Construction of Early Warning Index System for Oil Field Water Drive Development Dynamic System Taking into Account the Weighted Shortest-Circuit Computer Algorithm

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Abstract. This paper puts forward the meaning of early warning of dynamic system of oilfield water drive development and its significance to oilfield development. Then the construction principle of early warning index system of weighted shortest-circuit computer algorithm is explained in detail. Finally, the early warning index system is determined by computer simulation analysis of the dynamic change of geological state index and control condition index by using the weighted coefficient of each influence factor.

Keywords: Short Circuit Computer Algorithm, Oil Field, Early Warning Index

1. Introduction
Early warning of dynamic system for oilfield water drive development is a comprehensive work[1]. It is of great practical significance to analyze and systematically evaluate the dynamic changes injected and produced during the development process[2]. In order to develop the oil field effectively, the evaluation system of the development effect of oil field water drive is established by computer technology based on artificial neural grid and fuzzy comprehensive evaluation algorithm design. Based on the systematic analysis of the development process of oil field water drive and mastering the specific implementation rules, processes, methods and methods of water drive development, a set of evaluation system of oil field water drive development effect is developed. In order to ensure high yield, stable yield and high recovery, an early warning system is urgently needed for oilfield development[3]. The comprehensive evaluation and diagnosis analysis of reservoir injection and production system during oilfield development can make the advantages and disadvantages of oilfield development block clear at a glance, diagnose and discover all kinds of problems and their influence
degree in oilfield development process in time, so as to provide decision basis for management. Systematic and comprehensive evaluation and diagnosis and analysis of the overall management level, control development level, reservoir geological conditions and so on require scientific quantitative decomposition to reflect the characteristics of dynamic changes in oilfield development, and establish a set of index system reflecting the effect of oilfield development, that is, early warning index system. The index system is the premise of evaluation and early warning diagnosis and analysis activities, and the design of index system and the screening of indicators are very important, which determines the accuracy and effectiveness of evaluation and diagnosis and analysis results[4]. Based on the method of system analysis and the principle of correlation analysis, the early warning index system of oil field water drive development dynamic system is studied.

2. Significance of early warning on development effect of oil field water drive
In order to make the advantages, disadvantages and future development direction and trend of oilfield water flooding development clear at a glance, the dynamic changes in the whole complex system are comprehensively analyzed and evaluated[5]. This is not only a prerequisite for development adjustment measures and management policies to improve oil and gas recovery, but also provides a strong basis for further development of oil field water drive development strategy. In a sense, the early warning model is also a comprehensive evaluation model of the development strategy, control measures, control degree and development management level implemented by people in the oil field production process, which is helpful to evaluate the scientific rationality of the oil field production process, summarize the production process, and then adjust the production process. The early warning of the development effect of oilfield water drive takes the dynamic system of oilfield water drive development as the core, and carries on the scientific evaluation and the diagnosis to the oilfield water drive development dynamic process, which provides the prerequisite for reducing the development risk and formulating the development adjustment measures and management policies in a targeted way.

3. Construction of early warning index system for oil field water drive development dynamic system by weighted shortest circuit computer algorithm
Based on the principle of fuzzy comprehensive evaluation method and weighted shortest circuit algorithm, an early warning model for the development effect of oilfield water drive is established. Firstly, the historical data of the evaluation index system of oilfield water drive development is obtained. According to the fuzzy comprehensive evaluation rule, the influence index in the calculation result is taken as the output sample of weighted shortest circuit computer algorithm. The historical data of oilfield water drive development dynamic early warning index system is taken as the input sample of weighted shortest circuit computer algorithm[6]. Then the three-layer forward neural network with one-way propagation is learned and trained. When a pair of input and output learning sample are provided to the network, the temporary value in the index system propagates from the input layer through each middle layer to the output layer, and the input response of the network is obtained each neuron of the output layer[7]. Next, according to the direction of reducing the target output and the actual error, the connection weights are corrected layer by layer from the output layer through each intermediate layer, and finally back to the output layer. As this error inverse propagation correction
continues, the correct rate of the network response to the input mode increases continuously until the network converges to a given error allowable value, thus determining the network structure. Finally, the data sequence of the early warning index system of the oil field water drive development dynamic system is taken as the system influence index input, and the weight simulation calculation is carried out to get the corresponding output. Figure 1 is the result of the early warning model of the oil field water drive development effect. The concrete steps are as follows: first, the integrated evaluation method of AHP and fuzzy evaluation method is used to evaluate the development effect of oil field water drive. That is: determine the weight of each index and evaluation criteria, and then combined with the historical data of oil field water drive development effect evaluation index system, and according to the fuzzy evaluation method of the calculation of comprehensive calculation, finally get the comprehensive evaluation value of oil field water drive development effect. Secondly, using the established evaluation index system and combining with the principle of neural network, the early warning diagnosis model of multi-input and single output is established, and then the comprehensive evaluation value of oilfield water drive development effect calculated in the first step is taken as the output of the model. Thirdly, the data of the evaluation index system of oil field block which needs to carry on the early warning of the development effect of oil field water drive is used as the input data of the early warning diagnosis model of learning and training, and the output value of the early warning diagnosis model is finally obtained by calculation. Finally, the output end of the early warning diagnosis model is divided into three intervals, and the output value of the actual calculated early warning diagnosis model is compared to see which interval it matches, and the corresponding alarm degree is given.

