Development of recommendations to block the influence of the natural draft in extreme negative temperatures of «Ushkatyn -3» mine

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Abstract. Given the different combinations of main fan installation in the mine working system and evaluated the efficacy of the selected ventilation system. For blocking or reducing the negative impact of natural draft in extreme winter conditions is proposed to use local ventilation fans (LVF) installed in a tunnel without jumper and working according to the counter-interaction ventilation principle.

Key words: ventilation network, recycling, natural draft, depression, resistance, jumper, trunk speed.
Introduction. Applied to mining conditions of deposit Ushkatyn selected joint-III open-underground mining imposes a number of features for organizing airing at working adjacent to the career of the array of underground mining. Exit row directly on the workings of the pit ventilation complicates mine because of the influence of natural draft, which in real terms is not always taken into account [1].

Ventilation network is a system consisting of fans and associated with each other workings of various shapes, sections and lengths, the main purpose of which, in addition to solving technological problems, to provide the required exchange of air in underground mines with external ambient air.

Materials and methods. Moving air flow due to natural factors, changes in conditions of extreme temperature parameters of air, usually leads to negative consequences in the organization of ventilation of underground workings. Depending on how the effect of a natural draft ventilation may be different. For example, in winter at low temperatures and suction method natural draft ventilation will increase the amount of air in the mine, which ultimately leads to hypothermia and the frosting on the workings and the possible destruction of the hydraulic systems.

In winter, cold air arriving path is planned to install heaters. Along with the positive effect of negative air temperature warms up to the required standards of PB, there is a negative effect. Any rise in temperature coming from the mine air flow automatically enhances the action of natural draft. Increased flow of cold air masses in underground working. This should be considered when choosing a radiator, and at very low extreme temperature changes in the outside air to provide partial or complete blockage of the natural draft in order to reduce adverse effects. [2]

Prevention or limitation of the negative impact of natural traction device may be provided by air curtains, or the installation and operation of local ventilation fan. The latter option is preferable because the complete or partial restriction of the action of natural draft in extreme conditions can be based on the interaction of the oncoming air flow in the development of a stream flowing out of the fan air stream.

The main research question is to develop ways of dealing with the influence of natural traction in winter conditions for the mine Ushkatyn-3.

The magnitude of depression natural draft $h_f$ is defined as the difference between the weights of comparable columns of air in the incoming and outgoing streams. Features opening Zhairemsky mine galleries leads to the manifestation of a natural draft that mainly depends on the atmospheric air column, conventionally conducted on the level of development of air supply to the level ventilation duct. It follows that the magnitude and direction of action of natural draft depends on the outdoor temperature. It is a schematic diagram of the organization of the mine ventilation through the suction method of supplying air to the underground workings. Action for natural draft option considered will manifest itself as the first and second horizons. However, its influence due to their different elevations will be different. Thus, for example, horizon 1-2 depression natural draft pressure is defined as the difference in points 1 and 2, that is $h = P_1 - P_2$ Accordingly, the horizon for 3-4 $h$, we have $h = P_3 - P_4$.

Calculation depression natural draft is based on the difference of equal height columns of air in the incoming and outgoing jets and can be carried out based on the following approaches [3].

![Schematic diagram to assess the impact of natural draft](image)

Figure 1 - Schematic diagram to assess the impact of natural draft

1. Assuming that the air density $\rho = \rho_c = \text{const}$ (isochoric process) depression natural draft is calculated by the formula

$$h_f = H (\rho_p - \rho_{\text{wet, ref}}) g,$$  

(1)

where $\rho_p$ and $\rho_{\text{wet, ref}}$ - the average height $H$ of the incoming air density and outgoing streams, kg / m$^3$;

$g$ - acceleration due to gravity, m / s$^2$.

Average height air density for each post is an expression of
\[
\rho_{cp} = \frac{\rho_1 + \rho_2 + \rho_3 + \cdots + \rho_n}{n},
\]

where \(\rho_1, \rho_2, \rho_3, \ldots, \rho_n\) - density of the air in the respective measuring points, kg \(/ m^3\); 
\(n\) - number of measuring points.

At each point of the air density is calculated by the formula

\[
\rho_i = 0,00347 \frac{P_i}{273 + t_i}
\]

where \(P_i\) - atmospheric pressure in the \(i\)-th point, Pa; 
\(t_i\) - air temperature in the \(i\)-th point, °C.

