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Distributions of airflow in four rectangular section roadways with different supporting methods in underground coal mines

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A R T I C L E I N F O

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A B S T R A C T

A study has been carried out in four rectangular section roadways with different supporting methods in Yuwu Coal Company (a longwall mine), by measurements of airflow velocities in cross-section of the roadways. The asymmetrical distributions of airflow in each roadway section was obtained. The paper analyzes the low airflow velocity region of roadways through the drawing of the distributions of airflow in each roadway section. The supporting methods influence the low airflow velocity region around the roof and wall of roadways. It is shown that the low airflow velocity region increase with surface roughness of the roof and wall. The high airflow velocity region was located around the floor of the roadway with rough roof and wall. However, in the roadways with smooth roof and wall the high airflow velocity region was located around the center of section. The risk assessment should be carried out in the low airflow velocity region in the roadway with rough roof and wall. To ensure the safety of coal mining, higher volume of air intake or more smooth roof and wall of the roadways should be achieved in a dangerous zone.

1. Introduction

The mine's ventilation system should provide miners with sufficient fresh air and ensure a safe and productive environment. In order to prevent explosion of methane and gas poisoning, the distributions of airflow need to be analyze. The airflow could carry off the toxic gases, CO and NO_2, but the concentration would be high in the low airflow velocity region. The air quantity and average air velocity are the parameters measured in roadways and the range of average air velocity is regulated. However, the regulation of the distributions of airflow in roadways has not found.

A number of studies have been carried out on underground mine air flow behaviors. Herdeen and Sullivan (1993) were among the first who introduced Computational Fluid Dynamics (CFDs) to investigate airflow ventilation in mines; however, their model was not validated against experimental data. Then there were many researches of ventilation by means of 3D, computational methods taking into account time and validating these models by measurement programmes.

Uchino and Inoue (1997) developed CFD model for auxiliary ventilation and validated the model against blowing ventilation data. Moloney and Lowndes (1999) drew a comparison of measured underground air velocities and air flows simulated by CFDs. Suglo and Frimpong (2001) used empirical methods to assess the efficiencies of auxiliary ventilation systems. Toraño et al. (2002) created a program for calculating ventilation in tunneling works based on an explicit method. Wala et al. (2003) validated their CFD model for longwall ventilation with lab scale data for methane concentration. Parra et al. (2005) given a numerical and experimental analysis of different ventilation systems in deep mines. A CFDs study on ventilation flow paths in longwall gobs has been conducted by Yuan et al. (2006). Hargreaves and Lowndes (2007) used CFD to model the underground mine air flow behavior and ventilation airflow patterns. Onder and Cevik (2008) developed a predictive model of the volume flow rate reaching the end of a leaky ventilation duct for a simple auxiliary ventilation system using multiple regression analysis.

Wang et al. (2009) proposed a 3D unsteady quasi-single phase models to optimize the ventilation time with different tunneling lengths and analyzed the distributions of airflow, CO and dust in the diversion tunnel. The prediction by the present model for airflow in a diversion tunnel is confirmed by the experimental values reported by Nakayama (1998). Methane emissions both in longwall mining and in dead-end roadways vary considerably according to the type of coal and the work carried out at the face (Karacan, 2008).

