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Research Article

The study of displacing oil in extra-low permeable oil field

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Abstract: The study on displacing oil is a new kind of experimental technology based on the macro waterflood displacement experiments, combined with the technology of nuclear magnetic resonance (NMR), mercury injection, etc, to study two phase percolation mechanism to simulate hydrogen oil as medium. According to the displacement fluid T2 cutoff value and infiltration absorption ,displacement function can be divided into displacement mechanism and seepage mechanism of absorption, and quantitative calculate recovery degree of different phase, so as to realize the combination on oil displacement effect of macro and micro pore space.
Keywords: T2 cutoff value; Infiltration absorption; Recovery degree; Macro oil displacement; Microscopic pore.

INTRODUCTION

Combined the nuclear magnetic resonance (NMR) with conventional water flooding experiment, using low field nuclear magnetic resonance instrument respectively test sample saturated water, bound water state, T2 relaxation time spectrum under different water cut stage and residual oil state[1-5]. as a result of the simulated oil of the experiments contains no hydrogen, so the NMR experiment simulation oil does not produce the signal[6-8], the signal quantity all contributed by water. The T2 relaxation time spectrum of the change of water can reflect the change of oil in the pore, and combine the contrast research of nuclear magnetic resonance (NMR) and mercury injection, nuclear magnetic resonance (NMR) signal can be converted to pore radius distribution, so it can determine the displacement oil and residual oil distribution in different pore of the irreducible water, under different water cut stage and residual oil state[9-10].

EXPERIMENT METHOD

(1) Wash oil, drying, test core permeability data;
(2) Make the core vacuum and saturate it formation water, and test its saturated water T2 spectra by nuclear magnetic resonance (NMR);
(3) Use hydrogen to simulate core saturated with oil ,and establish T2 spectra by irreducible water, displacement ratio of 10 pv, nuclear magnetic resonance (NMR) to test the status of bound water;
(4) According to the experimental design, adopt a constant velocity or constant pressure water drive oil, record different water cut stage pressure, oil and water output and T2 spectra;
(5) Drive oil by waterflood until no oil output, use nuclear magnetic resonance (NMR) test the status of residual oil T2 spectra;
(6) Deal with the experimental data.

ANALYSIS WATER FLOODING MECHANISM

typical T2 relaxation time spectrum of low permeability cores under different condition, between the two curves the saturated water and saturated oil state is the initial oil in the pore distribution. oil saturation and water flooding the final state between the two curves for displacement oil in the pore distribution and state of saturated water and water drive oil final status to the distribution of residual oil in the pore. The part which T2 relaxation time less than oil T2 of cutoff value (yellow area) can be displacement rely on infiltration absorption effect. The part of the T2 relaxation time greater than the T2 cutoff value for oil displacement (the blue areas) is produced depend on displacement function.

Pore throat radius of nuclear magnetic resonance T2 cutoff value that corresponds to the pore throat radius of the is the single phase fluid flow limit. When water flooding, the extraction oil contains both oil which pore throat radius greater than the pore space ,and oil which pore throat radius less than the pore space.

CASE ANALYSIS

Studied water flooding displacement efficiency experiment of five regional (or field) CY, LX, QJ, GL, GLT, and the permeability vacuum oil displacement efficiency and analyzed displacement efficiency.

Table-1: Statistical analysis table of displacement efficiency of different blocks oil

District/oil fied	Core number	well	poro /%	perm /mD	Displacement efficiency/%	Infliton absorbtion efficiency/ %	Displacement oil efficiency
CY	1	X71	15.633	2.356	48.29	19.46	28.82
LX	2	T261	11.078	5.458	51.21	10.17	41.04
QJN	3	G93	11.086	2.412	51.17	16.39	34.78
GLN	4	G633	16.207	3.191	50.50	16.24	34.26
GL	5	G86	15.503	12.966	54.74	8.92	45.82

First of all, displacement efficiency of different permeability rock sample is different there are certain regularity between them. Combined with test results from table 1 , the total oil displacement efficiency of five blocks are around 50%, its relation with permeability is not very strong. However, from the point of the effect of different oil displacement method, displacement efficiency and permeability has good logarithmic relationship, with the increase of permeability, displacement efficiency increased and the relationship is as follows:

$$\eta_{dis} = 8.6107\ln(K_g) + 24.619 \quad (1)$$

In type, η_{dis} is the displacement oil displacement efficiency, %; K_g is gas logging permeability, mD. Permeability oil displacement efficiency and permeability also presents good absorption of logarithmic relationship. With the increase of permeability, infiltration absorption oil displacement efficiency increased,and the formula is as follows:

$$\eta_{imb} = -5.7464\ln(K_g) + 22.461 \quad (2)$$

In type, η_{dis} is permeability oil displacement efficiency, %; K_g is gas logging permeability, mD. This shows that with permeability lower, the permeability and absorption function enhance. So for low permeability, very low permeability reservoir, permeability suction has large effect on seepage law, and make full use of infiltration absorption effect has great significance to improve recovery factor.

Moreover, water flooding displacement efficiency changes before and after water breakthrough has a certain regularity.

From table 2, for the total oil displacement efficiency, on the whole, displacement efficiency before see water are large than after see water. In other words, for low permeability, low permeability reservoir, most(accounted for about 68.89%) of the crude oil is produced in anhydrous oil production period, anhydrous oil production period is an important oil production period, especially in QJ, GLN and GL. Crude oil is mainly produced before water breakthrough and oil efficiency when see water is 40.14%, and oil displacement efficiency after water breakthrough increase smaller, and the average value is 12%; For CY, LX region, the production period and water cut oil production period is important oil producing period, there is no water oil displacement efficiency is 28.16%, the increase oil displacement efficiency after water breakthrough is significant, and the average growth is 21.58%.

Before water breakthrough, infiltration absorption function and displacement function of CY area play an important role on improve oil displacement efficiency , infiltration absorption effect contribute even more to improve oil displacement efficiency than the displacement effect, while the remaining four blocks, displacement effect than permeability interaction contribution to improve oil displacement efficiency. Contribution of displacement function is about the seepage interaction 3 ~ 7 times. After water breakthrough, CY area and LX oil displacement efficiency in depend on displacement effect to contribution, the contribution of displacement function is about 4 ~ 5 times that of infiltration absorption effect, while for the difference of the contribution of the other three blocks, displacement and seepage suction function are smaller.

Table-2: Oil displacement efficiency contrast before and after water breakthrough

ditrict / oil field	Core number	perm /mD	Displacement efficiency/%		Efficiency before breakthrough/%		Efficioncy increasing afer breakthrough/%	
			Before breakthrough	After breakthrough	displacement	Infiltration absorbtion	displacement	Infiltration absorbtion
CY	1	2.356	28.92	19.37	13.81	15.11	15.02	4.35
LX	2	5.458	27.41	23.80	21.58	5.83	19.46	4.34
QJN	3	2.412	37.75	13.42	30.76	6.99	4.02	9.40
GLN	4	3.191	40.56	9.93	28.72	11.84	5.54	4.39
GL	5	12.966	42.10	12.64	36.66	5.45	9.16	3.47

CONCLUSION

(1) For the low and extra-low permeability reservoir, nearly 70% of the crude oil is produced in the absence of water produced period;

(2) Both before and after water breakthrough, displacement function has a very important contribution to oil displacement. the Dialysis effect happened before water breakthrough. Therefore, should try to prolong the anhydrous production period, low water cut oil Wells production and to give full play to the infiltration absorption effect, d ensure high oil displacement efficiency.

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