Study on the law and application effect of variable fluidity polymer flooding to enhance oil recovery

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Abstract: At present, our country most of reservoir with low permeability, strong heterogeneity and poor sand body development characteristics, so for maximizing the aggregate material oil displacement effect of technology on the basis of reservoir play, need on polymer flooding experiment foundation of the converter combined with oil displacement wall and degree of control theory and flow theory, polymer qualitative drop sticky technology is put forward. This paper first analyzed the introduction of variable fluidity polymer in detail, combined with the principle of variable fluidity polymer technology, summed up the experimental process and results of variable fluidity polymer flooding enhanced oil recovery.

Key words: Variable fluidity polymer; Recovery factor; Technical personnel; The technology principle.

1. Introduction

Converter degree of polymer phase drop glue injection displacement front pressure gradient is large, can be together and form a high oil saturation wall, reduce the moisture content, significantly increase the high permeable zone flow resistance, and subsequent low adhesion slug, in turn, in the form of accelerated into match into the low permeable formation, significantly enlarge the swept volume of low permeable formation, improve the degree of high, medium and low permeability layers, On the basis of reducing the cost of polymer injection, the recovery efficiency of polymer flooding in heterogeneous reservoirs is further improved.

2. Introduction to variable fluidity polymers

Changing mobility of polymer chemical oil displacement process often accompanied by a wall, produced crude oil enrichment area, and mobility of polymer flooding wall directly reflects the advancement of techniques used to recovery efficiency of method has certain validity, so oil enrichment area and the larger wall construction, improve the recovery ratio is more scientific and effective. For this reason, technicians make a basic data model based on the dynamics of the oil wall formed by polymer flooding, and effectively deduce the basic conditions of the oil wall. The number of polymeric substances is significantly higher than that of other parameter combinations, so the core factor of the oil wall is the viscosity grade produced by the variable fluidity polymer. The greater the viscosity of the variable fluidity polymer foundation, the higher the oil wall foundation saturation, and the larger the construction range. Therefore, the aggregate capacity of the base oil wall should be continuously improved in the process of progressively filling the characteristic polymers of the scale, and the operation capacity of the variable fluidity polymer was defined according to the basic concentration, size and other data required by the viscosity level of the oil wall polymerization model under the condition of multi-stage oil flooding.

3. Principle of variable fluidity polymer technology

In the process of variable fluidity polymer test, the basic principle of further enhancing oil recovery firstly requires the selection of polymer solution substances with different concentrations and viscosity, and the matching into oil layers with different permeability to fulfill the basic requirements of variable fluidity polymer and fluidity control ability with different permeability [1]. When the variable fluidity polymer solution enters the high permeability layer, the displacement front will form a high saturation oil wall due to the large inclination rate of the variable fluidity polymer base concentration on the curve structure, which can play a good fluidity control ability and greatly increase the resistance of the high permeability layer.

With the increase of perfusion pressure, the absorption pressure difference between medium and low permeability layers increases significantly, and the volume expansion reduces the fluidity difference between high, medium and low permeability layers in variable fluidity polymer solution. In addition, due to the variable

flow degree is the basic role of the polymer front-end adhesiveness, the high permeable zone formed by high saturation make wall of oil water saturation falling fast, as the subsequent meet mobility control function drops, the low adhesion slug piston slow progress to converter degree of polymer produced port, effectively delay the high permeability break time, Therefore, this technical means is only suitable for variable fluidity polymer flooding, fundamentally ensuring variable fluidity polymer flooding to improve oil recovery.

4. Eor experiment flow of variable fluidity polymer flooding

4.1 Experimental conditions

4.1.1 The core conditions

In order to ensure the accuracy of experimental results, it is necessary to make at least three permeability plate structural models according to the information and data. The model size data is 30×30×4.5 cm, and the basic permeability is 700MD and 400MD. Structure at the same time each tablet model need arrangement of electrodes and pressure well testing equipment, to ensure that in the current transformer in the process of polymer flooding to improve oil recovery experiment using motor testing equipment resistivity details about each test points of the actual change, and according to the standard of resistivity, saturation curve data reverse deduction saturation change rule of each spot. experimental flow structure diagram [2].

4.1.2 The experimental oil

In the selection of experimental oil materials, crude oil and kerosene should be prepared according to a certain proportion of the simulated experimental oil, and ensure that the viscosity of the oil material in the environment below 45 degrees is 9.8 Mpa.s. 3. Experiment with moisture

The selection of experimental water mainly includes injection water, polymer configuration water and subsequent injection water, etc. For the simulated water resources with a general salinity of 486mg/L injected water, the ion composition of the water resources needs to use the same quality of the field injected water. For the polymer water, the basic salinity of the water resources should be 918mg/L, and the salinity of the subsequent injected water should be 500 mg/L KC1 solution. Then, the change rule of subsequent injected water in saturated state is fully detected.

5. Polymer material

The molecular weight of variable fluidity polymer produced by a company in China is generally 1.2x107, so in the actual process of energy material coordination, it is necessary to first configure clear and dilute, and configure the mass base concentration of 2500mg/L.2000mg/L and 1500mg/L, and inject the variable fluidity polymer after shearing into the experimental model data. Basic viscosity characteristics of polymers are shown in Table 1 and characteristics of polymers at different concentrations [3].

