Spotlight: Colorado School of Mines constructs test facility and studies flame propagation through rock rubble to investigate explosive behavior in longwall gobs.

Alpha Foundation Grant ASTI14-2: Combustion Modeling of Explosive Gas Zones in Longwall Gobs

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It is well known that explosive gases can accumulate within gobs of underground longwall coal mines and potentially expand into the active face areas of the mine creating the opportunity for deadly explosions such as the Upper Big Branch catastrophe that resulted in 29 fatalities. This concern has prompted research to more fully understand the behavior of explosive gas zones within the longwall gob.

Much of this effort has focused on the understanding the formation of these explosive zones and sophisticated computational combustion modeling to study the behavior and propagation of an explosive event. Such modeling is very complex and a major challenge is how to validate the models such that the results can be deemed credible and sufficient to study influential factors that are relevant to coal mine explosions. For longwall gob studies, the effort is complicated by the presence of rubble from the caving of the overburden.

The Colorado School of Mines constructed a Gas Explosion Test Facility, which allows investigation of methane explosions through rock rubble. Both small scale and large scale combustion reactors were built. The small-scale test facility consists of two reactors: a 5 cm diameter steel reactor and 13.5 cm diameter quartz reactor. The quartz reactor provided a unique opportunity to image the flame interaction with the rubble to provide a visual observation of what is transpiring in this complex interaction. The large-scale test facility consists of two steel reactors: a 31 cm diameter reactor installed in a state-of-the-art research laboratory and a 71cm diameter reactor installed outdoors at CSM's experimental mine research facility.

These major discoveries and insights are important for model validation include:

- After the flame passes through and over rock rubble, a portion of unburned gas mixes with hot products and interacts with the hot rock and causes a re-ignition event. Small jets of ignition events are observed from the voids between the rock rubble.
- Rich methane-air flames have a slower burning velocity within the simulated gob tests compared to lean and stoichiometric conditions.
- The void spacing of the rock rubble, sphericity, and packing enhances turbulence upstream of the flame and increases back pressure downstream of the flame resulting in significantly faster flame propagation velocities reducing run-up length to becoming fully turbulent with the enhanced potential of transitioning to detonation as the rock barrier length is increased.