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Research Article

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A research method to predict tight reservoir capacity based on comprehensive productivity index

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ABSTRACT

Reservoir capacity is closely related to the effective thickness of the reservoir, permeability, porosity, saturation and resistivity. At present, the method to predict and evaluate tight reservoir can be rarely used. Comprehensive Productivity index is a research method to predict productivity based on the combination of logging and testing date. This method applied is stronger. The method of comprehensive productivity index is selected of the better formula of correlation coefficient based on the relationship between the combination of five parameters (the effective thickness of the reservoir, permeability, porosity, saturation and resistivity) and the different relationship of productivity index . In this paper, to predict reservoir capacity through the comprehensive arrangement analysis on tight reservoir data in Karamay Oilfield based on the method of Comprehensive productivity index. In real application, we need to choose one of methods to establish the relationship between Comprehensive productivity index and Productivity index in order to predict Productivity effectively. The results show that the method is not only reasonable and practical, but also has certain guiding significance to the exploration and development of tight reservoir.

Key words: Tight reservoir, Comprehensive Productivity index, Productivity index, Productivity prediction, Significance

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INTRODUCTION

Productivity evaluation is not only the comprehensive evaluation of technology to the ability of reservoir capacity, but also the important link to improve exploration efficiency and reduce the cost, in addition the premise to develop a reasonable basis. The productivity prediction is based mostly on Darcy's law in high porosity and permeability reservoir, but more than half of oil and gas reservoirs in special low permeability of tight reservoirs in China. Fluid does not comply with Darcy's law in low permeability reservoir in low-velocity percolation state, in addition to being viscous resistance , but also by the fluid and the adsorption resistance of the rock or water film attract resistance, only overcome this resistance liquid can flow. Productivity evaluation of low porosity and low permeability reservoir becomes more difficult. Traditional reservoir productivity evaluation and prediction methods are basically using test data of test oil and production test by formation pressure , bottom hole flowing pressure and test production or using reservoir numerical method to forecast the production capacity. At present, there is no a mature method to predict dense reservoir productivity. The key factors which influence the production of each well is mainly reservoir effective thickness, permeability, porosity, saturation and resistivity .Using only a single factor to predict reservoir capacity will lead to large errors, we need to consider a combination of key factors affecting the reservoir in order to more accurately predict reservoir capacity. In this paper, we use the key factors to affect reservoir capacity as the main evaluation parameter. The combination of logging and well test data is used to establish the comprehensive productivity index, which can predict the dense reservoir capacity. This topic provides a new, simple and practical method for the capacity evaluation and prediction, which has a certain guiding significance to the exploration and development of oilfield.

EXPERIMENTAL SECTION

2.1 Construction of comprehensive productivity index

Generally, the greater the effective thickness of reservoir , the higher well production rate; permeability is directly to the flow ability of reservoir ,when the greater the permeability, the greater the flow capacity of the reservoir ;the larger reservoir porosity ,the stronger percolation ability, so the porosity have a direct impact on the size of the well fluid production; on the limit standard of the reservoir litho logy and physical property, the higher reservoir resistivity , the higher the sufficient oil of the reservoir[9-10].Therefore , if only we use a certain single factor of the reservoir to establish relationship with the productivity of well testing to determine the capacity of oil well, which will inevitably have limitations ,but they have a good correlation between the combination.

In order to accurately predict reservoir capacity, we need to consider a comprehensive evaluation index, which consider the key factors that can be closely related to the reservoir production as much as possible. Therefore, we need to establish a productivity index through effective thickness, permeability, porosity, saturation and resistivity of the combination of reservoir parameters .The quantitative relationship between productivity index and the productivity index of reservoir, which be called integrated production index.

2.2 Quantitative prediction and effectiveness evaluation of reservoir productivity

The production of each well is likely to be the contribution of a layer segment ,which based on the single segment of perforating fracturing as to single well; The production of each well may be the contribution of multiple layers ,which based on multiple segments of perforating fracturing as to single well. On the basis of identification of the oil and water , through the method of statistical analysis ,the well testing and logging data have been put into in certain area in Karamay ,using the relationship between comprehensive productivity index and productivity index of the well-known to predict productivity of the unknown wells.

