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Implementing Alternate Polymer flooding to Improve Dry Powder Utilization

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Implementing Alternate Polymer flooding to Improve Dry Powder Utilization

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Author brief introduction Yuan Yuan, engineer, graduated from Daqing Petroleum College in 2006, majoring in resource exploration engineering, engaged in tertiary oil recovery and development. E-mail: yyuan_dz@petrochina.com.cn，

Abstract. After more than ten years of industrialized production, polymer flooding in Daqing Oilfield has formed a relatively mature matching development technology, and the tertiary oil recovery production mainly by polymer flooding has accounted for about one third of the total oil field. However, in recent years, the problem of increasing the amount of polymer dry powder and worsening the development effect and benefit has become increasingly prominent. In order to improve the development effect of tertiary oil recovery, reduce the cost of tertiary oil recovery and improve the utilization ratio of dry powder, the alternating polymer injection technology for second class reservoir is explored and implemented. By optimizing the parameters of alternating polymer injection, the optimum injection period, viscosity and strength are given quantitatively on the basis of laboratory research and numerical simulation. After application , good results have been achieved. This technology provides technical reserve and practical experience for efficient development of polymer flooding in second class reservoir.

1. Questions raised

After 15 years of industrialized development, polymer flooding [1] in Development Zone A has formed a relatively perfect matching adjustment technology. The proportion of tertiary oil recovery mainly by polymer flooding increased from 44.3% during the 11th Five-Year Plan period to 59.6% during the 12th Five-Year Plan period. However, in recent years, most of the injected polymer blocks have entered the stage of increasing water content. The amount of polymer is increasing year by year, and the amount of dry powder increased from 5768 tons in 2006 to 23293 tons in 2010. The development effect and benefit are getting worse and worse. The TOP decreased from 310 t/t in 2006 to 99 t/t in 2010, and from 88 t/t in 2006 to 59 t/t in 2010. It is imperative to explore an efficient development model of polymer flooding in order to ensure the reduction of three production costs, improve dry powder utilization ratio and polymer flooding efficiency[2], and strive to achieve the goal of reducing the annual consumption of chemical agents by 10% and effectively improving the level of oilfield development.

2. Study on Alternate Polymer flooding in Second Class Reservoir

In order to further study the feasibility and slug optimization of alternating injection in second class reservoir, we compared the difference between alternating injection and single slug injection in injection profile[3], inhalation volume of low permeability reservoir and water cut change of

production wells by using indoor physical model, and optimized alternating period and alternating viscosity by using numerical simulation technology, thus we found out the optimum slug combination in second class reservoirs.

2.1 Laboratory Physical Model Experiment of Alternating Polymer Injection

The evaluation experiment of polymer injection effect in simulated heterogeneous reservoir under constant velocity condition was carried out. Two parallel cores (permeability 200 and 800mD), 12 combinations of two polymer concentrations (1000mg/L and 2000 mg/L), two molecular weights (12.0-16 million, 25 million) and three slug alternations (0.14 PV, 0.28 PV, 0.56 PV) were used to study the effect of different slug assemblages on enhanced oil recovery in heterogeneous reservoirs.

Physical simulation results show that alternating injection can restrain profile reversal [5], increase fluid absorption in low permeability layer, control inefficient and ineffective circulation, thus enhancing recovery and reducing consumption.

2.2 Mathematical Modeling of Alternating Polymer Injection Chamber

In order to guide field application more accurately, 10 wells with relatively high injection pressure in the study area are divided into high pressure wells and 7 wells with relatively low injection pressure into low pressure wells. On the basis of this division, the high and low pressure well areas are studied respectively. Twenty schemes are designed for injection cycle, i.e. 10 schemes for high and low pressure wellbore areas, and 10 schemes for injection viscosity, i.e. 5 schemes for high and low pressure wellbore areas.

