Research on prediction method of subsequent water flooding index of an oilfield

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Abstract. With the gradual end of polymer flooding in polymer flooding blocks of type II oil reservoirs, the scale of subsequent water flooding production and injection in oil fields is increasing. As can be seen from the subsequent water flooding production, due to different factors such as reservoir properties and injection-production rates, various indicators in the block vary greatly, which brings difficulties to the prediction of indicators in the later stage. Therefore, it is urgent to carry out follow-up research on the change law of water-flooding related indexes to provide scientific basis for index prediction and index control. Based on a large number of actual production data of oil field, the influencing factors of index change are analyzed, and the variation law of actual index of subsequent water flooding in oil field is made clear. By fitting the actual production data of successive water flooding blocks over the years, the empirical formula which accords with the water flooding characteristic curve and production decline of an oilfield is given.

Key words: Class II reservoir; Polymer flooding; Follow-up water flooding; Rule of index change

1. Analysis of subsequent water drive development situation

With the end of polymer injection in polymer flooding block of class II oil reservoir, the scale of subsequent water flooding production and injection in oil field is expanding continuously. In the actual production process, there are problems such as fast water cut recovery, fast production decline, and large variation of indicators between blocks in subsequent water flooding blocks, which make it difficult to forecast and control the indicators in later blocks. Therefore, subsequent water flooding blocks in the actual production data statistics, analysis and reduction injection-production adjustment, measures, thus the influence of various factors on the indexes such as, and by using mathematical statistics, water drive characteristic curve, production decline method research of subsequent water flooding stage indices such as water cut, and determine the subsequent water flooding development index change rule, It provides a basis for production prediction and index control of water flooding block in the future.

2. Study on the change law of development index

2.1 Mathematical statistics method research development index change rule

Statistical category, to turn the block subsequent water flooding oil after water injection, found that the changes of subsequent water flooding blocks as polymer production, reduced water phase viscosity, oil flow rate increases, the water absorption ability enhancement, category, subsequent water flooding oil water injectivity index increases gradually, the type of reservoir each subsequent water flooding blocks as the water injectivity index rises 20.0%, The apparent water absorption index of each block in subsequent water flooding of the second oil layer increased by about 28.0%.

In terms of liquid production, the variation trend of liquid volume is basically consistent with that of water injection. Look from producing fluid index, subsequent water flooding blocks as polymer production, water phase viscosity, oil flow rate increases, block produced fluid volume stability, production pressure differential is reduced, or block production pressure differential stability, fluid volume increases, subsequent water flooding producing fluid index increases gradually, the type of reservoir subsequent water flooding blocks, each producing fluid index rise at 17.0%, The liquid production index of each subsequent water flooding block of the second type oil layer increased by about 22.0%.

2.2 The water drive curve method is used to study and develop the variation law of index

When the water cut reaches a certain percentage and there is a straight line between the accumulative liquid production, the logarithm of accumulative water production and the accumulative oil production, the data fitting of the straight line segment is carried out to obtain the empirical formula. On this basis, the oil production, water cut and other indicators are predicted by using fixed liquid method. At present, there are four widely used waterflooding characteristic curves: TYPE A, type B, type C and type D.

Through the transformation of four kinds of water flooding characteristic curves, the linear relation equation of cumulative fluid production and cumulative oil production is established.

Combining with the actual production data of each block, the empirical formula of each block is obtained and the index is predicted. Taking the subsequent water flooding block of a certain area as an example, four empirical formulas of different water flooding characteristic curves of a certain area are obtained.

