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Gas Well Annulus Pressure Time Sequence Predictive Algorithm Research

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Abstract: The abnormality of gas well annulus pressure is one of the main risks that threaten the safety of gas wells and affect their production efficiency. In order to further improve the level of Gas Well Annulus Pressure management, this study introduced the time sequence prediction method. Through the design of multiple variable gray prediction algorithms and neural network prediction algorithm design, the effectiveness of the model was verified by the comparison of the prediction results and the actual measurement data. The research results verify the feasibility of the time sequence predictive algorithm on the dynamic prediction of the gas well annulus pressure, which provides theoretical support for the early diagnosis and active prevention of the gas well annulus pressure.

Keywords: Gas Well Annulus Pressure, Multi -variable gray prediction, Neural network prediction, Production safety.

1. Introduce

As my country has accelerated the development of oil and natural gas, the phenomenon of gas in the gas well is becoming more and more prominent. In order to reduce the impact of gas wells on production on production, there must be predictive research on gas wells[1].The time sequence prediction method is a statistical method that reveals the system's dynamic structure and laws based on dynamic data. At present, several common time sequence predictions are: regression analysis prediction method, gray system prediction method, and artificial neural network prediction method. The risk -free gas well that has been judged to be risky must be pre -judged as much as possible, and the time sequence prediction method is introduced from the perspective of informatization[2].

In short, according to the characteristics of the gas well circular system, according to the existing knowledge, the time sequence is used to predict the circular pressure. Early diagnosis and active prevention of abnormal circular pressure, providing new research ideas and methods for the management of gas well annulus pressure[3].

2. Gray System Prediction

The gray system prediction is a study of information modeling. It combines the random process and the gray process, and uses the statistical law of the gray amount to generate data generation The number of new information priority is one of the basic principles of the theory of the gray system[4]. It emphasizes the importance of new information in related analysis, which means that the new information is more influencing the current operation of the system than the old information. "It continuously adds new information and deletes irrelevant outdated information, which can dynamically reflect the latest development trend of the system[5]. Based on the principle of gray -associated analysis and new information priority, a gas well circular pressure multi -variable gray predictive algorithm with metabolic functions with metabolic functions is designed. Obtain the latest measured data over time, update the modeling time sequence, dynamically predict the gas well circular pressure pressure The change trend, the calculation process is shown in Figure 1:

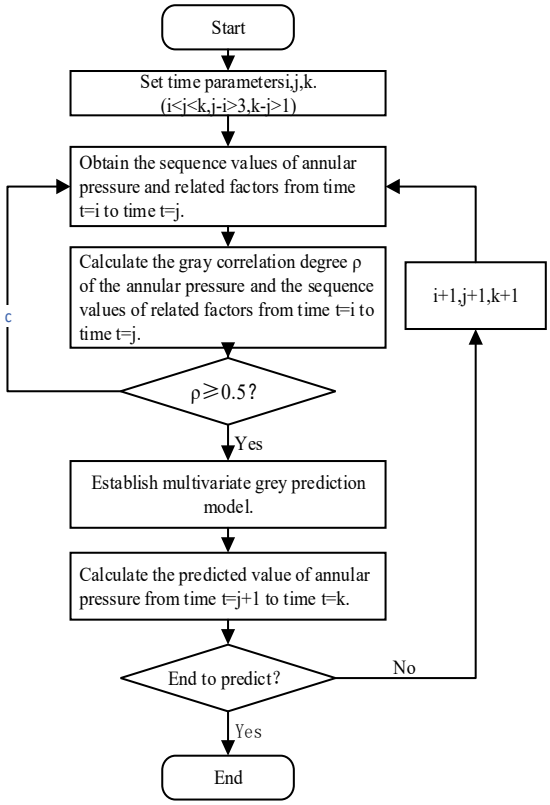

Figure 1. Gas well annulus pressure,multi -variable gray predictive algorithm flowchart

3. Neural Network Prediction Algorithm Design

Neural network is a mathematical model established by the micro structure and functions of the human nervous system[6]. It is an important way to simulate human intelligence. It is generally composed of input layers, hidden layers, and output layers. According to the structure and basic functions of biological neurons, the expression is:

$$h_{w,b}(x) = f\left(\sum_{i=1}^{n} w_i x_i + b\right) \quad (1)$$

First, build a three -layer neural network. The cyclopenic

pressure sensitivity factors analyzed as gray as a related variable input layer are used as the output layer as the output layer. The time period of a large adjustment of the output of gas well at a certain period of time is used as the training set, and the time period of the production of large adjustment in another period of time is used as the test set. The setting of related parameters is as follows:

