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A Critical Evaluation of Combustible Dust Test Methods

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ABSTRACT

The sugar dust explosion in Georgia on February 7, 2008 killed 14 workers and injured many others (OSHA, 2009). As a consequence of this explosion, OSHA revised its Combustible Dust National Emphasis (NEP) program. The NEP targets 64 industries with more than 1,000 inspections and has found more than 4,000 combustible dust related violations. Grain dust is a combustible dust. If a concentration of grain dust at or above the minimum explosive concentration (MEC) is ignited, a primary explosion or deflagration will result. This primary explosion will produce a pressure wave followed by a fire front. The turbulence caused the fast moving pressure wave can entrain layered dust in a second, larger chamber which can be ignited by the relatively slow moving fire front, producing a more damaging secondary deflagration. It has been alleged that dust found in cotton gins is a combustible dust. Tests were conducted by the Center for Agricultural Air Quality Engineering and Science (CAAQES) and by a commercial laboratory to determine if gin dust was a combustible dust. The CAAQES laboratory reported that gin dust was not a combustible dust. The commercial laboratory reported no deflagrations with the Hartman tube for 110 tests for concentrations ranging from 208 to 16,700 g/m^3. These "screening" tests were performed using a totally enclosed Hartman tube with a stationary, 10 Joule (J) ignition source. If the measured gage pressure exceeded 0.4 bar, it was assumed that a deflagration had occurred. ASTM and NFPA require that a more rigorous test be performed by the testing laboratory if no deflagrations result from the screening tests. This procedure consists of testing a wide range of dust concentrations in a totally enclosed 20 liter (L) chamber with pyrotechnic, chemical igniters of 2,500, 5,000 or 10,000 J. If the measured gage pressure exceeded one bar for this 20L test, it was assumed that a deflagration had occurred. The testing laboratory's results from the more rigorous testing indicated that gin dust was a combustible dust. A detailed analysis of the different testing methods revealed that the 20L chamber testing protocol was problematic. Using pressure rise as the indicator that a deflagration occurred in the 20L testing can lead to a conclusion that a non-combustible dust is combustible when it is not. The rise in pressure may be a consequence of the thermal reaction result as the flame from the pyrotechnic igniter passes through the dust cloud. A theoretical analysis is presented illustrating that the pressure resulting from the thermal reaction of one gram of dust along with the associated rise in temperature in the 20L chamber will produce a pressure in excess of the threshold used by the testing laboratory's 20L test deflagration indicator.