This is not "Dust" so I don't have a problem!

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There has been a great deal of interest in the field of combustible dust explosion/fire protection since the Port Wentworth, GA sugar dust explosion that occurred at Imperial Sugar. There have been several US Chemical Safety Board reports on the subject of dust explosions and the Occupational Safety and Health Administration (OSHA) has issued a national emphasis program instructing auditors about how to asses a dust explosion hazard. Additionally, there has been renewed interest in the activities of the National Fire Protection Agency (NFPA) with regard to combustible dust fire and explosion risk mitigation standards. These agencies are addressing issues such as dust explosion venting, dust explosion suppression, fugitive dust clean up, combustible dust hazard classification zones etc. In all cases they are addressing "dust" hazards, but what is a "dust"? The NFPA 654 defines it as finely divided particles that can be dispersed in air.

Other NFPA standards define it as particulates with particle size limitations. For example; section 3.3.27.1 of NFPA 664-2012, *"Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities"*, states that a Deflagrable Wood Dust is wood particulate matter capable of propagating a flame that has a mass mean diameter of 500 microns or smaller. Then section 3.3.27.2 of the same standard states that dry nondeflagrable wood dust is wood particulate material that has a mass median particle size greater than 500 microns. NFPA 664 is not alone in this type of narrow interpretation. Section 3.3.1 of NFPA 61-2008, *"Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities"*, states that Agricultural Dust is any finely divided solid agricultural material 420 microns or smaller in diameter that presents a fire or explosion hazard when dispersed and ignited in air. Even OSHA defines combustible dust as flammable particulate material less than 420 micron. The rational being that particles greater than 420-500 microns do not pose a threat of an explosion. From first hand experience in operating a testing laboratory we know that this is not true.

This article will present some data from experiments conducted in a 20-L Siwek chamber and spherical 1-m³ chamber that demonstrates the explosibility of combustible dusts that have a mean particle diameter greater than 500 microns. This information is discussed in greater detail in a presentation authored by Erdem Ural, Stuart Johnsonand Ashok Ghose Dastidar titled *"Effect of Particle Shape and Size Distribution* *on Dust Explosion Risks"* and delivered at the 8th Global Congress on Process Safety, from April 1-5, 2012 in Houston, TX.

One of the "dusts" selected for this study was wood dust purchased from American Wood Fibers. Two grades were selected to provide distinct particle size distributions. The first was a fine material – Grade 14020 – which will be referred to as Wood Flour and the second was a coarse material – Grade 2020 – which will be referred to as Wood Dust. The Wood Dust material was sieved to remove the fraction of particles that were between 500µm and 850µm for testing. The particle size distribution information is presented in Table 1. The Wood Flour is very fine with a mean particle diameter of approximately 60µm. The Wood Dust is very coarse having a mean diameter of approximately 840µm; this material can even be considered as "nondeflagrable wood dust" per the NFPA 664 standard.

It is important to note that even though the Wood Dust was sieved material there might still be particles which have elongated morphologies so the short axis may be less than 850µm, allowing the particle to pass through the sieve, but the long axis may be much greater than the screen opening. Figure 1 is a micrograph of the type of particle which would have passed through the sieve.

Table 1: Particle size distribution of test samples

Sample	**Mean Diameter**	**Diameter on %**			**Moisture wt%**
		10%	50%	90%	
Grade 14020 "Wood Flour"	59.5 µm	11.5 µm	53.3 µm	114.8 µm	1.57
Grade 2020 "Wood Dust"	836.8 µm	458.9 µm	787.0 µm	1272.5 µm	3.85

