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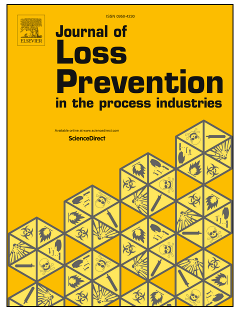

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Effect of Coal-Limestone Mixtures on Dust Dispersion Behind a Moving Shock Wave

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Abstract Secondary dust explosions in coal mines or industrial settings are known to cause greater catastrophic hazards than the coupled primary explosions themselves. The shock waves produced during a primary explosion lift surrounding coal particles from neighboring areas, and if added in an effort to create an inert mixture, limestone as well. This experimental study characterized the coupled effects of dust dispersion from coal-limestone mixtures and moisture-varied limestone dust. A shock tube modified to evaluate dust dispersion provided the optical access to characterize the shock wave/dust-layer interaction. The moisture-varied limestone samples were tested at three shock Mach numbers, namely M_s = 1.1, 1.23, and 1.4, with trending data showing an average increase of 10% in overall lifting heights and 20% in initial linear growth rates for the moisture-reduced, dried samples, as compared to undried samples stored in standard temperature and pressure (STP) conditions. The coal-limestone mixture samples were tested at two shock Mach numbers, namely M_s = 1.24 and 1.57, with the 75% limestone sample having the highest and the 25% limestone sample having the lowest effective dust dispersion effects. Conceivably, the effective moisture reduction in the samples led to fewer agglomerations and/or reduced densities, influencing the ability of lift forces to act on the particles, while as the limestone content was increased in coal-limestone mixtures, dust layers grew faster, larger, and transitioned into more pronounced instabilities on the dust-gas boundaries. The combined effects of dispersion, SEM imagery, and the study of test facility shadowgraphs lead to recommending the ignition-inhibiting coal-limestone mixture containing 50% limestone. The dust-layer rise height was measured with respect to time after the shock passage, where regardless of mixture-ratio or moisture content in the samples, initial linear dust growth rates increased with shock Mach number. Linear and unstable regimes were also identified in the data samples, as seen in previous studies by the authors.

Keywords Dust explosion hazards; Limestone moisture content; Coal-limestone mixture; Dust layer; Shock tube; High-speed imaging.