

Main Characteristics of Shale Gas Reservoir and Its Influence on Reservoir Improvement

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Abstract: There are two main storage states of shale gas, one is the storage state in which shale gas is mainly adsorbed in the reservoir and, the other is the free state of shale gas in reservoir. Shale gas has strong heterogeneity. Therefore, in the process of the development of shale gas reservoir, in order to enhance productivity, it is necessary to transform the shale gas reservoir after completion. The characteristics of shale gas reservoirs should be fully taken into account in the relevant reservoir modification, and relevant modification schemes should be formulated according to the characteristics of shale gas reservoirs. In this paper, the main characteristics of shale gas reservoir are analyzed, and the influence of the main characteristics of shale gas reservoir on reservoir transformation is explored.

1. Introduction

With the continuous development of social and economic level, the demand for oil and gas resources is increasing all over the world, and the exploitation of shale gas is paid more and more attention by all countries in the world. Shale gas belongs to a new type of mineral resources, and its occurrence forms are mainly dissolved, adsorbed and free. Nowadays, the exploitation effect of shale gas is unsatisfactory all over the world. Because of the special storage characteristics of shale gas, exploitation is more difficult. Therefore, in order to achieve effective exploitation of shale gas, relevant measures must be taken to transform shale gas reservoir. However, in the process of shale gas reservoir transformation, relevant characteristics of shale gas reservoir should be understood beforehand, and the transformation work should be carried out according to the characteristics of shale gas reservoir.

2. Main Characteristics of Shale Gas Reservoir

2.1 Rich in Organic Matter and Clay Minerals

Autogenic self-reservoir is one of the main characteristics of shale gas, so there is more organic matter in shale gas reservoir. High content of organic matter in shale gas reservoir is the basic characteristic. Data show that a lot of organic carbon has been found in shale gas reservoirs in typical shale development areas of North America. For example, in basins of northwest Canada in North America, the content of organic carbon in shale gas reservoirs exceeds 2%, and in some areas, it exceeds 5.5%. According to the above data, it can be determined that the basic characteristic of shale gas reservoir is rich in organic material. The content of organic matter in shale gas reservoirs in China is also relatively high, generally over 1%. Shale gas reservoirs which are rich in organic matter also contain relatively abundant clay minerals, which is also one of the characteristics of shale gas reservoirs. In the United States, the clay mineral content in some shale gas reservoirs is even as high as 70%. In China, the average content of clay minerals in shale gas reservoirs is about 50%.

2.2 Fine Mineral Granularity

According to the rock structure, the shale structure is the main manifestation of shale structure, and the fine mineral granularity is an important part of the rock. The fine degree of mineral crystal

determines the mineral granularity. According to sedimentation environment, the main environment of shale is deep-water environment or still water environment, while the deep-water environment and still water environment are far away from the source. The clastic minerals will appear in the precipitation environment after a long-time and long-distance transportation. The components of clastic minerals are mostly mud grade and present in the form of fine grains, which are relatively rare in silt grade. This phenomenon makes shale gas reservoir have the characteristics of muddy structure.

2.3 Extremely Low Porosity and Permeability

Shale gas reservoirs have two main material characteristics, one is porosity and the other is very low permeability. An analytical data from the United States shows that the average porosity of shale gas reservoirs is 5.1% and the average of total porosity is about 5.5%. Permeability is usually not higher than 0.1 MD and the average radius of throat porosity is below 0.005mm. In China, the shale gas reservoir is similar to that in the United States in porosity and permeability.

2.4 Spatial Distribution Characteristics of Shale

In China, based on the regional scale, there are continental, marine and transitional facies shale between marine and continent. There are differences in thermal maturity and organic matter content in continental, marine and transitional facies shale between marine and continent. In China, there are four major development areas of shale gas reservoir, namely Qinghai-Tibet region, northwest region, central and eastern region and southern region. The distribution of organic shale is affected by many external environments, including the sedimentary environment in which it is located, and the tectonic background. Dark shale with rich organic matter is mainly formed in the transgression of sea (transgression of lake) system tract which is caused by the rise of relative sea level^[1]. The areas favorable for the development of organic matter-rich dark shale are deep-sea basins and closed-off gulf areas. The gas-bearing shale is located on the transgressive erosion surface and the sequence boundary, and the tectonic setting of organic shale also affects the distribution of shale with abundant organic matters. The organic matter preservation, deposition and diagenesis of organic shale are affected by different tectonic backgrounds of organic shale. For the preservation of organic matter of shale, the preservation effect of fault line basin is better. For shale deposits, their sedimentary characteristics are determined by the depth of water body.

2.5 Heterogeneity of Shale Gas Reservoir

Heterogeneity of shale gas reservoir is affected by the structural characteristics and composition of shale, including transverse heterogeneity and longitudinal heterogeneity. Horizontal heterogeneity is based on the distribution characteristics on the plane, and longitudinal heterogeneity is the variation law of the vertical void characteristics, rock composition, gas storage performance and rock composition. The heterogeneity of shale gas reservoir is mainly featured by organic matter, constituent minerals and reservoir structure^[2]. The heterogeneity of rock formed in the process of primitive deposition. In addition, the heterogeneity of rock is influenced by diagenesis, tectonism and sedimentation.

