

WHITE PAPER

How Well Do You Know Your Dust?

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The collection and testing of dust samples is a long-established practice used by many powder and bulk processors to make informed dust collection decisions. Dust testing protocols have not changed markedly in recent years. The importance of dust testing, however, has changed, and the implications are significant. While knowing your dust has always been good practice, it is rapidly becoming a necessity in today's regulatory climate.

This article will review two separate types of testing: (1) explosibility testing, which is used to determine whether a dust is combustible; and (2) bench testing, which pinpoints numerous physical properties of the dust. Both categories of tests are needed to determine the best dust collection system for your application and whether explosion venting equipment must be part of that system.

Explosibility Testing

A recent (6-08-08) segment on the CBS News series "60 Minutes" reported that "devastating dust explosions at American factories are more common now than ever. Since 1980, there have been at least 350 such explosions in the U.S., killing 133 people and injuring hundreds more." At the time of this writing, a measure that will require OSHA to impose new safety rules for combustible dust has been approved by the House of Representatives and awaits a Senate vote.

In the meantime, OSHA has identified and contacted 30,000 companies considered to be at risk of explosion from combustible dusts. OSHA is addressing the issue aggressively through its National Emphasis



When advanced testing is needed on combustible dusts, full-scale explosion test vessels can be used. (Fike Corp.)

Program on safe handling of combustible dusts and through enforcement of the “National Fire Protection Association (NFPA) 68 Standard on Explosion Protection by Deflagration Venting”, a 2007 standard that provides mandatory explosion venting requirements for dust collection



Test chamber used for standard explosibility testing (Fike-Corp.)

applications involving combustible dusts. The main purpose of explosion venting is to save lives by preventing a dust collector from exploding, so the importance of getting this equipment right cannot be understated.

What does all this have to do with dust testing? To determine whether your dust is combustible, it must undergo explosibility testing in accordance with ASTM test methods. NFPA 68 stipulates that if a dust sample is available, it must be tested. The standard further states that it is the responsibility of the end-user (i.e., the plant or safety engineer) to commission the required testing and report on results. This is a noteworthy change from past practice: What used to be a “guideline” is now a “standard” and is regarded as mandatory.

Explosibility testing is available through several companies that specialize in explosion protection services. You can opt to go directly to such a company, or you can commission the testing through your dust collection supplier.

Using your dust sample a lab will start with a screening test to determine whether the dust is inert or explosive. If the dust is inert, testing will stop there. If it is combustible, the lab will conduct further testing on dust cloud explosibility parameters to pinpoint the K_{st} (defined as the deflagration index of a dust cloud, or rate of pressure rise) and P_{max} (the maximum pressure in a contained explosion). Costs will range from around \$600 for screening only to about \$1,400 for the standard battery of ASTM explosibility tests if needed.

Even if you believe your dust to be inert, it still must be tested under NFPA 68. For example, paper dust may be inherently inert



Test rig using multiple dust collectors to perform specialized full-scale dust testing.

– but if a coating or glue is mixed in during processing, it can drastically change the combustibility characteristics of the dust. Explosibility testing is the only way to know for sure, and is therefore the only way to guarantee compliance. You might be surprised by the results when you submit your dust for testing.

If your dust is found to be even slightly combustible, you will be required to use explosion venting equipment on your dust collector. The specific results of the explosibility testing will enable your dust collection supplier to determine whether you can use a standard explosion vent; or whether the vent size, ducting and related components will need to be specially calculated and modified to ensure compliance. Either way, ask for documentation that the equipment has been manufactured in accordance with the latest NFPA standards.

Bench Testing

Whether you are planning a new dust collection system or updating existing equipment, dust collection is a complex process affected by dozens of variables. Dust sample bench testing is an excellent tool for knowing your dust better, forming the basis for sound and accurate equipment selection.

Bench testing is beneficial in many ways. By identifying the dust characteristics properly, you can determine the right type of collector and filtration media for your needs and determine the right equipment sizing and air-to-cloth ratio needed for optimal energy savings and operational efficiency. This can help to minimize maintenance problems and meet more stringent emission requirements while extending filter life.

