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Short-term Forecasts of Methane Concentration in Ventilation Airways in front of Longwall Faces

Abstract

Doctoral dissertation under the title „Short-term Forecasts of Methane Concentration in Ventilation Airways in front of Longwall Faces" covers the subject connected with the methane hazard, which is at present one of the most dangerous hazards occurring in underground mines. The main issue undertaken in the dissertation is producing short-term forecasts of methane concentration in ventilation airways in front of longwall faces. The justification of the subject area is its relevance to occupational safety improvement in mine headings and averting disaster caused by methane explosion, the concentration of which can exceed the critical level. My dissertation is focused on the area, especially on the development of a propriety method enabling this kind of prediction as well as its implementation in the software called MetPred and its testing with the use of the collected data. Furthermore, there has been performed a qualitative comparison for the proposed method and a competitive baseline method employing linear regression.

The main innovative element of the dissertation is based on the development and testing of the author's method of average and maximum methane concentration forecasts in ventilation airways in front of longwall faces. This method is a hybrid solution making use of several different statistics in which a weighted average of the final forecast is calculated. Weights are determined in a machine learning process through the use of the so-called supervised learning method and more precisely: "contribution-based learning". Data feeding the algorithm come from ex post (or current) readings of methane concentration levels for a specific ventilation airway. In the process of learning the method makes use of a full accessible dataset from ex post readings for the purpose of dynamic determination of weights for particular statistics, which makes it more effective (in sense of the quality of obtained results) from the base method, id est the one which uses only linear regression.

It was for comparative purposes that a base method was used. For this very method a set of forecasts making use of the collected measurement data was conducted. The obtained results were used to determine comparative statistics.

The applied research methodology used in the study relies on implementing the proposed forecasting method in the author's computer software under the name MetPred. Thereafter a number of forecasts for the collected real measurement data were made. The obtained values were used to make a qualitative comparison of the said subject-specific method with the already mentioned: base method. In order to make a comparison there were used several statistics elaborated on in the latter part of the present study. Through the use of the author's MetPred program and a spreadsheet a forecast simulation for seven longwalls in Polish coal mines was performed. The range of input data for individual walls oscillated from 64 to over 400 readings. For the predicted values received in this way there were determined values of selected statistics.

The aim of determining all the above mentioned statistics was to make a qualitative comparison of the proposed adaptive method with the base method using a linear regression function feature set.

In relation to an adaptive method it is worth stressing that it works, similarly to a base method, within the time limit not exceeding a few seconds. Apart from that, a proposed and realized by MetPred heuristics significantly improves the predicted forecast accuracy compared with a base method. In consequence all the obtained results are burdened with a smaller error compared with the forecast realized by a competitive method. The solution proposed in the dissertation is characterized by significantly smaller errors in determining forecast values, which finally results in their quality and practical value.