DOI: 10.21276/sjet

Scholars Journal of Engineering and Technology (SJET) **ISSN 2321-435X (Online)**
Sch. J. Eng. Tech., 2017; 5(5):226-231 **ISSN 2347-9523 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Research Article

Optimization of Injection Parameters of Polymer Flooding in X Block CLASS-Ⅱ Reservoir

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Abstract: The type Ⅱ oil layers (it is also named thin and poor layers) in Block X is now in the later stage of high water cut with an average water content of 91.7%. In order to reduce the decline of production and improve the development effect of oil field, it is preliminary planned to exploit the potential of polymer flooding in X block after 10 years of water flooding development. The influence of the concentration of polymer solution and the amount of polymer on oil displacement was studied by numerical simulation. The results showed that the optimum concentration of polymer solution was 1200mg / L, and the optimum polymer content was 1200mg / L.PV.
Keywords: X block; ploymer flooding; parameter optimization; numerical simulation.

INTRODUCTION

China has developed most of the oil field has been in the high water and high recovery stage, the eastern part of the majority of the old oil field integrated water up to 90% or more, recoverable reserves of more than 70%. Due to the heterogeneity of reservoirs and the difference of oil and water properties, it is more and more difficult to rely on conventional methods. At present, the chemical flooding is the main tapping measures in the late stage of high water content, and the polymer flood is an important part of chemical flooding. Polymer flooding can effectively add water viscosity, reduce the water phase permeability, improve the displacement phase and the displacement phase ratio, expand the volume and improve the efficiency of washing [1].

X BLOCK OVERVIEW

The general trend of the top surface structure of the X block is low east, the eastern structure is gentle and the western structure is steep. There are three normal faults in the study area. The working area is 1.16Km^2 and the geological reserves is 107.32×10^4 tons. The working area is 1.16Km^2 and the geological reserves is 107.32×10^4 tons.

As of May 2016, X block comprehensive recovery degree of 37.03%, water content of 91.7%. At the same time, from the submerged situation (Table 1), the effective thickness of more than 2.0m of the whole layer of high flooding;1.0 ~ 2.0m between the high flooding ratio of 81.6%;0.5 ~ 1.0m between the oil Mainly in the middle and high flooding mainly; effective thickness of less than 0.5m thin layer flooding ratio is low,66.6%, and mainly in the low flooding. From the flooding situation analysis, X block reservoir utilization is very good, water drive further digging more difficult. The initial plan for the X block water development 10 years after the polymer flooding potential. As of May 2026, X block comprehensive recovery degree of 43.18%, water content of 96.5%.

Table 1: Flooding situation of X block

Thickness level	High flooding (%)			Medium flooding (%)			Low flooding (%)			Total (%)		
	Number of layers	Sandstone	Effective	Number of layers	Sandstone	Effective	Number of layers	Sandstone	Effective	Number of layers	Sandstone	Effective
≥2.0m	98.9	99.0	99.1	1.1	1.0	0.9				100.0	100.0	100.0
1.0～2.0 m	81.6	87.1	84.0	18.4	12.9	16.0				100.0	100.0	100.0
0.5～1.0 m	49.2	49.9	51.4	49.2	49.1	47.4	1.6	1.0	1.2	98.4	99.0	98.8
<0.5m	23.3	37.3	26.3	43.3	40.2	44.4	33.3	22.5	29.3	66.6	77.5	70.7
小计	73.3	85.3	89.9	22.5	13.7	9.4	4.3	0.9	0.7	95.8	99.0	99.3

X BLOCK GEOLOGICAL MODEL ESTABLISHMENT AND HISTORICAL FIT

On the basis of collecting the basic data of X block, the petrel complex structure frame module is used to establish the fine fault model and fine structure model of the study area. In order to meet the requirements of reservoir numerical simulation, 12 wells were selected as the post-mortem to verify the structural model accuracy, with an average error of 0.62, which meets the accuracy requirements. At the same time, the establishment of the attribute model is carried out on the basis of the sedimentary facies model. According to the results of geological modeling, the numerical simulation software Eclipse for historical fitting, as of March 2016, X block actual cumulative oil production is 39.74 × 10^4 tons, calculate the cumulative oil production 40.12 × 10^4 tons, the relative error of 0.96%; The actual water content is 95.1%, the water content is 94.64%, the relative error is 0.48%, and the single well fit rate is 71.2%. The accuracy of fitting is high, indicating that the current model can reflect the real situation of the ground, so as to provide a reliable basis for future program adjustment.

