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A Dense Oil Reservoir Micro Pore Structure Characteristic

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Abstract: This research mainly from the reservoir property of dense oil reservoir characteristics, reservoir microscopic pore structure characteristics, microscopic pore structure and reservoir percolation characteristics and so on three aspects of the study area reservoir microscopic pore structure characteristics were integrated and comprehensive study. Summarized the distribution of reservoir pore structure in the study area, and from the vertical reservoir porosity and permeability distribution were analyzed, and concluded that the physical properties of the reservoir are mainly influenced by lithology.
Keywords: tight reservoir; porosity; permeability; Reservoir physical property.

INTRODUCTION

Rock pore structure is defined geometry and pore throat size distribution and interconnected relationships. Reservoir rock's pore space is divided into pore and throat is an essential prerequisite for the study of rock pore structure, general, can be called the larger space of the rock particles surrounded by porosity, while in the narrow section of the connectivity between particles called the throat [1]. Fluid flow in the rock, will be affected by the control of flow channel, obviously, the size and distribution of pore throat, and their geometry is affect the reservoir storage capacity and the main factors of seepage characteristics. Study the pore structure of the rock, therefore, come to know of ultra-low permeability - the basis of the permeability of reservoir seepage law, is to explain the ultra-low permeability - the key to encounter difficulties in the development of the permeability of reservoir.

Overall evaluation of reservoir physical property

Our object of petroleum and natural gas industry standard of classification will be SY/T6285-1997 porosity partitioning six grades, respectively, for the special high porosity (φ> 30%), high porosity (25%≤φ≤30%), in the hole (15%≤φ≤25%), low porosity (10%≤φ≤15%, especially low porosity (5%≤φ≤10%), super low porosity (φ＜5%). The permeability can be divided into seven levels, respectively, for special hypertonic (K≥2000×10-3 μm2) and high permeability (500×10-3 μm2 < K < 2000×10-3 μm2), infiltration (50×10-3 μm2 < K < 500×10-3 μm2), low permeability (10×10-3 μm2 < K < 50×10-3 μm2), extra low permeability (1×10-3 μm2 < K < 10×10-3 μm2), ultra low permeability (0.1×10-3 μm2 < K < 1×10-3 μm2), non permeability (k < 0.1×10-3 μm2). The research based on this standard to evaluate and analyze the physical properties of the reservoir in the study area.

The study areas of 66 wells 3108 cores of effective porosity of samples of Gaotaizi reservoir porosity were studied. Results showed that, reservoir porosity average 14.28%. Among them, 0% ~ 5% the proportion of 7.8%, 5% to 10% of the proportion of 26.3%, 10% ~ 15% rate was 28.7%, 15% ~ 20% of the proportion was 20.7%, 20% to 25% the proportion accounted for 13.9% and 25% ~ 30% to 2.6%, with reference to the above criteria, Gaotaizi oil reservoir belongs to the special low porosity and high porosity reservoir, but poor reservoir porosity accounted for the vast majority.

The study areas of 65 wells 2829 cores of effective permeability of samples of Gaotaizi reservoir permeability were studied. Results showed that, reservoir porosity average 26.76×10-3μm^2. Among them, 0% ~ 5% the proportion of 7.8%, 5% to 10% of the proportion of 24.3%, 10% ~ 15% rate was 29.7%, 15% ~ 20% of the proportion was 21.7%, 20% to 25% the proportion accounted for 14.9% and 25% ~ 30% to 1.6%, with reference to the above criteria, Gaotaizi oil reservoir belongs to the extra low porosity and high porosity reservoir, but poor reservoir porosity accounted for the vast majority.

Overall, the study area is mainly Gaotaizi special low porosity reservoir - Ultra hole, low permeability - non-permeability reservoirs, was very poor.

Overall evaluation of reservoir pore structure

The study area 22 wells 73 pieces of conventional mercury injection samples, compiled the Gaotaizi reservoir of normal pressure mercury curve diagram (Figure 1), of Gaotaizi reservoir pore structure was evaluated and analyzed. Research shows that the study area reservoir pore structure is poor as a whole, maximum pore radius of the average value for 1.97um. The average pore radius of the average value is only 0.71um, relative sorting coefficient of average 29.501. The average value of the maximum mercury saturation is only 72.584%, displacement pressure average value up to 5.998Mpa. Reservoir pore throat radius is small, poor sorting; connectivity is not good which may reflect. 19.145, 70.483% 87.172% sample, instrument, sample matching connected law of Gaotaizi reservoir pore structure is complex, and the conventional reservoir has some differences, mainly manifested in the pore throat and pore throat size, sorting is not good, such as gold and 54 11 well, the pore throat is relatively large, sorting is relatively good, but the maximum mercury saturation and the final residual mercury saturation is only 63.795% 38.436% exit efficiency 39.75%, reflecting the connectivity is poor, and the Qi Ping 1 well 23, the pore throat radius is relatively small, the sorting is poor, but the maximum mercury saturation and the final residual mercury saturation respectively to reach maximum efficiency and reflect the pore throat connection is relatively good. In addition, Gaotaizi reservoir asymmetric strong heterogeneity reservoir, different wells of the pore structure differences great (apricot 83 wells with a flush 1 well overall characteristics of pore structure differences apparent pore structure, even with a well (such as gold 82 wells) between different samples pore structure also have bigger difference, take everything in contains a low porosity, low permeability reservoirs -- tight reservoir and so on many kinds of reservoir level.

