Follow Up Grant AFC215-73: Numerical Analysis of Gas Explosions in Coal Mines

Initial Grant AFC215-20: Numerical Tools for Mitigation of Methane Explosions in Coal Mines

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Focus of the proposed follow-on work: Based on all of the work we have done for the Alpha Foundation, we concluded that future work on numerical simulation of properties of methane-air explosions in coal mines should include studies of the effects of chemical additives that may be present in methane-air mixtures, effects of different channel geometries, and effects of the presence of coal dust. For the next two-year follow-on project, however, we propose to focus on the first two problems: the effects of higher hydrocarbons and channel geometries.

An important new addition to this project will be the availability of data taken at the Colorado School of Mines (CSM). Throughout the project, simulation results will be compared with their experimental measurements relevant to the proposed research as they become available.

Expected outcome: Specific simulation results on flame acceleration and DDT in channels containing natural gas will help the coal mining industry to design and optimize new devices for explosion prevention and mitigation, such as active and passive barriers. New scaling laws developed from these results will allow extrapolations to larger scales for a variety of channel geometries. From a more basic point of view, a major outcome of this work will be insights and criteria for acceleration and DDT that will enable us to decipher the basic controlling mechanisms of these phenomena.

Specific Aims of Proposed Research:

(1) To predict the development of explosions for additional tunnel mine geometries by varying the tunnel blockage ratio and obstacle spacing. These additional geometries will also include tunnels partially filled with rock rubble. Scaling laws will be developed for various geometries, and used to extrapolate the results on large scales. A similar approach was used in the previous project for one fixed blockage ratio and obstacle spacing.

(2) To predict the development of explosions for methane-air mixtures blended with higher hydrocarbons, such as ethane and propane. There hydrocarbons are known to increase the reactivity and detonability of methane-air mixtures, and are expected to affect the acceleration and DDT. Chemical reaction models will be developed using the technique tested in the previous project.

(3) To analyze the protective seal design specifications. As part of these simulations, pressure histories at protective seals will be calculated and compared with current MSHA criteria for seal design.