# Evaluation and Influence Factors Analysis of Polymer Flooding in D Zone of an Oilfield

**Dongmei Liu**

The Third Oil Extraction Plant of Daqing Oilfield Co., Ltd.

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**Abstract:** The physical properties of crude oil in D zone of transitional zone are poor, the sedimentary types of each sedimentary unit are different and the heterogeneity is strong. At the same time, due to the high degree of water drive and scattered distribution of remaining oil, the ratio of high and medium water flooded thickness is as high as 89.7% before injection, and the inefficient and invalid circulation at the bottom of thick reservoir is serious. The injection pressure distribution of injection wells is unbalanced and the amount of polymer used is large. In this paper, the variation law of injection and production parameters during polymer flooding in this area is summarized and analyzed, and the polymer flooding effect is evaluated. The research results can provide a basis for further understanding the development law of polymer flooding in transitional zone and timely and effective development and adjustment.

## 1. Block survey

The D area was put into operation in November 2011. It adopts 125m * 125m well spacing five point method area well pattern, and a total of 251 wells. In August 2013, when the polymer dosage was 104PV.mg / L, the block began to take effect. In April 2014, when the polymer dosage was 242 PV.mg / L, the block entered the low water-cut period. The low water-cut period lasted 12 months and the lowest water-cut was 89.09%. Compared with the pre-injection period, the water-cut decreased by 7.32 percentage points. and is now in the stage of water cut recovery. The comprehensive water cut is 96.56%. The polymer dosage is 1038 PV mg / L. The polymer solution has been accumulatively injected with 1260.53×104 m3, the pore volume injected with 0.890 PV. The stage recovery is 10.55%, the recovery is increased by 8.10%, and the recovery is expected to increase by 10.0%.

## 2. Evaluation of development effect of polymer flooding in D area

Compared with the first class reservoir in the pure oil zone, the dynamic change law of injection-production wells in the transition zone D is basically the same, but the injection pressure, liquid production and other indicators have their own characteristics.

In the blank water drive stage, the injection pressure is low, and the injection pressure increases greatly after injection, and maintains a high level.

The injection pressure of D zone in blank water flooding stage is 8.5 MPa, 6.6 MPa lower than fracture pressure, 87.5% lower than 5 MPa of fracture pressure, 10.8%, 36.5% more than that of A and B zone in pure oil zone, After polymer injection, because the viscosity of the injected solution is greatly increased and the polymer is adsorbed and trapped in the reservoir, the percolation resistance increases and the injection pressure rises.

From the contrast curves, it can be seen that the change trend of each block is the same: the injection pressure rises faster at the initial stage of polymer injection, and the injection pressure begins to rise slowly and then tends to be gentle when the injection pore volume multiple is 0.20. However, compared with areas A and B of polymer injection block in pure oil area, the injection pressure in zone D of transition zone is only lower than that in block B1, and the increase amplitude is larger.

At the same time, The blank water drive suction index of 7.89m3/d.MPa is about half of the A and

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B zones, and the decline amplitude after polymer injection is almost the same as that in A and B zones of pure oil, with a decrease of about 40%.

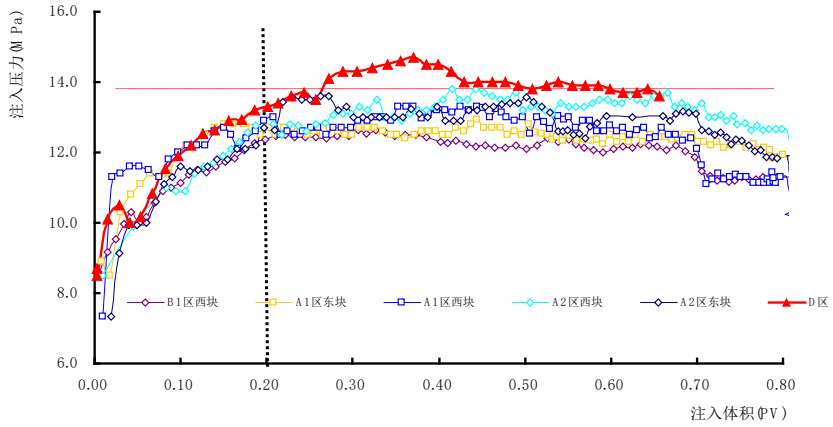


Fig. 1 Relationship between injection volume and injection pressure in each block

After inhalation, the suction profile is improved, but the suction condition of the low permeability reservoirs is poor.