In practical calculations, in view of the small height difference between the levels of temperature adjustment column of outside air can be uniformly distributed and take the appropriate temperature, measured at the mouth of the gallery corresponding horizon.

The second method of calculating the depression natural draft is based on the constancy of the mean air temperature for the incoming and outgoing air jets (isothermal process). The calculation is performed using the formula

\[
h_e = P_o \left( e^{\frac{gH}{R_e(273 + t_{in})}} - e^{\frac{gH}{R_e(273 + t_{out})}} \right)
\]

where \(h_e\) - depression natural draft, Pa; 
\(H\) - height of the air column comparable with incoming and outgoing streams, m; 
\(P_o\) - atmospheric pressure, Pa; 
\(R\) - gas constant \((R_g = 287 \, J / kg \cdot K)\); 
\(t_{in}\) and \(t_{out}\) - average height pillars temperature of the incoming and outgoing streams, °C.

Translation atmospheric pressure \(P\) measured in the water. Art in Pa by the formula

\[
P_o = 13,6 \times 9,81 \times P
\]

contained approximately equivalent method to obtain the final results. However, evaluating them in relation to the task to determine the effect on the state of natural draft ventilation of underground workings of the mine, it should be noted that the second method is preferable to the first [4].

If the first method to determine the average height of air density at each point is necessary to measure two parameters atmospheric pressure and ambient temperature, in the second only the air temperature, which explicitly included in the calculation formula.

In turn, the reduction in the number of measured parameters to improve the accuracy of calculations performed.

**Discussion.** To block or reduce the negative impact of natural traction in extreme winter conditions are encouraged to use local ventilation fans (VMP) that are installed in a tunnel without jumper and working on the principle of counter-interaction ventilation flows (Fig. 2).

**Figure 2** - Calculation scheme to assess the impact of the upper urinary tract to limit the natural draft

Value of dynamic pressure developed at HMP counter interaction of air flows determined from the dependence of the form [2]
\[ h_{in} = \frac{\rho}{2} \left[ 2\nu^2 \frac{S_a}{S} - \left(1.06 - 94\alpha\right)\left(\nu^2 - \nu^2_v\right) \right]. \]  

(6)

where \( h_{in} \) - depression created in the development of active flow at the outlet of the fan, Pa;

\( \nu_1 \) and \( \nu_2 \) - average air velocity in the zone of the fan local ventilation, m/s;

\( \nu_v \) - the average air velocity at the outlet of the fan, m/s;

\( S \) - cross section generation in fan installation, m^2;

\( S_a \) - cross-section of the outlet holes of the fan, m^2;

\( \alpha \) - drag coefficient, Pa \cdot s^2 / m^2;

\( \rho \) - density of air, kg/m^3.

Since the flow velocity at the outlet of the fan \( \nu_{in} \to \nu_v, \nu_{out} \to \nu_v \), formula (6) can be simplified and further analysis we assume that

\[ h_{in} = \rho \frac{S_a}{S} \nu^2_v. \]

Bearing in mind that after substituting the formula (7) takes the form

\[ h_{in} = 0.785 \rho \frac{d^2_a}{S} \nu^2_v. \]

To neutralize the negative impact of natural draft or control its value requires that the value of the dynamic pressure generated by FMP, consistent with the value of the natural draft, then there

\[ h = h_{in} = 0. \]  

(9)

Hydrostatic (isochoric) method for calculating the energy balance equation (7) with (1) and (8) takes the form

\[ 0.785 n \rho \frac{d^2_a}{S} \nu^2_v H \left(\rho - \rho_{av, out}\right) g. \]  

(10)

From (10) we find the required air flow rate at the outlet of the fan for a given diameter it.

\[ \nu = \sqrt{\frac{g \left(\rho - \rho_{av, out}\right) H S}{0.785 n \rho d^2_a}}. \]

At a given rate of air flow at the outlet of the fan required diameter orifice is defined by the formula

\[ d_a = \sqrt{\frac{g \left(\rho - \rho_{av, out}\right) H S}{0.785 n \nu^2_v}}. \]

