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DUST PARTICLE FLOW-FIELD CHARACTERIZATION USING HIGH-SPEED DIGITAL IN-LINE HOLOGRAPHY (DIH) DURING MINIMUM-IGNITION ENERGY TESTING

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Abstract:

Improvement of dust explosion risk assessment and mitigation strategies in the process industries is a continual pursuit to reduces the frequency and severity of hazardous explosions. To improve the current understanding of dust ignitibility during laboratory-scale tests, new diagnostic techniques are required to enable the imaging and characterization of microscopic dust particles in the vicinity of the ignition spark in minimum ignition energy (MIE) testing device. In this study, high-speed digital in-line holography (DIH) is employed to obtain quantitative particle size, concentration, and velocity information from dust particles in a Kühner MIKE 3 MIE testing apparatus prior to ignition. A high-speed DIH experimental system for the volumetric, non-intrusive, and in-situ imaging and characterization of various dusts dispersed at the standard MIE test pressure are presented. Interference patterns created by suspended micron-size dust particles upon illumination of a monochromatic laser light source are imaged using a high-frame-rate CMOS camera coupled to a high-magnification lens system. Post processing of digitally refocused images provide visual characterization of the particle field, while resulting particle size and velocity distribution data quantify the central tendency and variability of each dispersion. The time evolutions of particle concentration and velocities are also presented to provide transient characterization of each dust. These results provide new quantitative dust particle data and establish a method for identifying microscopic dispersion conditions that can be related to dust cloud ignitibility and the MIE.

Keywords:

Dust Explosions, Particle Characterization, Digital In-Line Holography, Minimum Ignition Energy

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