In practical application, the relationship of three mathematical parameter optimization of the productivity index and productivity index be used to predict productivity of the unknown wells. The first is based on the product of the combination of four parameters(the effective thickness, permeability, porosity and resistivity)to establish a comprehensive productivity index called ZZ (RT), by fitting $ZZ(RT) = H \times K \times \varphi \times Rt$ and productivity index, to set up the prediction formula of reservoir productivity; the second is based on the product of the combination of four parameters(the effective thickness, permeability, porosity and oil saturation)to establish a comprehensive productivity index called ZZ (So), by fitting $ZZ(S0) = H \times K \times \varphi \times S0$and productivity index, to set up the prediction formula of reservoir productivity ; the last is based on the product of the combination of five parameters(the effective thickness, permeability, porosity, resistivity and oil saturation)to establish a comprehensive productivity index called ZZ (RS), by fitting $ZZ(RS) = H \times K \times \varphi \times S0\times Rt$ and productivity index, to set up the prediction formula of reservoir productivity.

According to table 1, the relation graphs between the comprehensive productivity index and productivity index were respectively drawn, as shown in figure 1, figure 2 and figure 3.

Table 1 the date table of three Comprehensive Productivity index

Well type	the effective thickness (m)	permeability (Md)	porosity （%）	oil saturation (%)	resistivity (Ωm)	ZZ(SO) （m*Md)	ZZ(RT) (m*Md*Ωm)	ZZ(RS) (m*Md*Ωm)	the actual productivity index m3/(d*Mpa)	Productivity index preduction m3/(d*Mpa)
A1	9.1	0.3067	6.44	36.56	24.40	657.1084	438.4905	16030.5537	0.0405	0.0868
A2	9.2	0.6717	12.01	55.70	26.68	4133.8334	1979.9229	110281.7054	0.1078	0.1810
A4	9	0.0498	9.45	52.62	39.11	222.8088	165.6034	8714.0533	0.0515	0.0794
A5	6	0.4481	7.86	26.69	39.11	563.9934	826.4437	22057.7835	0.0777	0.0928
A6	15	0.6195	8.98	39.80	69.39	3322.0950	5792.0196	230535.8932	0.3251	0.3013
A7	10	0.6927	9.31	36.14	45.21	2329.5326	2914.4297	105327.4881	0.1956	0.1761
B1	9.2	1.0162	10.34	3.35	77.27	323.8478	7469.4193	25022.5546	0.1550	0.0958
B2	10.2	0.0087	11.05	22.11	33.33	21.7304	32.7597	724.3168	0.0371	0.0715
B3	16.6	0.0960	9.91	49.56	29.55	782.5332	466.5467	23121.1244	0.0843	0.0939
B4	14.2	0.8768	13.54	50.12	72.41	8449.2588	12206.9200	611663.6180	0.5615	0.6824
B5	13.7	0.9648	12.96	53.54	82.24	9171.5182	14087.8904	754230.6446	0.6692	0.8250

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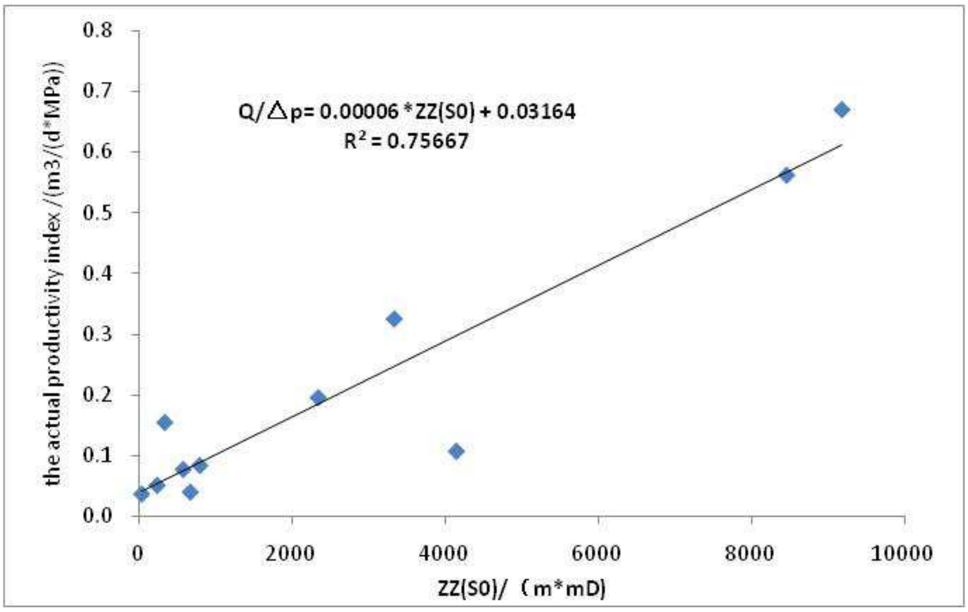

