SINAN DEMIR and V'YACHESLAV AKKERMAN, Dept. of Mechanical and Aerospace Engineering, West Virginia University, Morgantown, WV, 26506. Recent Progress towards a Predictive Scenario of a Methane-Air-Coal Dust Fire in a Mining Passage.

The (coal) mining industry historically has ones of the highest occupational fatality and injury rates for employees. This is an exceptional concern for West Virginia, where a large portion of the state economy is based on mines. In this respect, accidental methane-dusty explosions and fires belong to the most dangerous coalmining disasters because they may cause injuries and deaths of personnel as well as a destruction of costly equipment. As a result, a fundamental physical understanding of the combustion processes in the premixed methane/air/coal-dust environment is critically needed. The present investigation is a step in this direction. Specifically, the key stages and characteristics of the premixed flame evolution in a typical mining passage, such as the flame propagation velocities, acceleration rates and run-up distances, are scrutinized by means of the analytical endeavors, with a particular focus on the dynamics of an expanding flamefront and on flame acceleration due to a "finger"-like shape of the flamefront. As a result, the "expanding" and "finger" flame acceleration scenarios are combined into a unified analytical formulation. Both the two-dimensional planar and cylindrical-axisymmetric geometries are considered. Starting with an incompressible formulation, we subsequently extend the analysis to account for gas compressibility, because the latter inevitably becomes substantial as soon as the flame spreading velocity starts approaching the sound threshold. Finally, the incompressible and compressible approaches are compared, with the detailed parametric study performed for various lean and rich methane/air/coal-dust mixtures.

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