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The Study on Hydrophobic Association Polymer's Adaptability to Pubei Reservior G2 Block

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Abstract: Simulated the reservoir conditions(47.5℃) of the PuBei reservior G2 block in Daqing oil field， the resistance coefficient and residual resistance coefficient of both hydrophobic associating polymer and the common polymer with middle relative molecular mass are measured and the oil displacement experiments using the three layers of heterogeneity of artificial core were carried out. Then the results of the experiment were analyzed. The experimental results show that under the condition of different concentrations and different viscosity, the resistance coefficient and residual resistance coefficient of hydrophobic associating polymer are both higher than the common one obviously. Advanced treated wastewater., whose salinity is 5366 mg/L, was used for preparation of polymer solution. The oil displacement efficiency in the three layers of synthetic of heterogeneous cores shows that the oil recovery enhanced by 700mg/L of hydrophobic associating polymer is 16.11%, which is 3.57% higher than by 1200mg/L of common polymer on the basis of water drive recovery factor. Then hydrophobic associating polymer has a better oil displacement effect for the low permeability core and is more suitable for the polymer flooding in PuBei reservior G2 block.

Keywords: PuBei reservior G2 block, hydrophobic associating polymer, resistance coefficient, residual resistance coefficient, enhanced oil recovery.

INTRODUCTION

As one of the three main methods of oil production in Daqing oil field, polymer flooding can also increase the macroscopic sweep volume and increase the microscopic oil displacement efficiency. It has been widely used and achieved remarkable results. Hydrophobic type anti-salt polymer [1-3] is a kind of multi-functional monomer composite polymer. It has been proven that the polymer has an obvious viscosity advantage than common polymer in the higher salinity water system.

Different types of polymers have different adaptability to different permeable strata and the displacement effect is different[4-6]. PuBei reservior G2 block in Daqing oilfield is a middle-low permeability reservoir. The thin oil layers have low producing degree and The salinity of sewage used in the polymer solution is higher in the development process. Thus it need to be further tested whether the polymer's physical and chemical properties can meet the requirements of polymer flooding in class ii and class iii reservoir. And the thin oil layers in low-permeability oilfields and whether has good applicability in PuBei reservior G2 block.

The author through the polymer injection capacity experiment, evaluation is conducted to evaluate the performance of the common polymer and hydrophobic associating polymer to improve mobility ratio and reduce the ability of reservoir permeability [7, 8]. And through the combination of artificial indoor different permeability core displacement experiment, so as to provide technical guidance for the widely use of polymers in the middle-low permeability reservoir of PuBei reservior G2 block.

EXPERIMENTAL DESIGN

Compare the constant-voltage method of two kinds of polymer drag coefficient and residual resistance coefficient as a result, the evaluation of ordinary polymer and hydrophobic associating polymer to improve mobility ratio and reduce the technical index of the reservoir permeability ability; According to the results of the experimental results of the artificial core oil displacement, it is evaluated that the hydrophobic associative polymers are better able to drive the oil in the lower permeability reservoir under the lower permeability reservoir.

The resistance coefficient and residual resistance coefficient

The basic parameters of the core selected, experiment scheme and the resistance coefficient and residual resistance coefficient of two kinds of polymer solution with different concentrations and viscosity through core respectively. The determination results are shown in table 1 and table 2.

Table 1: The determination results of resistance coefficient and residual resistance coefficient of two kinds of polymer solution with different concentrations

NO.	Permeability $10^{-3}\mu m^2$	Polymer Type	concentration mg/L	resistance coefficient	residual resistance coefficient
A9	254	common polymer	800	15.86	4.91
A12	253		1000	21.23	5.98
A13	259		1200	35.00	8.33
A11	251		1300	38.61	9.08
A30	248		1400	40.58	10.58
A22	243	hydrophobic associating polymer	500	36.5	10.29
A10	257		600	52.34	14.6
A14	256		700	69.8	20.81
A25	243		800	96.47	29.89
A32	250		900	105.32	31.17

Table 2: The determination results of resistance coefficient and residual resistance coefficient of two kinds of polymer solution with different viscosity

NO.	Permeability $10^{-3}\mu m^2$	Polymer Type	viscosity mPa·s	resistance coefficient	residual resistance coefficient
A9	254	common polymer	10	15.67	4.71
A12	253		15	16.14	5.05
A3	245		20	31.52	7.10
A16	258		25	35.27	8.89
A34	244		30	38.21	9.87
A7	263	hydrophobic associating polymer	10	53.12	12.01
A10	257		15	55.07	15.22
A1	250		20	62.1	18.38
A8	263		25	70.72	19.76
A36	247		30	72.80	21.85

Evaluation analysis of polymer's applicable performance

The data in the table 1 and table 2 can be seen that resistance coefficient and residual resistance coefficient of low concentration (viscosity) of the hydrophobic associating polymer solution were higher than the high concentration (viscosity) of ordinary polymer solution.

