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A Method for Continual Monitoring the Natural Ventilating Pressure

F. Kopâëek
VSB - Technical University of Ostrava, Faculty of Mining and Geology, Ostrava, Czech Republic
R. Ceniga
OKD - Mine Darkov, Manager of Ventilation, Karvina, Czech Republic
M. TabaSek
Postgraduate doctoral student of the VSB - Technical University of Ostrava, Faculty of Mechanical Engineering, Czech Republic

ABSTRACT: A new information on continual monitoring the natural ventilating pressure on the basis of temperature measuring is here submitted. Thermometers of mine air are placed in downcast and upcast shafts while their measured levels are transmitted to the control computer. The values of barometric and fan static pressures are simultaneously transmitted to the same computer where all the input data are processed by means of computer algorithm. In such a way obtained results can be continually used at any time.

I INTRODUCTION

Natural ventilation pressure (NVP) is the very important consequence of mining thermal energy. Especially it becomes significant in cases, where ventilation is running with combination of main fan (MF) and natural ventilation, and where the colliers are very deep.

Deep mines in the Czech Republic can be found in geographical region where daily and seasonal ranges ot surface air increase the mechanism of natural ventilating effect. The authors have known many ways how to analyse NVP, however for economic ventilation controls, continuous monitoring of running MF and NVP values are necessary.

Correct selection for solving possibility is minimized, so the balance U-tube can be used in downcast and upcast shafts as well as a set of transmitting thermometers where only dry temperatures are measured.

2 DESIGN THEORY

Mine Darkov has been situated within the Ostrava-Karvinâ coalfield with the most significant Czech hard coal deposits, see Figure 3. Mine Darkov had performed the preparation and equipment installation in terms of total main ventilating reconstruction. The aim was to work-out the computer algorithm of continual monitoring NVP in the local mine conditions. This method was chosen on the basis of skip or cage operating experience in the downcast (DC) and upcast (UC) shafts. However, the balance U-tube method has, been very questionable and unreliable.

On the other hand the wetness in UC is often linked to water droplets that are not suitable for wet temperature measuring. Therefore the simplest formulation of enhancement pressure directly to bottom of shafts from measured dry temperature was chosen.

The determination of NVP has been used in hydrostatic method, so-called mean density method (McPherson 1993)

$$NVP = g.H.(\rho_{md} - \rho_{mu}) \quad [Pa] \tag{1}$$

where:
ρ_{md} is the average density in the DC
ρ_{mu} is the average density in the UC
H is the vertical depth of shafts

The average densities are calculated by means of simplified scheme of Darkov Mine ventilation system, see Figure 1.

$$\rho_{md} = \frac{\sum_{i=1}^{i=5} \rho_i . a_i}{H} \quad [kg.m^{-3}] \tag{2}$$

$$\rho_{mu} = \frac{\sum_{i=6}^{i=13} \rho_i . a_i}{H} \quad [kg.m^{-3}] \tag{3}$$