X BLOCK INJECTION PARAMETER OPTIMIZATION

Many studies have shown that the injection parameters, such as the amount of injected polymer, the injection concentration and the injection rate, which can greatly improve the effect of polymer flooding can be improved by increasing the injection parameters[2-4].

Optimization of polymer concentration

The polymer concentration was 800mg / L, 1000mg / L, 1200mg / L, 1500mg / L, and the concentration of polymer was 1200mg / L.PV, the molecular weight was 25 million, and the concentration of the polymer was 800mg / 1800mg / L. The increase in recovery of these five polymer concentrations (subsequent water flooding to 98% water) was calculated. Comparison of the water content of different polymer concentration, Nissan oil comparison shown in Figure 1, Figure 2, different polymer concentration development indicators are shown in Table 2.

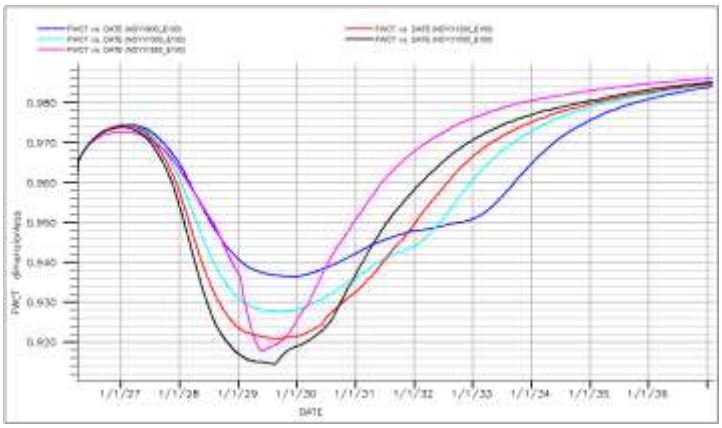

Fig-1: The water cut curve of different injection concentration

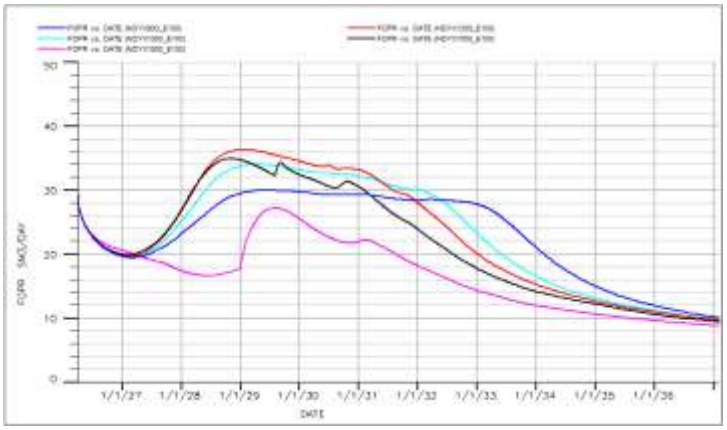

Fig-2: The oil production rate curve of different injection concentration

Table 2: Prediction of development index of different polymer concentration

Polymer concentration (mg/L)	Injection speed (PV/a)	Polymer dosage (mg/L.PV)	Polymer fraction Weight (Million)	Stage of development (%)	Improve oil recovery (%)	Minimum moisture content (%)
800	0.18	1200	LH2500	9.82	8.47	93.60
1000	0.18	1200	LH2500	10.16	8.81	92.70
1200	0.18	1200	LH2500	10.68	9.33	92.10
1500	0.18	1200	LH2500	10.10	8.75	91.40
1800	0.18	1200	LH2500	8.33	6.98	91.80