The higher the resistance coefficient, the more resistance of the polymer solution to the seepage process in the reservoir pore media and the larger the volume of the oil is swept. The greater the residual resistance coefficient, the greater the magnitude of the permeability of the polymer solution to reduce the permeability of the reservoir. Hydrophobic associating polymer has higher resistance coefficient and residual resistance coefficient than common polymer by contrast. It has better seepage ability and the ability to adjust reservoir pore water absorption profile, more help to enlarge sweep volume displacement fluid and enhanced oil recovery.

Therefore, in the similar between PuBei reservior G2 block permeability core, the hydrophobic associating polymer has better formation adaptability to PuBei reservior G2 block of low permeability reservoir than common polymer.

The stability of porous media permeability is reduced

As shown in figure1 and figure2 respectively in the same viscosity (20mPa.s) common points polymer and hydrophobic associating polymer solution in the process of the resistance coefficient and residual resistance coefficient determination of the relationship between time and the corresponding flow curve.

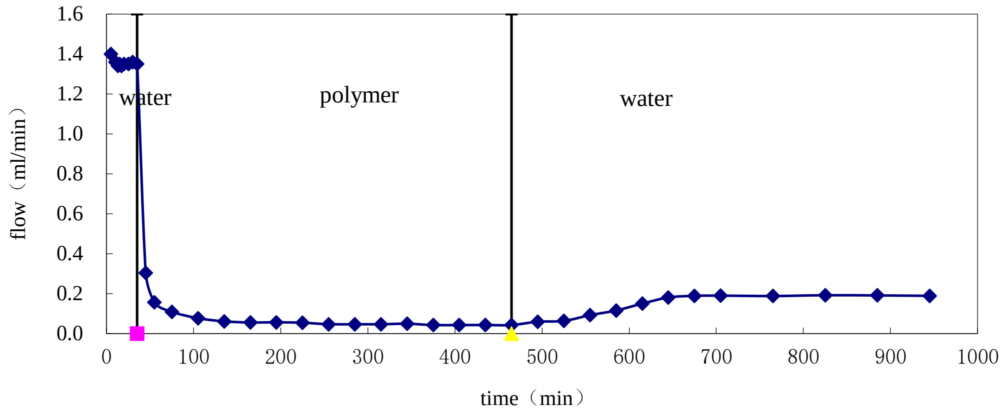

Fig-1: The curves of determination process of the common polymer（20mPa.s）

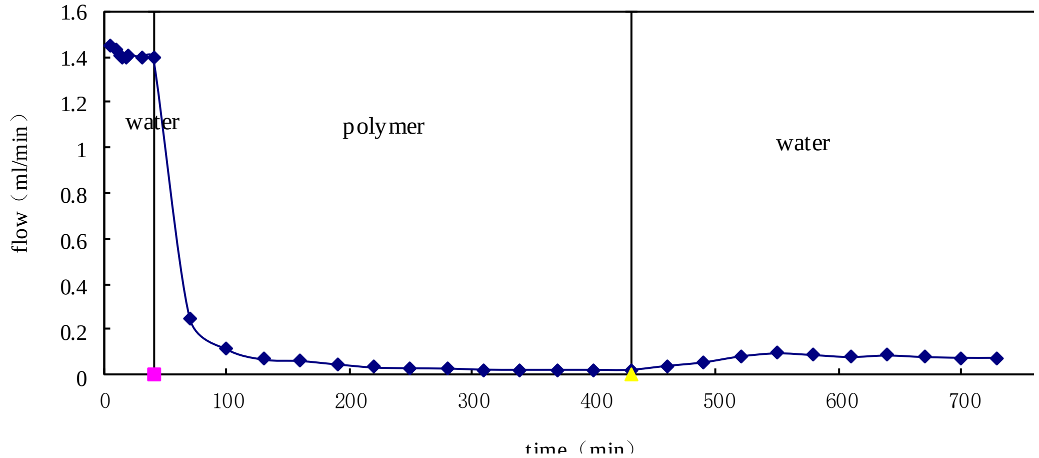

Fig-2: The curves of determination process of the hydrophobic associating polymer（20mPa.s）

In polymer solution seepage stage, the flow of common polymer is slightly higher than that of hydrophobic associating polymer, showing that in the process of injecting polymer, percolation resistance of the common polymer solution is small and the associating polymer is larger. In subsequent water flooding stage, both of polymers' flow are increased, but the appearance of water flow increase amplitude is obvious when associating polymer is less than in the ordinary polymer, showing that hydrophobic associating polymer has stable ability to reduce the permeability of porous media.

