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Study on Subdivision Adjustment of Water Injection Wells in Multi-Layer Sandstone Oilfield

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Abstract: Multilayer heterogeneous sandstone oilfield in high water cut stage, the longitudinal upper sand body heterogeneity, each layer there is a big difference to use, the interlayer interference law is not clear. The research on subdivision water injection for different types of reservoir boundaries. In different high and low permeability core combination of series and parallel experiments, clarified the EOR effect to improve the core combination of different subdivision water injection. Application of grey correlation method, the main factors affecting the breakdown of water to control. Through the pilot test statistics X, Y reservoir, define reasonable subdivision water injection adjustment limit, guide the injection wells scheme can better segment measuring and adjusting control work, high water horizon invalid circulation, strengthen the use of low water flooding zones, alleviate the contradiction between layers.

Introduction

Experiment scheme. In XY oilfield of the reservoir permeability distribution based on the actual design, the combination of different permeability, physical simulation was carried out in the case of continuous water injection, monitoring the core flow changes, analysis of the water absorbing capacity of the core, in order to further study in different regions and different types of reservoir in general water injection and stratified water conditions to determine the use of differences. Different types of storage layer and provide the basis for the block layer subdivision water injection line. The design of different combinations of 6 cores, each combination from heterogeneous artificial cores (2.5cm diameter) * 10cm (length) 2 groups, with 0.5MPa displacement pressure simulation of commingled water injection in 1 groups, in order to reduce the pressure for the simulation of subdivision water injection in 1 groups of high permeability cores in water flooding at 40% (Table 1). The difference of recovery ratio between different injection methods is compared, and the feasibility of enhancing waterflood recovery by subdividing water injection is verified.

Table 1 Experimental scheme of series parallel combination of different permeability cores

Different permeability combination(mD)	Differential Multiple	Displacement Number (time)	First group plan (simulated flooding)	Second sets of programs (simulated subdivision flooding)
5 and 10	2	2	The constant 0.5MPa displacement pressure difference, when two cores are displaced together to 98% water, calculates the recovery ratio, and compares the recovery ratio of different core combinations	When simulating waterflooding development to 40% water cut, the displacement ratio of high permeability core is decreased, and the recovery ratio of two cores to 98% different water content is calculated respectively
5 and 15	3	2		
5 and 25	5	2		
5 and 50	10	2		
5 and 100	20	2		
5 and 200	40	2		

Experimental results and understanding. Results: the combination of multiple cores of different permeability differential is greater, more serious heterogeneity, general series simulation experiment of water flooding, the oil recovery is low overall combined core (Figure 2); subdivision water flooding parallel simulation experiment, different core combination of overall recovery has been improved, which combined core difference the greater the multiple segments after water injection EOR is larger (Figure 3).

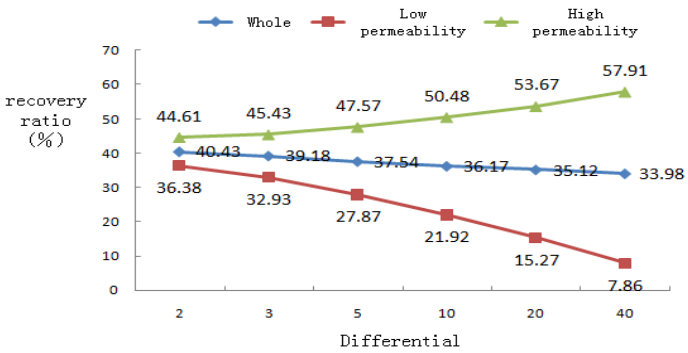

Fig. 1 simulation experiment of different core combination

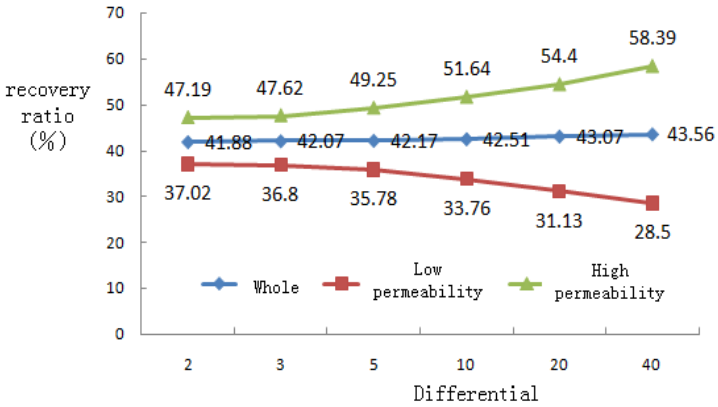

Fig. 2 subdivision water injection experiment with different core combination

Analysis of main influencing factors of production condition

Consider a variety of factors affecting subdivision injection layers water injection effect, determine the system behavior reflect the reference sequence of X0 (k) and the influence of the

behavior of the system of comparative sequence Xi (k) (i=1,2,3, V, m).