From the above chart and table can be seen

1. From the point of view of water content, the higher the concentration of polymer, the higher the decrease of water content, the faster the later moisture content increases (Fig. 1) when the other conditions (injection capacity, injection rate, etc.) are the same
2. from the injection capacity, different concentrations of polymer injection capacity is different, when the polymer concentration is less than 1200mg / L, the basic can all the injection, when the polymer concentration of 1500mg / L, the injection capacity is poor;
3. In terms of recovery level, the concentration increases and the stage recovery increases when the reservoir conditions and the limit water (98%) are determined. However, when the polymer concentration is greater than 1200 mg / L, The degree decreases with increasing polymer concentration. The reason is that when the polymer concentration increases to a certain extent, the viscosity increases faster, thus increasing the injection resistance, under the injection of bottomhole pressure limit, the daily injection volume decreases, resulting in displacement effect worse.

At the same time, the viscosity of the 1200 mg / L polymer solution is slightly greater than the viscosity of the underground crude oil. Therefore, a polymer having a concentration of 1200 mg / L was selected in consideration of possible viscosity loss and development effect during the injection.

Optimization of polymer dosage

According to the reservoir condition, the polymer concentration was 1200mg / L, the molecular weight was LH2500 million, and the dosage of the polymer was 960mg / L.PV, 1080mg / L.PV, 1200mg / L.PV, 1340 mg / L.PV, 1440 mg / L.PV, 1560 mg / L.PV. The recovery of these six schemes was calculated (subsequent water flooding to 98% water). Comparison of the amount of different polymer water content, daily injection capacity shown in Figure 3, Figure 4. Different polymer dosage development indicators are shown in Table 3.

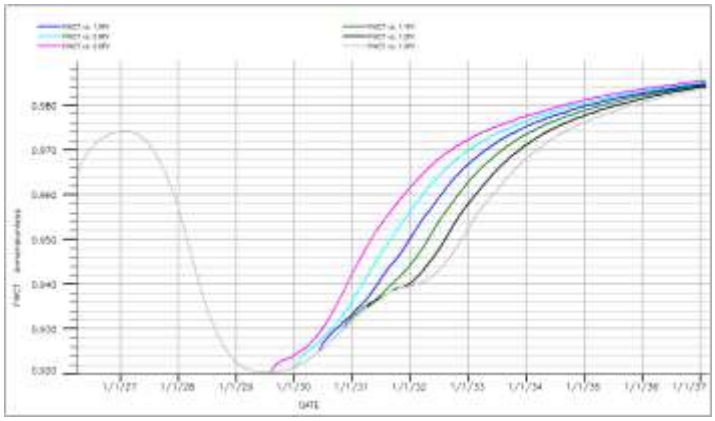

Fig-3:The water cut curve of different polymer injection amount

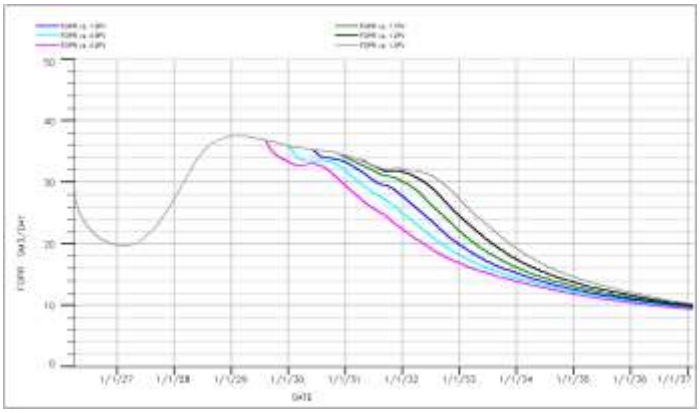

Fig-4: The oil production rate curve of different polymer injection amount

Table 3: Prediction of development index of different polymer injection amount

The degree of polymer (mg/L)	Injection speed(PV/a)	Pore volume multiple(PV)	Polymer dosage (mg/L.PV)	Polymer molecular weight(Million)	Stage of development(%)	Improve oil recovery (%)	Minimum moisture content (%)	Tons of oil increased(t/t)
1200	0.18	0.8	960	LH2500	9.13	7.78	92.01	68.18
1200	0.18	0.9	1080	LH2500	9.91	8.56	92.01	64.52
1200	0.18	1.0	1200	LH2500	10.68	9.33	92.01	61.38
1200	0.18	1.1	1320	LH2500	10.84	9.49	92.01	58.80
1200	0.18	1.2	1440	LH2500	10.96	9.61	92.01	56.53
1200	0.18	1.3	1560	LH2500	11.05	9.7	92.01	54.68

As can be seen from the above figure and table, the water content of several polymer blocks injected into the design reached the lowest value in July 2029. The smaller the amount of polymer, the faster the development of the late water, reaching the limit of water (98%) the shorter the time, the shorter the development period. From the increase in oil production, the greater the amount of polymer, oil production more, but the increase in the range of different.