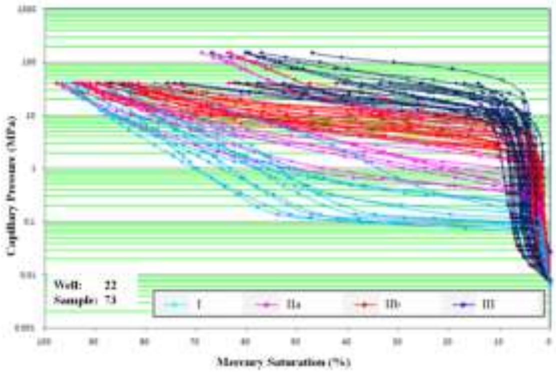

Fig-1: Gaotaizi reservoir in the conventional mercury injection curve

The overall evaluation of the radius of pore throat

The study area 22 well 73 pieces of conventional mercury injection samples, compiled the Gaotaizi reservoir pore throat radius distribution (Figure 2), to evaluate and analysis the characteristics of distribution of Gaotaizi reservoir pore throat radius. As can be seen from the chart, Gaotaizi reservoir pore throat radius is mainly distributed between 0.025 ~ 0.25 m and a number of pore throat radius distribution in 0.4 m to 10 m, sorting bias, permeability with radius distribution peak bit and radius of the pore throat distribution peaks corresponding is better, but permeability tribute offer radius slightly thin pore throat, radius of the peak is located in the pore throat, reflecting the larger proportion of the pore throat contribution to permeability more. Through the analysis of reservoir pore throat radius distribution diagram and some samples of cast thin section, scanning electron microscope (SEM) found, Gaotaizi reservoir pore layers generally smaller and less development pore connectivity. Poor, cast thin section sample fractures but generally smaller cracks.

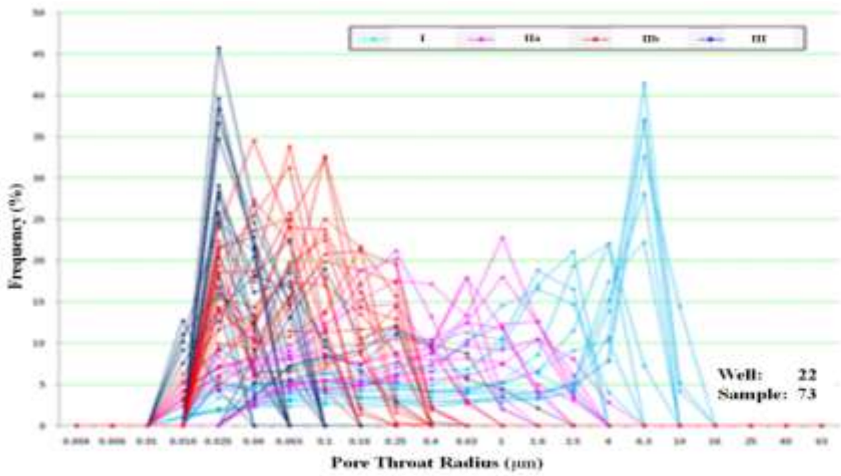

Fig-2: Gaotaizi reservoir pore throat radius distribution

Micro pore structure and seepage characteristics of reservoir

In view of the low porosity and super low porosity, low permeability non permeable reservoir microcosmic pore structure and flow characteristics of the relationship between the complexity of, only a single technology is difficult to obtain ideal result must be comprehensive use of a variety of techniques, can more comprehensively and systematically on the microcosmic pore structure and seepage characteristics of the reservoir relationship of qualitative and quantitative characterization, and this is the main development direction of the research [2]. This study using conventional mercury injection technology, constant pressure mercury technology, oil-water two-phase flow technology and nuclear magnetic resonance (NMR) Gaotaizi reservoirs in the study area of extra low porosity ultra low porosity and super low permeability non permeable reservoir microcosmic pore structure and seepage characteristics of the relationship between comprehensive and systematic analysis and research.

The present study microscopic reservoir pore structure and flow characteristics of the relationship is widely used as a routine method of mercury technology [3-5], which solves the problem raised by many of the scene, used widely in the production of oil, conventional mercury intrusion techniques can be qualitatively and semi-quantitatively study reservoir pore structure, obtained from the capillary curve can reflect pore throat size, pore-throat sorting parameters pore throat connectivity and percolation, and then through these mercury parameters of Micro - pore structure and flow characteristics of the relationship.

Study on correlation between parameters and permeability of conventional mercury injection

First of all the conventional mercury injection samples (73 samples of 22 wells) pressure mercury parameters and permeability relevance were studied and then permeability > 0.1×10^{-3} μm^2 and permeability < $0.1\times 10^{-3}\mu m^2$, two interval on permeability of different levels were studied, to get a more accurate conclusions.

