

Research Article

Diagnosis method of casing damage based on BP neural network

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Abstract: One of the major problems faced by the oilfields in the middle time is casing damage. The neural network, the improvement BP as well as the three-layer feed forward neural network applied in damage diagnosis is a key way to prevent damage. The formations of the damage are corresponded to the input vector. Factors such as casing age limit, strata stress, soaking time are described as real Numbers between 0 ~ 1. Multi -factor constitute a fuzzy vector. Thus, working status such as the output of neural network, a large number of field data and categorical reduction constitute the training simple. After those trainings, predictions of the casing status can be completed.

Keywords: oil and water Wells casing; Multi-factor; Neural network; Fuzzy evaluation

INTRODUCTION

The middle and later periods of the oilfield production, the casing damage is serious of Oil and water Wells, especially in the old oil region of water injection development, casing damage has become the main problem of restricting its development, Casing damage prediction research is an important content of the governance of casing damage. There are many influence factors of casing damage[1-2], casing deformation condition is more complex, that is why it is very difficult to comprehensive analysis and forecast of casing damage. Some of the forecasting methods of casing damage analysis of carrying capacity of casing from the Angle of mechanics, But the complexity of the geological conditions made it very difficult to describe the complicated causes of casing damage physical model using a single mathematical methods, there are different degrees of errors of the mathematical model and the choice of boundary condition, in this model of the software system also inevitably exist complex system, and poor usability.

Aiming at the above problem, to develop the evaluation research of casing damage wells based on the improved BP network. Avoids the weakness of poor universality, and cannot need the new problems and the new method, and improving the operability and practicability of the software to predict the casing damage, the prediction accuracy is above 70%, and has received the good effect. The accurately forecast of

casing damage wells has provide guidance for engineering personnel to adopt effective measures to prevent casing damage, and economic benefit is enormous.

The basic principle of neural network

The basic principle of BP neural network [3]

BP neural network is a three-layer feed forward neural network model, the basic idea is to adjust and modify the connection weights of the network through the network output error back propagation, and then to minimize network error, the training process includes the forward calculation and error back propagation.

The traditional BP network, the Sigmoid function as the node function in general. The correction formula of BP algorithm can be unified as follows:

$$W_{ji}(t+1) = W_{ji}(t) + \eta \delta_{pj} O_{pi} \quad (1)$$

$$\delta_{pi} = -\frac{\partial E_p}{\partial a_{pi}} \quad (2)$$

In the formula W_{ji} means the connection power of neurons, η means learning-ratio of network,

O_{pi} means output of the sample of P , δ_{pj} means error in the revised, the expressions can be seen from (2), from the type (1) and type (2) we

can see that the traditional BP algorithm fix right value through the steepest gradient descent.

The lack and improved of BP algorithm

The defects of BP algorithm including slow convergence speed, and poor convergence of network caused by the local minimum, During the study of this paper, the traditional neural network learning algorithm is improved in order to solve these problems, and abandon the traditional error back propagation algorithm, to train neural network used particle swarm

optimization(PSO)[4], PSO is a kind of optimization tools based on population, the initialized of system is a group of random solutions, search for the optimal value through the iterative. Compared with genetic algorithm, it has no crossover and mutation operation such as the genetic algorithm, but to search by the particles in the solution space to follow the optimal particle. Therefore, this method avoids the derivative operations of traditional method, improve the efficiency of learning of the neural network, save training time, the differences of two algorithms is shown in Fig-1.

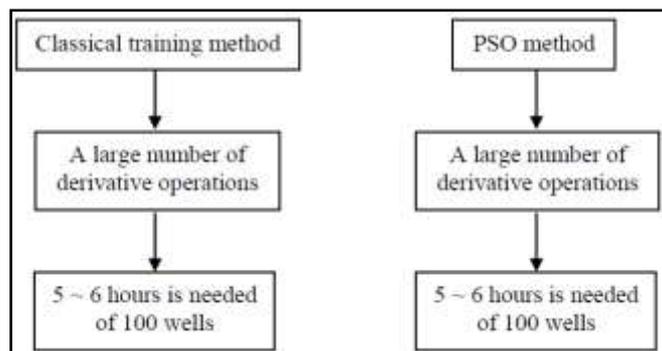


Fig-1: Schematic diagram of the differences of two algorithms

The analysis of casing damage factor

From the point of view of structure, casing damage is more serious in tectonic axis and near the fault; from the point of view of litho logy, Casing damage of mudstone and shale accounted for 60-70% and oil accounted for 30%. The number of casing damage Wells is different with the different injection time, and different development phase, overall, at the time of mining strength casing damage relatively large proportion. Through the analysis of the second peak of casing damage in daqing oilfield, the main factors of casing damage is:

- The leaching water caused by flooding of clay and shale is a major factor of casing damage

By a number of flooding of clay and shale, shear strength and internal friction coefficient will reduced greatly, different degree of creep will caused by the change of water content. Mudstone creep expansion and extrusion casing under the effect of some external force, is often caused single well casing damage. Casing damage horizon of vertical distribution is given priority to with argillaceous rock in reservoir area and shallow reservoir.

- Pore pressure imbalance within the formation caused by the unbalanced injection is one of the main reason of casing damage

Uneven high and low pressure area in a development blocks inside and outside caused by the uneven pore pressure, Periphery rock mass lift under the pressure caused by pore skeleton expansion in the high

pressure area, On the contrary , Periphery rock mass Sink due to the tension caused by pore skeleton contraction in the low pressure area. This kind of vertical lifting of rock mass easy to cause casing damage. This kind of situation usually occurs in shallow reservoirs.