For thermodynamic conditions (isothermal) method for calculating the energy balance equation, taking into account (3) takes the form

\[ 0.785 n \rho \frac{d^2_a}{S} \nu^2_v P_o \left( e^{\frac{gH}{287(273 + \nu)}} - e^{\frac{gH}{287(273 + \nu_{out})}} \right). \]

We find the required air flow rate at the outlet of the fan for a given diameter it.
where \( n \) - number of simultaneously engaged fans to reduce the impact of natural draft. Determined, if the calculated velocity at the exit of the fan exceeds the capabilities received to install VMP. In this case, to achieve a positive effect should be installed on the parallel operation of several fans. For fixed values of the diameter of the outlet section of the fan \( d \) and air velocity \( v \) in the required number of fans \( n \) can be found from (10) or (13):

a) the hydrostatic method of calculation

\[
 n = \frac{(\rho_n - \rho_{av, out}) \cdot 595 \cdot S}{0.785 \cdot n \cdot d^2}.
\]  

(16)

b) the method for calculating the thermodynamic

In the presence of source data identifying the necessary parameters for fan selection can be performed by any of the above dependencies [5]. It should be borne in mind that the most effective means of reducing the negative impact on the natural draft ventilation network is the velocity of the air flow at the outlet of the fan at the counter interaction with the main flow of air entering the mine. One result of the calculations determining the required parameters of choice for fan installations Zhairemsky mine conditions are presented in Table 1-6.

| \( r_{av, out} \), ° C. | Estimated parameters at \( P_o = 98800 \) Pa; \( S = 17.6 \text{ m}^2; H = 50 \text{ m} \) | \( \rho_n, \) kg / m³ | \( n, \) Pa | \( V_{av, out}, \) m / s | \( Q_{av, out}, \) m³ / s | \( V, \) m / s | \( Q, \) m³ / s |
|---------------------|--------------------------------------------|----------------|--------|----------------|----------------|-----------|-----------|
| 1,382               | 73.95                                       | 49.48          | 19.04  | 34.99          | 13.12          |
| 1,411               | 88.06                                       | 53.44          | 20.57  | 37.78          | 14.54          |
| 1,440               | 102.76                                      | 57.14          | 21.99  | 40.41          | 15.55          |
| 1,471               | 118.10                                      | 60.61          | 23.33  | 42.86          | 16.49          |
| 1,503               | 134.11                                      | 63.89          | 24.59  | 45.18          | 17.39          |
| 1,532               | 78.32                                       | 50.87          | 19.58  | 35.97          | 13.84          |
| 1,411               | 92.43                                       | 54.74          | 21.07  | 38.71          | 14.90          |
| 1,440               | 107.76                                      | 58.34          | 22.45  | 41.26          | 15.88          |
| 1,471               | 122.47                                      | 61.72          | 23.75  | 43.64          | 16.79          |
| 1,503               | 138.48                                      | 64.93          | 24.99  | 45.91          | 17.67          |
Table 2- Summary results of calculation of parameters in fan diameter \(d = 0.8\) m when installed in a tunnel number 2

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 84.75    | 52.97| 20.38      | 37.46           | 14.42      |
| - 30     | 1,411| 98.86    | 56.62| 21.79      | 40.04           | 15.41      |
| - 35     | 1,440| 113.56   | 60.07| 23.12      | 42.48           | 16.35      |
| - 40     | 1,471| 128.90   | 63.32| 24.37      | 44.77           | 17.23      |
| - 45     | 1,503| 144.91   | 66.42| 25.56      | 46.96           | 18.07      |

Table 2- Summary results of calculation of parameters in fan diameter \(d = 0.8\) m when installed in a tunnel number 2

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 88.96    | 54.27| 20.89      | 38.37           | 14.77      |
| - 30     | 1,411| 103.07   | 57.81| 22.25      | 40.88           | 15.73      |
| - 35     | 1,440| 117.77   | 61.17| 23.54      | 43.26           | 16.65      |
| - 40     | 1,471| 133.11   | 64.35| 24.76      | 45.50           | 17.51      |
| - 45     | 1,503| 149.12   | 67.38| 25.93      | 47.64           | 18.33      |

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 73.95    | 43.30| 21.76      | 30.62           | 15.39      |
| - 30     | 1,411| 88.06    | 46.76| 23.50      | 33.06           | 16.62      |
| - 35     | 1,440| 102.76   | 50.00| 25.13      | 35.36           | 17.77      |
| - 40     | 1,471| 118.10   | 53.00| 26.64      | 37.50           | 18.85      |
| - 45     | 1,503| 134.11   | 55.91| 28.10      | 39.53           | 19.87      |