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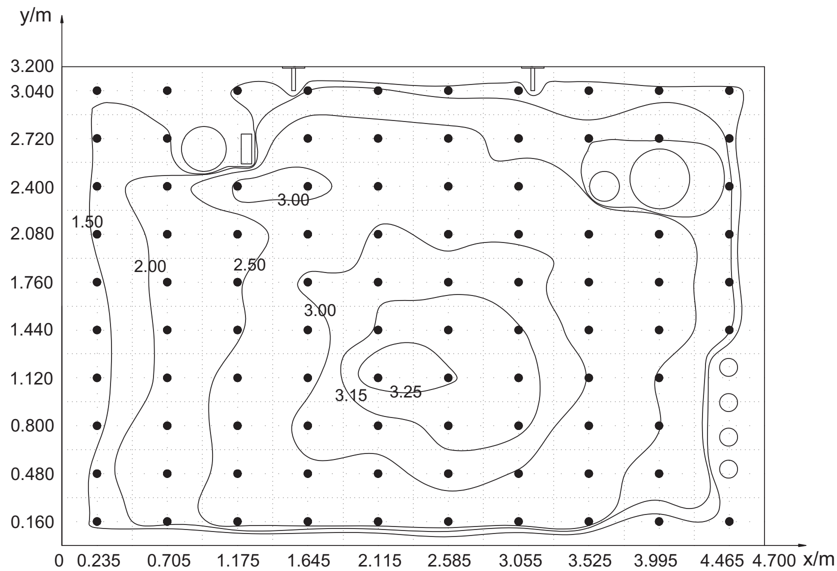
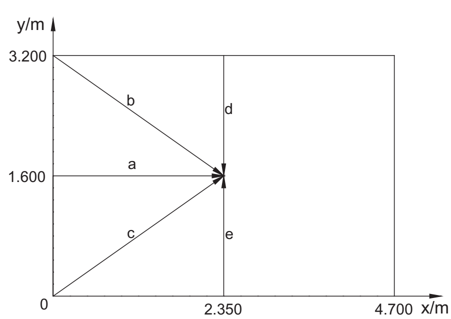
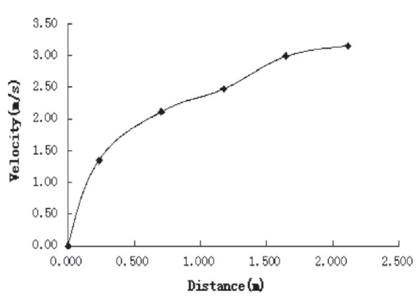


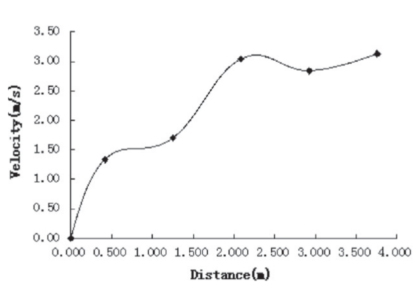
Fig. 1. Velocity distribution (m/s) in main ventilation roadway of N1102 (bolting with wire mesh).



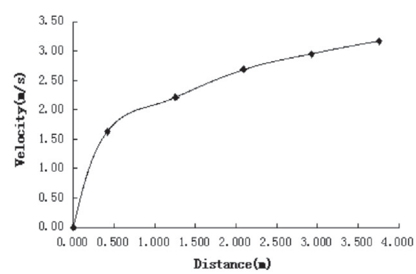
(A) Layout of the analytic paths in the cross-section of main ventilation roadway of N1102.



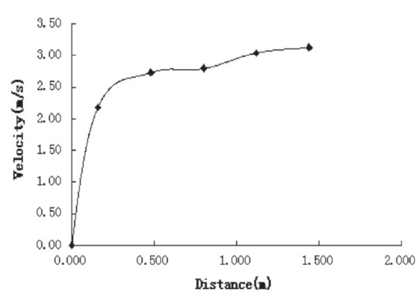
(B) Evolution of airflow velocities in direction a according to the distance from the boundary.



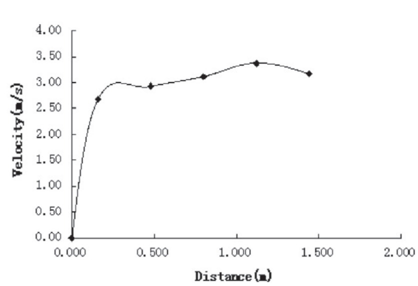
(C) Evolution of airflow velocities in direction b according to the distance from the boundary.



(D) Evolution of airflow velocities in direction c according to the distance from the boundary.



(E) Evolution of airflow velocities in direction d according to the distance from the boundary.



(F) Evolution of airflow velocities in direction e according to the distance from the boundary.

Fig. 2. Analysis diagram of main ventilation roadway of N1102.