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The Analysis of Weak Base ASP Flooding Injection-production Capacity

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Abstract. Weak base ASP flooding is an important technique to replace oil production. Field tests show that weak base ASP flooding achieves the good effect of EOR 18% in classIIreservoir, and has many other advantages such as strong injection-production capacity, high production speed and oil increasing multiples, light scaling and emulsion level and easy to clean. It has a broad prospect. This paper analyzes the changing characteristics of weak base ASP flooding injection-production capacity, compares two types of polymer flooding blocks with similar reservoir conditions, identifies key factors affecting injection-production capacity and provides insights for future development of weak base ASP flooding in classII reservoirs.

1. Introduction

Weak base asp flooding experimental area covers an area of 1.21km^2, geological reserves of 116.31×10^{4}t and pore volume of 219.21×10^{4}m^3, with five spot well patterns of 125m well spacing consisting of 35 injection wells, 44 production wells and 24 central wells. The test objective oil reservoir is SaII10-12, and enhanced recovery is 29.02% in the central area.(Table 1.)

Table 1. Comparison of reservoir conditions in different blocks

Block	Producing position	Well spacing(m)	Effective thickness(m)	Permeability (μm^2)	Controlling degree of polymer flooding(％)
Weak base block	SaII10-12	125	6.6	0.53	90.0
Polymer block	SaII10-16	150	14.8	0.45	86.4

2. Change characteristics of injection-production capacity

2.1. weak alkali ternary flooding has strong injection capacity

After chemical flooding in the weak alkali ternary test area, the injection pressure rose steadily (Table 2.), with the highest increase to 10.80MPa, 82.4% higher than the end of water flooding, and the largest decrease of 23.1% compared to the apparent inhalation index. The injection pressure of the polymer flooding in class II reservoirs increased by 71.1% at the maximum, and decreased by 59.0%

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than the apparent inhalation index.The test indicated that the weak alkali ternary compound flooding owned strong injection capacity.

2.2. weak alkali ternary flooding has strong fluid production capacity

After the oilfield entered the effective stage, as the flow resistance increases continuously, the pressure conduction ability of the reservoir decreased, and the liquid production quantity and liquid production index also decreased. In the chemical flooding stage of the weak alkali ternary test area, the non-dimensional liquid production volume was 0.94, the maximum drop in the liquid production index was 31.3%, the maximum drop in the polymer flooding was 0.64, and the maximum drop in the liquid production index was 48.7%.

Table 2. Injection capacity change table in different stages in weak base ASP flooding

Project	Blank water flooding	Prepolymer flooding	ASP flooding	Follow up polymer flooding
Injection pressure(MPa)	5.92	8.17	10.15	10.80
Injection pressure rise(%)		38.0	71.5	82.4
Apparent absorption index(m^3•d^{-1}•m^{-1}•MPa^{-1})	0.78	0.60	0.64	0.62
Decrease of ratio of apparent inhalation index(%)		23.1	18.0	20.5

3. Analysis of factors affecting injection production capacity

3.1. Influence of reservoir development

The 24 central Wells with improving injection-production relationship in the whole region were classified (Table 3.). Judging from the injection-production situation of the classified Wells and the surrounding injection Wells (Table 4.), as the development of the reservoir changed from good to bad, the injection-production capacity of the well group gradually became worse. Therefore, the development of the reservoir was the basis for improving injection-production capacity

3.2. Influence of injection-production spacing

The variation of driving pressure gradient, apparent inhalation index and liquid production index in different spacing test areas showed that the pressure gradient was 0.149MPa/m, apparent inhalation index decreased by 52.1%, liquid production index decreased by 31.3% in the Weak base asp flooding with 125m spacing. For polymer flooding in class IIreservoir with the 150m well spacing,the apparent inhalation index decreased by 52.1% and the liquid production index decreased by 48.1%.The result shows that injection-production well spacing is reduced, injection capacity of weak alkali asymmetric flooding is increased by about twice, and liquid production capacity is reduced by about 20%.

