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"The Influence of Changes of Atmospheric Air Temperature on the Field of Aerodynamic Potential in Mine Ventilation Net"

Prof. H Bystroń gave the definition of aerodynamic potential Φ_v as the difference between the value of air pressure in selected measurement cross-section of an underground excavation and the value of air pressure in the same cross-section during isentropic process:

$$\Phi_V = p - p_s = p - p_0\{1 - \frac{\kappa - 1}{\kappa} \cdot \frac{\rho_0}{p_0}[g \cdot (z - z_0) + \frac{1}{2}(w^2 - w_0^2)]\}^{\frac{\kappa}{\kappa - 1}}$$

where:

p_o, ρ_o – pressure, density of atmospheric air,

z, z_o – geodesic height, exact for measurement cross-section and for outset of intake shaft,

w, w_o – air velocity, exact in measurement cross-section and in outset of intake shaft,

κ – isentropic exponent in Poisson's equation,

g – gravity acceleration.

It is assumed that changes of temperature of atmospheric air are slow and during determination of quasi-stationary field of aerodynamic potential they can be neglected with assumption of average values of air density.

However, there are some practical observations (from mining experience) which show that in spite of constant value of difference of aerodynamic potentials (determined correctly according to proper methodology) there were changes of direction of air streams.

The aim of the work - research into influence of changes of thermal parameters of atmospheric air (especially temperature) on creation of the field of aerodynamic potential in mine ventilation net and into possibilities of taking into consideration these changes to creation of quasi-stationary representation of the field.

Application of the devices with constant record of measurement data for temperature, pressure and air humidity allows to determine the value of aerodynamic potential in any selected moment of the time without corrections.

It allowed to give the thesis:

It is possible to determine relations describing the influence of changes of air temperature on the field of aerodynamic potential in mine ventilation net.

Research have been undertaken in former "Bytom II" mine plant and they have covered the sampling of the data (physical parameters of atmospheric and mine air) in selected periods of time during five measurement series (lasting from one to six weeks). THP-1 were measuring devices and they were connected with Methane-Fire System of the mine.

Survey data have been selected among large set of data according to assumed methodology

in purpose to obtain of the states of the field of aerodynamic potential at 8AM, 4PM and at the midnight. Selection of the time was connected with the shifts in the mine operation schedule.

As the result of conducted analysis of equations it was stated that it was purposeful to consider 15 quantities (considering J/m^3 and J/kg), then correlation analysis has been performed for them. It allowed to find the quantities and relations between them were under following research with application of STATISTICA software.

Linear simple regression has been applied to describe relations between aerodynamic potential and only dry temperature of atmospheric air. Multiple regression has been applied to describe relations between aerodynamic potential and pressure and virtual temperature of atmospheric air and mine air pressure in measuring point.

Application of mixed variable (the difference of atmospheric air pressure and mine air pressure in measuring point) allows to simplify the equation of multiple regression to linear regression. Air temperature is the second variable. According to this simplification – the surface diagrams (useful for visualization) have been obtained.

Basing on conducted analysis of measurement data (obtained in working mine) following conclusions can be drawn:

1. There is strong correlation between aerodynamic potential and dry and virtual temperature. It indicates significant influence of atmospheric air temperature on creation of aerodynamic potential in mine ventilation net.
2. In the case of simple linear regression for data collected in stage 1,2 and 4 the values of correlation coefficient were 0,7-0,86 and for fifth stage 0,62. However standard errors of estimation had values from 40 to 150 J/m^3 or J/kg. It indicates that during description of the influence of air parameters changes on the field of aerodynamic potential changes of air pressure must be taken into account, too, however the influence of pressure is less than the influence of temperature.
3. Five different linear functions with two or three variables have been considered during multiple regression analysis. In every case when regression equations are filled with air temperature – values of correlation are high (higher than 0,8).
4. The influence of changes of atmospheric temperature on the field of aerodynamic potential is possible to describe by functions for every location in ventilation net. The most detailed method is with application of two functions: $\Phi_v = f(p_o, T_{vo}, p)$ or $\Phi_v = f(p_o, T_{vo}, p)$.
5. During reduction of non-stationary field of aerodynamic potential to quasi-stationary field it is necessary to take into consideration not only changes of atmospheric pressure values but also virtual temperature. It can be done by application of the equation for correction (derived in this thesis). The correction strongly depends on difference of geodesic heights for selected measuring points.