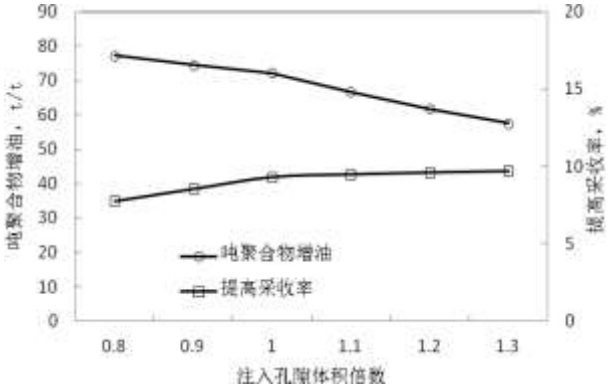

Fig-5: Polymer flooding effect with different injection amount

Fig. 5 is a graph showing the relationship between the volume fraction of the pore volume of the polymer injected and the oil recovery and the oil increase. As can be seen from the figure, the greater the amount of polymer, the greater the degree of recovery, when the amount of polymer to 1200mg / L.PV (injection pore volume multiple of 1.0PV, polymer solution concentration of 1200mg / L), Continue to increase the amount of polymer, the stage did not significantly improve the degree of recovery; while tons of polymer fuel consumption decreased accelerated. But the amount of the final polymer needs to be determined in terms of economic evaluation. According to the oil field to provide some of the major economic parameters or reference to "oil industry construction project economic evaluation methods and parameters," a book to the value of different polymer consumption of the injection program for economic evaluation. The evaluation results are shown in Table 4.

Table 4: Economic evaluation results

Polymer dosage (mg/L.PV)	Net present value (Million yuan)	Internal Rate of Return (%)	Investment profit ratio	Incremental net limit
0	403.7	24.2	0.06	—
960	4758	27.3	0.176	4354
1080	5079	28.9	0.183	4675
1200	5396	30.5	0.191	4992
1320	5347	29.4	0.187	4728
1440	5287	28.1	0.185	4492
1560	5214	27.6	0.18	4378

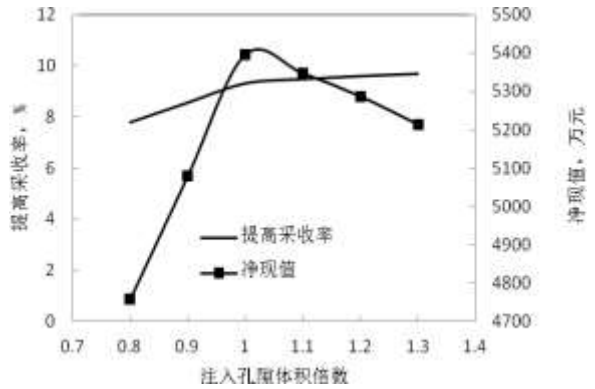

Fig-6: Polymer amount economic optimization

Figure 6 is a graph showing the relationship between the volume fraction of the pore size of the polymer injected and the recovery and net present value. It can be seen from the figure that with the increase of the amount of polymer, the degree of recovery is monotonically increasing, but the net present value increases first and then decreases, and the optimum dosage of the polymer can be 1200 mg / L.

CONCLUSIONS

(1) The numerical simulation was used to optimize the parameters of the X-block high-concentration

polymer flood, and the polymer concentration was determined to be 1200mg / L, taking into account the possible viscosity loss and development effect during the injection.

(2) injection of 1200 mg / L of polymer 1PV can achieve better economic value, in the period of time can increase the recovery rate of 9.33%, the most profitable 49.92 million yuan.

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