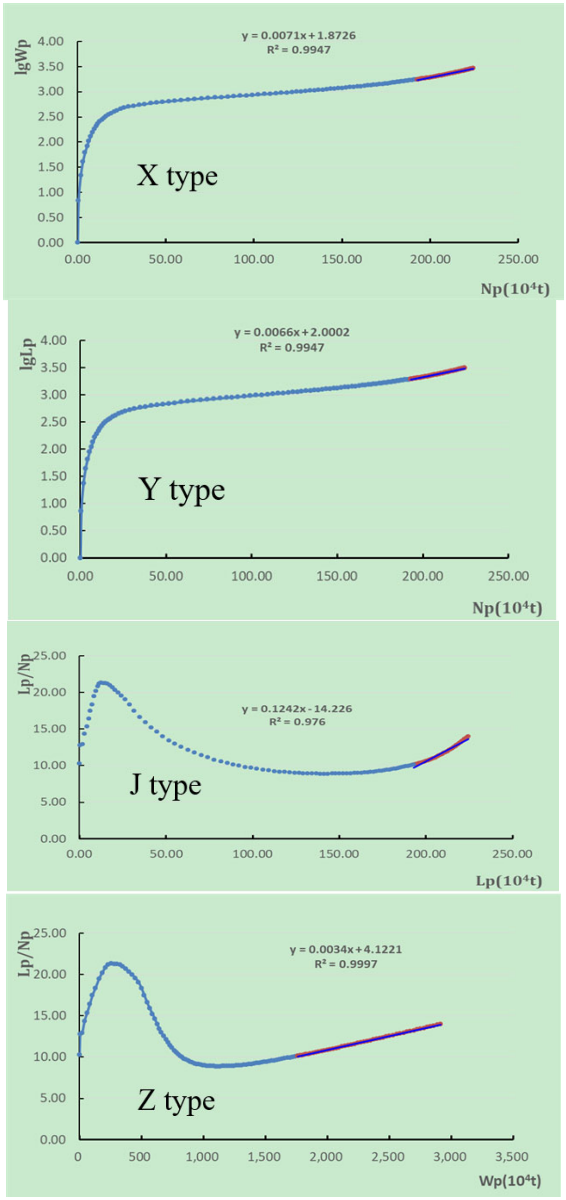

Fig. 1 A water flooding characteristic curve of subsequent water flooding in an area

Table 1 Prediction parameters of four subsequent water flooding curves in a certain area

The valuation method	X type Curve	Y type Curve	Z type Curve	J type Curve
A value	1.8726	2.0002	-14.226	4.1221
B value	0.0071	0.0066	0.1242	0.0034

From the verification results of influenza a and d predicted results is relatively accurate, the worst c, mainly because of influenza a, d type water drive characteristic curve in linear time is longer, more obvious, the fitting accuracy is higher, and the water drive characteristic curve c a straight run of subsequent water flooding stage is not obvious, so the fitting precision is low, regularity is not obvious, can predict oil producing results.

2.3 Production decline method research and development index change rule

In the development process of oilfield water flooding, after the high and stable production period of oilfield water flooding, production will begin to decline in a certain law, and the decline rate of production is called the decline rate. The decline type of production is not only related to reservoir driving type, reservoir and fluid properties, but also related to reservoir recovery mode and development adjustment. The main types of decline are exponential decline, hyperbolic decline and harmonic decline. According to the statistical study on the actual data, after the oilfield enters the production decline stage, its decline rate is expressed as [5-8] :

$$D = -\frac{\mathrm{d}q}{q\mathrm{d}t} = kq^n$$

Type in the : D ——Yield decline rate ; q —— Production of oil and gas field in decline stage T （104t）. n ——Decline index.

When the initial decline rate is constant, the exponential decline curve is the fastest, followed by hyperbolic decline, and harmonic decline is the slowest. The empirical formula of each block is obtained by using the above decline equation and fitting analysis combined with the actual production data of each block, and the index prediction is made. Take the subsequent water flooding block of a certain area as an example.

According to the above analysis results, hyperbolic decline was adopted for production prediction in the subsequent water flooding stage, and the prediction results were consistent with the actual data. The following are the prediction results of subsequent water flooding oil production decline for the first and second oil reservoirs.

3. Conclusion

(1) According to the results of mathematical statistics, the capacity of water absorption and liquid production in subsequent water flooding blocks is enhanced with the gradual production of polymers. The capacity of water injection and liquid production increases by about 20.0% in the first three years of subsequent water flooding, which provides room for water addition in the implementation plan of sewage balance control in the later period.

(2) Through the comparative analysis of the fitting results of four water flooding characteristic curves and three decline curves, the subsequent water flooding index changes of an oilfield are consistent with the a and D type water flooding characteristic curves and the hyperbolic production decline curve. The prediction results of the three decline curves for a class of oil reservoirs with a longer water flooding time are basically consistent.

(3) Based on the water flooding curve and hyperbolic decline empirical formula of each subsequent water flooding block, the oil production in the next ten years is predicted. It is estimated that the cumulative oil production from 2020 to 2029 will be 415.2× 104T, the annual average oil production will be 41.5× 104T, and the annual oil production in 2029 will remain above 33.4× 104T.

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