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OPERATIONAL AND STATISTICAL MANAGEMENT IN RELATION TO DETERMINATION OF AERODINAMIC RESISTANCE ON MINING LINES

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Abstract. When we talk about the mining works, which are in such a function, so that air currents pass through such aerodynamic lines, then we are dealing with the need to calculate the aerodynamic resistances in such aeration networks. Ventilation systems, in the broadest practical and technical sense, are nothing but a reflection of the aeration plans of the mine as a whole or of its individual parts in an appropriate schematic manner, which includes only those specific works through which it circulates. air, while other works are excluded. The ventilation network does not fully comply with the mining plans, because the air circulation system does not take into account blind works, preparatory works as well as works or other parts of the mine, which are insulated with doors or ambushes. For the purpose of analysis of the aeration system, calculation of aerodynamic resistances, aeration quantities and depressions of the aeration networks can be presented in the following schematic forms: spatial schemes, linear or orientation schemes, canonical schemes, quantitative schemes, potential schemes. Spatial schemes facilitate the general orientation of the way of mining. The spatial scheme also shows the short connections as well as the transport routes where the ambushes with doors are located. In these schemes the breathing and exhalation well must be clearly presented. The key points (nodes) of the network should be marked with consecutive numbers, starting from the breathing well, while the direction of air movement is marked by arrows. As far as possible, spatial schemes should be built according to the following principles: horizontal works should be presented horizontally; dishenders and bremzbergers appear on the slope 60^0 to the horizon; vertical works (wells, blind wells) must be presented vertically; traverbanks are presented with a slope of 30^0 ; lavat (wide working fronts) usually appear as dishendeite. Usually for complicated aeration networks, orientation for the aeration method of the mine only on the basis of the spatial aeration scheme can be difficult. In such cases the problem is greatly simplified through orientation schemes in which not all aeration routes are presented, but only wells, levels, areas of use as well as other characteristic aeration sites (for example, car rooms, explosives, etc.). .). The canonical schemes aim at a clear reflection of the ventilation system in order to facilitate the analysis and all possible calculations. In these schemes are marked the locations of the fans, possibly their depression, the direction (current) of the currents, the fields of use (workshops), the regulating ambushes, as well as other ambushes or ventilation doors and eventually the resistance of the branches as well as the quantities of the air passing through each branch.

Keywords: Mining, Mining Ventilation, Ventilation Networks, Management, Statistical Analysis

1. Introduction

The calculation of ventilation systems is basically based on the assignment of the following details: a) determination of air currents in the branches of the system (ventilation network);

b) determination of the aerodynamic resistance of the system as a whole;

c) determination of the quantities of air distributed in each branch of the system;

d) determining the pressure loss (height of general depression) in the system as a whole, which is functionally related to the characteristics of the ventilators in the system.

To solve the aeration system in the points set out above we must know the following data: a) the source point of the depression and the direction of its action (for example at which point of the system the fan is located and in what direction the fan in question operates);

b) resistance of works through which air flows (aerodynamic resistance of the branch between two joints); c) the total amount of air entering or leaving the mine (this size determines the proper capacity of the fan).

2. Serial system calculation .

Aeration of air without branching the air at all and sending it from the entrance to the mine in a certain way serially through all the underground workshops to the exit of the mine [the lowest degree of aeration in the system. This simple method of aeration contains the dangers and mining of methane, coal dust, or endangered by underground fires is not allowed by standard norms, because the explosion of methane or coal dust as well as the toxic products of fires are easily transmitted by one workshop in the other, and thus the scale of the disaster is significantly increased. Even from a technical - engineering and economic point of view, this way of ventilation is characterized by shortcomings compared to the branched ventilation systems. The total resistance R of the serial aeration system is equal to the sum of the resistances of each plant, which means:

$$R = \sum_{i=1}^{n} R_i = R_1 + R_2 + \dots + R_n \quad \textbf{(1).}$$

The total depression of the system is calculated according to:

$$h = R \cdot Q^2 = Q^2 \cdot \sum_{i=1}^{n} R_i \quad (2),$$

where Q - is the amount of air circulating in the system

The required ventilation fan power is

$$N = \frac{Q \cdot h}{\eta_V} = \frac{Q^3 \cdot \sum_{i=1}^{n} R_i}{\eta_V} \quad \textbf{(3),}$$

so η is the fan utilization coefficient.

