Understanding the Flow Mechanism of Fuyu oil layer in a certain Block

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Abstract: The Fuyu oil layer in a certain block is an ultra-low permeability oil layer. The development scale of sand bodies in the Fuyu oil layer is narrow, with rapid changes in facies on the plane, strong reservoir heterogeneity, and complex oil and gas accumulation and oil water distribution. Understanding the flow mechanism of the Fuyu oil layer in a certain block can help improve the development effect of this block

Keywords: ultra-low permeability reservoir; Flow Mechanism; Fuyu oil layer

1. General situation

1.1 Structural features

A certain block is located in the northern part of Zone A, The general trend of the top structure of Fuyu oil layer in this block is high in the east and low in the west. The eastern structure is gentle and the western structure is steep. The faults in a certain area are relatively developed, with a total of 15 faults, all of which are normal faults, mainly in the northwest and north-northwest directions.

1.2 Oil-Water Distribution and Reservoir Types

According to the analysis of core, oil testing, and logging interpretation results, the overall trend of oil-water distribution in the Fuyu oil layer of a certain block is the distribution of upper oil and lower water. With the increase of reservoir burial depth, the depth of oil bottom increases in different fault blocks, and there is no unified oil-water interface.

Vertically, the oil-water distribution generally follows the distribution law of upper oil and lower water. The oil layer is mainly developed in Fu I group and Fu II group, and the oil-water layer and water layer are mainly distributed in the lower and lower layers of Fu III group.

On the plane, due to different structural locations, fault combinations, and sand body distribution characteristics, there are different oil and water distributions in different regions.

1.3 Reservoir characteristics

A set of delta plain and delta front subfacies sand bodies with shallow lake deltas as the background were deposited in the Fuyu oil layer of a certain block, with a large area of distributary channel sand bodies developed.

The reservoir of Fuyu oil layer in a block is mainly characterized by underwater distributary channel sand and inter-channel sand. Due to the influence of fault zone and sedimentary facies belt, it has the characteristics of many layers of sandstone, thin single layer thickness, large interlayer difference and poor plane continuity, and there is no obvious main oil layer. In the plane distribution, the effective thickness is thick in the north and thin in the south, and the north is continuous and scattered in the south, showing a nearly north-south strip distribution, which has a good matching relationship with the fault zone. The effective thickness of Fu I group is significantly larger than that of Fu II group.

2. Flow mechanism of Fuyu oil layer in a certain block

The Fuyu oil layer in a certain block belongs to a low porosity and ultra-low permeability reservoir, which is difficult to develop and has poor results. Clarifying the flow mechanism of the Fuyu oil layer in this area can provide a basis for the next development of the Fuyu oil layer.

2.1 Variation characteristics of starting pressure gradient in Fuyu oil layer

The starting pressure gradient of the Fuyu oil oil layer in a certain block is relatively large, making it difficult to start water drive oil. The start-up pressure gradient of water flooding in Fuyu oil layer of a certain block has a power function relationship with permeability and porosity. When the permeability is less than or equal to 1.0 × 10^{-3} μm^2, the start-up pressure gradient increases rapidly. Figure 1.

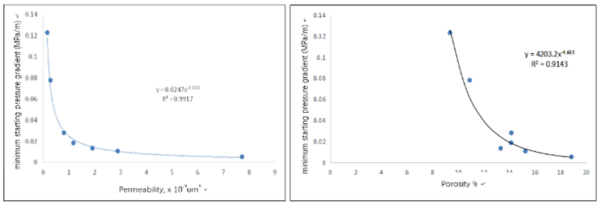

Fig.1 Relationship between start-up pressure gradient and permeability & The relationship between starting pressure gradient and porsity

2.2 Characteristics of oil-water two-phase flow in Fuyu oil reservoir

The water phase Relative permeability rises rapidly in the early stage, which belongs to the linear upward convex curve. The water phase Relative permeability is low when residual oil is present, and the oil phase Relative permeability decreases rapidly, indicating that the reservoir water injection development is difficult.

The two equal permeability points of oil and water are greater than 50%, the span of the two phase co permeability zone is narrow, and the bound water saturation and residual oil saturation are high, indicating that the reservoir is hydrophilic.

2.3 Distribution pattern of fluid availability in Fuyu oil reservoir

2.3.1 Research on the Distribution Law of Movable Fluid (Water) in Fuyu Reservoir

(1) There is a good linear correlation between the total movable fluid (water) saturation and permeability of the core in a certain block of Fuyu oil reservoir. As the core permeability increases, the total movable fluid saturation increases.