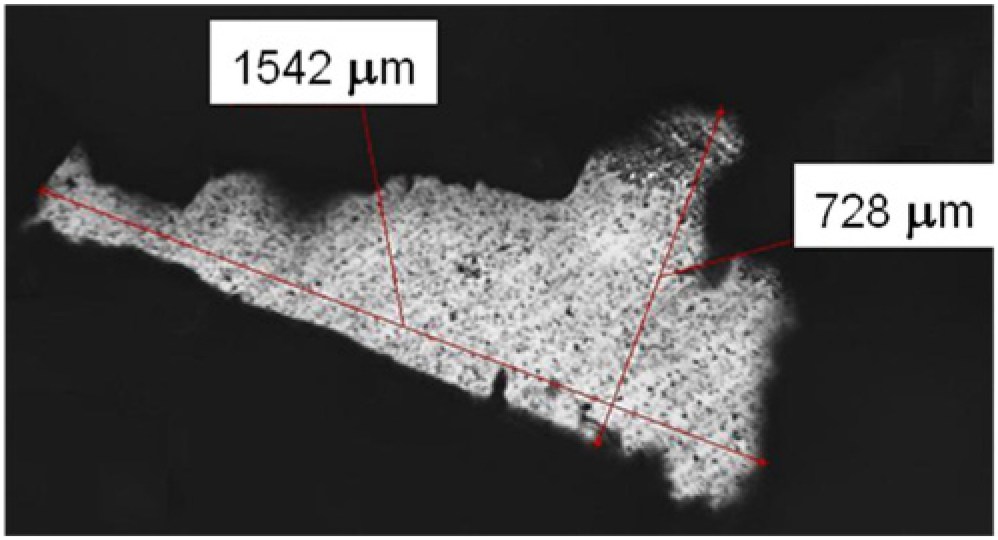

Figure 1 Micrograph of a Wood Dust particle.

These two materials were used as the source samples for various mixtures used for explosion severity tests that were performed. The Wood Flour mixtures with 0%, 50%, 80%, 90%, and 95% Wood Dust mixtures were tested in addition to 100% Wood Dust.

In order to establish the explosibility of the wood mixtures, test method ASTM E1226-10, *"Standard Test Method for Explosibility of Dust Clouds"*, was selected to be performed in both chambers to ascertain explosion severity. In this method a pre-weighed dust mixture is dispersed into the combustion chamber with compressed air creating a confined cloud of "dust". Then after a preset delay, two 5-kJ igniters are discharged and the resulting pressure rise from the combustion of the cloud is recorded as a function of time. This process is repeated with increasing quantities of dust until a maximum value has been found for the explosion overpressure and the maximum rate at which the explosion progresses. According to ASTM E1226, dusts deflagrations producing P_{max} greater than 1 barg are explosible. An example of a typical pressure-time trace is presented in Figure 2 below.

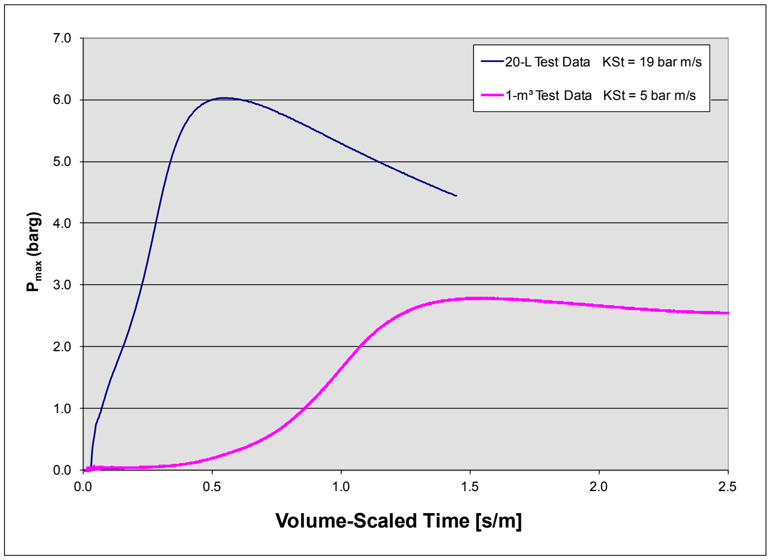

Figure 2 Pressure-time traces of 100% Wood Dust deflagration tests.

In Figure 2 the test data is plotted for 100% coarse Wood Dust in both the 20-L chamber and 1-m³ chamber. The explosion overpressure, expressed in barg, is plotted on the ordinate with the volume-scaled time, in s/m, on the abscissa. The results from the 20-L chamber (blue line) indicate that the deflagration resulted in a 6 bar overpressure with a 19 bar m/s rate of pressure rise. Additionally, the 1-m³ data (pink line) indicates that the deflagration in that chamber produced an overpressure of 2.8 bar and a rate of pressure rise of 5 bar m/s. It is important to note that the dispersion mechanism on the 1-m³ chamber was designed primarily to disperse very fine dust having a particle size less than 65µm. As a result, slow burning of dust clouds at high dust loadings with coarse material may be expected. The important factor to note is that material; which according to some NFPA standards, should not be capable of supporting flame propagation appears to do so very well.

