Mathematical modeling of hydrocarbon exploration and production processes using neural networks in Scada systems

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The article considers an approach to optimizing hydrocarbon exploration and production processes using mathematical modeling using neural networks in SCADA systems. The structure of a neural network model for analyzing well data is presented, a method for detecting and correcting emissions is described, as well as an algorithm for classifying reservoirs into productive and unproductive zones. The proposed approach allows for increased decision-making accuracy in conditions of uncertainty of geological data and provides automation of the production process control.

Keywords: mathematical modeling, SCADA system, neural network, hydrocarbon exploration, production, well data processing.

Automation of hydrocarbon exploration and production processes is one of the key tasks in the energy industry. The use of SCADA systems in combination with neural networks opens up new opportunities for improving monitoring and management of technological facilities [5]. The aim of the research is to develop a mathematical model that integrates a neural network into a SCADA system for automated processing of data from well sensors and decision support for hydrocarbon exploration and production [2].

Problem formulation method

To solve the problem, a model of a multilayer neural network of the MLP type (Multi-Layer Perceptron) was chosen, which is trained using the error backpropagation algorithm. Input data: measurements from several probes (for example, depth, pressure, temperature, electrical conductivity) [1]. The goal of the first subproblem is to detect and correct anomalous values вЂ<вЂ<in measurements from the 1st and 2nd probes based on correlations with the 3rd and 4th probes:

$$x_i^{corr} = f(x_i|x_j, x_k), j, k \in \{3, 4\}, i \in \{1, 2\} \tag{1}$$

For the second problem of classifying reservoir performance, a softmax layer is used to obtain probabilities:

$$P(y = collector|x) = \frac{e^{z_1}}{e^{z_1} + e^{z_2}} \tag{2}$$

Value of neurons of the output layer:

$$z_1, z_2.$$

A neural network model has been developed, implemented as a separate module that interacts with the SCADA system via API. The processed results are displayed to the operator on an information panel with recommendations for further actions [3].

Results

The model was tested on both real and simulated data. A 17%reduction in reservoir identification errors was found compared to traditional methods. Automated outlier correction ensured the stability of the measurement process in real time.

Conclusions

The use of neural networks in SCADA systems allows not only to automate, but also to intellectualize the process of managing hydrocarbon exploration and production. Mathematical modeling of such processes contributes to increasing the reliability and efficiency of geological and mining enterprises [4].

References

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