CFD Modelling of a Sudden Gas Outburst Event on a Longwall Face and a Development Heading

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ABSTRACT

The sudden release of large volumes of gas and coal on the longwall face and development panel poses significant safety risks in underground mining operations. Such events can overcome the capacity of normal ventilation systems, leading to temporary ventilation interruptions and creating back-flush zones with elevated gas levels near the burst site. To better understand this phenomenon and its potential impact on typical longwall operations and development headings, Computational Fluid Dynamics (CFD) modelling, is employed to simulate likely scenarios of gas outbursts where CO_2 is the predominant gas ejected. For outbursts on the longwall face, three-dimensional CFD models were developed, including shearer, hydraulic supports, armoured face conveyor, bridge stage loader, and conveyor belt. The simulations considered parameters such as shearer positions (close to the maingate or at the mid-face), the total volume of outburst gas (350, 550 and 1100 m^3/s) and face quantity (40, 50 and 60 m^3/s), resulting in a total of 18 scenarios being numerically simulated and analysed. The simulation results indicate that an increase in the total volume of outburst gas leads to a corresponding increase in the maximum back-flush distance, whereas higher face ventilation quantities tend to reduce the back-flush distance. Similarly, for outbursts in the development heading, three-dimensional CFD models were constructed to include major equipment, such as continuous miner, shuttle car and ventilation tube. Two parameters were considered, with due consideration of the distance between the first cut-through and the heading face of the travel road, and the total volume of outburst gas. The analysis of simulation results reveals that with a rise in the total volume of outburst gas, the maximum back-flushing distance generally increases. These CFD modelling results enhance the understanding of CO_2 migration dynamics during sudden outbursts in both longwall face and development heading, and the maximum back-flush distance obtained from CFD simulations provides valuable insights for determining the impact zone and safe distances to be included in remote mining procedures for both longwall face and development panels.