The pressure loss or depression of the serial system is determined by the sum of the pressure losses in each branch of the system (mine workshop) through which the air passes from the inlet to the outlet (principle of conservation of energy from the Bernoulli equation):

$$h = \sum_{i=1}^{n} h_i = h_1 + h_2 + \dots + h_n = \sum_{i=1}^{n} R_i \cdot Q_i^2$$

$^{1\ 2}$ **(4).**
1 1

The air flow can be represented as a product between the cross-sectional area (A) of the flow branch and the flow velocity (v), according to
$Q = A \cdot v = \varepsilon \cdot A \cdot v^{1}$ (5),

so that ε is the coefficient of contraction (suppression) of the air stream. According to the flow continuity equation we have:
$v^2 =$
h
ρ (6).

According to equations (5) and (6) we get:
Q
Q
$A2$
$. =$
$=$
$\varepsilon\ h$
v
ε
$\cdot$
ρ (7).

For the serial aeration system equivalent holes (holes) are required according to:
1 1
$= n$
2
A
$\sum =$
2
A_i
(8),
i
1

respectively:
2
$\cdot = \sum =$
Q
ρ
n
2 2
$A\ A$
$i\ \cdot$
2
$h\ 2\varepsilon$
i (9).
$=$

1

3. Solve a concrete example.

Further, a concrete example will be chosen, where the serial system ventilation network is presented according to figure 1:

4.

5.

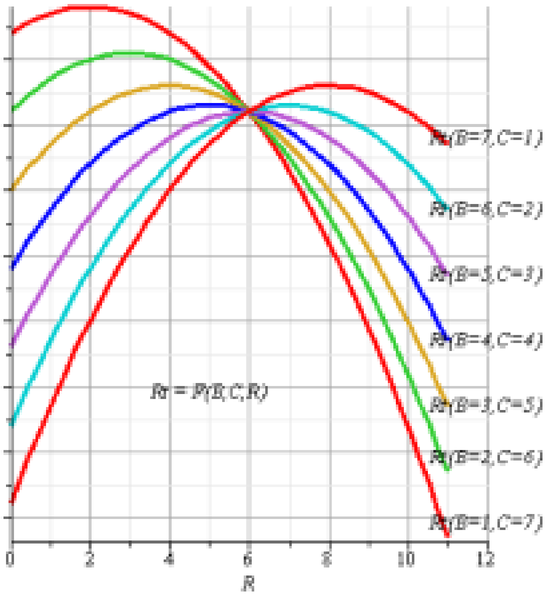
6.

1 2 3 4 5 6

Figure 1: *Serial connection of workshops in the mine.*

Figure 1 shows the serial connection of the workshops in the mine. The total resistance for this case is: *R R R R R R*
= - + - + - + - + - =
1 2 2 3 3 4 4 5 5 6
R R B R R R C R R= + − + + − +
( ) 2 ( ) 7
(10),

so that parameters B and C are determined experimentally. According to (10) is obtained for this case:



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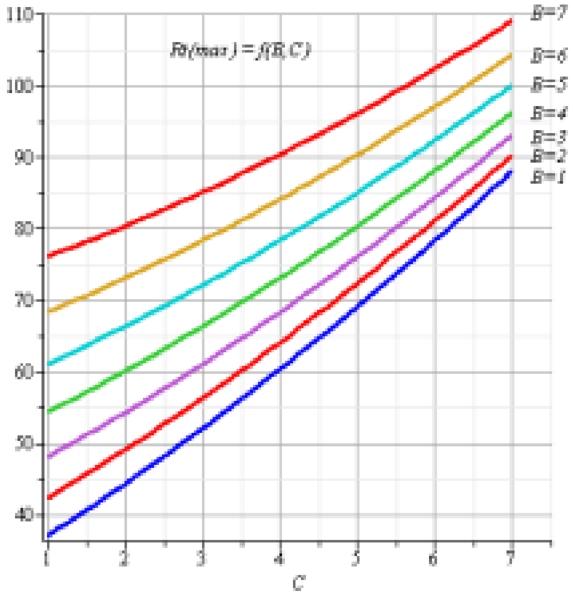