After inhalation, the suction section of D area is improved, and the suction thickness ratio is similar to that of B area, but lower than that of A area. However, compared with the first class reservoirs in A and B areas, the proportion of suction thickness with permeability less than 300 *10-3 micron 2 is lower than 6.9 percentage points in the east of B area and 26.4 percentage points in A area.

Table 1 suction profile statistics for injection wells in area D (40 ports)

| Permeability grading | <300 ($\times10^{-3}\mu m^2$) | | 300-500 ($\times10^{-3}\mu m^2$) | | 500-800 ($\times10^{-3}\mu m^2$) | | >800 ($\times10^{-3}\mu m^2$) | | total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time | Suction thickness ratio (%) | Relative inhalation (%) | Suction thickness ratio (%) | Relative inhalation (%) | Suction thickness ratio (%) | Relative inhalation (%) | Suction thickness ratio (%) | Relative inhalation (%) | Suction thickness ratio (%) | Absolute water absorption ($m^3$) |
| Pre polymer injection | 46.2 | 11.4 | 55.8 | 17 | 60.6 | 17.2 | 72.8 | 54.4 | 61.8 | 72.5 |
| 2013 | 48.3 | 14.3 | 69.6 | 21 | 78.0 | 17.9 | 72.0 | 46.8 | 69.2 | 74.1 |
| 2014 | 48.3 | 15.7 | 74.7 | 19.7 | 80.1 | 18 | 74.9 | 46.6 | 71.3 | 76 |
| 2015 | 44.3 | 14.3 | 56.9 | 14.8 | 58.8 | 14.4 | 73.0 | 56.5 | 63.1 | 71 |

Compared with polymer flooding in pure oil reservoirs, the performance of oil wells is basically the same, but the productivity index is low and the decline is small.

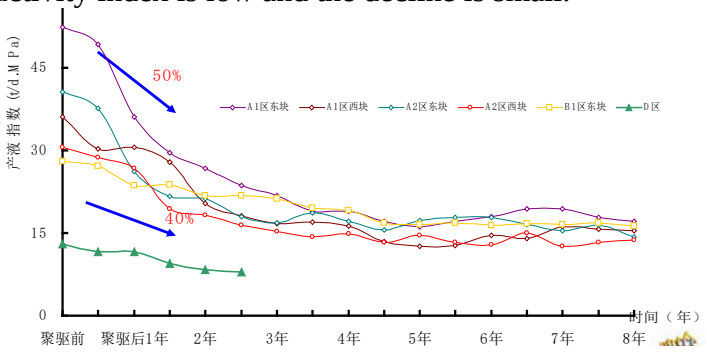


Fig. 2 variation curves of liquid production index for polymer flooding in different blocks

According to the dynamic response of oil wells, the performance of oil wells in D area is basically the same as that in pure oil area after polymer injection, but in polymer flooding stage, the cumulative liquid production curves of A and B areas in pure oil area always lie above the curve of D area in transition zone. From the dynamic data of production wells, it is found that the liquid production index in D area is lower than that in pure oil area, and the blank water flooding liquid production

index is about half of the A and B type reservoirs. After the effect, the liquid production rate of the oil wells decreases, but the decreasing extent of the liquid production rate and the liquid production index of the oil wells is lower than that of the A and B areas.

Compared with the polymer injection block in the pure oil area, the polymer flooding effect in the transitional zone is worse, which is shown as follows: the water cut drops slowly and the water cut drops slowly during the production period; the effective time is early, but the effective ratio is low; the duration of the low value period is short, the recovery speed is fast; the oil recovery speed and the enhanced oil recovery rate are low;

Compared with block A and block B of pure oil area, the production wells in D area have earlier effect time, but after effect, the water cut of production wells decreases slowly and the decline amplitude is lower. When the polymer dosage is between 47-242 mg/L.PV, the water cut of oil wells keeps decreasing, and the initial water cut decreases slowly. After the polymer dosage is 169 mg/L.PV, the water cut decreases rapidly, from 96.38% to 90.84%, and the water cut decreases by 5.54 percentage points, which is equivalent to the polymer dosage of 35 mg/L.PV.

## 3. Analysis of influencing factors on development effect of polymer flooding in D area

(1) the influence of the water flooding foundation well pattern is large, and the remaining oil is difficult to tap.

The basic well pattern of water flooding in D area is well controlled, the production life is long, the oil saturation is low and the comprehensive water cut is high before polymer injection.

