ABSTRACT

The issue of coal workers’ pneumoconiosis (CWP) has recently re-emerged in some Australian mines. Harmful effects from coal dust inhalation have been well documented, but the underlying causes and mechanisms of CWP are still debatable. Several recent epidemiological studies in the United States have shown a general correlation exists between the concentration of pyrite within coal and the prevalence of CWP in miners. However, none of these studies have made any distinction between the presence of reactive pyrite and the presence of unreactive pyrite. This omission leads to a lost opportunity to understand the possible mechanisms for the dust that is generated from coal containing reactive pyrite and can also lead to coals containing unreactive pyrite being falsely identified as a CWP hazard. Reactive pyrite in coal oxidises under ambient mine conditions to produce various iron sulphate minerals such as melanterite, rozenite and roemerite. Rapid reaction rates are promoted by the form (size and morphology) of the reactive pyrite present, which provides both increased surface area and increased porosity for easy air access to reaction sites. The reaction products formed are needle-like crystals at thicknesses in the order of 1-2 µm (melanterite and rozenite) and prismatic crystals with thicknesses less than 5 µm (roemerite). The densities of these minerals are significantly less than quartz, which makes them prone to becoming airborne with the normal coal dust. In fact, the mix of these mineral salts is commonly referred to as “fairy dust” by mine workers due to the way that they can become entrained and sparkle in the mine ventilation air, particularly if they occur in the upper part of a seam that is forming a coal roof. This paper will provide examples of the various products of reactive pyrite oxidation found in Australian coal samples and discuss their implications as a hazard in the mine environment with respect to CWP.
ABSTRACT

Dust sampling is pivotal in estimating the ‘dose’ of dust exposure and in deriving dose-response curves in epidemiological studies. Over the last half a century, gravimetric sampling has been fundamental means for dust exposure monitoring using recognised respirable size-selective standard. In Australia, gravimetric sampling technique was followed since 1987 using Higgins-Dewell (HD) type cyclones (AS2295). The re-emergence of ‘Black Lung’ or Coal Workers Pneumoconiosis (CWP) in Queensland, Australia has re-kindled the under-standing of personal dust monitoring, compliance determination, its accuracy and timeliness of sampling results as well as galvanised the focus on dust control systems. Reporting dust levels in real time empowers miners and operators to take immediate action to avoid being exposed to excessive airborne dust. To this end, after two decades of intensive research in the USA had led to the introduction of gravimetric based continuous personal dust monitors (CPDMs) called as PDM3700 as a compliance tool. The new real-time mass based sensor is a continuous mass based dust monitor using the Tapered Element Oscillating Microbalance (TEOM) principle and is significantly superior to the current gravimetric sampling methodology.

Currently, the over-all respirable dust standard in US coal mines is reduced from the historic 2.0 to 1.5 mg/m3. This paper provides the results of a comparative pair-wise study of the existing gravimetric sampler and the PDM3700 carried out in 3 different Australian underground mines. The field results consistently suggests that there is a significant ‘measurement bias’ between the current gravimetric HD sampler and the PDM3700 monitor operated using the similar HD type cyclone. The results show that the currently used cyclone measurements are approximately 45% higher than the ‘auditable’ PDM3700 monitor at the current compliance limit of 2 mg/m3. Based on the review of extensive data, the differences can be attributed to the AS2985/ISO1995 non-conformance of the gravimetric sampler, collection of up to 36% of sample dust with an average D90 of 15 µm, significant variation in sampler flow rates and to the inherent cyclone design flaws that has been over-come by the PDM3700 monitor. This finding has significant consequence in validating the historic exposure results and its use in medical surveillance programmes, and current approach to non-compliance determination.
Study on coal wettability in presence of surfactants by sink test

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ABSTRACT

High concentration of airborne coal particles is the main reason leading to health and safety hazards in underground coal mines. Water spray has been considered the most common method to suppress coal particles in mine sites, but the using of plain water is not effective enough to capture coal particles. By adding surfactants, coal wettability can be improved which will increase the coal dust suppression efficiency. In this study, a modified sink test was employed to evaluate coal wettability in presence of two anionic surfactants: sodium dodecyl sulphate (SDS) and sodium dodecyl benzene sulphonate (SDBS). Sink rates were calculated by sink weight versus time obtained from the sink test. Different surfactant concentrations (0.01%, 0.05%, 0.1%, 0.2% and 0.4%) and two types of water (tap water and deionized water) were selected to investigate wettability of coal particles with three size ranges (0~38µm, 53~75µm and 75~90µm). The results show that both SDS and SDBS surfactants can lower the water surface tension and improve coal wettability performance. Sink rates increased as the surfactant concentration increasing, and surfactants solution prepared by deionized water perform better in enhancing coal wettability than that in tap water. Also, coal wettability varies from different coal particle sizes, the smaller coal particle is, the worse wettability it possess.
The application and technology of surfactant-magnetized water for efficient coal dust suppression

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ABSTRACT

To effectively control coal dust in underground mines, based on the synergistic theory between surfactants and magnetization, the surfactant-magnetized water spraying was proposed as an efficient dust suppression technology. A cost effective composite chemical surfactant was developed, which only requires 0.03 wt% for effective dust suppression when magnetized. Due to the limited space in underground mines, a compact surfactant-magnetize water generation system was designed. The system can accurately prepare the low concentration surfactant solution, and continuously magnetize the solution in an efficient manner. A high-intensity magnetic generation device with 300-350 mT magnetic power was also invented. It is based on an interlaced arrangement method of magnets and a spiral propulsion structure of the water channel. Field application in an underground longwall mine indicated that the respirable dust and total dust suppression efficiency reached more than 83%, which significantly improved the underground working environment.