***Figure.2**: Total aerodynamic resistance $R_t = f(B,C,R)$ for the elaborated case.*

***Figure.3:** Maximum value of total aerodynamic resistance $R_{t(max)} = f(B,C)$ for the elaborated case.*

Figure 2 shows the aerodynamic resistance R_t [Pa] for the case elaborated as a function of parameters B and C, as well as the single aerodynamic resistance (R). Analyzing the diagram we can conclude:

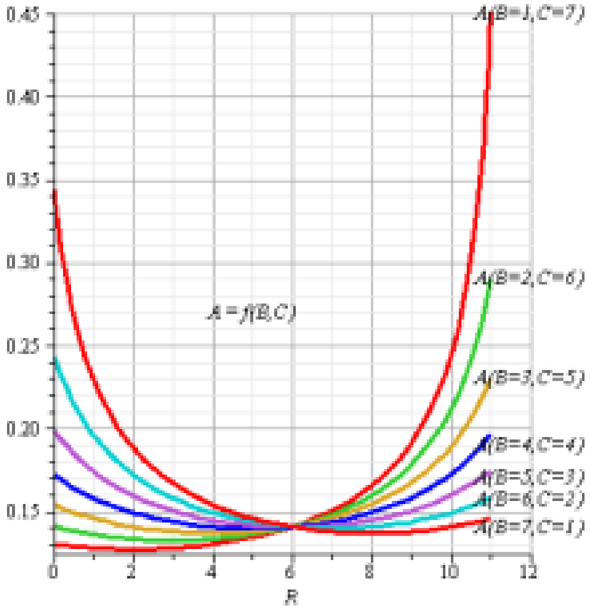
- As the unit resistance R increases, the total resistance increases widely to a maximum value, and then decreases to the value.

- As parameter B increases and the value of parameter C decreases, the maximum of the parametric curve is pushed towards the larger values of the single resistance.

Figure 3 shows the maximum aerodynamic resistance $R_{t(max)}$ [Pa] as a function of parameters B and C. Analyzing this diagram we can conclude:

- With the increase of parameter C, the largest value of the total aerodynamic resistance belongs to the larger value of the parameter B.

- The growth trend of the respective parametric curve is more pronounced for the smallest value of parameter B.



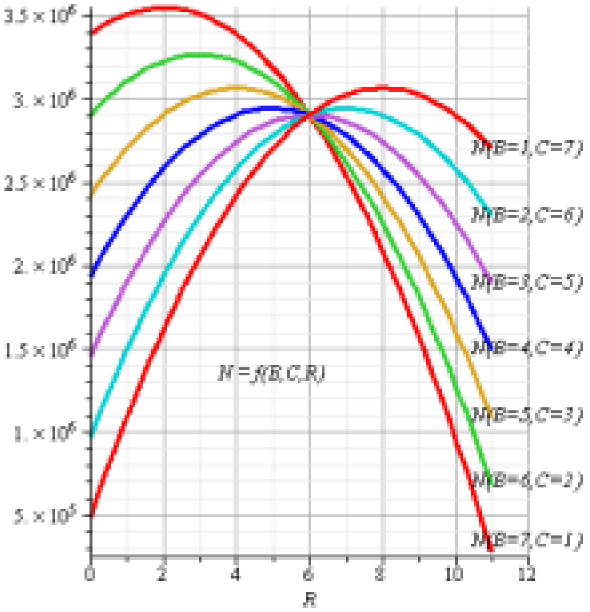


Figure.4: *Equivalent holes as a function of parameters*
B,C and unit resistance R.. ***Figure 5****: Proper power for fan drive , N = f(B,C,R). E i l h l f i f BCd*

Figure 4 shows the equivalent hole of mine A [m^2] as a function of parameters B, C, R. Analyzing the diagram, it can be concluded:

- With increasing unit resistance R, the equivalent hole decreases widely to a minimum value, and then increases.

- The parametric curves with the parameter B increasing, and with the parameter C decreasing, the minimum is pushed towards the larger values of the unit resistance R, so that the trend of change is now less pronounced.

