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The prediction of scaling time in producing wells of ASP flooding in the fourth plant of Daqing oilfield

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Abstract. After used technology of the ASP flooding in the fourth plant of Daqing oilfield, the problem of scaling becomes serious in oil wells. The scale samples do not dissolve to acid or alkali, and it difficult to be treated with regular method, so it has influenced the normal proceeding of well production. For solving this phenomenon, the displacement experiment was proceeded to simulate the site actual oil production conditions by using the high pressure physical simulation tests. By measurement of variation law of permeability in the process of ASP flooding and pH value in produced liquid along with time, the paper predicted the starting time and duration of scaling during oil well production. And rationality of the prediction results was verified by using the local test results. Finally the prediction formulas of scaling time which the oil wells with different spacing in ASP flooding were summarized.

Introduction

After used technology of the ASP flooding in the fourth plant of Daqing oilfield, the oil recovery factor can be improved remarkably [1]. But because of alkali existing in the ASP, some ions have great change in produced liquid, and the serious scaling has occurred in the oil wells [2-3]. The scale sample is difficult to be treated because most of scale samples are complex scales [4] which do not dissolve to acid or alkali. Oil well scaling has great effect on normal oil production and improvement of the economic benefits. If the time of the oil well scaling can be predicted accurately, some relevant measures could be applied urgently to clean and prevent the of oil well scaling.

Oil displacement experiment

This section mainly introduces the experimental equipment and displacement process.

The high pressure physical simulation test is used to simulate the site actual oil production conditions. The reservoir temperature is simulated by the thermostat. The experimental equipment is shown in Fig.1.

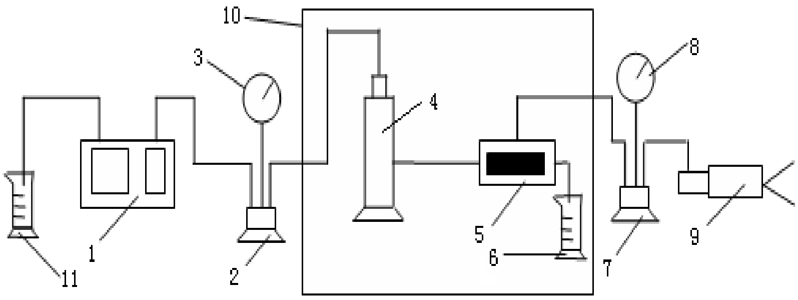

Fig.1 Experimental equipment

Where, 1 is plunger pump, 2 and 7 are six-port valves, 3and 8 are pressure gauges, 4 is intermediate container, 5 is a core holder which the length is 80cm, 6 and 11 are graduates, 9 is hand pump, 10 is thermostat.

We select a group of cores with close gas log permeability, the total length of the cores is 69.614cm, and the cross section area is 4.64cm^2, Displacement process is shown in Fig.2.

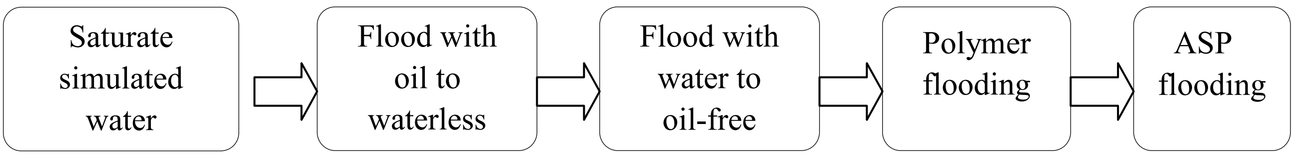

Fig.2 The process of displacement

Experimental material

Simulated Water: the water quality dates of reservoir show that the total salinity of the simulated water is 4512.7mg/l. The compounding scheme is shown in table 1.

Table 1 The compounding scheme of simulated water

Material	$MgCl_2$	$CaCl_2$	Na_2SO_4	NaCl	$NaHCO_3$
Concentration [mg/l]	39.2	49.9	177.4	1483.1	2300

Polymer: concentration is 1500 mg/l.

ASP: the alkali concentration is 5%, Surfactant concentration is 0.25%, Polymer concentration is 2200 mg/l.

Experimental result analysis

The long core permeability and pH value of producing fluid will change with time in oil displacement experiment. The starting time and duration of scaling in oil wells were predicted by the experiment, its diagram is shown in Fig.3.

