Evaluation of Dust Explosibility Testing Methods
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Abstract
Dust explosions in grain handling facilities such as grain elevators and feed mills continue to occur. From 1976 until 2010, more than 500 dust explosions occurred. There was some concern that cotton gins were handling dust that was explosible. The Center for Agricultural Air Quality Engineering and Science (CAAQES) performed a series of tests in the CAAQES laboratory using the CAAQES method and reported that “gin dust” was not explosible (Parnell et al. 2012.) However, samples of the same gin dust were sent to a commercial laboratory using the ASTM testing protocol and the lab reported that gin dust was a “Class A” explosible dust.

There are a number of scientists and engineers who equate explosible with combustible. The authors believe that equating combustible with explosible is problematic. Palmer, (1973) addressed this topic as follows: “All explosible dusts are combustible but not all combustible dusts are explosible.” There is a simple test for determining the mass fraction of a dust that is combustible. Not all dusts are explosible.

There were several problems detected in the ASTM process of testing gin dust for explosibility. A potential explosible dust is dispersed into a totally enclosed 20L chamber. A subsequent flame used to ignite the dust cloud is propagated through the dust cloud. (The energy of the flame may be as high as 10 kJ.) If the resulting measured test pressure exceeds 1 bar (14.5 psig) the dust is classified as explosible. The only criterion for classifying a dust as explosible is the resulting pressure in an enclosed chamber. There is a possibility that sufficient pressure will result without a self-propagating flame passing through the dust cloud in the totally enclosed 20L chamber. The result is classifying a dust as explosible when it is not.

The CAAQES protocol was developed to determine if a dust was explosible. The criterion used to classify a dust as explosible is a measured minimum explosible concentration (MEC). Since the ignition source is stationary, the pressure needed to burst the diaphragm must be a
consequence of a self-propagated flame through the cloud. The pressure versus time curve illustrates the pressure rise and subsequent vacuum when the diaphragm bursts. The CAAQES method consists of performing tests for different concentrations of the dust in a 28.3L (one cubic foot) Plexiglas chamber fitted with a pressure transducers and a paper diaphragm that bursts when the dust is ignited. The ignition source is a stationary hot coil. The chamber is a cube. A measured quantity of dust to be tested is placed in a crucible in the chamber. (The mass of dust placed in the crucible is sufficient to produce concentration that is at or exceeds the MEC when the dust is entrained with a short blast of compressed air. The chamber is designed so that the paper diaphragm will burst at 2 psig. (This is the pressure that is reported to be typical of primary explosions.)

If one incorrect explosibility test has resulted in an incorrect determination that a dust is a class ‘A’ exploisible dust using the ASTM protocol, there can be others. This can be a problem in the prevention of dust explosions. It is assumed that an industry handling a dust that is classified as exploisible will be treated differently than one handling dust that is not exploisible.