

# **Characteristics and strategies of three major contradictions for continental facies multi-layered sandstone reservoir at ultra-high water cut stage**

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**Abstract:** Daqing oil field has large continental facies multi-layered sandstone reservoirs, which are at ultra-high water cut stage. There exist significant changes in prediction characteristics of various reservoirs. Based on the water displacing oil experiment, fine reservoir numerical simulation and dynamic production monitoring data, the variable characteristics of the three major contradictions of planer layer, interlayer and inner layer in high water cut stage, as well as the dominant factors influencing above contradictions were systemically analyzed, providing a reference for the development of multi-layered sandstone reservoirs using water flooding technique.

**Key words:** Continental facies. Multi-layered sandstone reservoirs. Ultra-high water cut stage. Three major contradictions mechanism.

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## **I. INTRODUCTION**

When reservoir at ultra-high water cut stage. high recovery degree of the "double high" development phase, with the rising of water cut, the sandstone reservoir after long-term water erosion, reservoir property, pore structure, wettability and seepage flow characteristic parameters such as change, to a certain extent, resulting in determining differences in high mobility ratio, low permeability reservoir increases sharply. Although development adjustment, but still show flat for determining phase that the inside layer, interlayer and further highlights has characteristics of the three major contradiction. The development facing the problems more sharp complicated and contradictions, the development difficulty is becoming more and more big.

## **II. THREE BIG CONTRADICTION ANALYSIS**

### **2.1 Interlayer contradiction analysis**

In the early stage of development, the contradiction between layers is mainly due to the heterogeneity caused by. In the ultra-high water cut stage, factors of oil flow rate increases gradually, high permeable zone of fluid increase, low permeable formation produced fluid volume decreases and intensify interlayer contradiction, resulting in ineffective circulation.

In the ultra-high water cut stage, on the basis of the total fluid volume unchanged, affected by oil flow rate change, high permeability layer produced fluid volume increase, low permeability layer produced fluid volume decrease, exacerbating the interlayer contradiction, resulting in inefficient circulation.

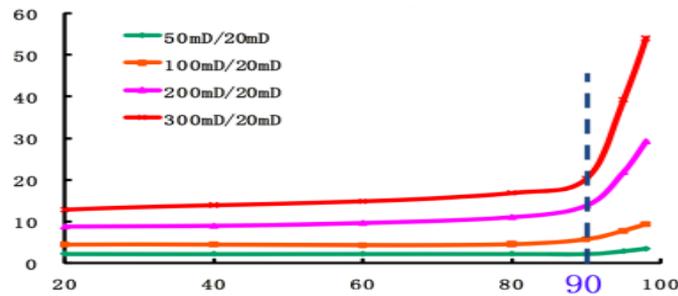


Fig 1 Oil flow rate under different poor permeability change with moisture content of the curve

As shown in Figure 1, when different permeability reservoir commingled production, when water cut is more than 90%, mobility ratio increases rapidly, The bigger differential reservoir changes, resulting in interlayer contradiction.

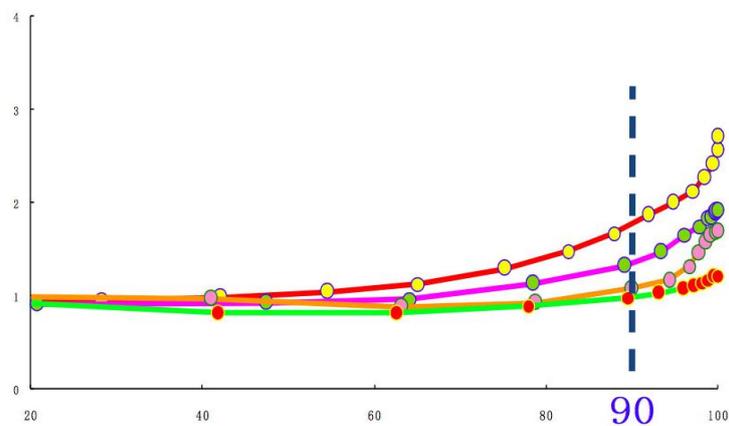


Fig 2 The dimensionless oil production under different permeability poor index curve with moisture content changes

As shown in Figure 2, physical simulation experiments also show that the permeability of the high phase dimensionless liquid production index increased significantly. With the increase of water cut, oil layers with different permeability mobility ratio increases, the water 90% after the greater the difference of the oil mobility ratio increases rapidly. The vertical mobility of oil layers with different permeability difference, the sharpening contradictions between the layers.

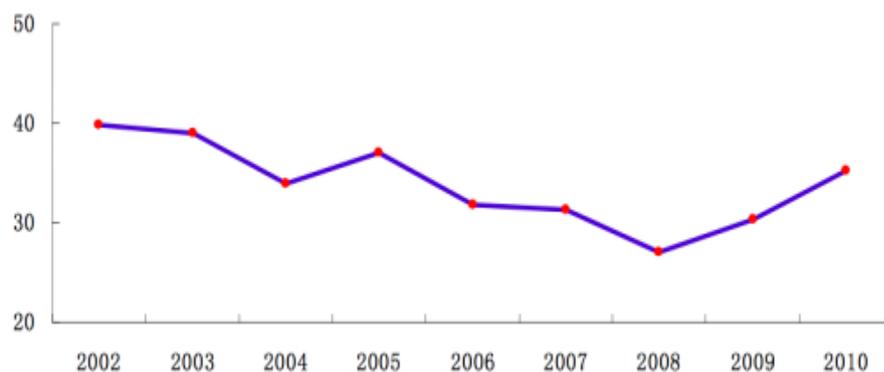


Fig3 Apricot east six injection wells after absorbing water thickness change curve in 2002

As shown in Figure 3, look from actual data analysis, due to late high water cut stage, the interlayer contradiction intensified, deterioration in reservoir water condition gradually, apricot six eastern area, for example: under the condition of injection Wells of various kinds of measures workload flat, sandstone bibulous ply proportion dropped year by year.

