



## Collecting and testing DUST

Knowing dust characteristics  
facilitates ventilation equipment selection

By Lee Morgan

**I**n 1998, both the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) issued more stringent requirements relating to the use of respirators in plants. Though respirators are critical to shielding workers from ambient dust and fumes, they are not the total answer.

The new OSHA standard (29 CFR 1910.134) states that employers are expected to use engineering controls to protect workers from air contaminants and *not* rely on respirators alone. While respirators do a good job of protecting workers' lungs, they do nothing to safeguard machinery and process areas from contamination that may result in costly equipment failure, constant rework, or general cleaning nuisances.

The equipment currently used in

fabricating plants has reached a new level of sophistication. High-definition plasma cutters, laser cutters, and other computerized systems are more sensitive than machinery was 10 or 20 years ago. If dust is not collected properly from laser tables, welding stations, and similar areas, a million-dollar investment can be ruined in no time.

A well-designed and maintained dust and fume collection system is needed to prevent such problems and keep facilities in compliance with



**Figure 1**

A dual-laser particle analyzer is used in bench testing to perform particle size analysis.



**Figure 2**

Four types of dust collectors are contained in this full-scale testing apparatus.

current air-quality requirements. In some cases, a good dust collection and ventilation system can eliminate the need for personal respirators and the challenge of getting employees to wear them.

Despite the importance of dust collection, most equipment decisions are based solely on guesswork, on previous experience, or on general recommendations from suppliers. Finding the right dust collection system is a complex task affected by dozens of variables. The situation does not lend itself to guessing games.

Fabricators often are unaware that dust and fume collection can be approached scientifically using dust sample testing as the basis for sound and accurate equipment selection.

Testing dust is beneficial in many ways. By identifying the dust characteristics properly, you can determine the right type of collector (such as baghouse or cartridge system) and filtration media for your needs and determine the size equipment you need for optimal energy savings and operational efficiency. By using the right equipment, you can minimize maintenance problems and reduce emissions while extending filter life.

### **Finding a Qualified Test Lab**

A few independent test laboratories have dust collection experience, and some equipment manufacturers also offer testing. Before selecting a lab, review these questions with potential vendors:

#### **1. How much does testing cost?**

Independent labs may charge anywhere from \$300 to \$10,000, depending on the scope of the testing. Some manufacturers 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.

#### **2. How long does testing take?**

The testing usually takes no more than a day to complete, but additional time is needed to prepare a written report. Ask whether you are allowed to visit the lab during testing: You may find it useful to participate in the test process.

**3. What kinds of tests are available?** Find out how many “small-sample” or “bench” test procedures typically are used to evaluate dust samples and whether full-scale testing is available.

**4. What samples or other materials will be needed to run the tests?** Bench testing requires only a 1-

pint dust sample in an airtight container. For full-scale testing, a 55-gallon drum of dust is needed. Proper collection of the sample is important to make sure that it represents the state in which the filter will collect it. If you have an existing dust collector, a dirty bag or cartridge is an ideal sample.

The lab also should ask you to provide 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, which means less-valid test results.

#### **5. What type of reports and recommendations will be provided?**

Based on test data and your application input, you should receive a recommendation that includes filter type (i.e., bag or cartridge), media type, and air-to-cloth ratio (defined as the velocity of the gas stream through the filter media). Lab application engineers also can recommend the proper dust discharge equipment design, including hopper angle and rotary airlock versus screw conveyor, and advise you on what will be needed to get the dust out of the collector.

## Dust-testing Methods

For the majority of dust-testing situations, small-sample or bench testing will suffice. Common bench tests include:

**1. Particle size analysis**, which reveals the dust's particle size distribution down to the submicron range. This information determines the filtration efficiency required to meet emission standards. The dual-laser particle analyzer shown in **Figure 1** 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.

For example, the exhaust dust from a plasma cutter includes submicron carbon particles mixed with much larger steel particles. Scientific testing is the only way to identify the tiny particles of carbon dust, which helps you to choose the appropriate equipment and filter media. **Sieve analysis** is a related test that measures particle size larger than 100 microns.

**2. A video microscope**, which 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—a common occurrence with processes involving oily steel. Oil can cause serious problems with dry-dust collectors, sometimes dictating the use of an alternative system.

**3. Pycnometer testing**, which 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. For example, aluminum weighs 165 pounds per cubic foot. **Bulk density** is the weight of the same material in the form of dust. For example, flame-sprayed aluminum dust weighs only 1 to 2 pounds per

cubic foot. Pycnometer testing can help to determine the efficiency of cyclonic-type dust collectors.

**4. A moisture analyzer**, which 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**, which 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 such as cast-iron grindings, the collector must be designed with low inlet velocity. If inlet velocity is too high, the dust will re-entrain on the filter elements, abrading the filters and causing premature wear.

**6. Terminal velocity testing**, which pinpoints the air velocity required to lift the dust. This information helps to determine correct filter housing size and bag length. Horizontal convey 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.

In some cases, after bench testing is completed, a lab might need further information to troubleshoot an existing collector problem or to predict the behavior of an unusual or difficult dust. In these situations, full-scale testing using one or more dust collectors

may be needed. Full-scale testing also can help fabricators to meet particularly strict emission requirements involving toxic dust and fumes such as those emitted when cutting or welding galvanized material.

