

High-Speed Digital In-Line Holography for Dust Particle Imaging and Characterization

Christian Schweizer^{1,*}, Ankit Saini², Daniel Guildenbecher³, Chad Mashuga², and Waruna Kulatilaka¹

1. J. Mike Walker '66 Department of Mechanical Engineering, Texas A&M University, College Station, Texas 77843
2. Artie McFerrin Department of Chemical Engineering, Texas A&M University, College Station, Texas 77843
3. Engineering Sciences Center, Sandia National Laboratories, Albuquerque, New Mexico 87185

*Presenter E-mail: schweizer@tamu.edu

Abstract

The continual pursuit to improve safety and reduce dust deflagration and explosion events in the process industries necessitates the development of diagnostic techniques that can image and characterize microscopic dust particles in minimum ignition energy (MIE) testing devices. In the present study, high-speed digital in-line holography (DIH) is used for the volumetric, non-intrusive, and in-situ imaging and characterization of dust particles dispersed in a Kühner MIKE 3 MIE testing apparatus prior to ignition. A high-speed DIH experimental system for the extraction of quantitative size, concentration, and velocity data for various dust particles is presented. This quantitative data is presented visually by digitally refocused images of the particle field, and statistically by dust particle size and velocity distributions. The transient behaviour of the dust dispersions is captured by the evolution of dust particle concentrations and velocities over time. These results demonstrate the capability of high-speed DIH to obtain quantitative dust particle data in the ignition volume of interest. Visual, statistical, and transient characterization capabilities allow for the analysis and comparison of different dusts and dispersion conditions. These methods will be applied in future MIE tests under combustible conditions to relate microscopic dust characteristics to dust cloud ignitability.

Keywords: Dust Flammability, Dust Explosions, Digital In-Line Holography, Ignition

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.