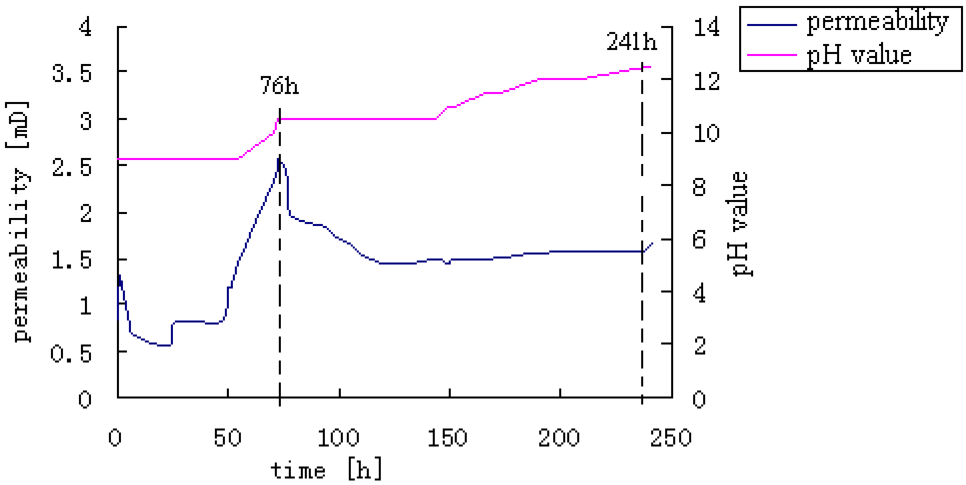

Fig.3 The change of permeability and pH value with time in ASP flooding

The experiment showed that the long core permeability began to decrease after 76 hours, and then became steady. So the long core began to scaling at 76 hours. After the displacement experiment reached to 76 hours, dissolution ions by ASP were enriched to concentration of scaling in the produced position, and then the long core began to scaling. The original big path in core were plug by the scale samples, result in injection pressure increased and permeability reduced. With the displacement, the scale velocity of dissolution ions by ASP in the produced position reached a dynamic balance with the washing action of ASP, the permeability tended gradually towards stability and pH value increased.

241 hours after displacement, the long core permeability was recovered. The scaling ions gradually decreased along with the displacement, and the long core was affected by the erosion action of strength alkaline ASP, result in the permeability recovered. So the duration of scaling is 165 hours (76 h to 241 h).

The actual well spacing of the fourth plant of Daqing oilfield is 150m. Based on this conclusion, the starting time of scaling for 150m well spacing obtained from Eq.1.

$$\frac{150m \times 76\text{h}}{0.7\text{m} \times 24\text{h} \times 365\text{d}} = 1.86\text{a} \qquad \text{(Eq.1)}$$

The duration of scaling for 150m well spacing obtained from Eq.2.

$$\frac{150\text{m} \times (241\text{h} - 76\text{h})}{0.7\text{m} \times 24\text{h} \times 365\text{d}} = 4.04\text{a} \qquad \text{(Eq.2)}$$

The long core in oil displacement experiment is homogeneous columnar core, but the actual petroleum reservoir is the complex heterogeneous reservoir with difference. So the starting time and duration of scaling in producing wells of ASP flooding could be calculated by the Eq. 3 and Eq.4.

$$t_1 = \frac{0.012L}{V_K} \qquad \text{(Eq.3)}$$

$$t_2 = \frac{0.027L}{V_K} \qquad \text{(Eq.4)}$$

Where, t_1 is the starting time of scaling for different well spacing, t_2 is the duration of scaling for different well spacing, L is well spacing, V_K is the difference coefficient of reservoir.

Field result

East Ⅱ block of Xingshugang in the fourth plant of Daqing oilfield was put into production in Aug. of 2008, and the stable daily fluid production were 5700 m^3 to 6200 m^3 during 9 months period from Aug. of 2008 to Apr. of 2009. The daily fluid production began to decrease from May. of 2009 to Dec. of 2010, and the production reduced from 5929 m^3 to 3764 m^3. After then the daily fluid production slowly recovered a bit. In other words the daily fluid production began to decrease after oil wells produced 9 mouths, and the fall time lasted for 20 months.

The actual well spacing of the fourth plant of Daqing oilfield is 150m, and the difference coefficient of reservoir is about 2 to 3. The calculation results of Eq.3 and Eq.4 showed that the oil wells began to scaling after produced 9 mouths, and duration of scaling is 20 mouths. The calculation results were consistent with the results of the daily fluid production for the scaling time. Therefore, the prediction results for the starting time and duration of scaling in oil wells have their rationality.

Conclusions

1. The starting time and duration of scaling in oil wells can be predicted in the indoor displacement experiment. By the changes of the long core permeability and pH value of producing fluid, the starting time and duration of scaling are 76h and 156h respectively for 70 cm columnar core.
2. The actual petroleum reservoirs are the heterogeneous reservoirs with the difference coefficient, the starting time and duration of scaling can be predicted by the changes of permeability and pH value in producing wells of ASP flooding.

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