**Figure 2** shows a full-scale testing apparatus equipped with four types of dust collectors. Tests can be run on any or all of the collectors to determine the best equipment choice for the application using either real-time or accelerated testing that simulates actual operating conditions. In addition to comparing the collectors, many performance variables also can be evaluated, including different media types, filter configurations, air-to-cloth ratios, temperatures, airflows, and dust loading conditions.

Customers may view the testing and make changes in a "what if" context to evaluate the impact of different variables.

## After Testing Is Complete

The fabricator now can work knowledgeably with the equipment supplier to choose the appropriate collector and filter media type, the best air-to-cloth ratio, the proper can velocity (defined as the upward flow of air through the housing), and the best inlet and hopper design. The end result is a dust collection system that delivers reduced emissions, reliable operation, and optimal protection of workers and equipment. ■

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# How testing succeeds where guesswork fails

Company X, which used a wheel-blasting system to finish steel beams, was not attaining adequate dust pulse-down filter cleaning with its cartridge-type collector, resulting in high delta P. (Pressure drop or “delta P” in inches of water gauge [w.g.] is the measurement of how dirty the cartridges are.) The company sent a used cellulose media filter cartridge to a laboratory for dust testing.

An initial particle size analysis revealed a very fine dust mixed with larger metal dust, which was confirmed when the number and volume distributions of the dust were measured (see **Figures 3A** and **3B**).

Dust analyzed under a video microscope supported this finding. The larger steel particles were surrounded by blotches of agglomerated mill-scale dust (see **Figure 4**). This finer dust is the carbon that is pulverized off the steel by the blasting wheel.

While these procedures provided useful information on the dust’s size and characteristics, the bench test results did not

offer an adequate explanation for the current dust collector problems. A full-scale test was carried out to provide more in-depth analysis.

The lab engineers hypothesized that special silicone-treated filter media might perform better than the standard cellulose media.

Silicone had been shown to prevent finer dusts from impregnating the media. The focus of the full-scale test was to compare the differential pressure drop of the two media under similar conditions. A media change can reduce pressure drop, thereby increasing filtering efficiency.

In the lab, the cleaning system in the test collector was set to pulse automatically every 15 seconds. A 55-gallon drum of blasting dust was fed gradually into a cartridge dust collector on the full-scale test apparatus. A computer, which controlled the feed rate as well as air-to-cloth, air volume, and airflow ratios, produced real-time graphs of the collector’s delta P and emissions.

To test the two media, lab personnel set the inlet dust feed at a very high rate to simulate dust loading in an accelerated manner. The feed rate also determined how fast the delta P would climb across the filter media. As the test continued, the engineers varied the feed and pulse rates and observed results to determine whether the filters were performing satisfactorily.

Satisfactory performance is defined as a recovery in differential pressure after half of the filter elements are pulsed. If performance is not satisfactory, settings are adjusted to maintain a constant load of dust. This process is repeated over several hours.

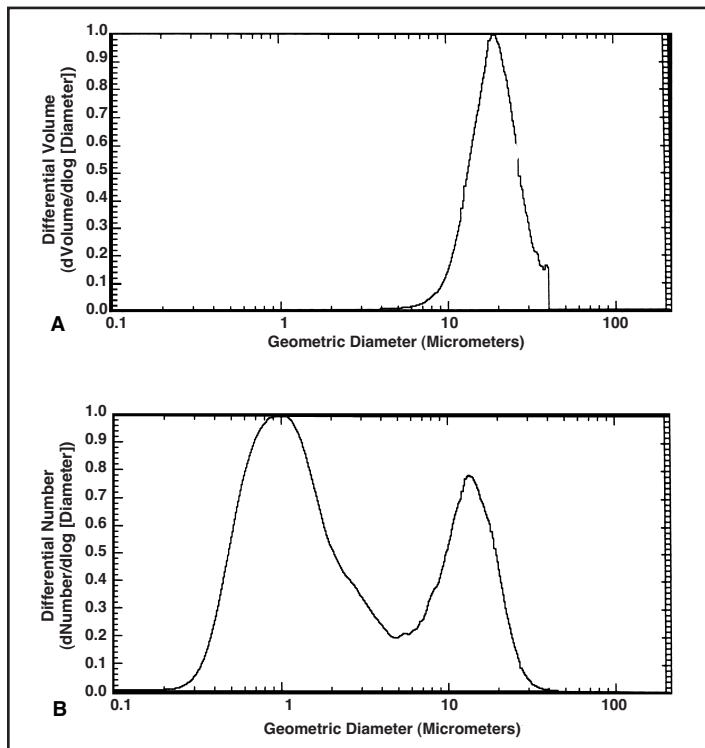
Using this test approach, the standard media stabilized at a pressure drop of 2.7 inches w.g. The silicone-treated media, by contrast, stabilized at 1.9 inch w.g.—a 0.8-inch w.g. reduction. Based on these results, the engineers determined that the silicone-treated media performed better and could be expected to experience lower pressure losses under actual operating conditions. In real-life experience, this pressure drop reduction also can be expected to result in improved airflow, lower energy usage, and longer filter life.

Without testing, Company X would have had to resort to trial and error to resolve its dust collection problem. Testing solved the problem and led to performance enhancements that could not otherwise have been anticipated.



**Figure 4**

This magnification of steel blasting dust shows that fine and large dusts were mixed.



**Figure 3**

These graphs show particle number and volume distribution of the same dust.

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