- The casing stress concentration caused by the non-uniform stress of casing

Fault location poor stability, three to the in-situ stress concentration, the injected water cause pressure-out, and formation pressure out of balance on both sides of the fault, the increase of stress concentration cause fault activity and make casing damage of the oil Wells drilling in the fault.

The identification of many factors influencing casing damage

- The sample mode selection and processing

Casing damage is the result of a variety of factors, it is influenced by lateral status, production status and various measures, the shape of the casing damage varied from different blocks, the ways to solve this problem is: According to the actual situation, select the appropriate test blocks, the well lateral data, production data and measures data as the input of neural network, regard the work of the current state of the casing as the teacher signal. Define neural network model, to training of network based on the input signal vector and teacher signal, and make the network convergence, neural network after the training, can be estimated the status of the casing based on the input, input related samples, to compare the output of the neural network with the

teacher signal, if meet the requirement of error, and then enter the next sample; On the other hand, recalculate the cumulative values, until all the samples meet the requirement of error, and the end of the neural network learning process. Neural network training scheme is shown in Fig-2.

The statistics and mining the data of 5040 casing damage wells selected from production of one factory

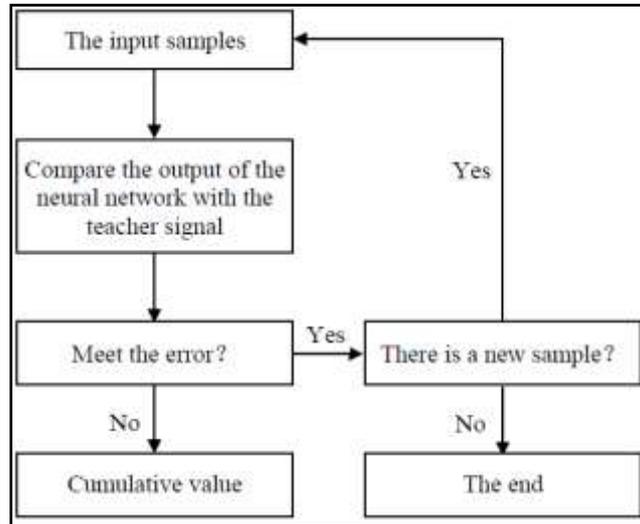


Fig-2: neural network training process

- The identification process of casing damage

The learning of neural network can be guided or without guidance. The process is: to complete the study through modifying the network connection weights when one set is repeated input. The network is

and four factory, the sensitive data of affect the casing working conditions as the input vector of neural network, and specification and transformation the vector, described as a real number between 0 ~ 1, these factors are often difficult to describe by mathematical means, but can be given a value by expert fuzzy, in this way, multiple factors constitute a fuzzy vector of casing damage factors.

connected. And include input layer, hidden layer and output layer. Input to a neural network node must be digital, and fell on the closed interval [0, 1]. This would require the specification or transformation of input attribute values are.

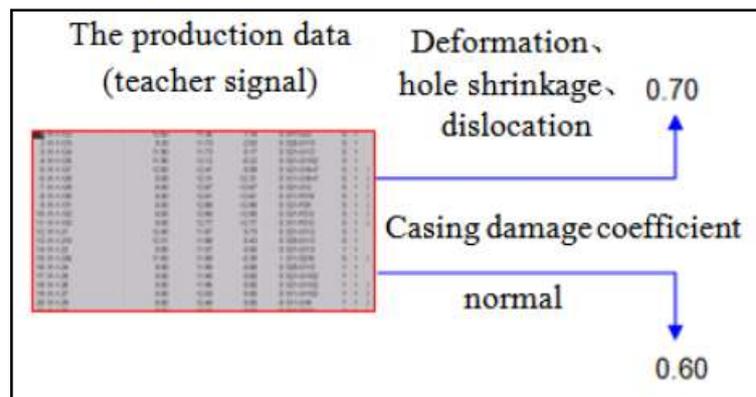


Fig-3: identification of casing damage

Neural network in working condition after the training, the casing damage related production data is submitted to the neural network as the input vector, the neural network will produce a real number to show the probability of casing damage. Through the explanation for this number, we can predict the casing condition of this well.

Establishment and application of the software
The establishment of prediction software of the casing damage

The program software is established based on the above theory; the software has the following features:

- The data statistical analysis function

Classification statistics and analysis for casing damage data from the point of horizon, depth,

secondary casing damage and service life and the system pressure fluctuations, and given the distribution rule of casing damage.

- The self-learning function of neural networks

The software can learning and training according to the existing data of casing damage, and correction weights automatically. The neural network can memory the characteristics of the input mode through learning, and applies the features in the diagnosis of new individual.

- The inversion and prediction of casing damage

Neural network prediction can be implemented successfully after studying, it established the corresponding relationship between production data and state of casing, the casing damage related production data is submitted to the neural network as the input vector, the neural network will produce a real number to show the probability of casing damage. Through the explanation for this number, we can predict the casing condition of this well.

Application validation

To train the network again using the sample of the data of 59 wells of production of four factory in 2002, established the corresponding relationship between production data and state of casing, Projections on casing damage in 2003, the casing damage related production data is submitted to the neural network as the input vector, The neural network will produce a real number to show the probability of casing damage. Through the explanation for this number, we can predict the casing condition of this well, 14 Wells of 59wells to predict failure, 11 normal wells be predicted damage wells, forecast accuracy of 76.2%.

CONCLUSION

- Compare with the traditional method, neural network method avoid the shortcomings which parameters to get hard and boundary conditions is difficult to determine, it implements the corresponding relationship between production data and state of casing.
- Analysis the factor of casing damage by means of data mining, various factors from the field data, strong operability.
- Analysis the multi- factor of casing damage using the neural network, and provides a new method and means to identify the status of the casing. Realize the evaluation of casing damage wells on the basis of a large number of data mining, and have achieved a good result.

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