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Micro-Flow Characteristics and Influencing Factors of Low Permeability Reservoir: A Case Study of Chang 6 Reservoir of Jiyuan Area in Ordos Basin

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Abstract: Applications of real sandstone micro-models to research micro-flow characteristics of Chang 6 reservoir in Jiyuan area of Ordos Basin, and analyzes the relationship between physical property, Pore throat and displacement efficiency by combining thin casting sections, scanning-electron micro-scopes and constant-rate mercury injection. Results show that there are finger-like, reticular and homogeneous flows in Chang 6reservoir research areas and the rock of the research area can be divided to remind intergranular pore dissolved pore as well as dissolve-remind intergranular pore. Different types of rock have different microflow characteristics in which displacement efficiency is different. The displacement efficiency of dissolve mind intergranular pore is high, and the dissolved pore is low. Heterogeneity is the main internal factors affecting displacement efficiency, and physical properties and pore throat impact on displacement efficiency weakness. Of the external factors, water injection pressure and injection water multiple have a large influence on displacement efficiency compared to multiple injections. Improvements to the water injection pressure will have a better effect on improving oil displacement efficiency.
Keywords: Ordos Basin; water flooding; micro-flow characteristic; displacement efficiency.

INTRODUCTION

Low permeability reservoirs have a poor reservoir property, strong heterogeneity, complex water flooding characteristics, after years of development, the present reservoir natural energy is insufficient, the well fluid productivity, productivity index after water breakthrough falling fast, obvious non-darcy seepage features, the well occurs slowly, etc. Aiming at the characteristics of low permeability oil reservoirs, develop good technology development policy, improve the water flood sweep volume, is the key of reservoir production. The water flooding seepage characteristics become the focus of the current study, is also the key to improve reservoir recovery efficiency. Kyi tableland area is in the west of ordos basin, across the northern Shaanxi slope and day ring hollow zone, formation smoothly. Research district 6 paragraph for delta deposit, distributary channel sand body development, is one of the important oil layers of yanchang formation in ordos basin. The average porosity is 10.7%, belongs to the low hole - ultra-low permeability reservoirs. The author will use the sandstone microscopic model for her tableland region of change 6 reservoir microscopic seepage characteristics and its influencing factors were studied, and combined with the casting thin sections, X-ray diffraction, mercury injection and constant velocity mercury injection, etc to the research district 6 reservoir group study of petrology, pore characteristics, aims to understand the micro seepage characteristics and its influencing factors, provide theoretical basis for fine oilfield injection-production adjustment.

MICRO SEEPAGE EXPERIMENT AND CHARACTERISTICS

The study of real sandstone microscopic model (patent number: ZL931051703, international patent classification number: Lord G09B23/40) is using reservoir natural core, the extraction, drying, equal slices, grinding process, after pasting between two pieces of glass. General model size is about 2.5 cm x 2.5 cm, bearing capacity is 0.2 MPa, 200 ℃ heat resistance, pressure temperature resistant capacity of 100 ℃.

Model has authenticity and visibility, compared with light carved glass model, the model using the real sandstone core, retain most of the physical properties and pore structure, rock surface filler content, and through microscopic system and image acquisition system, can be directly observed seepage flow characteristic of the fluid in the pores of the rock, compared with the conventional core experiments, visibility.

Experiments with simulated water is according to actual formation water and injected water made from the nature and composition, viscosity is about 1 mpa, s.Experiments with simulated oil is made from crude oil

properties in the region, viscosity of about 2.24 mPa, s.In order to facilitate observation, water with a small amount of methylene blue, blue simulation oil to add a small amount of oil soluble red red.

Gap types of samples in the experiment, the analysis of its characteristics of seepage, and combining with the casting thin sections, scanning electron microscopy (sem) and constant speed mercury penetration, the pore structure and the relationship between the seepage characteristics were analyzed.

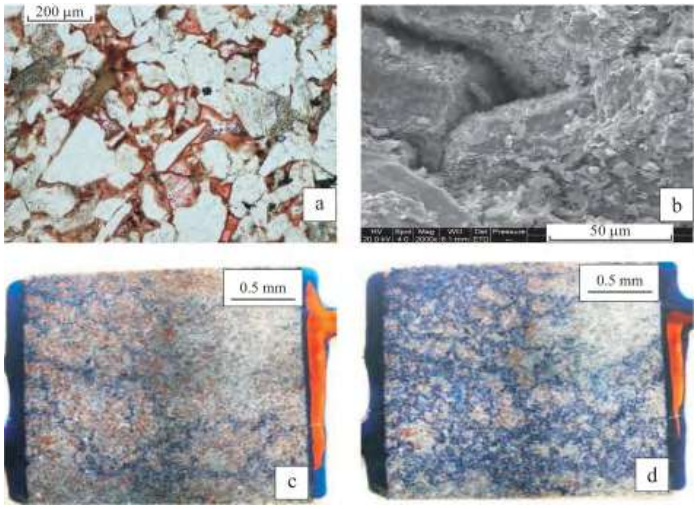

Fig-1: Microscopic photos of remind intergranular pores (a, b) and water flooding with models of intergranular pore(c, d)

THE INFLUENCE FACTORS OF OIL DISPLACEMENT EFFICIENCY

For water flooding reservoir, oil displacement efficiency directly affects the development effect is good or bad, the factors affecting the displacement efficiency of pore structure, physical property, wettability, etc. This research through the micro seepage experiment, the casting thin sections, constant speed mercury penetration, such as comprehensive analysis, the physical properties, pore throat, heterogeneity and other internal factors and external factors such as injection pressure, injection water multiple effects on oil displacement efficiency is analyzed.