(1) Three factors of oil pressure, temperature, and instant yield are used as the input layer of the neural network, and the historical data of the well -empty pressure of the well as the output layer of the neurons, and 10 neurons are selected as hidden function test nodes to form 3 -10-1 neural network;

(2) Set the learning rate to 0.01, and the number of network iterations is set to 1000;

(3) Set the transmission function of the hidden layer and the transport layer and the network training function.

The neural network structure adopted in this section is 3-10-1, and the schematic diagram of artificial neural network training is shown in Figure 2.

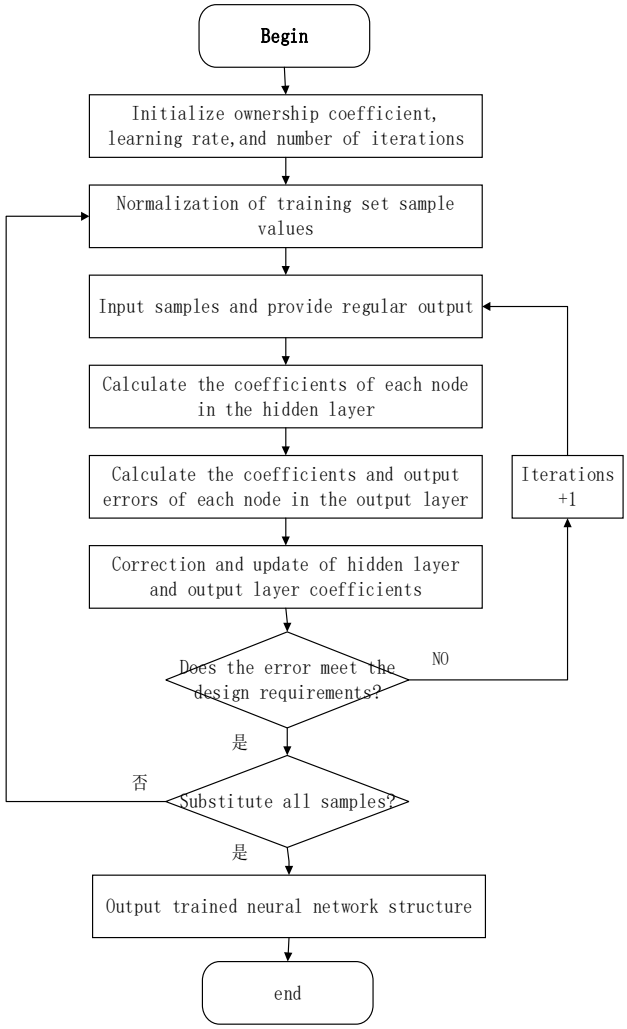

Figure 2. Gas well annulus pressure neural network prediction algorithm flow chart

4. Example Analysis

4.1. Example Analysis of Gray System Prediction Algorithm

First of all, the GM (1, 1) model was established to establish the GM (1, 1) model at 00: 00 to 06: 00, and the GM (1, 1) model was established, and a precise test was performed[7]. Get 00: 00-06: 00 The oil pressure and the temperature gray GM (1,1) prediction of the well-exit temperature in the period of the time period of the average relative percentage error accuracy level reaches the level, and the gas production gray GM (1,1) forecast an average relatively percentage percentage percentage percentage The error accuracy level reaches secondary, so it can be used for short -term prediction[8]. Through the predicted value of each factors from the establishment of the gray GM (1,1) model at 07: 00-11: 00, the calculation result is shown in Table 1:

Table 1. Each relevant factors 07: 00-11: 00 Forecast values

Time	Oil pressure(MPa)	temperature(℃)	Instant yield(m^3)
07:00	55.674	33.894	202095.417
08:00	55.178	34.182	204973.519
09:00	54.688	34.471	207892.608
10:00	54.201	34.764	210853.269
11:00	53.719	35.058	213856.094

Establish a multi -variable gray prediction model for the A ring pressure sequence and related factors. Among them, the data of 00: 00-06: 00 is used as the basis for the minimum of the model parameter. In the restoration of the time response, calculate the prediction value of the pressure of the circular wells at the time of the circular port at a time, and the comparison of the circular pressure prediction results of the 07: 00-11: 00 is as shown in Table 2.