Fig. 1 the relationship between Comprehensive Productivity index and Productivity index

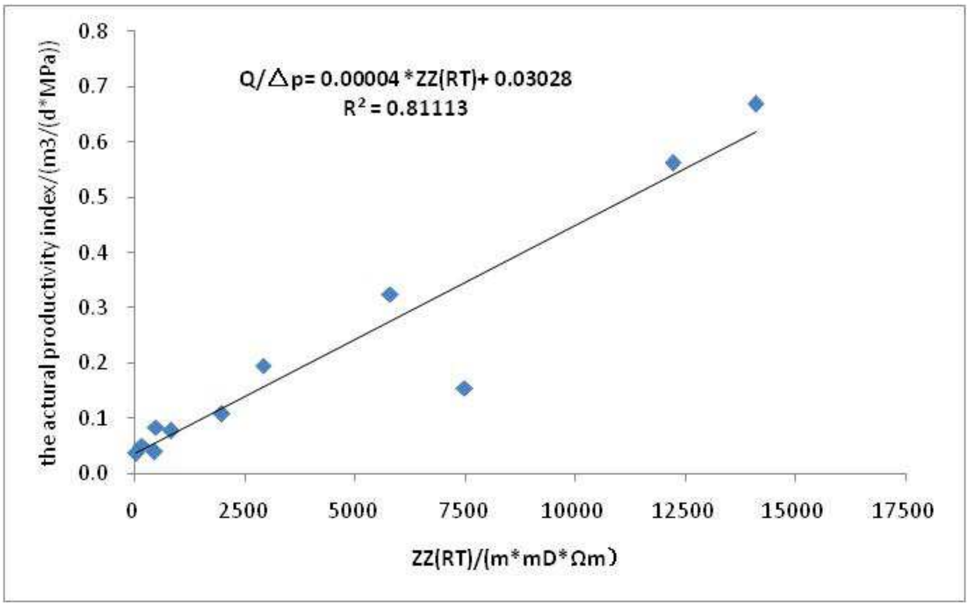

Fig. 2 the relationship between Comprehensive Productivity index and Productivity index

These correlations of regression formulas between the comprehensive production capacity index and productivity index are better from the analysis contrast of figure1, figure2 and figure 3.The correlation of the production forecasting formula as to ZZ（RS）is the best. Therefore, it is preferable to predict the tight reservoir capacity of this area ,which can use the regression formula between the comprehensive index ZZ（RS） and productivity index. The contrast diagram between the productivity index of the regression formula which be calculated by Q/Δp=0.000001*ZZ(RS)+0.070731 and the actual productivity index is shown in figure 4. The fitting effect is good, which can be seen in figure 4.

