Gas reservoir and emission modelling to evaluate gas drainage to control tailgate gas concentration and fugitive emissions

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ABSTRACT

The process of longwall coal extraction coal causes fractures in the overlying and underlying strata and these fractures become pathways for gas released from adjacent coal seams to flow into the mine workings and contaminate the ventilation air. If the rate of gas emission exceeds the diluting capacity of the ventilation air, the gas concentration will increase and exceed the statutory limit resulting in production delays.

All potential gas sources within the planned mining area, including coal seams located above and below the working seam, should be identified and sufficient gas data collected and used to determine the specific gas emission from each gas source. Gas reservoir and emission modelling is recommended to determine specific gas emission and changes in gas emission from individual sources over the planned mining area. Accurate gas reservoir and emission modelling provides the information required to accurately design gas drainage programs to effectively manage gas emissions and minimise the risk of ‘gas-outs’.

Given the increasing occurrence of incidents of gas concentration in ventilation air exceeding the 2.0% statutory limit and changes to mine plans to avoid ‘difficult-to-drain’ areas, it is apparent that many operations are not effectively utilising gas reservoir and emission modelling to identify high gas emission areas and are not completing sufficient gas drainage in advance of planned mining.

The process of gas reservoir and emission modelling to support gas drainage design to control tailgate gas concentration and fugitive emissions is presented and discussed.
Coal Seam Gas Predrainage Optimisation

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ABSTRACT

Gas management practices across the Australian underground coal industry have evolved significantly since the early nineties with the introduction of hazard management plans, directional drilling techniques and surface gas predrainage methods, the refinement of longwall post drainage systems, the statutory role of the Ventilation Officer and the widespread use of ventilation simulation software.

The improvements are evidenced by a substantial reduction in the occurrence of outbursts and gas related delays during a period where coal production rates have increased three to four fold. The development of appropriate gas management strategies have been afforded by the use of reservoir simulators and a significant increase in the availability of measured gas reservoir data, in particular gas content and composition, adsorption isotherms and permeability. That said significant opportunities exist to:

- Optimise gas drainage designs
- Further reduce the occurrence of delays to mining resulting from inadequate gas predrainage
- Better assess areas of apparent low permeability conditions that may have previously been assessed as being unfeasible to mine due to excessive gas drainage costs.

This paper describes the current status of gas management practices in Australia and proposes areas where opportunities exist that offer the potential to optimise gas predrainage designs and ensure that when mine plans and schedules inevitably change gas predrainage designs are modified with confidence. In short it involves a shift away from the “Set and Forget” mindset to one that is more able to respond appropriately and efficiently to the dynamic nature of underground coal mining and heterogeneous nature of coal seams.
Comparison of characteristic gas evolution trends of several Australian coal types with increasing temperature

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ABSTRACT

The mapping of underground coal mining sites for early detection of heating is required so appropriate measures to prevent the development of a spontaneous combustion event can be put in place. To recognise the heating development stage, normal practice uses gas trending information as a proxy for temperature with onsite gas monitoring playing a key role, alerting personnel when pre-set gas limits are exceeded. Today, leading practice requires the use of a Principal Mining Hazard Management Plan for spontaneous combustion. An important aspect of this plan is the development of a Trigger Action Response Plan (TARP) to manage and control any development of spontaneous combustion in underground workings. These plans rely on sound scientific gas evolution data trends associated with coal temperature increase in response to coal self-heating. Trigger levels within the TARP use this information to determine the implementation of appropriate actions and responses as early as possible.

This paper presents the results, analysis and interpretation of the gas evolution trends associated with the increasing temperature of several samples of Australian coal. Samples are subjected to a ramped temperature program from mine ambient temperature to 200 °C in a unidirectional air flow. The exit gas stream is sampled and analysed by gas chromatography to determine concentrations of oxygen, nitrogen, methane, carbon dioxide, carbon monoxide, hydrogen, ethane and ethylene. Each coal has its own site-specific characteristics that are sometimes related to the presence of seam gas as well as the changes in coal type. It is important to recognise these variations as they impact on establishing the most relevant gas indicators for both understanding the status of a heating from low temperature oxidation to more advanced stages and developing spontaneous combustion management and control.
The Australian Mine Ventilation Conference 2017

Paper Number: 77

Gases generating regulation of decomposed coal during process of self-ignition

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ABSTRACT

Open cast mining is the main coal produce method in Inner Mongolia, Xinjiang, Shaanxi und other Province in the north of China. There are two advantages of open cast mining, one is the economic benefits, which including short time and low investment for capital construction, large production scale, high productivity and low mining costs for a coal mine. The other is technical benefits, indicates the reliable production system and safety mining. On the other hand, open cast mining of coal is very readily to weathering, formed the decomposed coal. In addition, open cast mining is also accompanied by a number of disasters; outcrop fire is one of the main disasters in the mining. To obtain the evolution rule of outcrop fire, a high temperature-programmed system is adopted to simulate the self-ignition (spontaneous combustion) process of decomposed coal. The fresh coal and decomposed coal were selected from Liulingou, Zhungeer, Inner Mongolia, which were taken to test the macro characteristic parameters from constant temperature to 650°C. Moreover, the growth rate analysis method of indicating gases was applied to calculate the characteristic temperatures.

The results showed the decomposed coal continued to oxidise reaction during high-temperature and released plenty of heat to insist self-ignition. The humic acid, which was contained in the coal were taken place of thermal decomposition reaction as temperature rising. Leading to the increasing concentrations of CO₂, CH₄, C₂H₄ and C₂H₆ gases. The variation of CH₄, C₂H₄ and C₂H₆ gases has similarities. For decomposed coal influenced by the chemical weathering function, brought about the concentrations of the three gases keep balance on the low-temperature stage, then increased rapidly with the temperature rising. Additionally, particle size affected coal self-ignition. The particle size of > 0.9 mm produced much more CO than other samples. The study would have a vital influence on open cast mining while avoiding the self-ignition of coal.