A few independent test laboratories have dust collection experience, and can perform bench testing at costs ranging from \$300 to \$1,000. Some equipment manufacturers have in-house test labs and offer free testing as a value-added service to customers. Find out whether you are obligated to buy a dust collector if the manufacturer conducts tests for you.

The lab will ask you for a sample (see Note on Sampling Procedures) and should also ask for detailed application data. This data may include information on the process generating the dust, operating requirements, airflow and pressure-drop conditions, temperature and humidity, space constraints, and more. Without application data, no context exists for your test program, and test results will be less meaningful.



Particle-size analysis is used to reveal dust's particle-size distribution down to the submicron range.

Common bench tests include:

1. **Particle size analysis** reveals the dust's particle size distribution down to the submicron range. This information determines the filtration efficiency required to meet emissions standards. A dual-laser particle analyzer can pinpoint both the count (the number of particles of a given size) and the volume or mass spread of the dust. Knowing both is important because many dusts are mixed. Sieve analysis is a related test that measures large particle sizes (>100 microns).

2. A **video microscope** provides visual analysis of the dust shape and characteristics. Together with particle size analysis, this tool is vital for proper equipment selection, often helping to determine what type of collector should be used. For example, a microscope may be needed to see oil in the dust. Oil can cause serious problems with dry-dust collectors and may require the use of a filter media with an oleophobic or oil-resistant coating. In more drastic cases, an alternate collection system might be needed.

3. **Pychrometer testing** determines the true specific gravity of the dust as opposed to the bulk density. Specific gravity is the weight of a given material as a solid block. This test can help to determine the efficiency of cyclonic-type dust collectors.

4. A **moisture analyzer** measures a dust's moisture percentage by weight. This information can help to prevent or troubleshoot moisture problems that could affect filter performance. A humidity chamber is used to see how quickly a dust will absorb moisture. This test helps to identify hygroscopic (moisture-absorbent) dust. Hygroscopic dusts require widely pleated filter cartridges or bag-type filters, as these sticky dusts cause tightly pleated filters to plug up.

5. **Abrasion testing** measures the relative abrasiveness of dust. This knowledge helps to determine the optimal design of dust-handling components, including valves, inlets, and ductwork. For example, when capturing a highly abrasive dust, the collector must be designed with low inlet velocity. Otherwise, the dust will re-entrain on the filter elements, abrading the filters and causing premature wear.



A video microscope provides visual analysis of dust shape and characteristics.

6. Terminal velocity testing pinpoints the air velocity required to lift the dust. This information helps to determine correct dust collector size and bag or cartridge filter size. Horizontal velocity testing reveals the optimal velocity needed to move the dust horizontally, aiding in proper ductwork system design. Sliding angle/angle of repose testing determines the angle at which dust forms freely, aiding in hopper and dust discharge design. This test further identifies whether the dust tends to stick or agglomerate.

Specialized testing

The explosibility and bench tests described above will be sufficient in the great majority of cases. Sometimes, with a highly unusual or trouble-prone application, additional testing might be dictated.

Explosion test labs have the capability to perform a variety of advanced tests using both small- and large-scale explosion test vessels. A reputable lab will be able to make recommendations on further testing needed to analyze your combustible dust problem.

Similarly, after bench testing is completed, you might need further information to troubleshoot a serious collector problem or to predict the behavior of an unusual or difficult dust. In these situations, full-scale dust testing using one or more dust collectors may be considered. Full-scale testing apparatus is available from a handful of labs and may be used for real-time or accelerated testing that simulates actual operating conditions.

A Note on Sampling Procedures

Proper collection of the dust sample is important to make sure that it represents the state in which the filter will collect it. Begin by reviewing the dust's Material Safety Data Sheet to ensure that you take precautions against any hazards associated with the dust.



Every dust is different. The only way for plant personnel to know their dust is to commission laboratory testing.

If you have an existing dust collector, a dirty bag or cartridge is an ideal sample. Otherwise, take care to collect a sample that represents the dust to be captured by the collector. For example, dust swept from the floor is not representative, because it will contain impurities and larger particles with enough mass to have fallen to the floor. Dust from a hopper is not recommended either, because the sample won't represent the true particle size distribution of the dust captured by the filters. Ask the lab for further guidelines on proper sample collection

