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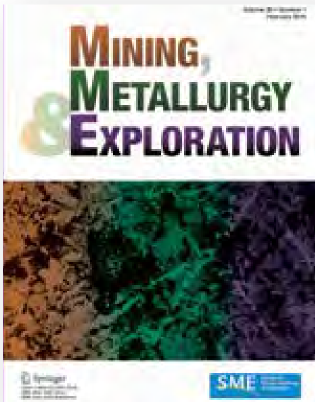

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Characterization of aerosols in an underground mine during a longwall move

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Keywords: Aerosols, Diesel, Dust, Underground mining, Longwall

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

Occupational exposures to respirable dust and submicrometer aerosols emitted by diesel-powered equipment are a health concern for underground mining operators and regulators. A study was conducted in an underground mine with the objective to identify, characterize and source apportion airborne aerosols at the setup face and recovery room during longwall move operations.

Summary

A fleet of more than 250 permissible heavy-duty, nonpermissible heavy-duty and nonpermissible light-duty diesel-powered vehicles is used to transport equipment, material and personnel in an underground mine. The periodic moves of massive longwall equipment from the recovery room at the mined panel to the setup face at the next panel requires extensive use of diesel-powered equipment. Those activities, when compared to normal production activities that use fewer diesel-powered equipment, have a higher potential to generate submicrometer aerosols. The results of sampling and measurements performed in six two-hour test periods

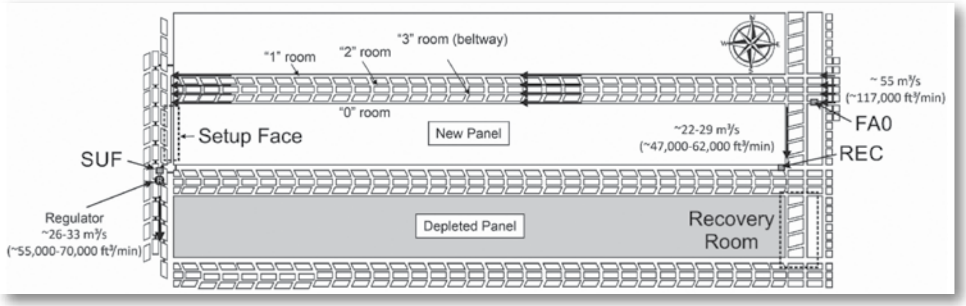

Fig. 1 Schematic of longwall panels and ventilation concept (not to scale).

during the mine's day shifts for three consecutive days (D1, D2 and D3) are examined in this study. Two of those tests were conducted on the first day (D1T1 and D1T2), two on the second day (D2T1 and D2T2) and two on the third day (D3T1 and D3T2). Sampling and measurements were performed at three locations: (1) FA0, located in the "0" room of the new longwall section, 50 m (164 ft) downwind of the fresh air split, (2) SUF, located 20 m (66 ft) upwind of the regulator and (3) REC, located 150 m (492 ft) upwind of the entrance to the recovery room (Fig. 1). These locations were selected to allow for (1) identification and characterization of aerosols at various workplaces and (2) source apportioning of aerosols to the activities of various diesel-powered vehicles operated outby and inby of the panels. For the purpose of this study, only area samples were collected; therefore, the observed concentrations cannot be interpreted as personal exposure levels.

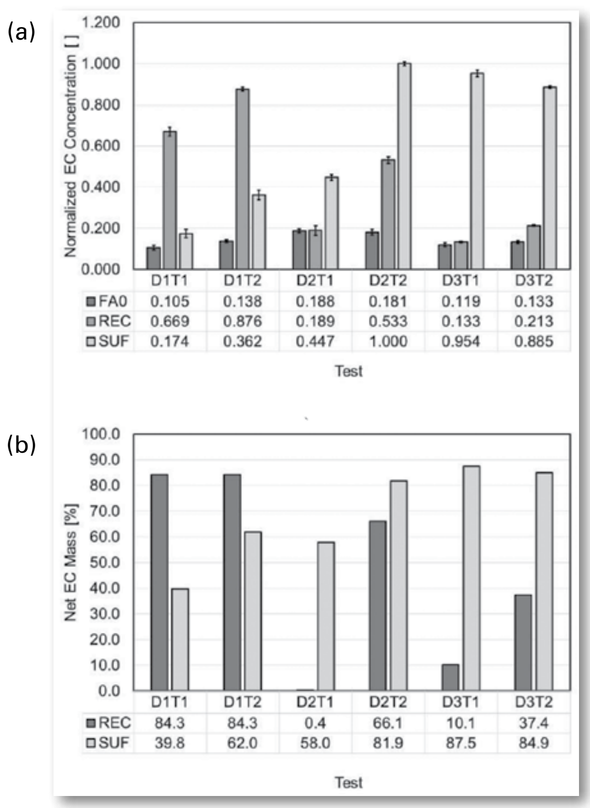

Fig. 2 (a) Normalized EC concentrations for FA0, REC and SUF, and (b) estimated net contribution of the diesel-powered vehicles operated on the REC loop and on the shield haulage and SUF loops to the concentrations of EC mass flow at REC and SUF, respectively.