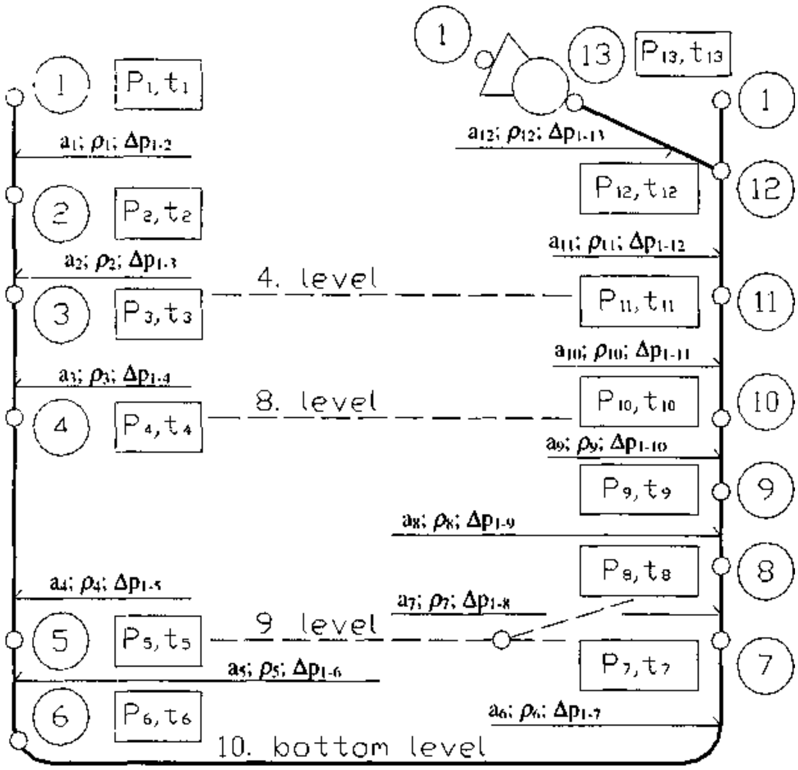


Figure 1 Darkov Mine Ventilation system

where:
pi to ps are middle densities in the sections of DC
ai to as are vertical lengths in the sections of DC
p_6, to pn are middle densities in the sections of workings and UC and under the same conditions the pressure in point No 2 is as follows (further for dry air in section 1 between points No I and No 2 is valid):

$$P_2 = b.\exp\left[\frac{0,03416.a_1}{0.5(546.3+t_1+t_2)}\right] \quad \text{[Pa]} \qquad (4)$$

ar, to au are vertical lengths in the sections of workings and UC

$H = \sum_{i=1}^{i=5} a_i = \sum_{i=6}^{i=13} a_i$ = 886 m, is a vertical depth of both shafts in Mine Darkov conditions.

$$\rho_1 = \frac{0.00348.0.5[b+(P_2-\Delta p_{1-2})]}{0.5(273.15+t_1+273.15+t_2)} \quad [\text{kg.m}^{-3}] \qquad (5)$$

where for equation (4) and (5):
11 and t: are temperatures in points No 1 and No 2
b is the barometric pressure
Pi is the pressure in point No 2
Api-: is the pressure difference between points No I and No 2

Further the calculation will be led in equations for densities pi to pn in the sections ai to au, see Figure 1.

Therefore, formulas (01), (02) and (03) give the NVP mine action. It means that the amount of NVP depends on continuous measurement of temperatures li to lu, barometric pressure b, MF airflow Q_v and pressure difference Δp_{13} from suction part of the main fan.

The control screen shows all monitoring data including fan operating point (FOP), characteristic curves of MF and activated characteristic resistance of colliery with NVP, see Figure 2 and Figure 6. In other words the FOP is determined by MF airflow (Q_v = 145 m'\s") and pressure difference Api.i = 2138 Pa), both are measured continually.

The system of operating point (SOP) is identified by equation,

$$Q_v = \sqrt{\frac{1}{R}\left[\Delta p_{13} - (\pm NVP)\right]} \qquad [m^3.s^{-1}] \qquad (6)$$

where R is the resistance of colliery.

In the expression (06) it is apparent that the "V" apex of the activated parabola is - for the constituent effect - situated in the minus part of vertical pressure different coordinate and vice versa.