**2.2 Plane contradiction analysis**

On the plane, poor permeability and sandbody connecting relations has much effect on the recovery factor. Water surface points of different permeability direction change sharply, the sharpening contradictions between the flat, flat sandbody connecting relations and permeability differential impact on the thickness of water and oil recovery is bigger, injection-production well in plane permeability differential minimum within the same channel with the highest degree.(Fig 3, Fig4).

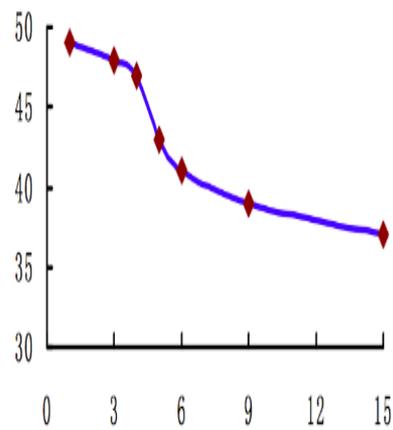
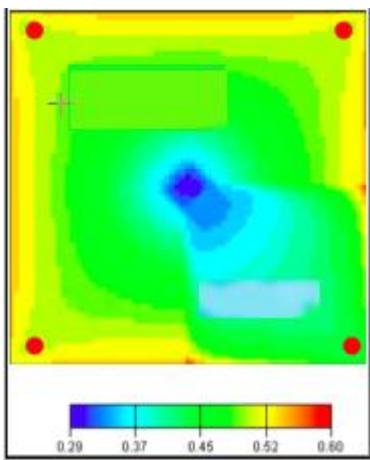


Fig3 Direction of different permeability oil saturation      Fig4 Recovery degree and plane permeability Relationship

**2.3 Intraformational contradiction analysis**

Infuse water along the high permeability layer position, the sharpening contradictions between the inside layer, cause layer within the invalid loops. Numerical simulation and physical simulation results show that the variation coefficient is greater than 1 positive rhythm reservoirs, high permeability section at the bottom of the form more easily advantage channel. At the bottom of the injected water in reservoir of high permeability parts have obvious dash.(Fig5, Fig6).

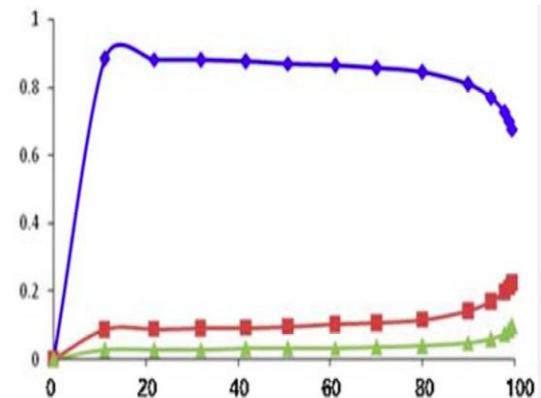
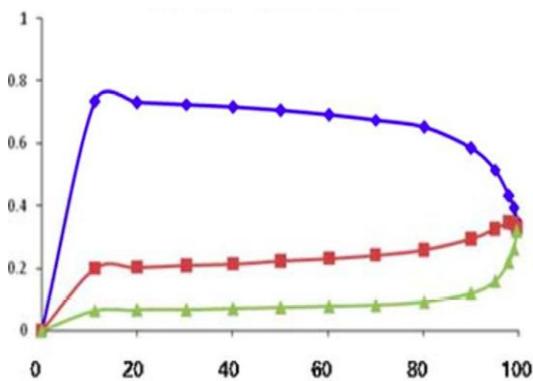


Fig 5 The coefficient of variation was 0.4 oil recovery degree

Fig 6 The coefficient of variation was 1.4 oil recovery degree

#### **2.4 Multi-layer sandstone reservoir "Structural adjustment" contradiction analysis**

At later stage of high water cut, the use of various sets of reservoir producing extent between formation and oil well the difference of moisture content, through such measures as fracturing, water plugging and injection-production system adjustment "stabilizing oil water control" structural adjustment measures, stabilizing oil water control to achieve the targets. After determining the basis of the highest water well network comprehensive water cut has risen to 94.15%, the lowest water comprehensive secondary infilling of the moisture content is up to 88.63%, a significant reduction in the maximum water difference between formation, using water difference between formation structural adjustment, improve the potential of oilfield development effect has been small.

### **III. CONCLUSIONS**

- (1) Due to the long-term water erosion, reservoir seepage flow characteristic of the reservoir physical properties, are changing to a certain extent, led to a certain degree of deterioration in ultra-high water cut stage more sandstone reservoir, the determining result in multi-layer sandstone reservoir development phase plane, interlayer and layer within the three major contradictions become more prominent.
- (2) Plane, interlayer and remaining oil mainly affected by the fluid flow inside the plane block or transformation, vertical within each small layer permeability difference, between sandwich and difference in rhythm, such as seepage control.
- (3) The fine water flooding in daqing oil field mining practice shows that terrestrial determining multi-layer sandstone reservoir in the three major contradictions and remaining oil distribution on the basis of the understanding, can through the fine exploration in the plane, interlayer and layer of the realization of the aim of improving for determining water flooding development effect.

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