(2)Permeability less than 1 × 10^{-3} μm^2 reservoir core, movable fluid mainly affected by radius less than 0.5 μm The throat control of m is difficult to develop; Greater than1 × 10^{-3} μm^2 reservoir core, with movable fluid mainly subjected to a radius of 0.5 μm Above m throat control.

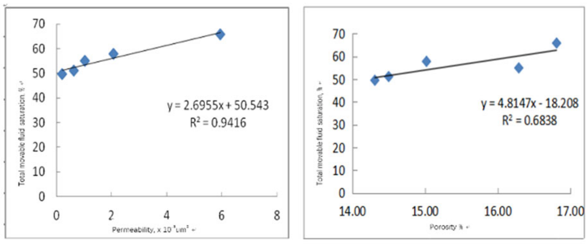

Fig.2 The relationship between total movable fluid and permeability in Fuyu oil reservior

2.3.2 Research on the Distribution Law of Movable Oil in Fuyu Reservoir

(1) The correlation between movable oil saturation and porosity in Fuyu reservoir is poor, showing a logarithmic function relationship with permeability, reaching a correlation of 0.9278. As the core permeability increases, movable oil saturation also increases.

(2)The upper limit value of water drive oil efficiency of Fuyu oil layer shows a Power function relationship with movable oil saturation, and a Exponential function relationship with permeability. The correlation between movable oil saturation and porosity is poor, and it shows a logarithmic function relationship with permeability. With the increase of core permeability, the upper limit value of movable oil saturation and water drive oil efficiency shows an increasing trend.

2.4 Experimental Study on the Infiltration Law and Influencing Factors of Fuyu Reservoir

2.4.1 Changes in Infiltration Recovery Factor and Infiltration Rate over Time

(1) The permeability recovery rate of the Fuyu oil layer in a certain block ranges from 3.72% to 5.67%, with an average of 4.87%.
(2) At the initial stage of imbibition, the imbibition oil recovery rate (the increase in imbibition recovery rate per unit time) is relatively fast, and the imbibition recovery rate during the first one-third of the imbibition process accounts for about 80% of the total imbibition recovery rate.

2.4.2 Effect of Water Saturation on Infiltration

Rock samples with the same conditions have different water saturation, and their imbibition ability and imbibition speed are different. As the water saturation of the core increases, the imbibition recovery rate and imbibition speed show a downward trend.

2.4.3 Effect of Wettability on Infiltration

Due to the increase of water saturation in cores with different water wetting degrees, compared with the results of imbibition under bound water conditions, the imbibition recovery rate and imbibition rate decrease with the increase of water saturation, but the degree of decrease is different. The weaker the water wetting degree, the greater the decrease.

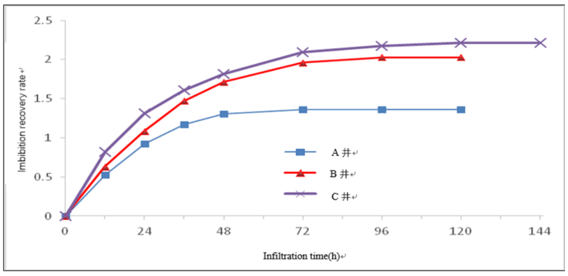

Fig. 3 Relationship between core imbibition recovery rate and imbibition time with different wetting indices

2.4.4 Impact of environmental pressure on infiltration

The imbibition recovery rate slightly increases with the increase of imbibition environmental pressure; Under the same pressure increase conditions, the increase in oil recovery rate increases with the increase of water storage wetting strength.

3. Conclusion

(1) The starting pressure gradient of water drive oil in Fuyu reservoir of a block is a Power function of permeability and porosity.
(2) the reservoir is hydrophilic.
(3)There is a good linear correlation between the total movable fluid (water) saturation and permeability of the core in a certain block of Fuyu oil reservoir. As the core permeability increases, the total movable fluid saturation increases;
(4) The average imbibition recovery rate of the Fuyu oil layer in a certain block is 4.87%, and the imbibition recovery rate increases with the increase of the wetting index; At the initial stage of imbibition, the imbibition oil recovery rate is relatively fast, and the imbibition recovery rate during the first one-third of the imbibition process accounts for about 80% of the total imbibition recovery rate.
(5) The process of imbibition and oil displacement is related to the permeability, wettability, and water saturation of reservoir rock samples under environmental pressure.

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