Filter Media Efficiency Does Not Equal Dust Collector Efficiency

Andy Winston, GE Energy, USA, explains the importance of all components of a dust collector when determining efficiency.

Introduction

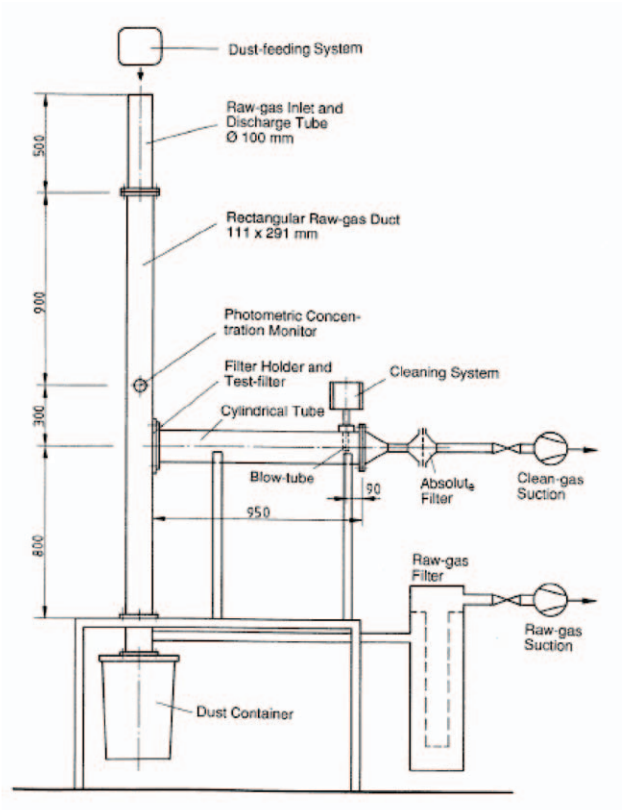
The efficiency of the filter media used in a dust collector does not equate to dust collector efficiency; the efficiency of a dust collector results from the combined efficiencies of all its components. It is important to remember that the filter media is just one component of the filter bag, and the filter bag is just one component of the dust collector system. Therefore, the proper functioning of all dust collector components determines dust collector efficiency.

Filtration media

There are two types of dry filtration media in use today: depth filtration media, and surface filtration media.

Depth filtration media requires maintaining a dust cake on the filter bag to achieve effective efficiency. Even if operated at near perfect levels, fabrics using depth filtration media can only achieve outlet emissions levels of about 0.01 gr/acf (23 mg/m^3).

Surface filtration media utilises an added barrier on the filtration fabric as the filtering layer. In modern filtration technology, the most widely used filtering layer in the industry is expanded PTFE (ePTFE) membrane. Filtration fabrics laminated with ePTFE membranes can achieve near perfect efficiency. However, as previously stated, the filtration fabric is just one of many components contributing to dust collector efficiency.



Test equipment.

Filtration fabric testing

In North America, the most widely used filtration fabric testing method is the Environmental Protection Agency's (EPA) Environmental Technology Verification (ETV) using American Society for Testing and Materials (ASTM) procedure D-6830-02 and Association of German Engineers (VDI) procedure 3296.

All EPA-ETV verification testing is performed under strict protocol, which includes specific requirements for testing, quality management, quality assurance, procedures for product selection, auditing of test laboratories, and the test report format, which is based on VDI 3926 and ASTM D-6830-02 test methods. This testing includes using a filter efficiency media analyser to measure particles that are 2.5 μm and smaller (PM 2.5). The test dust used is aluminium oxide dust with an average diameter of 1 μm. A 6 in. (150 mm) diameter fabric filter sample is tested at specified air and dust flow rates under simulated dust collector conditions. The test consists of three test runs, with each onsisting of three sequential phases (or test periods), during which dust and gas flow rates are maintained at constant test specifications. The test phases are as follows:

- A conditioning period consisting of 10 000 rapid pulse cycles.
- A recovery period consisting of 30 normal pulse cycles.
- A 6 hour test period in which the filter media is pulse-cleaned each time the pressure drop increases to 4 in. (100 mm).

The testing evaluates pressure drop as well as the cleaning requirements of the fabrics under test.

Test equipment

Tables 1 and 2 display laboratory test results for three samples of fibreglass laminated with ePTFE. Though the results vary, two of the three samples tested would pass particulate emissions regulations in any country.