Internal factors

The internal factors of the rock physical properties pore and throat, heterogeneity, etc. Compared with the conventional mercury penetration, constant speed mercury injection can accurately distinguish the pore and throat, and better reflect the microscopic characteristics of samples, so the casting thin sections, conventional mercury penetration, constant speed mercury injection combined with characterization of the pore structure of the rock. This study in order to in-depth analysis of rock microscopic pore structure and the relationship between the oil displacement efficiency, based on the displacement efficiency of the sample into three groups: A (Ed 70% or higher) and B (70% > Ed 50% or higher), C (Ed < 50%), each group choose A representative samples of oil displacement efficiency, G152 well (Ed = 86.13%), respectively H227 well (Ed = 51.10%) and G129 well (Ed = 40.93%), through constant speed mercury penetration, the casting thin sections and other internal factors of affecting oil displacement efficiency is analyzed.

1) Property

Samples can be seen from table 2, the correlation between physical properties and oil displacement efficiency is poorer, H227 well face sample rate is high, high porosity and permeability, physical properties of the samples is good, but the oil displacement efficiency of medium, G152 well face sample rate is low, reservoir property, its high oil displacement efficiency.Usually good sample its sorting general properties, formed in the water flooding process advantage channel, the water flooding area is smaller, high content of residual oil, the oil displacement efficiency is low [1].

2) Pore and throat

From different oil displacement efficiency of pore and throat radius distribution (figure 4, you can see that the pore radius and throat radius impact on oil displacement efficiency is small, some samples of pore and throat radius is big, but the pore throat sorting poor, strong heterogeneity, pore throat can't effectively unicom together, injected water can't displacement oil in the pore throat, so the oil displacement efficiency is low.

3) Heterogeneity

Research district 6 period of reservoir formed by the multi periodic superimposed sand bodies, with a strong heterogeneity. Heterogeneity is a very important factor affecting oil displacement efficiency. Can be seen

from table 2, oil displacement efficiency and sorting coefficient and homogeneous coefficient relationship, the smaller the sorting coefficient, homogeneous coefficient, the greater the heterogeneity of samples, the better, the higher the oil displacement efficiency. Through three samples of mercury injection curve also can be seen, samples of mercury injection curve has obvious G152 well platform, good pore throat sorting, H227 well samples under mercury injection curve concave, slightly platform, the sorting characteristics generally, and samples of mercury injection curves without G129 well platform, poor sorting.G152 well samples remaining intergranular pore percentage is high, the pore shape to the connected channels relatively homogeneous residual intergranular pore, heterogeneity is weak, so the sample uniform pore throat, good connectivity between the pore, injected water can quickly and efficiently into the pore throat, swept area is big, effective porosity, residual oil to oil membrane attached to the particle surface, solitary point and flow around less residual oil, oil displacement efficiency is high [2].

G129 well sample feldspar dissolved pore percentage is high, feldspar dissolved pore shape is complex, the effective pore percentage is low, so the sample has strong heterogeneity, and pore throat uneven, between pore connectivity is poor. Injected water easily along the large pore formation seepage channel advantage, affected area is small, die pore is more, residual oil to flow around or corner remaining in the void or invalid death pore, oil displacement efficiency is low [3]. Can be seen through the above analysis, the reservoir internal factors, physical properties, pore and throat have no obvious impact on oil displacement efficiency and oil displacement efficiency is crucial to the reservoir of homogeneity, the heterogeneity of the reservoir is weak, pore throat more homogenous, injected water swept area, the greater the residual oil content is less, the higher the oil displacement efficiency.

CONCLUSIONS

(1) Kyi tableland areas chang 6 reservoir water flooding seepage characteristics have a uniform shape, mesh, and finger, the seepage characteristics of different types of rock is different, in which solution pores - remaining intergranular groove rock is given priority to with uniform shape displacement, displacement effect is best.

(2) The internal factors affecting oil displacement efficiency with heterogeneity, physical properties and microscopic pore structure, heterogeneity are the main internal factors affecting the oil displacement efficiency. Rock heterogeneity is weak, the higher the oil displacement efficiency and oil displacement effect is better. Physical properties and microscopic pore smaller influence on the oil displacement efficiency of the rock.

(3) The external factors that affect the oil displacement efficiency are water injection pressure and injection water ratio, with the increase of injection pressure and injection water ratio on the rise, increase oil displacement efficiency. Compared to the injection water ratio, the effect of water injection pressure to improve oil displacement efficiency is better.

(4)The reservoir internal factors and external factors affecting the reservoir oil displacement efficiency, internal factors such as heterogeneity have innate effect on oil displacement efficiency, the external factors, such as injection pressure effect on oil displacement efficiency on the day after tomorrow. Internal factors such as heterogeneity effects on oil displacement efficiency is more direct, is the main influence factors of reservoir oil displacement efficiency.

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