Grant AFC719-68: Methane Watchdog Network - A Cost Effective Approach to Longwall Methane Monitoring and Control

Organization and Principal Investigator: West Virginia University (Derek Johnson)

Focus Area: Health and Safety Interventions

Priority Area: Innovative Methods of Methane Detection Near the Face and De-energizing the Longwall Equipment

Problem Statement and Research Approach: Currently, MSHA regulations require that only one methane monitor be mounted on the longwall shearer in a longwall face. The location of the monitor in a typical longwall face setting could be between 5 and 10 ft. away from the coal face and at around the midpoint in the height of the seam. Therefore, a single gas monitor is unable to detect the zones of higher methane concentrations, possibly explosive, either at the front upper (top) corner of the longwall face and along the front longwall gob edge immediately behind the shields. In addition, the response time of current sensors may be 10 or more seconds – which reduces its spatial reliability. For example, if the gas monitor on the shearer detects an explosive methane condition, the cutting drums (potential ignition source) may have already penetrated the explosive gas zone due to the delayed response from a single point measurement. Therefore, to improve further the safety at the longwall mining operations, a more responsive, multi-nodal gas monitoring system must be developed and deployed to control ventilation at the longwall faces and serve to proactively control shearer power to avoid explosive conditions.

We propose to develop an innovative Methane Watchdog system, which will deploy a low-cost, multi-nodal methane measurement network. The proposed system will employ a reliable and durable nodal methane-sensing network to monitor methane concentrations and velocity continuously along the full length of the longwall face. The system will measure, record, and report on discrete methane concentrations in nearly real time, along the front and rear ends of the canopy of the shields. The measured methane concentration distribution along the front tips of the shield canopy can be used as an algorithm input to decide whether the shearer should be de-energized before advancing into potentially explosive methane-air pockets. The methane concentration distribution along the rear end of the shield canopy (the front edge of longwall gob) and its development trend over time will enable the development of an improved bleeder ventilation plan. This strategy will ensure the front edge of the explosive methane zone (5% methane) in the gob area, especially near the face/tailgate corner, will remain sufficiently far from longwall face while reducing the likelihood of over-ventilating the gob to prevent the spontaneous combustion therein. Our multi-nodal methane measurements can be combined with shearer location and ventilation flow rates along the wall face to estimate the methane liberation rates (from coal seam ahead of the shearer) and from longwall gob. The ability to accurately collect, record, and analyze methane concentrations at multiple locations will immediately improve mine safety and will ultimately lead to better models and design methods to prevent the most feared hazards in underground coal mines – methane and dust explosions.

Specific Aims: Our research objective is to overcome current methane monitoring limitations by developing a robust and cost effective methane-monitoring network that can be used to predict and detect high concentrations, de-energize the shearer, and interface with automated ventilation control units. Our primary aim will focus on the aspect of low capital costs. Additional aims will also focus on durability of the sampling system and maintenance requirements of the proposed system.

- Demonstrate a fully functioning Methane Watchdog system with 10 nodes – including the capabilities of controlling virtual shearers and ventilation systems. Demonstration will occur at a simulated mining facility.