Using the extreme value method, the raw data of influencing factors of water injection effect are treated with dimensionless method. By using the method of grey relational analysis, the influence factors of the effective thickness, percentage of water absorption, and the factors affecting the daily gain of 61 wells in the well are analyzed and calculated in a vertical way. The grey relational analysis is used to calculate the influence factors of the daily gain of 50 wells (Table 2).

Grey correlation analysis results showed that the layer number and the development of reservoir, the ratio of the number of layers within card effective thickness, effective thickness, inner layer connectivity layer section connecting well number and layers within the permeability variation coefficient is the main factor affecting the effect of injection。

Table 2 Correlation table of influencing factors of effective thickness

Reference Series		Effective thickness percentage of water absorption	(%)	x_0	Relational grade	sort
Influence series	Geological parameter	Maximum permeability differential multiple	-	x_1	0.7064	7
		Ratio of number of layers to reservoir number	-	x_2	0.7668	1
		The effective thickness of layers within the card	(m)	x_3	0.7566	2
		Section within card number	(layer)	x_4	0.7126	6
		Coefficient of permeability variation in formation	-	x_5	0.7333	5
	Development parameter	Difference between injection pressure and fracture pressure	(MPa)	x_6	0.6696	11
		Maximum water cut difference in well area	(%)	x_7	0.6698	10
		Number of connected oil wells in section	-	x_8	0.7351	4
		Effective thickness in section	(m)	x_9	0.7361	3
	Management parameter	Qualified rate of water injection	(%)	X_{10}	0.6124	12
		Average interval between two washing wells	(day)	X_{11}	0.704	8
		Mean interval between two measurements	(day)	X_{12}	0.6999	9

Study on subdivision water injection limit of different types of oil reservoirs

The effective thickness of water percentage is more than 70% as the standard, to determine the X and Y layer of each of the 5 parameters by field practice statistics. It is suggested to subdivide the water flooding development as much as possible to ensure the balanced utilization of the small layers.

Table 3 Table of subdivision limits for different types of oil reservoirs in XY Oilfield

oil layer	portrait			plane	
	Ratio of the number of injected layers to the number of oil reservoirs	A card within the effective thickness (m)	Coefficient of permeability variation in section	Number of connected oil wells in section	Effective thickness in section (m)
X	≥0.5	＜4	＜0.5	≥3	≥3
Y	≥ 0.4	＜5	＜0.5	≥2	≥5

Field application practice

Application of new subdivision boundaries to re evaluate various types of reservoir subdivision standards, and X reservoir and Y reservoir main blocks are basically up to standard (Table 4). From the analysis of interlayer water in small layer thickness of 2.0m, the effective thickness of water absorption proportion has remained at a high level over 75%; thin effective thickness less than 2.0m layer use conditions significantly improved, the effective thickness of water absorption ratio reached 69.2%.

Table 4 Different types of oil reservoir subdivision on the table

oil layer	The longitudinal			The plane	
	Ratio of the number of injected layers to the number of oil reservoirs	A card within the effective thickness (m)	Coefficient of permeability variation in section	Number of connected oil wells in section	Effective thickness in section (m)
X	0.49	4.2	0.5	2.8	3.6
	near	near	Standard	near	Standard
Y	0.38	4.6	0.51	3.2	5.7
	near	Standard	near	Standard	Standard

Conclusions

1.The bigger the difference ratio of different permeability core combinations, the more serious the heterogeneity is, the lower the general water injection recovery ratio. The recovery efficiency of core flooding with different permeability can be improved by subdividing water injection；

2.Application of grey correlation analysis of mathematical methods, established the reservoir use mathematical model of factors of influence, clear water injection interval number and the ratio of the number of reservoir development, inner layer card effective thickness, permeability variation coefficient, interval interval number and interval connecting well connected 5 parameters for the effective thickness the main factors affecting reservoir production.

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