3. Influence of the Characteristics of Shale Gas Reservoir on the Improvement Effect of Reservoir

3.1 Effect of Shale Mineral Composition on Reservoir Improvement

According to the research data, there are rich organic matters in the shale gas reservoir in China, including clay minerals and organic carbon. In addition, it also contains some minerals such as dolomite, pyrite, feldspar and mica. There are many micro-pores on the surface of shale gas reservoir, and the surface area is relatively large, which leads to the strong adsorption capacity of shale gas reservoir to the gas. With the increase of clay content in shale gas reservoir, the surface of shale gas reservoir will be plastic, which seriously affects the gas production after pressure, and also affects the generation of complex seam net. Mica and quartz and other minerals present in shale gas

reservoir increase the brittleness of shale gas reservoir, which results in a decrease in the porosity of shale mineral and a decrease in the space of the reservoir free gas. If the calcite is buried, it will lead to the cementation of calcite, and the reduced pore size to a great extent, so that the content of adsorbed gas is greatly reduced. Once this condition occurs, it is difficult to see the gas after pressure. Therefore, on the basis of the effect of fracturing, to improve shale gas reservoir by means of hydraulic fracturing, it is suggested to find the equilibrium point between mineral content and gas-bearing property, and take into consideration the comprehensive reservoir potential and the characteristics of fracturing property.

3.2 Effect of Fracture on the Improvement of Reservoir

In the process of hydraulic fracturing, the crack can be easily generated, including the following reasons, such as the induced type crack produced by filling the drilling mud and the fracture caused by the cementation. These fractures, when passed, cause these cracks to be opened again due to the existence of net pressure, which coincide with the artificial cracks and form a more complex crack network. In general, the more the number of cracks, the more diverse and the more dispersed the fracture will be. At the same time, the coexisting property between the cracks will be getting better, so that the yield of shale gas after compression is improved. The angle between cracks is affected by the included angles, so that the crack becomes more complex, and the complexity can influence the effect of fracturing. When the included angle becomes small to a certain extent, the natural fracture will be expanded no matter how large the horizontal pressure difference is. Once the natural fracture is spread, the direction of artificial crack will be changed, and the artificial crack extends in the direction of naturally-formed crack, so that the extension direction of artificial crack is not controlled artificially, so that the seam net cannot be formed.

3.3 Influence of the Brittleness of Shale Gas Reservoir on the Reservoir Improvement

The effect of the shale gas reservoir pressure and the brittleness of the shale gas reservoir can also produce different changes due to the influence of the components of shale gas reservoir. For example, the storage capacity and flow capacity of shale gas reservoir will be enhanced with the decrease of induced fracture and natural fracture. Vice versa, the storage capacity and flow capacity among the shale gas reservoirs will decrease with the increase of induced fracture and natural fracture. The shale reservoir has a certain brittleness, therefore, when the external forces in the shale reservoir are increased, the shale reservoir will be fractured.

3.4 Effect of Geological Environment on the Reservoir Improvement

Two important factors are included in the geological environment of shale gas reservoir, one is crustal stress and the other is natural fracture. Natural fractures have great influence on fracturing fractures directly. The natural fractures affect fracturing fractures as follows: In the process of fracturing, the artificial fracture will extend along the direction of natural fracture, and more angle can be generated along with the increase of fracture. Therefore, in the process of fracturing, the contact between natural fractures should be strengthened as much as possible, so that the shale reservoir can be improved. In the case of an underground rock unit, it is affected by three stresses from three directions, which are perpendicular to each other, with one stress coming from the vertical direction and two other stresses from the horizontal direction and also perpendicular to each other. Our country is vast with a land area of nine hundred and six thousand square kilometers. Therefore, the geological structure of our country is very complex with great diversity, which leads to different distribution of stress. In the process of reforming the shale gas reservoir, stress will influence the effect of shale gas reservoir improvement to a certain extent. In the shale gas reservoir, due to the influence of the geological structure and other factors, the difference between horizontal stress and horizontal stress is not obvious, and the distribution of natural fracture is wider, so that, the geological conditions of shale gas reservoir are complicated, and the effect of fracturing cannot reach the expected standard.

4. Function and Significance of the Shale Gas Reservoir Improvement

The shale gas reserves of shale gas reservoir determine the commercial value of shale gas exploitation. In order to ensure the production quality, we should strengthen the application of drilling technology, production increasing craftwork of oil and gas and the engineering design technology to enhance the production capacity of the shale gas mining, increase the shale gas exploitation amount and reduce the cost of the shale gas exploitation engineering. Therefore, in the process of shale gas production, the shale gas reservoir improvement has a very important significance. During reforming shale gas reservoir, the application of hydraulic fracturing technology can effectively improve the mining performance of shale gas reservoir, thereby ensuring the economic benefit of the development of shale gas.

5. Conclusion

To sum up, the largest characteristic of shale gas reservoir is the self-generated and self-storage feature, and it also has the characteristics of high organic matter content, low permeability and porosity, spatial distribution of the shale, mud structure and so on. These characteristics have a certain effect on the improvement effect of the shale gas reservoir, and therefore, the effective mining plan should be developed according to the actual exploitation situation before the shale reservoir is improved, so as to ensure the smooth development of the shale gas production.

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