As the test results indicate, lower retained air permeability usually equates to higher outlet emissions. Even though the results shown above are good indications of how well a particular filtration fabric will perform, it is important to remember that only a 6 in. (150 mm) diameter sample of filtration fabric was tested. Only testing performed in an operating dust collector under actual conditions can determine the length of time that a filtration fabric can perform at these levels. Other laboratory tests can be performed to determine differences in the breaking strength of fibres in the fabrics, and these tests can provide a good comparison between different fabrics and products.

Even though one of the filtration fabric samples tested resulted in zero particulate emissions, it is very unlikely that an operational baghouse will produce zero emissions simply by utilising that fabric. Again, this is because the filtration fabric is only one of many components that contribute to overall dust collector efficiency.

Once a filtration fabric has been selected, it must be converted into a filter bag. In order for filter bags to function effectively, they must be:

- Sewn properly.
- Constructed to the correct dimensional specifications.
- Made to fit properly in the dust collector.
- Made of media appropriate for the application.

Table 1. ASTM D6830-02			
	Air permeability (cfm/ft.^{2})		
	Initial	After VDI	% retained
Sample 1	5.5	4.0	73
Sample 2	3.7	2.0	54
Sample 3	8.2	1.6	19

Table 2. Mean outlet particle concentration (emissions)	
Sample 1	0.000 mg/dscm
Sample 2	0.778 mg/dscm
Sample 3	1.900 mg/dscm

Even though a properly designed and constructed filter bag can help reduce outlet emissions, it is important to remember that the filter bag is only one of many components that contribute to overall dust collector efficiency.

Dust collector design is the key

Though laboratory tests can provide good guidelines for dust collector design, it should be understood that there is a significant difference between testing a filtration fabric sample in a laboratory and testing filtration fabrics in use in an operating dust collector. In a laboratory, testing is performed under simulated conditions on a single, small-diameter, easy-to-seal fabric sample, whereas stack testing filtration fabrics in a dust collector involves properly sealing thousands of filter bags operating in extremely harsh conditions.

Numerous conditions that affect emission levels can occur between the dust collector inlet and the dust collector outlet. Flawed filter bags, poor sealing to the tube sheets, and improper filter bag installation can all contribute to increased emissions, none of which result from the filtration fabric itself. Even if the filter bags are free of flaws and properly installed, emissions problems can still exist. It is important then to understand that overall dust collector design is the greatest contributor to how well the system operates.

Design practices that can adversely affect dust collector operation are:

- Aggressive air-to-cloth ratio.
- Poor filter bag cleaning controls.
- Poor dust collector inlet designs.
- Poor hopper evacuation.

Aggressive air-to-cloth ratios require filter bags to be cleaned more aggressively in order to maintain desired differential pressure and airflow, which equates to shorter filter bag life at desired emission levels.

Poor filter bag cleaning controls may allow filter bags to be cleaned more often than necessary, ultimately resulting in reduced filter bag life.

High inlet duct velocities can lead to filter bag mechanical failure due to abrasion, creating an emissions problem that will worsen daily and drastically reduce filter bag life.

Undersized dust removal systems can allow higher than desired dust levels in the hoppers, leading to filter bag abrasion. And if inlet velocities are high enough, catastrophic abrasion failures can occur.

Filter bags are only one component of the dust collector system, and cannot be expected to overcome design flaws while maintaining desired emission levels. In addition, dust collectors must be designed to handle maintenance while still online. In the case of filter bag failure, the damaged filter bag must be replaced immediately in order to minimise clean side contamination. In some countries, online maintenance is viewed as a safety risk. However, in a properly designed, compartmentalised dust collector, a compartment can be isolated for maintenance while posing no safety risk to the workers performing the maintenance.

Even the most well-designed system using the most efficient, properly manufactured filter bags in the dust collector can still be susceptible to issues that can derail the system, operations, and maintenance. Other areas that can create further potential problems are:

- Excessive filter bag cleaning.
- Excessive air volume.
- Poor start-up and shutdown procedures.
- Poor maintenance procedures.

In the harsh operating environment of today's cement industry, the reality is that there is no such thing as a problem-free dust collector system. However, problems can be mitigated by implementing a proactive preventive maintenance programme and more importantly, ensuring that the dust collector system is operated within the limits of its design.

The demand to reduce particulate emissions in the cement industry is an ongoing, worldwide challenge. Dust collector designs must become more conservative, controls must be modernised, and sound maintenance and operation procedures must be in place. Simply using the most efficient filter bags in the dust collector system will not solve the challenge of meeting new and increasingly stringent global emissions regulations. After all, the filter bag is just one of the many factors that determine dust collector efficiency.