The basic well pattern of D area is 350m * 350m four-point method. It was put into production in 1971. Compared with A and B area, the first class reservoir in D area has a long production period of 8 years and a high degree of control of 15.1%. The remaining oil potential is small before injection and the oil saturation is low. According to the oil saturation statistics, the oil saturation in D area is only 40.8% at the initial stage of polymer injection, which is lower than 13 percentage points in A and B area, and the recovery degree before polymer injection is 38.1%, higher than 31.5% in A area and 34.5% in B area. Before polymer injection, the ratio of high watered-out thickness in D area is 59.7%, which is much higher than 32.4% in A area and 23.9% in B area.

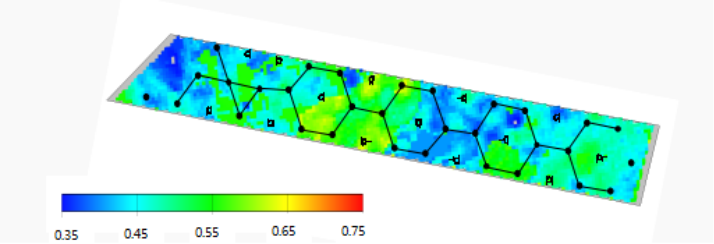


Fig. 3 oil saturation equivalence map in D area

Residual oil distribution is scattered before polymer injection. After polymer injection, the effect is not synchronous and the plane effect is different.

After polymer injection, the degree of effective well depends on the distribution of remaining oil before polymer injection. After the well with high oil saturation is effective, the water cut decreases greatly and the stable production time is long, and the water cut decreases slightly in low oil saturation wells. Because of the influence of the basic well pattern, the remaining oil in D area is scattered. The oil saturation near the base well is high, and the closer to the water injection well, the lower the oil saturation, the great difference of the oil production effect. According to the location of oil wells and the statistics of wells in each location, it can be seen that the ratio of high water flooding of old oil wells in the same well site is relatively low, and the water cut decline is the largest; the proportion of high water flooding of oil wells near water injection wells is high, and the effect is poor.

Near the point of water injection well, there are prominent contradictions in the layer, inefficient and inefficient circulation.

A class D reservoir is divided into 6 sedimentary units, of which 2 are developed with large area channel sand bodies, and have strong horizontal and vertical heterogeneity. The variation coefficient

of plane permeability is 0.68, which is 0.08 higher than that of A and B reservoirs, and the difference between the highest permeability and the lowest permeability is more than 800 ×10-3μm2 In addition, the relationship between injection and production of basic well pattern in D area is better than that in A and B area, and the production time is longer. After long-term water flooding, due to the effect of reservoir heterogeneity and gravity, the seepage resistance of high permeability layer becomes smaller, and most of the injected water flows along the high permeability layer, forming large pore channels at the bottom of the reservoir, resulting in inefficient and ineffective circulation of injected water.

The well spacing is small, the injection capacity and the fluid recovery speed are strong.

From the reservoir development point of view, D area is worse than A area, but better than B area, but the plane heterogeneity is strong. The number of injection and production wells in the same area is twice as many as A and B area, which leads to the suction index and liquid production index being half of A and B area, and the injection rate being 0.22 PV, 0.07 PV higher than A and B area. The decrease of liquid production and production index of oil well is lower than that of A and B.

The effect of two polymer flooding in the original polymer flooding test is poor.

The polymer flooding test was carried out with an irregular four-point well pattern of 175-200 m in well area from 1996 to 2002, and the oil recovery was increased by 8.55%. In 2011, four wells were diverted from the original well pattern to drill five wells, forming a 125m 65 After the water cut up in 2015, 10 injection wells were injected into the well, and 7 were stopped. The lowest comprehensive water cut was 96.65%. Only 2 wells had water cut below 95%.

## 4. Several Understandings

1) The dynamic change rule of one kind of oil layer in the transitional zone is basically the same as that in the pure oil area.

2) The viscosity of crude oil in transitional zone is high, and the polymer solution with higher viscosity is needed to achieve better oil displacement effect.

3) After long-term waterflooding development in the transitional zone, the inefficient and invalid circulation at the bottom of the reservoir is serious, and the polymer flooding efficiency is lower than that of the first-class reservoir in the pure oil zone.

4) The transitional zone is characterized by poor physical properties of crude oil, small residual oil potential, strong reservoir heterogeneity, and poor development effect.

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