extraction well spacing decreases, the injection and extraction is more likely to form a channel, which requires a faster injection and extraction rate and a higher cumulative injection and extraction ratio to continuously restore formation pressure.

2.4 Influence of injection pressure

As well spacing decreases, injection pressure rises at a slower rate and there is more room for injection pressure to rise, making it difficult to move the middle and low permeability layers and improving the oil formation movement to a lesser extent. In injection wells with lower injection pressure, the injection profile was not improved due to poor mobilization of the low and medium permeability layers. In the injection wells with higher injection pressure, the replacement layer was continuously used during polymer replacement and the injection profile was improved.

2.5 Drive differential pressure effect

2.5.1 Production of large differential pressure

After the well spacing was reduced, the production large pressure difference showed a gradual decrease trend as the production time was extended.

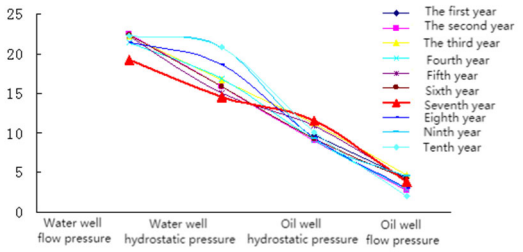

Fig.5 125m well spacing producing large pressure differential

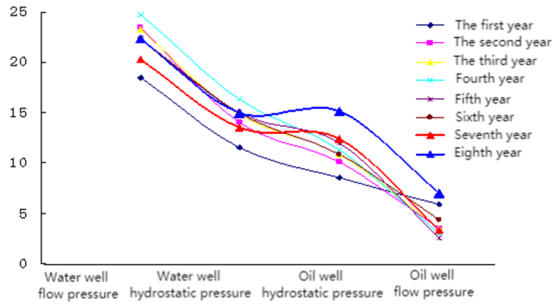

Fig.6 150m well spacing to produce large pressure differential

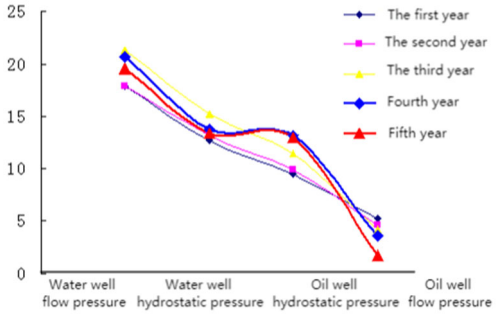

Fig.7 200m well distance producing large pressure differential

After the well spacing is reduced, the large pressure difference of production is lower, which makes it difficult to form an effective repulsion, and the polymer utilization rate is reduced, which affects the development effect of poly-drive. The block storage rate decreases, the utilization rate of polymer decreases, and the development effect becomes worse.

Under the same well spacing conditions, the lower the production differential and the longer the period to develop effective production differential, the worse the development effect of aggregation drive.

2.5.2 Drive differential pressure in the middle of the injection well

According to seepage theory, the seepage velocity is minimum at the midpoint of the main flow line, where the pressure gradient is minimal. If an effective driving system is to be established, the driving pressure gradient must be greater than the initiating pressure gradient at the midpoint [2].

$$\frac{dp}{dd} = \frac{P_H - P_W}{\ln \frac{d}{r_W}} \times \frac{2}{d}$$

PH: Bottom flow pressure of injected wells, MPa

PW: Bottom of well flow pressure in extraction wells, MPa

d: injector-producer distance, 125, 150, 200, m

rw: radius of wellbore, generally taken as 0.1m

As the well spacing shrinks, the greater the driving pressure gradient needed in the middle of the formation so that an effective driving pressure differential can be established.

2.5.3 Pressure gradient in the middle of the formation in injection and extraction wells

According to Muskat and Van Poollen's equation for the radius of investigation [1]

$$r_i = 0.12 \times \sqrt{\frac{Kt}{\phi \mu C_t}}$$

ri: survey radius or detection radius

K: permeability, μm2, take the value of 0.421

T: production time, h, take the value of 72~120 (well shutdown response time)

Φ: porosity, no factor, take the value of 0.24 (test four teams use)

μ: fluid viscosity, mpa.s, take the value of 6.7 (test four teams use)

Ct: integrated compression coefficient, MPa-1, 0.00139997 (used by Test Team 4)

Note: Ct = formation compression coefficient / 0.24 + water saturation 0.19 * water compression coefficient + oil saturation 0.81 * oil compression coefficient + gas saturation 0 * gas compression coefficient

The investigation radius formula is subject to different block permeability, the minimum is 12.6m and the maximum is 19.5m, and the minimum value of the middle distance of the measured formation pressure in different block injection wells is 86.1m and the maximum value is 170.6m.

The middle pressure gradient value of the injection and extraction well is derived from the relationship between the difference in formation pressure and the middle distance of the measured pressure value, and the size of this value represents the size of the middle driving capacity.

$$P_z = \frac{P_w - P_o}{R - r_{\max}}$$

Fig.8 Formula for calculating the pressure gradient in the middle

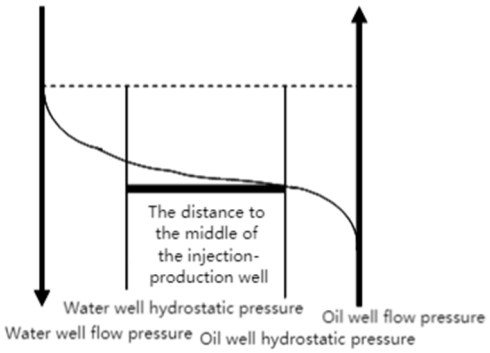

Fig.9 Schematic diagram of the middle distance of the stratum

Pz: Differential pressure in the middle of the formation in injection wells
Pw: Water well static pressure MPa
Po: Oil well static pressure MPa
R: injector-producer distance m
rmax: Maximum detection radius m
The first low value of the central pressure gradient occurs around the third year after injection and gathering, during which the oil wall advances to the bottom of the recovery well and the water content reaches its lowest value [3]. Once a stable injection and recovery pathway is established, the central pressure differential rises again and the cycle is repeated.
The earlier the low value of the pressure gradient in the middle of the injection and extraction well appears after the injection, the earlier the effect of the poly drive; if the low value does not appear, the effect is poor.

3. Recognize

3.1 High injection and low recovery solution is easy to advance. At 125 meters well spacing, the formation dip angle is less than 4 degrees inter-well solution is easy to advance.
3.2 With the reduction of well spacing, the start-up pressure has a tendency to decrease, the rise of injection pressure slows down, the pressure rises more space, and it is difficult to move the middle and low permeability layers, and the improvement of the moving condition is lower.
3.3 As well spacing decreases, it is easier to form channels between injection and recovery wells, requiring a faster injection rate and a higher cumulative injection ratio to continuously restore formation pressure and establish an effective driving pressure differential.
3.4 After the well spacing is reduced, the production large pressure difference is lower, and the longer the period to form an effective production large pressure difference, the more difficult it is to form an effective repulsion, the lower the polymer utilization rate, and the worse the development effect of poly-drive.
3.5 The first low value of the central pressure gradient appears around the third year after the injection of poly, during which the oil wall advances to the bottom of the recovery well and the water content reaches the lowest value. The earlier the low value of the pressure gradient in the middle of the injected well appears, the earlier the effect of the polycondensation drive; if the low value does not appear, the effect is poor.

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