Development of an information system to improve the efficiency of oil well operation

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Introduction

Planning can be defined as a function responsible for setting the goals and objectives of production, ways to achieve them and identifying the resources necessary for this. The problem of inefficient planning and forecasting has arisen partly due to the obsolescence of existing technical systems, the lack of full use of the amount of information and the insufficient general level of qualification of the personnel of enterprises.

The identified factors contributed to the need to create an automated information system. Together with the database, computer and software are included in the main intangible capital of oil and gas complexes.

Aim of the research

The purpose of this research work is to increase the efficiency of oil well operation by improving the quality of planning measures for its operation. In this regard, an automated information system is being developed, the introduction of which should improve the quality of decisions made and, as a result, bring additional profit by reducing the cost of operating wells and increasing the volume of oil produced.

Solution of the problem of analysis of the state of oil wells

The construction of a mathematical model consists of the following steps:

- collection of initial statistical data (ISD);
- checking the ISD for reliability;
- temporal forecasting;
- correlation analysis and estimation of correlation coefficients;
- conducting multiple regression analysis;
- formation of events and training of the neural network.

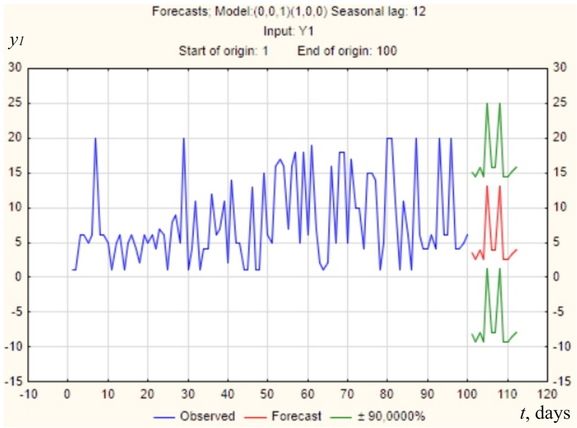

Fig.1 Current and predicted values of the variable y_1.

Time forecasting

To predict time series, we will use the method of autoregression and integrated moving average (ARIMS). The members of the time series depend on each other. The most significant connections are observed in neighboring members, but when moving away from each other, these connections quickly lose strength.

Correlation analysis

The critical value of the correlation coefficient is also calculated. When the value of the coefficient is higher than this critical value, the relationship between the variables can be considered significant.

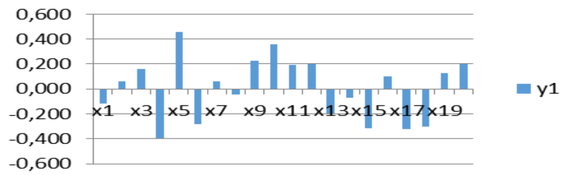

Fig.2 Correlation of factors with indicator y_1

Regression analysis

To predict the data, we used regression analysis. This statistical method for studying the influence of regressors (independent variables) on dependent variables is based on the least squares method (LSM). LSM is a method that requires minimizing the sum of the squared deviations of the desired functions from the available variables.

$$\sum_{i=1}^{n}(y_{ij} - f_j(x_{i1}, x_{i2}, ..., x_{im}))^2 \to \min \quad j = \overline{1,k}$$

Forward regression

The equation for the variable y1, obtained by direct selection:

$$y_1 = 0{,}276237 * x_5 - 0{,}274356 * x_6 + 0{,}227826 * x_{10} - 0{,}145037 * x_1$$

where y_1 - measures to improve oil production;
x_5 - number of pumps;
x_6 - rod length/rod diameter;
x_{10} - dynamic pressure (atm);
x_1 - group metering unit.

The absence of variables in the regression equation can be explained as follows: - the presence in the regression equation of only one variable from a pair with a high correlation is allowed;
- value significance according to the Fisher criterion for the variable does not exceed the value of 0.05.

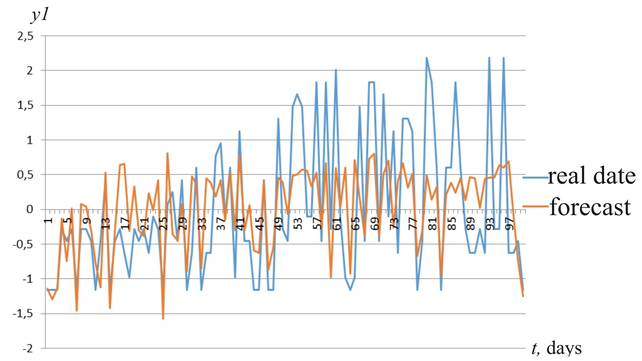

Fig.3 Forecast chart and real values of the indicator y_1

Comparison of forecasting methods

Method	y_1	y_3	y_3
Multiple regression	1,042628	0,572776	0,1124412
Forward Regression	0,628416	0,609849	0,100206
Backward Regression	0,625278	0,636958	0,1033774
A neural network trained on a small sample	0,1601	0,15226	0,2409
A neural network trained on a larger sample	0,2031	0,1334	0,2965

Conceptual design of the database:

The following application software was used to develop an automated information system:

1. DBMS SQL Server 2014;
2. Microsoft Visual Studio 2015;
3. Application software package IBM SPSS Statistics 26;
4. Spreadsheet editor Microsoft Excel 2016;
5. CASE tools: ERwin, BPwin.

Conclusion

The proposed automated information system can not only improve the quality of decisions made, but also increase production profits and the volume of oil produced. In the presented work, a set of measures necessary for the further operation of oil wells is determined.

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