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 78.32    | 44.56| 22.40      | 31.51           | 15.84      |
| - 30     | 1,411| 92.43    | 47.90| 24.08      | 33.87           | 17.02      |
| - 35     | 1,440| 107.76   | 51.05| 25.66      | 36.10           | 18.15      |
| - 40     | 1,471| 122.47   | 54.00| 27.14      | 38.19           | 19.20      |
| - 45     | 1,503| 138.48   | 56.81| 28.56      | 40.17           | 20.19      |

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 84.75    | 46.35| 23.30      | 32.77           | 16.47      |
| - 30     | 1,411| 98.86    | 49.54| 24.90      | 35.03           | 17.61      |
| - 35     | 1,440| 113.56   | 52.56| 26.42      | 37.17           | 18.68      |
| - 40     | 1,471| 128.90   | 55.40| 27.84      | 39.18           | 19.69      |
| - 45     | 1,503| 144.91   | 58.12| 29.21      | 41.09           | 20.65      |

| \(t\) av.out. | \(t\) | \(\rho_n\) | \(h_e\) | \(V_{in}\) m/s | \(Q_{in}\) m\(^3\)/s | \(V_{out}\) m/s | \(Q_{out}\) m\(^3\)/s |
| -------- | ---- | -------- | ---- | ----------- | ---------------- | ----------- | ----------------- |
| - 25     | 1,382| 88.96    | 47.49| 23.87      | 33.58           | 16.88      |
| $\bar{t}$, °C, | $\rho_n$, kg/m$^3$ | $h_a$, Pa | Estimated parameters at $P_o = 98800$ Pa; $S = 17.6$ m$^2$; $H = 50$ m | Required speed and air flow at the outlet during operation |
| --- | --- | --- | --- | --- |
|   |  |  | one fan $n = 1$ | two fans $n = 2$ |
|   |  |  | $V_{\infty}$ m/s | $Q_{\infty}$ m$^3$/s | $V_{\infty}$ m/s | $Q_{\infty}$ m$^3$/s |
| $t_{av.out}$ = 5 °C | | | | |
| 25 | 1.382 | 73.95 | 34.64 | 27.21 | 24.49 | 19.08 |
| 30 | 1.411 | 88.06 | 37.41 | 29.38 | 26.45 | 20.77 |
| 35 | 1.440 | 102.76 | 40.00 | 31.42 | 28.28 | 22.21 |
| 40 | 1.471 | 118.10 | 42.43 | 33.32 | 30.00 | 23.56 |
| 45 | 1.503 | 134.11 | 44.73 | 35.13 | 31.63 | 24.84 |
| $t_{av.out}$ = 7 °C | | | | |
| 25 | 1.382 | 78.32 | 35.65 | 28.00 | 25.21 | 19.80 |
| 30 | 1.411 | 92.43 | 38.32 | 30.10 | 27.10 | 21.28 |
| 35 | 1.440 | 107.76 | 40.84 | 32.08 | 28.88 | 22.68 |
| 40 | 1.471 | 122.47 | 43.20 | 33.93 | 30.55 | 24.00 |
| 45 | 1.503 | 138.48 | 45.45 | 35.70 | 32.14 | 25.24 |
| $t_{av.out}$ = 10 °C | | | | |
| 25 | 1.382 | 84.75 | 37.08 | 29.12 | 26.22 | 20.59 |
| 30 | 1.411 | 98.86 | 39.63 | 31.13 | 28.03 | 22.01 |
| 35 | 1.440 | 113.56 | 42.05 | 33.03 | 29.73 | 23.35 |
| 40 | 1.471 | 128.90 | 44.32 | 34.81 | 31.34 | 24.61 |
| 45 | 1.503 | 144.91 | 46.49 | 36.51 | 32.88 | 25.82 |
| $t_{av.out}$ = 12 °C | | | | |
| 25 | 1.382 | 88.96 | 37.99 | 29.84 | 26.86 | 21.10 |
| 30 | 1.411 | 103.07 | 40.47 | 31.79 | 28.61 | 22.47 |
| 35 | 1.440 | 117.77 | 42.82 | 33.63 | 30.28 | 23.78 |
| 40 | 1.471 | 133.11 | 45.04 | 35.37 | 31.85 | 25.01 |
| 45 | 1.503 | 149.12 | 47.16 | 37.04 | 33.35 | 26.19 |