According to the study of all conventional mercury injection samples using 22 wells 73 conventional mercury injection samples of conventional mercury injection parameters were studied and the correlation of permeability, the relationship between various types of mercury injection parameters and permeability diagram. The results show that parameters of maximum pore radius, mean radius, pore distribution peak etc. characterization of pore size and permeability were positively correlated, correlation, correlation coefficient R^2 in more than 0.7, reflecting the pore size of the reservoir permeability control effect is more significant; the sorting coefficient, skewness, relative sorting coefficient of pore characterization parameters and permeability between moderate deviations, with better permeability pore increase, correlation coefficient R^2 is 0.3 ~ 0.5, reflecting the pore permeability control of the reservoir is relatively small; the final residual saturation, Maximum efficiency, maximum mercury saturation of characterization of pore connectivity of parameters and permeability poor correlation and complex rules, correlation coefficient of R^2 is only about 0.2, reflect pore connectivity of reservoir permeability has no control.

According to the permeability > 0.1mD pressure mercury sample research: Study on permeability > $0.1\times10^{-3}\mu m^2$ storage laminated injection parameters and penetration of correlation with 23 conventional mercury injection sample data, the preparation of a variety of pressure mercury parameters and permeability in diagram (see figure 2-2-3-29), The results showed that the parameters, maximum pore radius, mean radius and pore distribution peak characterization of pore size and permeability were positively correlated, correlation, correlation coefficient R^2 at about 0.8, reflecting the pore size of the reservoir permeability control effect is more significant, is the main control factors of reservoir permeability; separation coefficient, skewness, relative sorting coefficient of pore characterization parameters and permeability poor correlation with good pore permeability increase, but the correlation coefficient of R^2 is only about 0.2, reflecting the pore permeability control effect of poor reservoir; finally, the maximum residual saturation exit efficiency, maximum mercury saturation. The pore connectivity and permeability parameters and the poor correlation rule is complex, the correlation coefficient of R^2 is only about 0.2, reflecting the pore connectivity of reservoir Poor permeability control.

Study on permeability of < 0.1 mercury samples: Mercury - reservoir parameters on the permeability less than $0.1\times10^{-3}\mu m^2$ of correlation with permeability using 25 conventional mercury injection samples, the preparation of a variety of relationship between mercury injection parameters and permeability map(Figure 2-3-30), results show that the parameters of maximum pore radius, radius, mean the characterization of pore distribution peak pore size were correlated with positive correlation between permeability, moderate preference, correlation coefficient R^2 at about 0.6, reflecting the pore size of the reservoir permeability control effect is relatively large; the sorting coefficient, skewness, relative permeability parameters and correlation sorting coefficient of secondary pore characterization, rule is complex. The correlation coefficient R^2 is 0.2 ~ 0.6, reflecting the pore permeability effect of moderate deviation of control reservoir; the final residual saturation, maximum return The efficiency, the maximum mercury saturation to characterize pore connectivity of parameters and permeability moderate correlation and the complexity of rule, the correlation coefficient R^2 is about 0.4, reflect pore connectivity of reservoir permeability control effect of moderate deviation.

Through the above 3 different permeability grade mercury injection parameters and permeability correlation found that pore size on all levels of the permeability reservoir seepage control effect is better, but the higher the permeability affected by pore size bigger, permeability decline affected by pore size decreased; pore connectivity between medium. The reservoir permeability is relatively complex, the overall effect is small, but there are differences in different permeability, permeability is mainly affected by the large pore size, the pore connectivity and permeability is less affected, hours affected by the pore size decreased, affected by the pore connectivity and the relatively increased. Reflect the reservoir permeability of low permeability and complexity of the factors and rules of the influence of diversity.

CONCLUSION

According to the type of reservoir pore structure, combined with the type of sedimentary microfiches and the characteristics of pore and permeability, the type of plane distribution of pore structure is made. The brownish red well, on behalf of the permeability was larger than 100 $\times10^{-3}$ μm^2, deep green well, on behalf of the permeability of 10-100$\times10^{-3}$ μm^2, blue well, permeability, 1-10$\times10^{-3}$ μm^2, black well, permeability is less than 1$\times10^{-3}$ μm^2, pie shaped graph for single well pore structure types, which deep red as a class I, yellow for class II, green for II B, blue for class III. On the whole, the northern type of pore structure is good, with a kind of main types of Southern bad pore structure in three categories based. From reservoir porosity and permeability distribution in vertical direction, since the GⅣ- GⅢ reservoir group, as a whole is a large water back cyclic sedimentation, show the lake area in the GⅣ part range is larger, sand ratio is not high, each small layer of sand on average than overall increased from bottom to top. Porosity and permeability change trend and sand ratio is consistent, physical properties of the reservoirs are mainly controlled by lithology. The reservoir rock permeability distribution in low permeability tight level, and mainly in dense and ultra low permeability; Porosity distribution in the hole - low grade, bore hole, low, low in terms of the development.

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