As the coarse Wood Dust is “contaminated” with fine material (adding 20% Wood flour to Wood Dust) the explosion severity measurements in the two chambers become similar, as seen in Figure 3. Both chambers produced peak overpressures in the range of 7 bar and had comparable rates of pressure rise. A comparison the of the peak overpressures and rates of pressure rise are made in Figures 4 and 5 respectively where the data is plotted as a function of percent coarse Wood Dust in the mixture. As in the previous figures, the Wood Flour – Wood Dust mixtures are explosible for all samples tested.

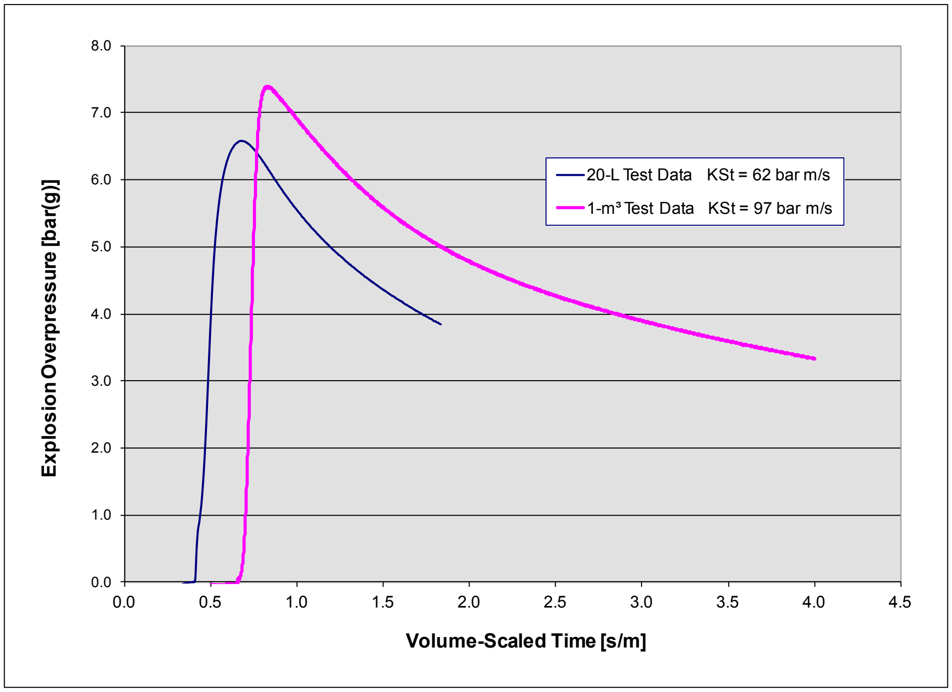

Figure 3 Pressure-time traces of 80% Wood Dust deflagration tests.

The test data clearly demonstrates that "nondeflagrable" wood dust as defined in NFPA 664 is actually an explosion hazard and that even a small amount of contamination with wood fines (Wood Flour in this case) is capable of making weak explosions energetic. Similar deflagration results were observed in the 1-m³ and 20-L scale for various dusts mixtures tested. Thereby, putting to rest the very dangerous myth that coarse wood particles having a mean particle size greater than 500 micron do not pose a dust explosion risk.

<u>References</u>

NFPA 664: Standard For The Prevention Of Fires And Explosions In Wood Processing And Woodworking Facilities,

NFPA 61: Standard For The Prevention Of Fires And Dust Explosions In Agricultural And Food Processing Facilities,

ASTM E1226 (2010) Standard Test Method for Explosibility of Dust Clouds,

Erdem Ural, Stuart Johnson and Ashok Ghose Dastidar, *"Effect of Particle Shape and Size Distribution on Dust Explosion Risks"* 8th Global Congress on Process Safety, from April 1-5, 2012 in Houston, TX.