Table 3. Well group classification index

Well group classification index	A	B	C
Effective thickness(m)	≥6	≥6	＜6
Single layer permeability range	≤10	＞10	＞10
A class of connected thickness ratio(%)	≥70%	60%-70%	＜60%

Table 4. Injection capacity contrast in weak base ASP flooding well

Classification	Injection pressure maximum increase(%)	The largest decrease in inhalation index(%)	The biggest decline in liquid production index(%)
A	84.40	19.35	15.42
B	77.45	23.87	28.02
C	69.70	42.19	35.29
Total	73.50	23.10	31.31

3.3. influence of injection parameters
According to the effects of different injection rates in the well group, due to the different injection rates, the injection pressure of the well group, the recovery time , the reduction of water content, the stable period, and the recovery degree varied with time. If the injection rate was too small or too large, the desired effect wasn't been achieved. When the injection rate was 0.20PV/a-0.25PV/a, the chemical flooding water reached the largest drop, and the oil recovery rate was kept at a high level for a long time. By adjusting the injection plan of"increasing gradient viscosity and balanced pressure", injection chemicals of experimental zone reached the distal formation,injection pressure rises steadily, interwell pressure difference shrinks, thickness of oil layer suction ratio incr1eases gradually, especially thin poor reservoirs are used effectively, expanding the sweep efficiency (Table 5.).

3.4. effects of emulsification and scale formation
When 0.12PV was injected into the ternary composite system in the test area, the central well began to work. When 0.27PV was injected, the recovery liquid was emulsified. The whole emulsifying process is 0.1-0.14PV. In the experimental area, six oil wells were seriously emulsified. Emulsified well ratio was 13.6%, and dimensionless fluid production was 0.89, non-emulsified Wells were 0.95, and liquid production decreased slowly.

In the test area, 21 oil Wells appeared scaling, among which there were sixteen wells and five screw pumps, accounting for 47.7% of the total oil Wells. Based on the scale composition of oil well, carbonate scale was the main component. dimensionless fluid production of scaling wells was 0.76 and unfouling wells were 0.94 and fluid production decreased slowly. By the application of effective lift technology and descaling technology of weak alkali ternary compound flooding, the production rate of injection-production well is kept above 90%, maintaining a high injection-production capacity.

Table 5. Table of adjustment of weak base test area "gradient thickening, balanced pressure"

Test stage	Tracking adjustment		Adjusted effect		
	Injection concentration(mg·L^{-1})	Injection viscosity (mPa·s)	Injection pressure (MPa)	$\triangle P=P_{max}-P_{min}$ (MPa)	Inhalation thickness Proportion(%)
Blank water flooding			5.92	5.11	81.16
	1712	48	7.66	2.46	82.00
ASP main slug	1907	63	9.67	2.08	87.81
	1979	65	9.78	2.22	88.91
ASP auxiliary slug	1891	65	10.15	2.12	90.17
Follow up polymer flooding	1500	69	10.80	2.04	92.73

3.5. Impact of measures
After oilfield development enters the peak period of effectiveness, some injection-production Wells fail to be allocated and the production volume of liquid greatly decreases. Therefore, injection-production capacity at this stage is the key to achieve the final development effect of the block. 18 Wells were fractured in the stage of chemical injection in the weak alkali ternary test area. By fracturing transformation and decreasing injection pressure, and the injection concentration was increased or remained unchanged, and the injection capacity and inhalation condition were improved. With 19 Wells fractured, the proportion of measures was 43.18%, and the the contribution to recovery was 2.52 percentage points. Fracturing measures effectively alleviated the decline of fluid production, expanded the oil displacement effect, and excavated the potential of thin and bad reservoir, providing a strong guarantee for improving the recovery rate.

4. Conclusion
(1) The injection-production capacity of weak alkali ternary composite flooding is higher than that of polymer flooding, and the water-bearing decreases greatly, and the recovery rate is twice as high as that of polymer flooding.

(2) The higher injection-production capacity is guaranteed by the extraction object of ternary compound flooding in secondary oil layers, reducing the injection-production well spacing, improving the control of chemical flooding, and establishing a large driving pressure gradient.

(3) By the adjustment of "gradient thickening, balanced pressure" and auxiliary measures to increase production and injection as well as the application of efficient operation technology of mechanical production wells, high injection and production capacity can be maintained.

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