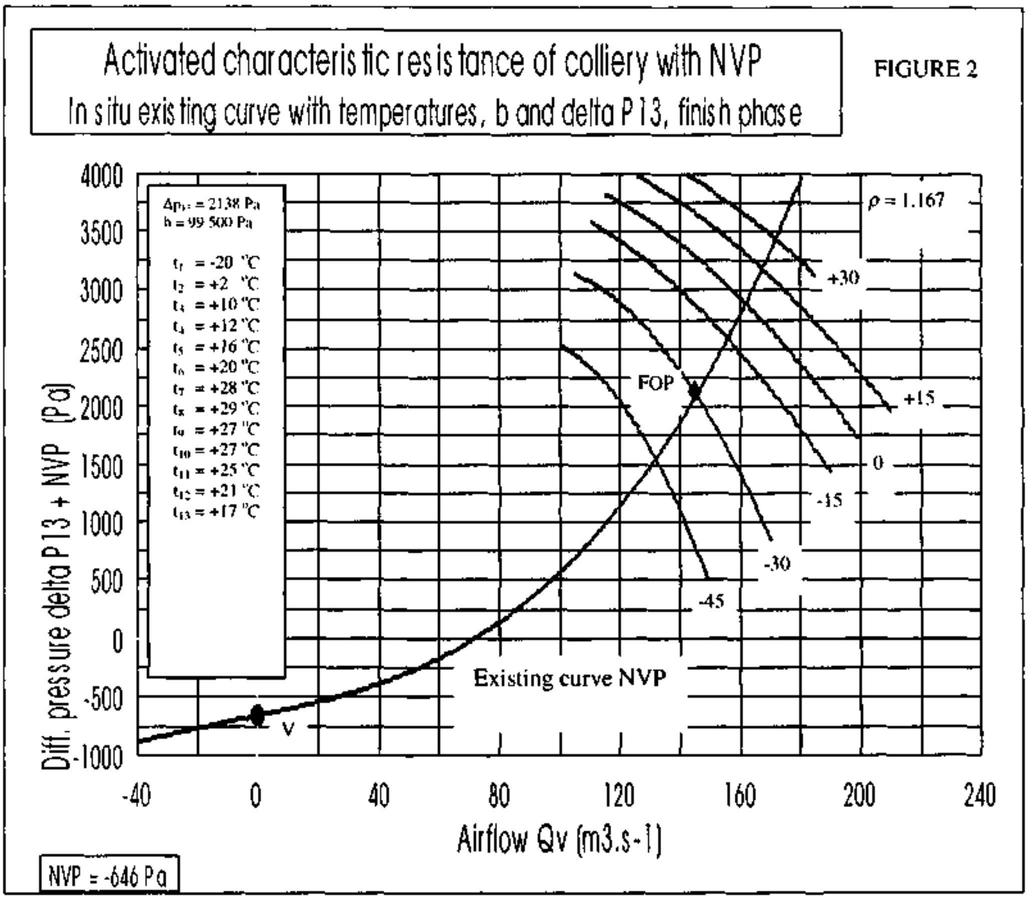


Figure 2 Control screen MF and NVP ventilation

The safety regulations in the Czech Republic make the MF measuring obligatory. The final effect of the measurement is the output in three forms of fan characteristic curves (Kopâfiek. 2001), as follows

- fan total pressure dependence on the airflow $\Delta p_{1v} = f(Q_v)$
- fan static pressure dependence on the airflow $\Delta p_{13} = f(Qv)$

  fan motor power input dependence on the airflow Pimi = f(Qv)

Now the dependence $\Delta p_{13} = f(Q_v)$ becomes the base on control screen MF and NVP ventilation.

see Figure 2 and Figure 6. The set of Darkov Mine MF regulation curves take the form of equation.

$$\Delta p_{13} = A_0 + A_1.Q_v + A_2.(Q_v)^2 \qquad [Pa] \qquad (7)$$

where Ao, Ai and A_2 are multinomial coefficients of the second rate.

It is important to say that the set of equation (7) is valid for standard density p_0 = 1,2 kg.m^{-3}. On the' contrary, the density in the point No 13 is as follows:

$$\rho_{13} = \frac{0.00348.(b - \Delta p_{13})}{273.15 + t_{13}} \quad [kg.m^{-3}] \qquad (8)$$

Therefore it is useful to modify the MF equation (7) into a new form:

$$\Delta p_{13} = \frac{\rho_{13}}{\rho_0}\left[A_0 + A_1 Q_v + A_2 (Q_v)^2\right] \; [Pa] \qquad (9)$$

It means that on the basis of monitoring p^ by equation (8) the MF curves (7) becomes the so-called "floating", in accordance with the resistance of colliery by equation (6).