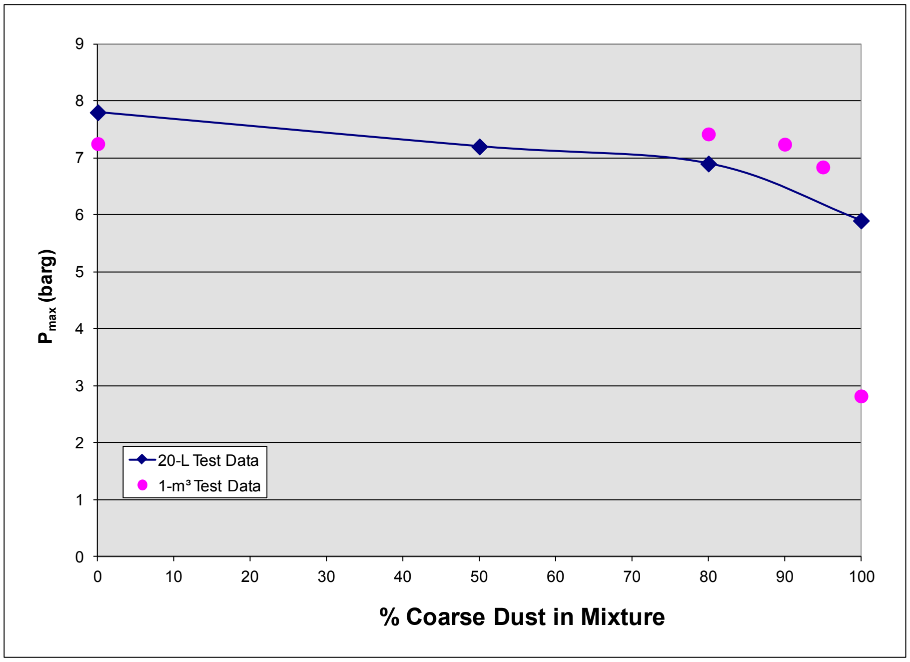

Figure 4 Explosion overpressure in the 20-L chamber and the 1-m³ chamber as a function of percent coarse Wood Dust in the mixture.

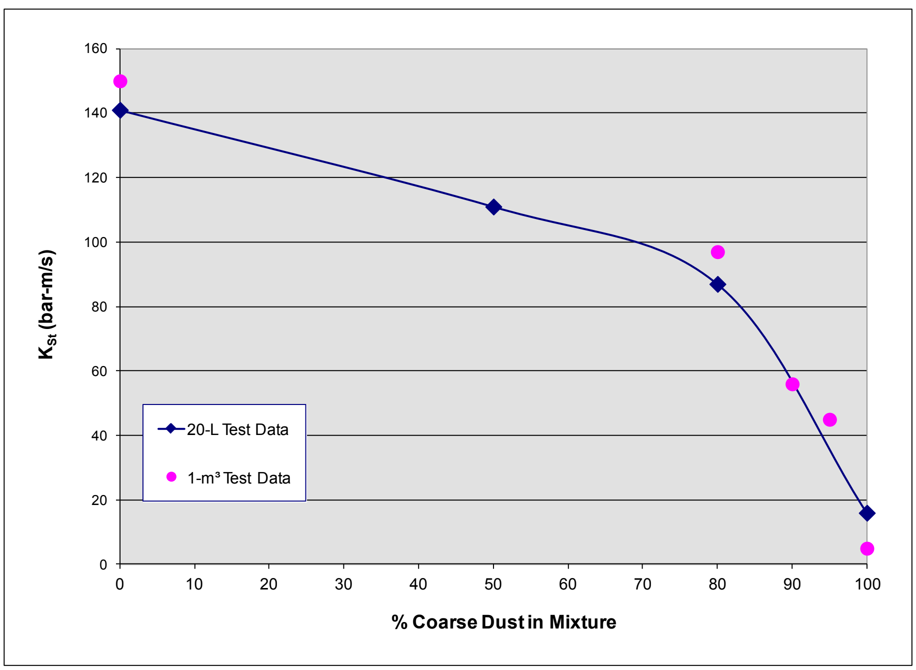

Figure 5 Explosion rate of pressure rise in the 20-L chamber and the 1-m³ chamber as a function of percent coarse Wood Dust in the mixture.