Figure 5 graphically presents the necessary power N [W] for driving the fan, as a function of parameters B, C and R. Analyzing the diagram, it can be concluded:

- With the increase of the unit resistance (R) the power increases widely to a maximum value, and then decreases towards the value.

- Maximum values are pushed to the right for parametric curves with value of parameter B increasing, and with value of parameter C decreasing, so that the trend of change is now less pronounced.

The diagrams in question are constructed for the air flow suppression coefficient ε = 65%, and for the η = 67 %fan efficiency, and for the air flow Q = 30 [m3/s].

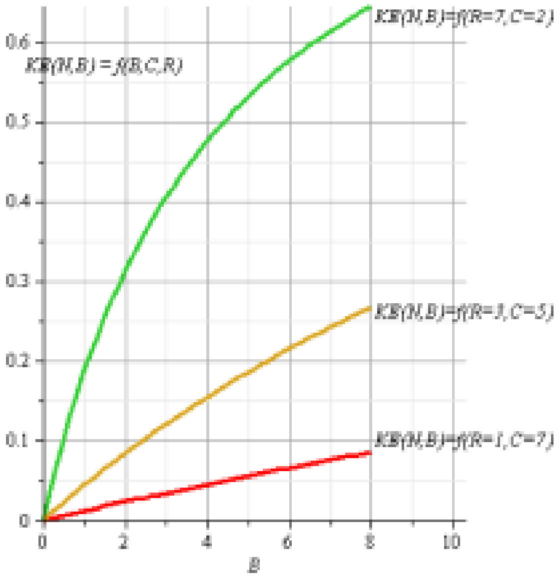
4. Statistical analysis of the problem in question.

Regarding the management of the statistical analysis of the problem in question, it is more important to determine the coefficient of elasticity (EC), which parameter is determined in principle according to:

∂ =(,)
Y X
X
EC X Y · ∂

(,)

Y X
(11).



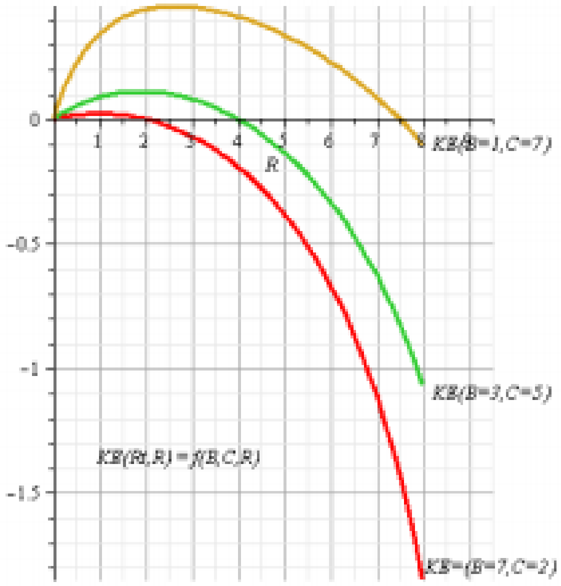


Figure 6: *Coefficient of elasticity of total resistance*
Figure 7*: Coefficient of elasticity of fan power*
(R_t, Pa) to single resistance (R, Pa). *KE(N,B) in function of parameters R,C,B.*

Figure 6 shows the coefficient of elasticity of the total resistance (Rt, Pa) to the unit resistance {R, Pa). Analyzing the diagram it can be concluded:

- With the increase of the unit resistance (R, Pa) the coefficient of elasticity KE (R_t, R) increases widely to a maximum value, and then decreases towards the value, taking in principle positive and negative values.

- The maximum value of the coefficient in question is greater for the smallest value of parameter B, and the largest value of parameter C, so that the trend of change is less pronounced.

- For example for the parametric curve KE (B = 1, C = 7), for R = 2.5, the maximum value of the coefficient 0.45 is reached. This means that when the unit resistance R changes by 1%, the total resistance increases (plus sign) by 0.45%, and so on.

Summary:

The paper discusses the problem of calculating ventilation networks in relation to the ventilation of workshops in the mine. The types of characteristic schemes of ventilation networks are emphasized. The way of calculating the total resistance, the size of the depression, the equivalent holes, as well as the necessary driving power of the fan is presented. The way of statistical management of the problem in question is also presented.

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