Table 2. A ring gas pressure 07: 00-11: 00 prediction results

Time	gas well annulus pressure prediction value (MPa)	gas well annulus pressure actual value (MPa)	error(%)
07:00	40.429	40.401	0.07%
08:00	40.634	40.565	0.17%
09:00	40.837	40.723	0.28%
10:00	41.039	40.853	0.46%
11:00	41.241	40.975	0.65%

4.2. Analysis of Neural Network Prediction Algorithms

Selected from 12:00 to 16:00 on October 2020 ($10 \times 10^4 m^3$) at 12:00-16: 00 (about $10\times 10^4 m^3$), the oil pressure, well estate temperature, instant yield, and A-ring gas pressure actual measurement value (measured by hour) for training set, Each parameter is as shown in Table 3. It iterative calculation is 1,000 times, and the accuracy of the neural network model reaches 0.99625.

Table 3. Parameter Training Collection of Each Parameters

Time	Oil pressure (MPa)	The well mouth temperature (℃)	Instant output (m^3)	gas well annulus pressure (MPa)
2020.10.20 12:00	58.846	51.608	356240.619	60.023
2020.10.20 13:00	58.811	53.103	356542.987	60.025
2020.10.20 14:00	58.780	52.914	352368.220	60.023
2020.10.20 15:00	58.801	53.750	347558.443	60.026
2020.10.20 16:00	58.818	51.774	340825.167	60.019

Use the above parameters of the above parameter to verify the effect of the neural network prediction effect at 0: 00-6: 00 on November 29, 2020 (about $5 \times 10^4 m^3$). As shown in Table 4, the error meets the prediction accuracy requirements and verified the artificial neural network. The validity of the circular pressure prediction when the yield is adjusted.

Table 4. Check piece test set

Time	Instant output (m^3)	gas well annulus pressure prediction (MPa)	gas well annulus pressure measurement (MPa)	error(%)
2020.11.29 0:00	257295.463	60.253	60.192	0.10%
2020.11.29 1:00	251931.842	60.251	60.195	0.09%
2020.11.29 2:00	251737.679	60.251	60.205	0.08%
2020.11.29 3:00	250534.258	60.249	60.206	0.07%
2020.11.29 4:00	252978.626	60.251	60.214	0.06%
2020.11.29 5:00	248761.070	60.244	60.216	0.05%

The accuracy of the prediction model of the neural network adjustment is shown in Figure 3.

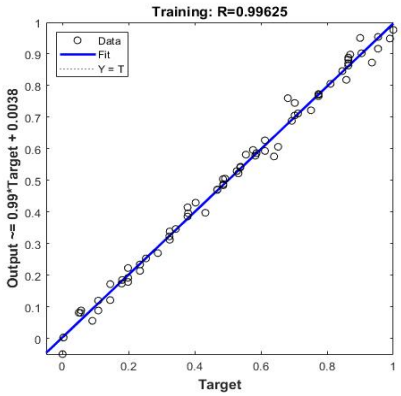

Figure 3. Neural network prediction model accuracy schematic diagram

5. Result

(1) For the daily management of known gas well annulus pressure, the time sequence prediction method is used to determine the future change trend. Based on the theory of multiple variable gray system theory, the gas wells that consider multiple correlation and specific metabolic functions have been studied. Pressing dynamic prediction methods. Taking a gas well in northwestern Sichuan as an example, research believes that oil pressure, well mouth temperature and instant yield are the sensitive factor of changing the changes in the gas in the gas well. The system theory is used for the effectiveness of the dynamic prediction of pressure dynamic prediction.

(2) Aiming at the forecast of the gas well annulus pressure during the production of the gas well, artificial neural network prediction experiments are carried out. The wells are used as

a related variable input layer with the temperature, oil pressure, and instantaneous output of the well. Taking a certain gas well annulus pressure in northwestern Sichuan as an example, the time period with a large adjustment of the output in the test gas well in a certain period of time is used as the training set, and the time period of the output of the output in the other time is used as a test set. The effectiveness of artificial neural networks is used for the prediction of circular pressure prediction when the gas well annulus pressure is adjusted.

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