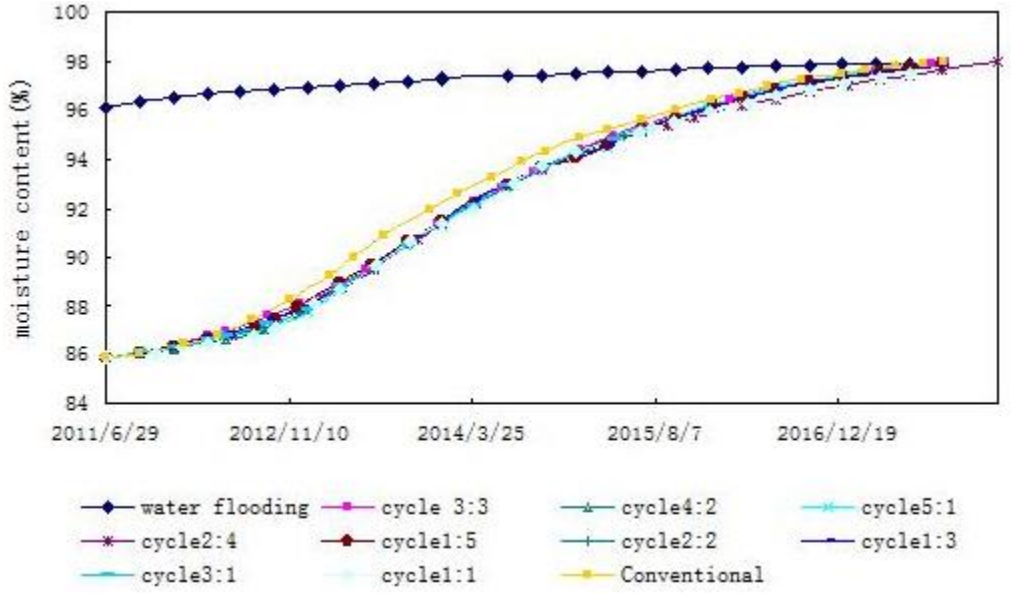

Figure 1. Water cut of low injection pressure wells in different periods

The results of numerical simulation show that the optimum cycle plan for low pressure wells is 2:4, i.e. injecting high concentration for 2 months before injecting low concentration for 4 months; the optimum injection viscosity alternative scheme is 90:50, i.e. injecting viscosity for the first two months is 90 mPa s, and viscosity for the next four months is 50 mPa s. The alternating recovery degree is 22.90%, and the conventional recovery degree is 21.76%, increasing by 1.14 percentage points. The optimum cycle plan for high pressure wells is 2:2, i.e. injecting low concentration for 2 months before injecting high concentration for 2 months; the optimum injection viscosity alternative plan is 40:80, i.e. injecting viscosity for the first two months is 40 mPa s, and viscosity for the second two months is 80 mPa s. According to this plan, the alternating recovery degree is 22.38%, and the conventional recovery degree is 21.03%, increasing by 1.35 percentage points.

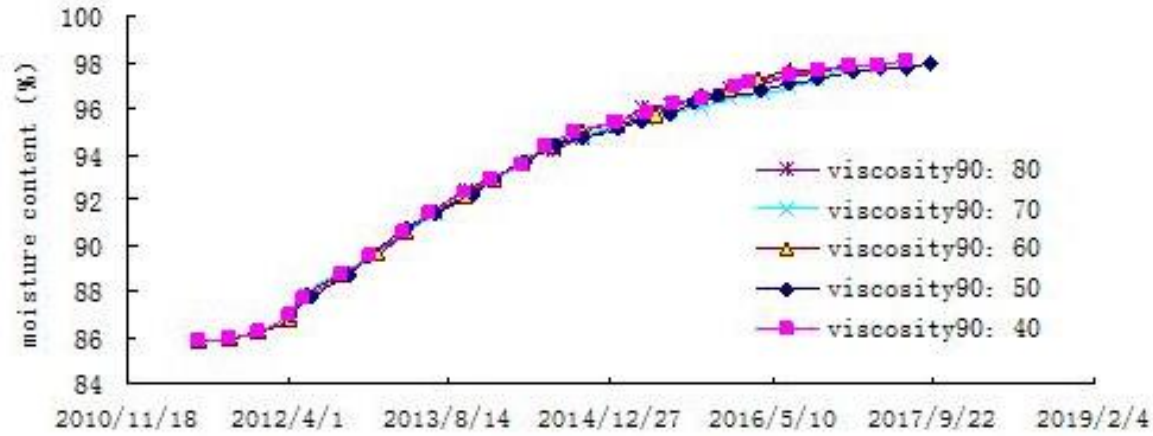

Figure 2. Water cut of low injection pressure wells at different viscosities

2.3 Application and Effect of Alternating Polymer Flooding in Second Class Reservoir

The research area is located in A injection station, and is in the stage of water cut rebound. Combining with the research results of physical simulation and numerical simulation in the alternating polymer injection chamber, 17 wells in the study area have achieved good results.

For 7 injection wells with low injection pressure, high and low concentration alternating polymer injection was carried out. The first slug was injected with high injection concentration of 2321 mg/L and injection viscosity of 88.4 mPa s. After adjustment, injection pressure increased by 0.9 MPa and apparent inhalation index decreased by 0.6 m3/d MPa. The inhalation profile was improved[6]. The proportion of inhalation thickness increased from 67.9% to 74.5%, and increased by 6.6 percentage points. The second slug was injected at a low concentration of 1313 mg/L with a injection viscosity of 53.8 mPa s, and the injection pressure remained stable after adjustment. The third slug was injected at a high concentration of 1452 mg/L with an injection viscosity of 80.7 mPa s, and the injection pressure remained stable after adjustment. The monthly water cut recovery rate of 12 wells around is 0.12%, which is 0.14 percentage points lower than that before adjustment.

For 10 wells with high injection pressure, low and high concentration alternating polymer injection was carried out. The first slug was injected at low concentration. Five wells simultaneously implemented stratification and subdivision adjustment, injection concentration 1131 mg/L, injection viscosity 47.3 mPa s. After adjustment, injection pressure increased by 0.4 MPa, apparent inhalation index decreased by 0.1 m3/d MPa, and dry powder was saved by 7 T per month. The inhalation profile was improved, and the proportion of inhalation thickness increased from 65.3% to 67.4%, an increase of 2.1 percentage points. The second slug was injected at a high concentration of 1224 mg/L with a injection viscosity of 67.6 mPa s, and the injection pressure remained stable after adjustment. The monthly water cut recovery rate of 14 oil wells around the area decreased by 0.20 percentage points.

2.4 Economic Benefit Evaluation

The research area has effectively improved the development effect by implementing alternative injection technology. One is the level of oil accumulation per ton[4]. In the study area, 45 tons of oil per ton is added, which is 5 tons higher than that in the area without alternating polymer injection, which effectively improves the utilization ratio of dry powder. Second, 3-year plan to inject 3758t dry powder, 3015t actual injection, save 743t, according to dry powder 20,000 yuan/ton, create economic benefits of 14.86 million yuan.

3. conclusion

By means of numerical simulation technology and according to the connectivity of well groups, the alternating polymer injection technology can effectively improve the utilization of medium and low permeability layers, control ineffective water injection and low efficiency fluid production in high

permeability layers, and achieve the purpose of energy saving and consumption reduction. Moreover, on the basis of improving oil recovery, the utilization ratio of dry powder is increased, the cost of three recovery is reduced, and the level of oilfield development is further improved, providing technical reserves and practical experience for the efficient development of polymer flooding in second class reservoirs.

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