The activities of vehicles used during selected intervals of the longwall move were monitored at seven locations distributed across the panels. The data were used to (1) identify vehicles that were operated during the study, (2) assess the extent of utilization of the heavy-duty and light-duty vehicles on different sections and (3) based on ventilation air flow distribution, apportion aerosols to the various activities and categories of the diesel-powered vehicles. Sampling and measurements were performed at FA0, SUF and TEC. The effects of the longwall move process on the submicrometer and respirable aerosols were studied in relation to the results of various analyses performed on the filter samples and the results of measurements with direct reading instruments. Submicrometer and respirable aerosol samples collected on quartz-fiber-filter media were analyzed in-house for elemental carbon (EC) and organic carbon (OC) using a thermo-optical transmittance (TOT) method following NIOSH Method 5040. An electrical low-pressure impactor (ELPI) from Dekati (Tampere, Finland) was used at SUF to take real-time measurements of concentrations and size distributions of aerosols. A PDM3600 (Thermo Fisher Scientific, Franklin, MA) personal dust monitor was used at each measurement location to continuously measure ambient concentrations of dust.

Key results

The vehicle monitoring in this study showed intermittent use of six diesel-powered, heavy-duty vehicles and one

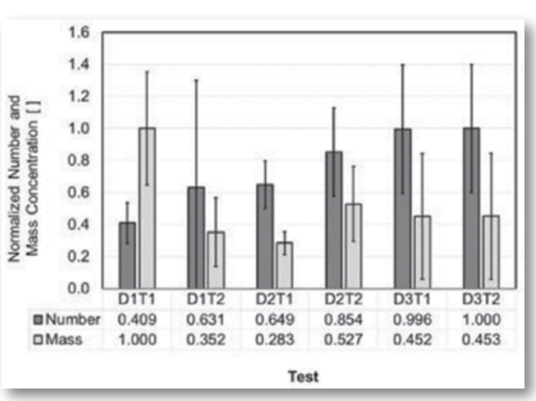

Fig. 3 Normalized average number and mass concentrations of aerosols at SUF.

battery-powered, heavy-duty vehicle on the new longwall panel. During the same period, the movements of more than 40 light-duty vehicles were recorded. The light-duty fleet consisted of various kinds of personnel and material carriers, three forklifts and one water truck.

The aerosols at the setup face were found to be distributed among diesel combustion-generated submicrometer and mechanically generated coarse aerosols. The submicrometer aerosols at the setup face and recovery room were sourced to the heavy-duty and light-duty diesel-powered vehicles operated inside and outside of the panel (Fig. 2a). Depending on the intensity of the activities on the panel, the outby sources contributed between 12.5 and 99.6 percent to the average elemental carbon mass flow at the setup face and recovery room (Fig. 2b). Extensively used light-duty vehicles that were operated in the shield haulage loop and/or outside of the longwall panels contributed measurably to the EC concentrations and number concentrations of aerosols downstream of the setup face.

The results of continuous measurements of aerosol concentrations with the ELPI during six tests were used to study the effects of the longwall move process on the number and mass concentrations and size distributions of aerosols at SUF. The vehicles that were operated over sporadic and transient duty cycles were found to produce wide ranges of number and mass concentrations (Fig. 3). The spikes in number and mass concentrations of aerosols downstream of the setup face were associated with the operation of diesel-powered vehicles near the measurement site. The combustion-generated aerosols dominated the number distributions. High instantaneous mass concentrations were primarily associated with entrainment of the dust by diesel- or battery-powered load-haul-dump vehicles operated close to SUF.

Reducing concentrations of diesel aerosols at the setup face and recovery room during longwall move operations would require concerted efforts devoted to elimination, substitution and/or control of various sources of diesel aerosols. Efforts to control emissions of aerosols from heavy-duty, diesel-powered vehicles operated at the section should be complemented with similar efforts to reduce emissions of aerosols from the large and extensively utilized fleet of light-duty vehicles operated at and outside of the longwall section. Suppressing entrainment of road dust by diesel- or battery-powered vehicles could help to reduce mass concentrations of dust on the sections. The findings of this study will help the underground mining industry in its efforts to reduce exposures of miners to diesel and coarse aerosols. ■

Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC). Mention of company names or products does not constitute endorsement by NIOSH or CDC.

References

A list of references is available in the full-text paper.

Development of a novel grinding process for iron ore pelletizing through HPGR milling in a closed circuit

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Keywords: Pelletizing; Agglomeration, HPGR, Milling

To read the full text of this paper (free for SME members), see the beginning of this section for step-by-step instructions.

Special Extended Abstract

The fundamental importance of comminution by high-pressure grinding roll (HPGR) technology to efficiently increase the particle surface area lies in lower energy and water consumptions for iron ore pellet feed production. This study compared the ball wet milling process with the innovative HPGR processing technology for hematite-goethite ores. Green-pellet balling and induration processes were simulated on the bench and pilot scales.

Summary

Grinding tests performed in a pilot-scale HPGR (diameter 1 m, width 0.32 m) evaluated the effects of feed moisture, product recirculation steps into the HPGR (without classification) and bentonite dosage. The Blaine specific surface area (BSA) increased steadily with successive ground product recirculation into the grinder, mainly due to microcracks generated within the particles submitted to shear stress and