The Australian Mine Ventilation Conference 2017

Paper Number: 32

Delivering a healthy atmosphere underground in a cost conscious environment

J J Black[1], J Sinclair[1], C Smith[2] and I van Aswegen[3]

1.
Mine Planning Engineer, South32 Cannington Mine
2.
Senior Mine Planning Engineer, South32 Cannington Mine
3.
Ventilation Engineer, South32 Cannington Mine

ABSTRACT

The adverse health impacts from diesel exhaust emissions (DEE) exposure are a well-known global concern. This evidence has triggered underground mining operations to review existing atmospheric conditions and assess the scale of the challenge faced. South32's Cannington Mine (Cannington) evaluated the ability to provide a healthy atmosphere from a whole mine approach. As such, taking into account existing controls including; maintenance strategies, fuel quality, mining operations, ventilation provisions, monitoring protocols, cost efficiency and effective education and training programs.

During the evaluation process, Cannington gave due recognition to the advice and guidance provided in the Queensland Guidance Note 21 (QGN21) and the Guidelines of New South Wales' MDG29 and Minerals Industry Advisory Council (MIAC) of Western Australia. Each of these documents acknowledges a mine ventilation rate of >0.06m3/s/kW is best for removal of DEE exposure in underground mines.

Cannington optimized existing primary ventilation infrastructure by implementing a modified Ventilation on Demand (VoD) system. This achieved sustainable operating and capital cost reductions without compromising delivery of adequate ventilation to work areas. The process also recognised that engaging mine workers' ownership of their work areas was key to maintaining a technically efficient ventilation system.

This paper will concentrate on Cannington's existing controls, their implementation and their cost conscious management for the prevention of increased DEE exposure; reducing the risk of both short and long term health impacts to as low as is reasonably practicable.

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Paper Number: 84

Wall-flow type DPF system to replace existing wet element filter systems used in typical LHDs in underground coal operations

N Coplin[1]

1.
Orbital Australia, WA

ABSTRACT

The need to protect workers from diesel particulate matter (DPM) has lead the underground coal mining industry to install disposable filter systems on their vehicles. While the disposable filters are efficient at removing significant DPM, the following major issues have arisen:

- High cost of operations. Disposable filters cost $250-300/each and need we be changed at least once per shift resulting in an estimated cost of up to $168M/year[1], in filters alone, to the NSW underground coal mining industry.
- Improper installation, damaged seals and lack of installing a new filter when the old filter is removed means that workers are still being exposed to excessive amounts of DPM.

In order to address the cost and health issues, implementation of a wall-flow filter system is being proposed. Switching to a wall-flow filter will address the cost issue as the on-going costs of these systems are minimal compared to disposable filter systems. It will also address the health issues as the filters do not need regular replacement in-service reducing the chance of improper installation and seal damage. Lastly, being that this is a permanent system, the driver cannot remove the filter and drive around without any filter being installed.

The implementation of the wall-flow system on engines in the underground coal industry would save the industry up to 80% (cost of paper filters less the cost of the wall-flow filters, including servicing, spread over 3 years). While the wall-flow filters will need occasional maintenance, the frequency and time required will be small compared to the current disposable filter requirements that it should be possible to do this during scheduled downtime

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Paper Number: 69

Morphology and chemical composition of dust and DPM nanoparticles by scanning transmission electron microscopy analysis