Different permeability core displacement experiment

Using three layers of non-homogeneous synthetic rectangular core of different permeability, the oil displacement effect comparison experiment (injection volume 0.64 PV) was conducted respectively between the common polymer solution (1200mg/L) and the hydrophobic (700mg/L) polymer solution, to evaluate the adaptation of two polymers to different permeability cores and the feasibility of oil displacement. The basic parameters of the core parameters and the results of the oil-flooding experiment were shown in table 3.

(1) The overall recovery ratio of two polymer solutions

The data in table 3 can be seen that the increase of the average permeability of the experimental core is increased by the increase of the average permeability of the experimental cores for the same injectant. This is because with the increase of the average permeability core, the core within the overall pore distribution gradually is improved and there are fewer areas that are difficult to sweep, thus polymer are more effective in their advantage of improving mobility ratio.

The average recovery rate was 3.57% higher than that of the average polymer. Especially for the combination of lower average permeability core, hydrophobic associating polymer flooding effect is much better than that in ordinary polymer, the enhanced recovery value is about 3.41% higher, showing the hydrophobic associating polymer is more suited to low permeability reservoir than common polymer

(2) Different displacement phase recovery of two polymer solutions

The average recovery of common polymer solution is higher than the subsequent stage of water flooding oil recovery. But there is no obvious gap for the hydrophobic associating polymer. This indicates that the recovery of the subsequent stage of water flooding is the main reason that hydrophobic associating polymer flooding effect is superior to the common medium polymer.

Analysis of the reason that in the common points of the polymer solution and the hydrophobic associating polymer solution injected sex is good, polymer solution into the high permeable zone, first stage of polymer flooding is more of the high permeability layer out of crude oil, then for subsequent water flooding; As the hydrophobic associating polymer formation has better adaptability, can form a large number of stranded in the high permeable zone, increased the filtrational resistance of high permeability layer, adjust the injection profile. So in the hydrophobic associating polymer flooding stage of subsequent water flooding, injected water more into the low permeability layers, and will not drive oil in low permeability layer displacement, thus greatly enhance oil recovery efficiency.

Table 3: Experimental scheme and results of polymer flooding

NO.	Permeability combination $10^{-3}\mu m^2$	original oil saturation %	Polymer type	stage recovery factor			average recovery of polymer %	average recovery %
				water	polymer	Subse-quent Water		
P5	10-300-500	68.64	common polymer	46.32	7.94	3.88	11.81	12.55
P6	200-500-800	69.64		47.58	8.59	3.98	12.57	
P7	300-600-1000	68.15		48.08	9.15	4.11	13.26	
K5	100-300-500	64.28	Hydro-phobic associating polymer	47.25	6.94	8.64	15.57	16.11
K6	200-500-800	61.48		47.77	7.67	8.42	16.10	
K7	300-600-1000	63.78		48.36	8.22	8.45	16.67	

CONCLUSIONS

（1） Two kinds of polymers have good injection, resistance coefficient and residual resistance coefficient are increased with the increase of concentration of polymer solution (viscosity).And the hydrophobic associating polymer solution was significantly higher than the ordinary polymer, which has better seepage ability and the ability to adjust reservoir pore water absorption profile.

（2） The 700mg/L hydrophobic associated polymer with the mineral value of 5366mg/L has good oil displacement effect in the low permeability, which 3.57% higher than the 1200mg/L common polymer. Under the low permeability core portfolio, its improved recovery value about 3.41% higher than common polymer, so it has better adaptability in the middle-low permeability reservoir of PuBei reservior G2 block.

（3） Due to the hydrophobic associating polymer has better adsorption ability of reservoir porosity, its in the subsequent stage of water flooding can increase seepage resistance of the high permeability layer better, so that the injection water can sweep oil more in low permeability layer, thus to enhance oil recovery efficiency as a whole. Therefore, the hydrophobic associating polymer can be used as a polymer for the displacement of reservoir oil in PuBei reservior G2 block, and can solve the problem of the utilization of waste water.

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