Project Title: Combustion Modeling of Explosive Gas Zones in Longwall Gobs

Organization: Colorado School of Mines

Partnerships: None

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Focus Area: Safety

SYNOPSIS

Problem Statement and Justification: Several mine fires and explosions, including the disaster at the Upper Big Branch mine in 2010 that caused 29 fatalities, have demonstrated that explosive gases can accumulate and explode within gobs of underground longwall coal mines and expand into the active face areas of the mine. Based on studies from numerous past mine explosions and fires, explosive gas zones (EGZs) exists in most, if not all longwall gobs. Several studies have been conducted looking at reducing the size of EGZs within the gob using various ventilation schemes.

Impact of the Research: The ultimate goal of this proposed research is the development of a CFD model of the longwall gob that can simulate EGZs based on various ventilation schemes and includes a combustion model to simulate explosions within the gob to determine the explosion hazard to miners working in the face or bleeder areas surrounding the gobs. Understanding the impact of an explosion in the longwall gob can guide new designs for mitigation strategies or containment of an explosion or improve the mine's emergency response and evacuation protocols to increase miners' safety. Currently there are models, which can predict location and volume of EGZs in a longwall gob, but are not capable of predicting the impact of explosion on miners if it occurs in the gob or nearby areas.

Objective(s) and Research Approach: The specific objectives and approaches for this proposed research is: 1) Investigate the explosive gas zones (EGZs) in gob-like conditions using an explosion testing apparatus. A gob explosion simulation apparatus (GESA) will be constructed to study flame propagation through rock rubble with various gob parameters (e.g. permeability, moisture content, barrier length, material prope11ies, and various methane-air concentrations). This will provide insight into the impact of the conditions found in the gob on explosions and flame propagation providing more accurate parameters to use in developing the combustion model. 2) Development and validation of a CFD combustion model using experimental data obtained from the proposed design of an experimental apparatus to study the impact of explosions within a longwall gob. A CFD combustion model of the test apparatus will be developed and validated with the results of the physical explosion tests. This validation is critical to gain the explosion propagation, pressure and flame spread parameters that are needed to examine EGZ explosions in longwall gobs. 3) Finally, incorporating the CFD combustion model into the full CFD ventilation model to investigate the safety hazard of EGZs based on methane/air concentrations, volume, location, gob conditions (e.g. porosity, permeability, moisture, etc.), and effective source of ignition. Researchers will use the results from an existing CFD numerical model of a longwall gob developed at CSM as the initial conditions for the combustion model and examine how flames, pressures, gases and other hazardous effects will propagate through the gob and into the active mine workings as a result of an EGZ explosion. Determining the specific hazards that miners may face as a consequence of such explosions and safe conditions (distance from face, volume and gas composition) that must be maintained to control the safety hazard from EGZ explosions. Each of the three objectives are interconnected and will rely on an iterative approach to finalize a model which will be capable of assessing the potential explosion hazard to miners due to the EGZs in the longwall gob.