Table 3- Summary results of calculation of parameters in fan diameter $d$= 1.0 m when installed in a tunnel number 2.
### Table 4 - Summary results of calculation of parameters in fan diameter \(d= 0.8 \text{ m} \) when installed in a tunnel number 1

| \(t_{\text{av.out.}} \) °C | \( \rho_n \), kg/m\(^3\) | \( h_e \), Pa | \( V_{\text{in}} \), m/s | \( Q_{\text{in}} \), m\(^3\)/s | \( V_{\text{in}} \), m/s | \( Q_{\text{in}} \), m\(^3\)/s |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 5               | 148,88          | 67,90           | 34,13           | 48,01           | 24,13           |
| 7               | 1,382           | 148,88          | 67,90           | 34,13           | 48,01           | 24,13           |
| 10              | 157,66          | 69,89           | 35,13           | 49,41           | 25,83           |
| 12              | 170,60          | 72,68           | 36,53           | 51,39           | 26,83           |

### Table 5 - Summary results of calculation of parameters in fan diameter \(d= 1.0 \text{ m} \) when installed in a tunnel number 1

| \(t_{\text{av.out.}} \) °C | \( \rho_n \), kg/m\(^3\) | \( h_e \), Pa | \( V_{\text{in}} \), m/s | \( Q_{\text{in}} \), m\(^3\)/s | \( V_{\text{in}} \), m/s | \( Q_{\text{in}} \), m\(^3\)/s |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 5               | 148,88          | 67,90           | 34,13           | 48,01           | 24,13           |
| 7               | 1,382           | 148,88          | 67,90           | 34,13           | 48,01           | 24,13           |
| 10              | 157,66          | 69,89           | 35,13           | 49,41           | 25,83           |
| 12              | 170,60          | 72,68           | 36,53           | 51,39           | 26,83           |
Table 6- Summary results of calculation of parameters in fan diameter \( d = 1.2 \) m when installed in a tunnel number 2

| \( t_{av.out} \) °C | \( \rho_n \), kg / m³ | \( h_e \), Pa | Required speed and air flow at the outlet during operation |
|-------------------|-------------------|---------|---------------------------------------------------------------|
|                   |                  |         | one fan \( n = 1 \)                                           |
|                   |                  |         | \( V_{in} \) m/s  \( Q_{in} \) m³/s                           |
|                   |                  |         | two fans \( n = 2 \)                                          |
|                   |                  |         | \( V_{in} \) m/s  \( Q_{in} \) m³/s                           |

| \( t_{av.out}= 5 \) °C | \( \rho_n \), kg / m³ | \( h_e \), Pa | \( V_{in} \) m/s  \( Q_{in} \) m³/s | \( V_{in} \) m/s  \( Q_{in} \) m³/s |
|-------------------|-------------------|---------|-------------------|-------------------|
| – 25              | 1,382             | 148,88  | 45,27             | 51,20             |
| – 30              | 1,411             | 177,29  | 48,89             | 55,29             |
| – 35              | 1,440             | 206,90  | 52,28             | 59,13             |
| – 40              | 1,471             | 237,80  | 55,45             | 62,71             |
| – 45              | 1,503             | 270,06  | 58,46             | 66,12             |

| \( t_{av.out}= 7 \) °C | \( \rho_n \), kg / m³ | \( h_e \), Pa | \( V_{in} \) m/s  \( Q_{in} \) m³/s | \( V_{in} \) m/s  \( Q_{in} \) m³/s |
|-------------------|-------------------|---------|-------------------|-------------------|
| – 25              | 1,382             | 170,60  | 48,15             | 54,59             |
| – 30              | 1,411             | 199,02  | 51,79             | 59,13             |
| – 35              | 1,440             | 228,63  | 54,59             | 62,71             |
| – 40              | 1,471             | 259,52  | 57,27             | 66,12             |
| – 45              | 1,503             | 291,78  | 60,15             | 70,64             |

