STUDY ON THE PROBABILITY OF VERIFYING COAL AND GAS OUTBURST THRESHOLD

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ABSTRACT-The coal and gas outburst threshold hypothesis theoretically explain several important manifestations of coal and gas outburst, such as high gas adsorption capacity, high gas pressure, temperature change, low gas permeability, and the presence of deformed coal. The coal and gas outburst threshold (OT), unit isosteric desorption enthalpy (UIDE), firmness coefficient (f), and adsorption capacity (N) are defined as independent variables, and the amount of crushed coal or gangue ejected by gas outburst as the dependent variable. The established multiple linear regression equation based on all coal and gas outburst accidents is used to verify the theoretical nature of the hypothesis of coal and gas outburst threshold through the significance test.

KEY WORD-coal and gas outburst threshold; multiple linear regression equation; significance test.

I. INTRODUCTION

The general process of scientific research activities is as follows: when people discover certain abnormal facts or unprecedented abnormal facts in scientific practical activities, the original theory and the past explanation method are imperfect, so there are need of new theories and explanations. People propose new explanatory theories through conjectures, explain relevant facts in new ways, and predict certain unknown facts. Hypothesis is that in the process of exploring the intricate mysteries of nature, people use the obtained empirical materials and known facts as the basis and use existing scientific theories as a guide to make speculative explanations of the causes of unknown natural things and their laws of motion. The hypothesis needs to test its scientific nature in practice and reduce its speculative nature to achieve theoretical understanding. Thereafter, in the process of testing a hypothesis, more new factual material will accumulate. This will gradually lead to the establishment of a system of laws and principles, as well as to the formation of a research tradition.

The prominence of coal and gas outburst is a catastrophic problem, and there have been many studies on this issue, including from the perspective of thermodynamic energy. There are two kinds of individual catastrophe-sensitive indicators. One is the laboratory repeatable measurement, such as the degree of coal damage, and the firmness coefficient of coal. Another is the on-site non-repeatable field measurement, such as the initial velocity of gas dispersion, and the gas pressure of coal seam [1-3]. There are some comprehensive indicators of danger, such as Chinese's D and K methods [4, 5], Russian's B method. Due to the usage of on-site non-repeatable individual indicator, all comprehensive indicators become on-site non-repeatable.

The basic step of thermodynamic hypothesis is to derive the temperature-pressure-adsorption equation (TPAE) from the series of laboratory repeatable isothermal adsorption data, to calculate the geometric constant, adsorption flow coefficient, temperature influencing parameter and pressure influencing parameter involved [6]. According to the TPAE to calculate the relationship between temperature and pressure at the isosteric adsorption, the unit isosteric adsorption enthalpy is calculated using the Clausius-Clapeyron equation. It is confirmed from the sign of the unit isosteric adsorption enthalpy that adsorption is an exothermic reaction that can spontaneously carry out, but the desorption is an endothermic reaction that cannot be carried out spontaneously [7, 8]. The unit isosteric adsorption enthalpy decreases out of proportion with the increase of adsorption capacity, which provides a theoretical basis for the absorption and storage of foreign energy [9]. According to the comparison of the unit isosteric adsorption enthalpy of normal coal and deformed coal, it is confirmed that deformed coal preferentially resolves with normal coal in the same coal seam and at the same temperature and pressure. Considering the coupling effect of desorption thermodynamics and structural stress, the product of the unit isosteric desorption enthalpy and the firmness coefficient is

defined as the coal and gas outburst threshold, which indicating the ease of occurrence of coal and gas outburst. The larger the threshold, the more difficult it is to protrude, and the smaller the threshold, the more likely it is to protrude. Until now, there is no mention about the verification of coal and gas outburst threshold.

II.   DISCUSSIONS

A. Statistical regression

Due to the complexity of the internal laws of objective things and the limitation of people's understanding, it is impossible to analyze the internal causal relationship of actual objects and establish mathematical models that conform to the mechanism laws. Therefore, when encountering some mathematical models that cannot be established by mechanism analysis, the method of collecting a large amount of data is usually adopted, and the model is established based on the statistical analysis of the data, among which the most widely used type of immediate model is the statistical regression model. Regression analysis is used to predict the value of one variable based on the value of another variable. The variable to predict is called the dependent variable. The variables used for predictor values are called independent variables. The regression model solution steps mainly include two parts: first: determine the basic type of regression model, and then calculate the expression of the regression equation; Second, it is a significance test for the regression model.