Table 1 Characteristics of polymers at different concentrations

Polymer mass concentration/ (mg.L- 1)	Before the shear viscosity/ (mPa.s)	After shear viscosity / (mPa.s)	Water salinity/ (mg.L- 1)
2500	267.33	177.07	918
2000	177.07	103.97	
1500	98.13	51.20	
1000	45.87	28.80	
500	13.87	11.73	

Pressure displacement conditions

In variable flow of polymer flooding to improve oil recovery, because indoor polymerization material constant speed displacement, the pumping pressure increase at any time, once the mine environment of the actual injection pressure compared with standard have obvious difference, you may need to use pressure limiting on the link way of displacement, ensure that base pressure is significantly higher than the highest water pressure range of 2 times, This resulted in the use of a speed reduction method to stabilize the pressure within two times the maximum water drive pressure.

The experimental scheme

In the experiment of variable fluidity polymer, each data and information model needs to design the standard dosage scheme of polymer at each stage, among which the total dosage of dry powder of polymer substance in the heterogeneous data model is 900 mg/(L.PV). Therefore, in the formulation of the experimental scheme, it is necessary to ensure the comprehensive water cut of 95% when using water flooding. The polymer phase requires a pressure-limited displacement model with a maximum polymer displacement pressure of no more than twice the maximum water displacement pressure. As shown in Table 2, the experimental scheme of cascade injection.

Table 2 Experimental scheme of step injection

model	plan	Injection pattern	Polymer slug combination formula (injection mass concentration, injection volume)
Homogeneous model 400MD	1	Arrangement in fall	2500mg/L,0.072PV2000mg/L,0.09PV1500mg/L,0.12PV 1000 mg/L，0. 18PV500mg/L，0. 36PV
	2	A single constant sticky	1 500 mg/L,0. 6 PV
	3	Pilot reinforced adhesion	500mg/L,0.36PV1000mg/L, 0.18PV1500mg/L,0.12PV 2 000 mg/L,0.09PV 2 500 mg/L,0.072 PV
Heterogeneous model 700/400/100MD	4	Pilot drop stick	2500mg/L,0.072PV2000mg/L,0.09PV1500mg/L,0.12PV 1 000 mg/L ,0. 18PV 500 mg/L, 0. 36PV
	5	A single constant sticky	1 500 mg/L,0. 6PV
	6	Pilot reinforced adhesion	500mg/L,0.36PV1000mg/L, 0.18PV1500mg/L,0.12PV2000 mg/L,0. 09PV2 500 mg/L,0.072PV
	7	Alternating injection	(2000 mg/L, 0. 075PV+1 000mg/L, 0. 15PV)

6. Experimental results of enhanced oil recovery by variable fluidity polymer flooding

6.1 Relationship between recovery degree and variable fluidity polymer

In the eOR experiment of variable fluidity polymer flooding, through the step injection experiment, the results show that: under the basic conditions of homogeneous data model and heterogeneous model, viscosity reduction injection, single constant viscosity, and step viscosity increase are carried out in a standard order from large to small. At the same time, combined with the basic water content curve structure diagram of homogeneous model, the more the basic water content decreases, the more the production level increases. It can be seen that the high-viscosity slug injected preferentially in the step viscosity reduction process can form a high-saturation oil wall at the displacement front, greatly reducing water content and greatly improving the recovery degree [4].

In recovery degree and study on the relationship between the variable flow degree of polymer process, need to the moisture content down low as the end part of the experiment process, at the same time after the oil wall and slug size study found that, in the pilot experiment scheme used in the wall of oil well and slug size generally 0.226 PV, the results are much smaller than phase 0.527 PV reinforced adhesion, but after the experiment development, It is found that the level of oil wall polymerization ability depends directly on the coalescence effect rather than on the slug size data.

6.2 Each resistance change rule

In the variable fluidity polymer experiment, the high permeability resistance of the equipment is significantly increased during the formation of the oil wall well at the leading edge. Therefore, the larger the scale and scope of the oil wall construction, the greater the resistance generated. In order to further shows that, high, medium and low permeable formation of resistance change law, technical personnel need to use the total mobility data calculation at all levels for characterizing the resistance change to explore, including total mobility in the implementation of the project mainly consists of polymerization degree of material flow, the oil and water two mobility characteristics, so its information flow numerical size further reaction ability of high and low, The smaller the overall numerical parameter of fluidity, the greater the flow resistance. For this reason, the change curves of total fluidity of each stratum with different injection methods further reflect the significant increase in resistance of the step viscosity reduction injection into the high-permeability layer, thus resulting in the increase of services with high resistance [5].

First, the resistance parameters formed by the displacement of slug by polymeric substances. Second, the oil wall formed by the polymer in the displacement front will lead to a significant increase in oil saturation during the testing process, resulting in a continuous increase in oil phase resistance. Thirdly, in the process of coalescence and formation of oil wall, water phase saturation decreases greatly, and the original high water content seepage channel is gradually replaced by high resistance polymer and rich high saturation oil wall, and the water phase flow capacity decreases obviously. These three reasons result in a substantial increase in the resistance of channeled channels in high permeability layers, which provides an important basis for the subsequent entry of low viscosity slug into medium and low permeability layers.

7. Conclusion

Therefore, laboratory experiments and mine field should be used to verify that multi-step viscosity reduction injection can further improve recovery under the condition of similar number of displacement slug.

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