B Habibi, B Van Devener, A Bugarski and K Homan

1.
Mine Engineer, Tronox Alkali, USA

ABSTRACT

The study was conducted to characterize dust and combustion-generated, submicron, diesel aerosols in the underground operations at Tronox's Westvaco Mine. The size-selected aerosols were collected from the general underground mine environment using Electron Low Pressure Impactor (Dekati, ELPI +). The ELPI+ is 14-stage impactor designed to collect samples and measure particle size distribution and concentration of aerosols with aerodynamic diameters between 6 nm and 10 µm. Scanning Transmission Electron Microscopy (S/TEM) and Energy Dispersive Spectroscopy (EDS) analysis were used to investigate the morphology, size distribution, and chemical composition of the agglomerates. Digital Micrograph software (Gatan, GMS 3) was used to measure the several attributes of agglomerates including the primary particles. The fractal dimension and shape factor were then obtained for agglomerates collected on the various sampling stages. The objective of this study was to investigate the correlation of morphology and attributes of agglomerates with respect to the size of agglomerates as well as the diesel aerosol sources. TEM imaging was also used to verify particle size distributions. The manuscript discusses challenges of correlating atmospheric nanostructure of diesel agglomerates and characteristics to a known diesel source using STEM analysis.

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Paper Number: 64

The development and validation of a fixed-point aerosol monitoring system for underground mining

F Velge[1] and G Arsenault

1.
Pinssar Pty Ltd, Qld

ABSTRACT

Amid increasing concerns about the effects of particulate matter from diesel engine exhaust on cancer and non-cancer endpoints, a system for the remote, regular measurement of sub-micron aerosols in underground environments was developed. Using proven laser-light scattering technology, the Pinssar Ambient Air Monitoring System, consisting of a distributed network of aerosol measurement instruments (Readers) and software, was developed to address concerns that the conventional measurement of diesel particulate results in delays in feedback to front-line personnel. This delay limits the ability of mine operators to make timely adjustments to conditions and work processes to prevent overexposure. This paper will outline the technology employed, the inbuilt solutions to addressing some recognised issues and those identified in development, the results of in-house and third-party trials and validation testing to establish the performance relative to other methods diesel particulate monitoring, and finally some suggested implementation applications.

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Paper Number: 96

Application of an environmental 'black carbon' particulate sensor for continuous measurement of DPM in three underground mines

J C Volkwein[1], E Sarver[2], C Barrett[2] and A D Hansen[3]

1.
Consultant, Canonsburg, PA, United States
2.
Virginia Tech, United States
3.
Magee Scientific, Berkley, CA, United States

ABSTRACT

Insuring that diesel exhaust particulate matter (DPM) levels in underground metal and nonmetal mines are maintained below statutory limits, is an essential requirement of mine ventilation systems. However, despite the cost of ventilation, the air flow rates are usually based upon models, assumptions, or measurements integrated over long durations. Real-time measurement of DPM, interpreted in terms mine activity schedules, can offer better ventilation management to keep DPM within regulated levels while controlling costs. This work presents data from three sites on the in-mine application of an environmental 'Black Carbon' particulate sensor which is very widely used in ambient-air monitoring networks.

A model AE33 Aethalometer was operated in three separate mines for periods of 2 weeks, 3 months, and 7+ months. Aethalometers are a class of environmental monitors which measure the light absorbance of aerosol particles at several optical wavelengths. Its data is reported in real time as a concentration of Black Carbon ('BC', a surrogate for DPM), and aromatic organic compounds which can indicate other forms of combustion. The data was used to 1) measure the relative efficiency of a new scale model DPM 'air scrubber'; 2) determine if ventilation could be reduced in a shotcrete loading facility; and 3) evaluate diurnal and weekly DPM levels in a large entry limestone mine. Instrument data were displayed locally, stored for later downloading, connected to a local "controller" and connected to one mine's underground network so that DPM data was presented in real-time to the mine ventilation engineering staff's surface office display.

The results showed that the 'air scrubber' removed 82-89% of the DPM; showed that DPM produced during shotcrete loading was only a minor part of overall DPM levels; and showed that wide variations in DPM levels existed in the limestone operation. The DPM monitor operated continuously in these underground environments for extended periods. Its only maintenance requirement is the routine replacement of filter tape on a two-week schedule. Ongoing testing of a sample diluter can extend filter change interval. The real-time data output of the Aethalometer is appropriate for direct integration into Ventilation-On-Demand control systems.