![Figure 1. Schematic diagram of weighted shortest circuit computer algorithm](image)

4. Weighted analysis of system dependency indicators

4.1 Geological status indicators

The correlation matrix can be calculated for the sample data the early stage, the correlation matrix can be calculated. The first three maximum eigenvalues of the correlation matrix are calculated as \( \lambda_1=4.34 \), \( \lambda_2=1.624 \), and \( \lambda_3=0.678 \) respectively. Their cumulative weights are 83.04\%. Therefore, 3 common
factors were taken for factor analysis. On the factor $f_1$, except that the coefficient of variation of ground saturation pressure difference and permeability is negative load, the rest is positive load, and the effective porosity, effective sandstone coefficient, flow coefficient have a large load, which indicates that the $f_1$ factor is related to the spatial environment of stored crude oil, so, it can be called reservoir geometric structure factor. At the factor $f_2$, except that the ground saturation pressure difference is a negative load, the rest is a positive load, especially the effective porosity, original oil saturation, single storage coefficient three indicators of the load is very large, the indicators involved are all related to the amount of oil stored in the oil field, so, can be called crude oil scale factor. Through the above factor analysis and explanation, it is clearer that reservoir geological quality is mainly determined by reservoir structure, crude oil scale, crude oil fluidity. This not only provides the theoretical basis for the future study of reservoir geological quality, but also points out the research direction. The weighted values of geological state indicators are shown in Table 1.

| Table 1. Weights of geological state indicators |
|-----------------------------------------------|
| variable                        | $f_1$  | $f_2$  | $f_3$  |
| Active porosity                 | 0.817  | -0.371 | 0.149  |
| Air permeability                | 0.695  | 0.568  | -0.353 |
| Effective sandstone coefficient | 0.821  | -0.230 | -0.095 |
| Saturation level                | 0.824  | 0.052  | 0.272  |
| Saturation pressure             | -0.747 | 0.366  | 0.307  |
| Variance coefficient            | -0.100 | 0.906  | -0.035 |
| Flow coefficient                | 0.902  | 0.222  | -0.195 |
| Single storage factor           | 0.674  | 0.324  | 0.562  |
| Weight coefficient              | 54.25  | 74.56  | 83.04  |

4.2. Control conditions indicators

For the control indicators can be the same factor analysis. Through calculation, the correlation matrix is the largest four eigenvalues of the calculation correlation matrix are $\mu_1$=3.581, $\mu_2$ =1.767, $\mu_3$ =1.464, $\mu_4$ =1.213, and the cumulative contribution rate obtained is 80.25%.It is obvious that these indexes indicate the influence of water injection, water injection pressure and water storage on oil recovery in water injection wells. For factor $f_2$, there is a large positive load mainly on the degree of extraction, well network density, cumulative injection pore volume multiple, while there is a weak positive load on the degree of water drive control and the degree of reserve utilization. Clearly these indexes are the main indexes that affect the oil recovery, so $f_2$ can be called the oil recovery factor. On the factor $f_3$, the most prominent positive load factors are the well network density, the degree of water drive control, the degree of reserve utilization, and the oil-water well number ratio has a weak positive load with the oil well flow pressure, which indicates the control degree of the well network distributed in the oil recovery process to the developed oil recovery, so $f_3$ can be called well control factor. No obvious common attribute on $f_4$, so it is not explained, which may be related to sample data.
Table 2. The weights of control condition indicators.

| Variables                  | $f_1$ | $f_2$ | $f_3$ | $f_4$ |
|---------------------------|-------|-------|-------|-------|
| Extent of mining          | 0.650 | 0.615 | -0.212| 0.207 |
| Water drive index         | -0.667| -0.129| 0.005 | 0.637 |
| Water well flow pressure  | -0.423| 0.208 | 0.195 | 0.402 |
| Oil well flow pressure    | -0.121| -0.824| -0.135| -0.003|
| Well ratio                | 0.132 | 0.616 | 0.582 | -0.150|
| Well network density      | 0.860 | -0.096| -0.186| 0.172 |
| Water storage rate        | -0.731| 0.186 | 0.204 | 0.405 |
| Volume of pores           | 0.618 | 0.096 | 0.510 | 0.527 |
| Water flooding control    | 0.693 | -0.282| 0.545 | 0.267 |
| Availability level        | 0.605 | -0.372| 0.625 | 0.195 |
| Weight contribution       | 35.810| 53.48 | 68.12 | 80.25 |

5. Conclusions
Through the analysis of the composition of the dynamic system of oil field water drive development, the index system for the information characterization of the dynamic system of oil field water drive development is determined. The determined index system is derived through systematic analysis, qualitative analysis, reservoir development mechanism analysis, which fully and reasonably embodies the principle of determining the index system comprehensively, scientifically and independently. The early warning index system of oilfield water drive development dynamic system is not only of high reference value for comprehensive evaluation of oilfield development level and development effect, but also the foundation of oilfield water drive development dynamic system early warning.

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