B. Independent variables

There are four independent variables, coal and gas outburst threshold (OT, as x_1), unit isosteric desorption enthalpy (UIDE, as x_2), coal firmness coefficient (f, as x_3), and adsorption amount (N, as x_4 cm$^{-3} \cdot$g). If the coal samples of every coal and gas outburst were available, all the above-mentioned independent variables are laboratory repeatable measurements, all the above-mentioned independent variables are known.

C. Dependent variable

There is a big difference between the scale of coal and gas outburst, and the scale of gas outburst is often expressed as protrusion strength. The protrusion strength refers to the amount of coal (rock) thrown out in each protrusion (ton) and the amount of gas gushing (m^3). Because the amount of gas is difficult to measure, usually the amount of protruding coal (rock) is used as the basis for division. There are generally four types:

1. Small protrusion: protrusion strength< 100 tons.

2. Medium-sized protrusion: protrusion strength 100 ton~500 ton (including 100 tons).

3. Large protrusion: protrusion strength 500 tons~1000 tons (including 500 tons).

4. Extra-large protrusion: protrusion strength≥ 1000 tons.

Based on this kind of four divisions, the dependent variable is a discontinuous function. Therefore, it is necessary to change the dependent variable into a continuous function (y=1=10 tons).

D. Multiple linear regression

In regression analysis, if there are two or more independent variables, it is called multiple regression. In fact, a phenomenon is often associated with multiple factors, and it is more effective and realistic to predict or estimate the dependent variable by an optimal combination of multiple independent variables than to predict or estimate with only one independent variable. Therefore, multiple linear regression is more practical than univariate linear regression. When establishing a multiple linear regression model, to ensure that the regression model has excellent explanatory ability and prediction effect, we should first pay attention to the selection of independent variables, and the criteria are:

(1) The independent variable must have a significant impact on the dependent variable and be closely and linearly correlated.

(2) the linear correlation between the independent variable and the dependent variable must be real and not formal.

(3) There should be a certain degree of mutual exclusivity between the independent variables, that is, the degree of correlation between the independent variables should not be higher than the degree of correlation between the independent variables and the dependent variables.

(4) The independent variable should have complete statistical data and its predicted value should be easily determined.

$$y_i = b_0 + b_1 x_{1,i} + b_2 x_{2,i} + b_3 x_{3,i} + b_4 x_{4,i}$$

Where, b_0 is the Constant terms. b_1, b_2, b_3 and b_4 are the partial regression coefficients.

E. Stepwise Regression

The basic idea of the stepwise regression analysis method is to automatically select the most important variables from many variables to choose from and build a prediction or explanatory model for regression analysis. The basic idea is to introduce the independent variables one by one, and the condition is that their partial regression sum of squares is significant after testing. At

the same time, each time a new independent variable is introduced, the old independent variables are tested one by one, and the independent variables that are not significant in the sum of squared by partial regression are eliminated.

F. Significance test

The regression model solution steps mainly include two parts: first: determine the basic type of regression model, and then calculate the expression of the regression equation; Second, it is a significance test for the regression model, such as (1) Correlation coefficient test, (2) F test method, (3) residual analysis. The under large number of observations.

III. CONCLUSION

The coal and gas outburst threshold hypothesis theoretically explains several important manifestations of coal and gas outburst, such as high gas adsorption capacity, high gas pressure, temperature change, low gas permeability, and the presence of deformed coal.

Many coal and gas outburst accidents could be used to verify the coal and gas outburst threshold theory. The coal and gas outburst threshold (OT), unit isosteric desorption enthalpy (UIDE), firmness coefficient (f), and adsorption capacity (N) are defined as independent variables, and the amount of crushed coal or gangue ejected by gas outburst as the dependent variable. The established multiple linear regression equation is used to verify the theoretical nature of the hypothesis of coal and gas outburst threshold.

IV. REFERENCE

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