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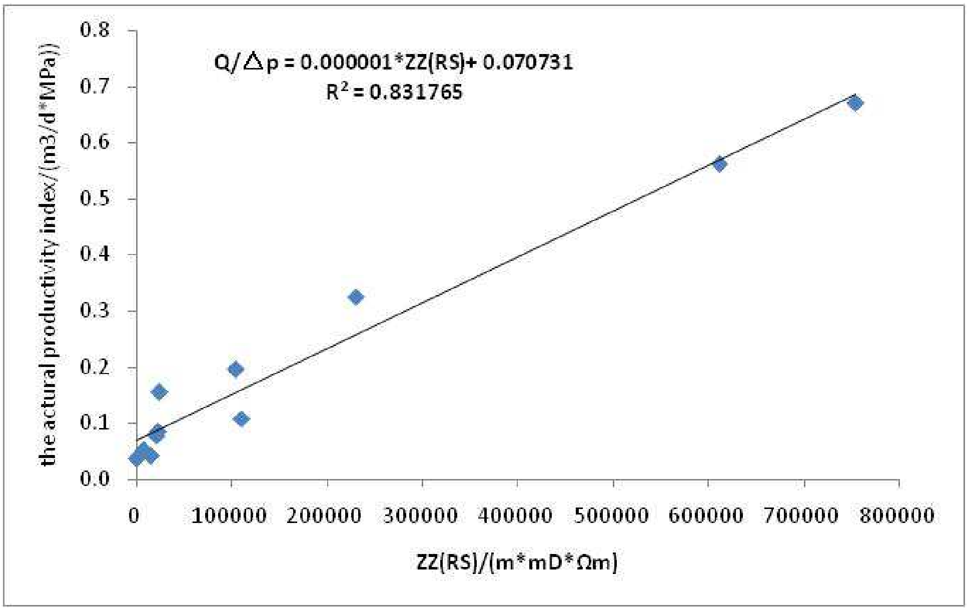

Fig.3 the relationship between Comprehensive Productivity index and Productivity index

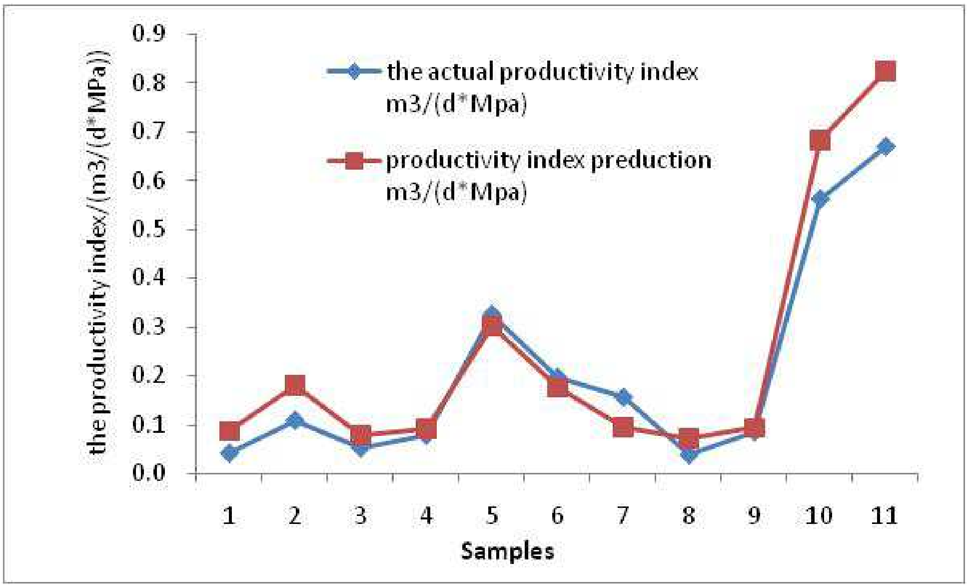

Fig. 4 the contrast diagram between Comprehensive Productivity index and Productivity index

CONCLUSION

Based on this study, certain conclusions have been made**:**

（1）The effect which considers the impact between the combination of reservoir parameter with productivity index to establish the formula to predict the productivity of tight reservoir is better. The more factors we consider, the better effect we predict tight reservoir .In actual application, therefore, we need to summarize the realistic productivity prediction expression.

（2）The method of comprehensive productivity index is closely related to the factor of reservoir , so it does not can completely determine the reservoir capacity .We need to consider more fetors into it in order to predict reservoir productivity accurately, such as shale content, well completion method et al.

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