| \( t_{av.out}= 10 \) °C | \( \rho_n \), kg / m³ | \( h_e \), Pa | \( V_{in} \) m/s  \( Q_{in} \) m³/s | \( V_{in} \) m/s  \( Q_{in} \) m³/s |
|-------------------|-------------------|---------|-------------------|-------------------|
| – 25              | 1,382             | 179,08  | 51,89             | 59,13             |
| – 30              | 1,411             | 207,49  | 54,59             | 62,71             |
| – 35              | 1,440             | 237,11  | 57,27             | 66,12             |
| – 40              | 1,471             | 268,01  | 60,15             | 70,64             |
| – 45              | 1,503             | 300,26  | 63,46             | 73,97             |

| \( t_{av.out}= 12 \) °C | \( \rho_n \), kg / m³ | \( h_e \), Pa | \( V_{in} \) m/s  \( Q_{in} \) m³/s | \( V_{in} \) m/s  \( Q_{in} \) m³/s |
|-------------------|-------------------|---------|-------------------|-------------------|
| – 25              | 1,382             | 180,16  | 55,57             | 62,71             |
| – 30              | 1,411             | 207,49  | 58,15             | 66,12             |
| – 35              | 1,440             | 237,11  | 60,15             | 70,64             |
| – 40              | 1,471             | 268,01  | 63,46             | 73,97             |
| – 45              | 1,503             | 300,26  | 66,12             | 77,51             |
|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 25 | 1,382 | 157,66 | 46,58 | 52,68 | 32,94 | 37,25 |
| 30 | 1,411 | 186,07 | 50,08 | 56,64 | 35,41 | 40,05 |
| 35 | 1,440 | 215,69 | 53,37 | 60,36 | 37,74 | 42,68 |
| 40 | 1,471 | 246,52 | 56,46 | 63,85 | 39,93 | 45,16 |
| 45 | 1,503 | 278,84 | 59,40 | 67,18 | 42,00 | 47,50 |

$T_{av.out.} = 10^\circ C$

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 25 | 1,382 | 170,60 | 48,46 | 54,81 | 34,26 | 38,75 |
| 30 | 1,411 | 199,02 | 51,79 | 58,57 | 36,62 | 41,42 |
| 35 | 1,440 | 228,63 | 54,95 | 62,15 | 38,86 | 43,95 |
| 40 | 1,471 | 259,52 | 57,92 | 65,51 | 40,96 | 46,32 |
| 45 | 1,503 | 291,78 | 60,76 | 68,72 | 42,96 | 48,59 |

$T_{av.out.} = 12^\circ C$

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 25 | 1,382 | 179,08 | 49,64 | 56,14 | 35,10 | 39,70 |
| 30 | 1,411 | 207,49 | 52,89 | 59,82 | 37,40 | 42,30 |
| 35 | 1,440 | 237,11 | 55,96 | 63,29 | 39,57 | 44,75 |
| 40 | 1,471 | 268,01 | 58,87 | 66,58 | 41,62 | 47,07 |
| 45 | 1,503 | 300,26 | 61,64 | 69,71 | 48,59 | 54,95 |

Evaluating the results of the calculations presented in Tables 1-6, it should be noted that with increasing temperature the outgoing jet increases depression natural draft. The tables in column 3 shows the vertical calculations depression natural draft conditions for outdoor temperature changes of air in the range of -25 °C to -45 °C. The analysis showed that the amount of change of natural draft depends not only on the temperature parameters of incoming and outgoing jets, but also the height of the column of air above the comparable relevant portals working levels. For example, for the gallery number 2 horizon at a height difference of 50 m for a given range of temperatures and outdoor air jet emanating from the mine natural draft varies from 74 Pa to 149 Pa. Similarly, for the gallery number 1 horizon when the same temperature settings and a height difference of 100 m depression natural draft varies from 149 Pa to 300 Pa. With regard to atmospheric pressure, then its effect on the value of depression natural draft is not significant. Therefore, all the calculations were performed for the average value of 740 mm Hg. Art. that SI is 98800 Pa.

Growth depression with natural draft ventilation suction method will contribute to the extreme conditions of low temperature an additional influx of air into the system of underground workings, which may have a negative impact on the organization conducting the process. For these conditions, it is proposed to block or reduce the negative impact of natural draft ventilation at the mine, installed in places Incoming cold air masses small fans running counter to the scheme of interaction of the jets.