The photos from Darkov Mine plant - from underground and surface place - are shown:

Figure 3 Overview of Darkov Mine

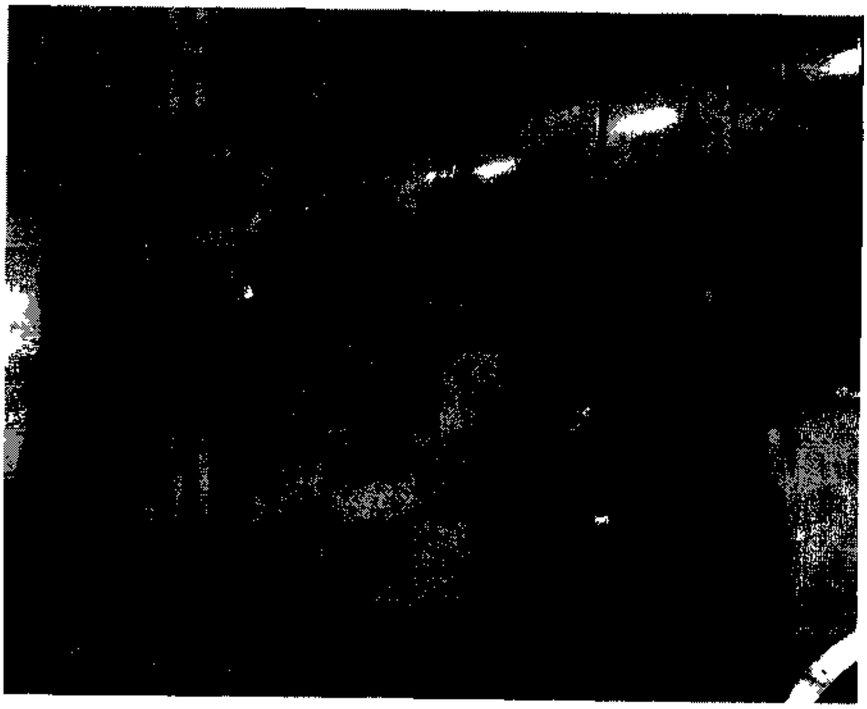


Figure 4 Overview of Darkov Main Fan axial type ARA-2-^550

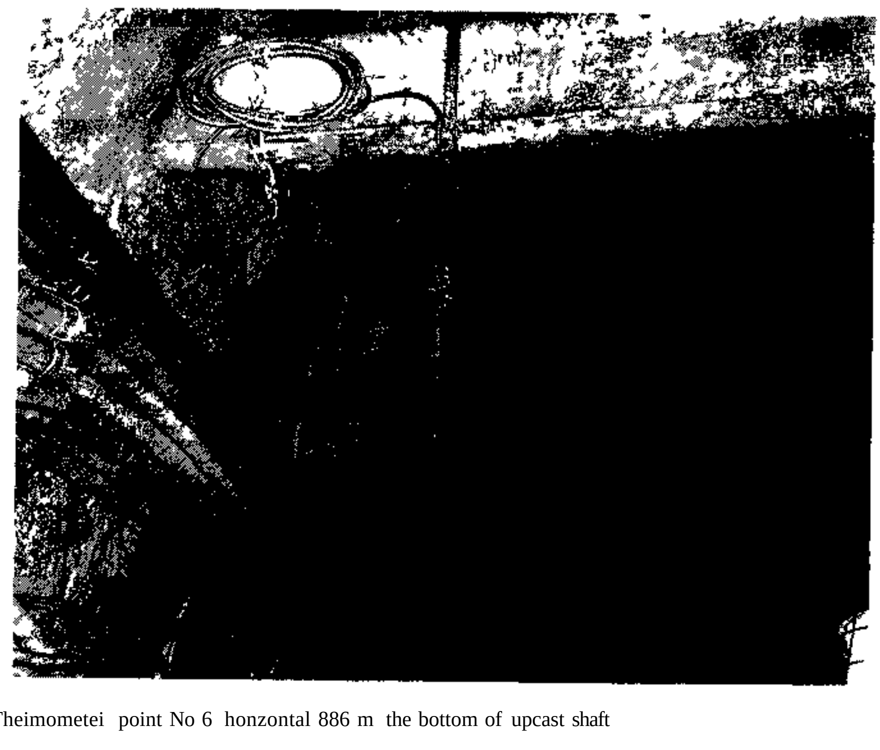
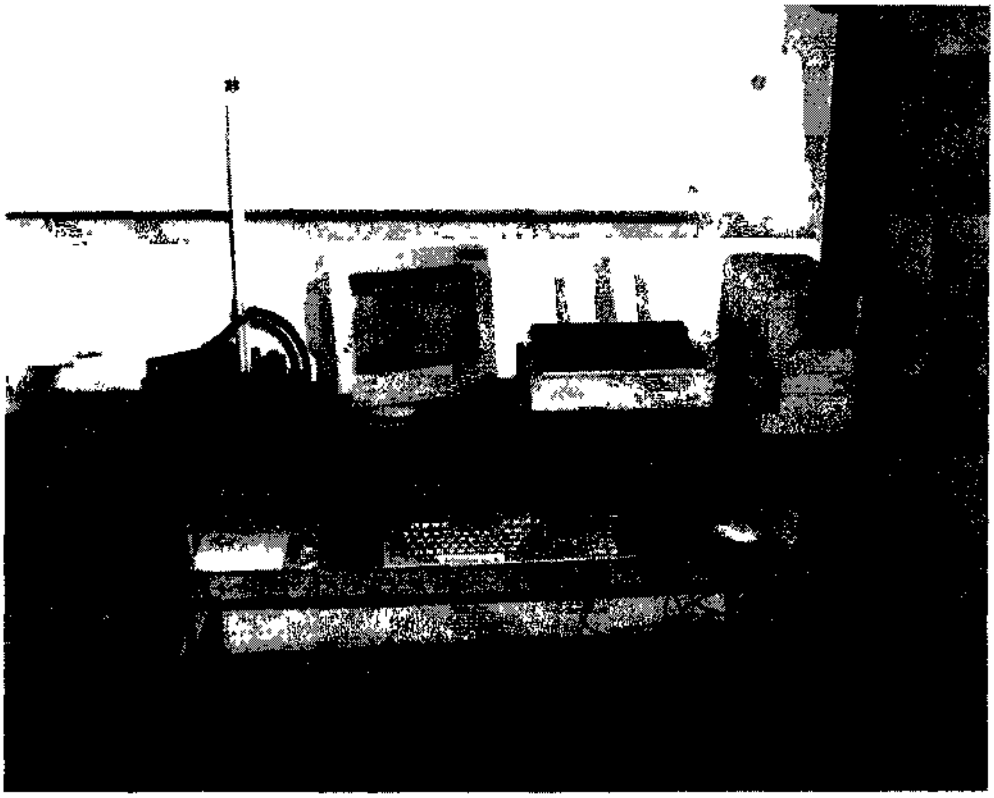


Figure 5 Theimometei point No 6 honzontal 886 m the bottom of upcast shaft



Fıguıe 6 Control PC of MF and NVP in Manager Ventilation office

3 CONCLUSIONS

The authors have shown one ot the methods ot continually determined natuial ventilating pressuie and main fan running It is important to say that operating results are very hopeful tor economic return ot investment lor future At present it is possible to assign saved energy of main plant ventilation There are simple and reliable opeıatıons led fiom control loom ot Ventilation Manager, see Figure 6

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