**Conclusion.** The choice of fan installation is done in such a way that when his work did not decrease the overall air flow and at the same time blocked the negative effects of the impact of natural draft. [6]

Initial data for the selection of the fan are:
- Temperature of the outside air $T_{n.} \circ C$;
- The temperature of the outgoing air stream of mine $T_{cf.m.} \circ C$;
- Atmospheric pressure $P_0$, Pa;
- Height comparable pillars air for a given horizon $H$, m;

Generating a cross-sectional view of the fan installation locations $S$, m².

Defined parameters:
- Density of the outer air $\rho_n$, kg / m³;
- The flow rate of air at the outlet of the fan at a predetermined orifice diameter $m$, m / s;
- Air flow rate at the outlet of the fan $Q$, m³ / s;
- The diameter of the outlet of the fan at a predetermined velocity air stream at the exit $d$, m.
All calculated parameters can be found on the above formulas or calculations according to [7].

Let us illustrate this with a concrete example.

Suppose you want to select local ventilation fan to be installed in the portal area of the gallery number 2. Introductory parameters are as follows:

- Temperature of the outside air \(t_{n} = -40^\circ\text{C}\);
- The temperature of the outgoing air stream of mine \(t_{\text{cf.ref}} = 5^\circ\text{C}\);
- Atmospheric pressure \(P_{o} = 98800\ \text{Pa}\);
- The height of the column of air comparable to specified conditions \(H = 50\ \text{m}\);
- Making the cross sectional area, wherein the fan is installed \(S_{a} = 17,6\ \text{m}^{2}\).

Accept the installation company Korfmann axial fan type AL - 10 - 300 diameter \(d = 1.0\ \text{m}\) for selected conditions, we find that the required air flow rate at the outlet of the fan should not be less than \(42.43\ \text{m}^{3}/\text{s}\) air flow.

Work area characteristics, limited points 1 and 2, the approximate equation

\[ h_{\text{in}} = H - R \cdot Q^{2}, \]  

(17)

where \(h_{\text{in}}\) - depression, developed a fan while working on the external network;

\(R\) - the source impedance of thrust;

\(H\) - constant to be determined.

Remove from the graph coordinates of points 1 and 2.

Point 1. \(H_{1} = 900\ \text{Pa};\ \ Q_{1} = 23\ \text{m}^{3}/\text{s}\).

Point 2. \(H_{2} = 200\ \text{Pa};\ \ Q_{1} = 32\ \text{m}^{3}/\text{s}\).

Since equation (17) must satisfy 1 and 2 points, given a fair shot will coordinate the following system of equations

Whence we find that \(H = 1648;\ \ R = 1.414\ \text{Pa} \cdot \text{s}^{2}/\text{m}^{6}\).

Thus, the equation describing the working part of the characteristics of the fan has the form

\[ h_{\text{in}} = 1648 - 1.414\ Q^{2} \]

Developed by the fan is spent on overcoming depression external resistance, ie \(h = h_{\text{in}}\), where \(h = R \cdot Q^{2}\).

Consequently, the required performance of the fan selected by Equation

\[ 1648 - 1.414\ Q = R \cdot Q^{2} \]

As the outside air duct of the fan is missing, then drag pipe \(R = 0\) and the equation becomes

\[ 1648 - 1.414\ Q^{2} = 0 \]

It follows that the actual airflow output of the fan when no conduit is equal to \(m/\text{s}\).

Thus, the selected fan provides the needed air flow, hence, the desired velocity of the airflow at the outlet of the fan.

When suction ventilation scheme, when the bulk of the air passes through a system of underground workings, do not expect much warm air and the surrounding array overlying horizon. Therefore, accumulation of heat in the atmosphere of the mine, and in the rock mass will be slow. In the transition to the discharge circuit airing in winter accumulated heat may not be enough to provide the required temperature parameters on the job horizons. At low freezing temperatures possible arrival of cold air masses and lower lying horizons.

Daylight injection scheme airing at low negative temperatures of air possible negative impact on the natural draft of the change in direction of air flow at the outlet of the portals, roll over air jets.

To assess the proposed approach to reduce the negative impact of natural draft, you must perform the experimental measurements in real conditions of the mine at low subzero temperatures under mine [8]

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