A fabric dust collector that consistently performs as designed will not only help your plant meet environmental emission limits but minimize your dust collection system’s energy use and operating and maintenance costs. In this two-part article, find six keys to ensuring that your dust collector operates reliably. Part II will appear in November 2012.

Seeing your dust collector as part of your plant’s dust collection system rather than as an independent machine can help you monitor the collector’s performance and quickly correct any problems so it will continue to operate reliably. What goes into making a dust collector reliable? A reliable dust collector will consistently:

- Meet federal EPA or state environmental permit limits.
- Maintain the differential pressure across the filters within a narrow range.
- Minimize the dust collection system’s energy consumption.
- Minimize operating and maintenance costs.

Before discussing the six keys to ensuring that your collector meets these performance criteria, let’s review some dust collector basics.
a row of filters to flex the filters and dislodge some of the dust so it can fall downward into the collector’s dust hopper. The next most common is the reverse-air system, which delivers low-pressure (3- to 5-psig) air from a dedicated blower through a rotating sweep arm down into a row of filters, which flexes the filters and dislodges dust. Both the pulse-jet and reverse-air systems clean the filters while the collector is online — that is, as system air flows through the collector — allowing the collector to operate continuously. The least common cleaning system is the shaker system, which vibrates or shakes the filters to dislodge dust from them when the collector is offline. This system is used in processes that can be shut down every few hours. [Editor’s note: All subsequent references to filter-cleaning systems in this article are for the most common type, the pulse-jet system.]

**Collector performance.** Two parameters are commonly used to describe dust collector performance: air-to-cloth ratio and can velocity. The *air-to-cloth ratio* (also called *filtration velocity*) is the airflow volume in cubic feet per minute through the collector divided by the filter surface area in square feet. The design air-to-cloth ratio for a given collector is based on the dust’s properties and the filter supplier’s or user’s experience. If the air velocity through the collector exceeds the collector’s design air-to-cloth ratio, the dust will penetrate the filter fabric, where it can’t be removed by the filter-cleaning system, blinding the filters.

The *can velocity* (also called *interstitial velocity* or *tank velocity*) is the velocity of the upward airflow between the filters in the collector. If the can velocity is higher than the dust’s settling velocity, dust won’t drop off the filters during automatic cleaning, and the collector will have to be shut down so the filters can be removed for cleaning or replacement.

Now let’s look at the six keys to ensuring that your dust collector operates reliably.

1. **Preventing dust hopper bridging**

The dust hopper in most dust collectors has a rotary airlock valve at the outlet for discharging the collected dust at regular intervals into a downstream container or conveyor. In many dust hoppers, this discharge valve (and the hopper outlet) is undersized, as shown in Figure 2, because it’s been designed to handle mass flow through the hopper rather than the bridging that often occurs. This mistake results from the assumption that the dust collected in the hopper will flow like the powder that generated the dust. However, dust doesn’t flow as easily as powder, and the dust can form a cohesive bridge over the hopper outlet if the discharge valve is smaller than the dust’s minimum bridging dimension (also called the *minimum outlet dimension*). The resulting bridge can cause the dust to back up into the collector’s filters.

If your collector’s dust hopper has an undersized discharge valve, the most effective solution is to replace the valve with a larger one, but this requires modifying the hopper outlet and the equipment at the valve’s discharge, making this option expensive and often impractical. A lower-cost
solution is to install flow aids in the hopper to break the dust bridge and get the dust to flow out. One common example is fluidizing air pads, which blast a film of air along the hopper’s inside wall to fluidize the dust and break the bridge. Another example is a vibrator. However, the vibrator should be operated only when the discharge valve is open and free to empty the dust from the hopper; otherwise, the vibrator will act as a compactor that makes the bridge more cohesive instead of breaking it.

Checking the filter-cleaning system’s operation. Every 1 or 2 weeks, the operator should monitor the operation of the pulse-jet filter-cleaning system’s solenoid and diaphragm valves for each filter row. If the cleaning system is operating normally, the collector’s differential-pressure gauge reading should twitch during the cleaning pulse, while at the same time the compressed-air supply’s pressure gauge reading should drop 20 to 40 psig and then quickly recover. If these readings indicate the cleaning system isn’t operating as it should, the operator should visually check the valves and, if necessary, the system’s timer board lights, to determine if the solenoid or diaphragm valve on a row of filters is malfunctioning. The operator should replace the malfunctioning valve. Keeping spare solenoid and diaphragm valves on hand will speed this process.

Checking the dust discharge operation. Each day, the operator should check for audible air leaks in the dust hopper and discharge valve and repair them. Because of the high vacuum (8 to 10 inches water column) in the dust collector, even seemingly small cracks in these areas can draw in large amounts of outside air. This air contains moisture that can cause dust caking and dust flow problems that result in bridging.

Each day, the operator should also check the capacity of the downstream destination for dust discharged from the collector. This destination — whether a container or conveyor — must have enough capacity to prevent dust from backing up into the collector’s filters. The container or conveyor suited to an application depends on the collector size and dust hopper shape. The simplest method for removing dust from a relatively small collector’s conical dust hopper is to discharge the dust into a drum that’s sealed to the dust hopper’s bottom and isolated by a manual slide gate. A conical hopper on a large collector typically discharges dust into a larger container or a process vessel; these require a rotary airlock valve to transfer dust from the collector’s high vacuum to the container’s or vessel’s atmospheric pressure. A trough-shaped hopper (such as for a collector with a rectangular rather than square or round footprint) discharges dust to a screw conveyor and also requires a rotary airlock valve.

To simplify the operator’s monitoring task, any of these dust discharge systems can be equipped with automatic controls to warn the operator when dust is backing up in the collector. For instance, these controls can include level sensors in the dust hopper linked to motion switches on the rotary airlock valve and screw conveyor. To prevent a flow aid from compacting the dust, it should be automatically controlled rather than allowed to run constantly.

Checking the collector’s inlet static pressure. Daily or weekly, the operator should check the gauge indicating the collector’s inlet static pressure, a very useful visual control
that indicates whether the airflow volume entering the collector from the dust collection system is within the system design limits. For instance, if the system’s design airflow is 10,000 cfm and the measured inlet static pressure at that flowrate is 10 inches water column, then a –20 percent change (to 8 inches water column) in inlet static pressure indicates a –10 percent change in the system airflow (9,000 cfm). Because the 20 percent change on the pressure gauge from one day to the next indicates that the problem is just starting to develop, the effort required to fix the problem will be minimal. In this case, the problem could be aging filters that now have 10 percent less airflow than when they were new, causing a corresponding static pressure decrease of 20 percent. By noting this change in its early stages, you can increase the filter-cleaning frequency before the collector’s operation is seriously affected; be aware, however, that more frequent cleaning will consume more compressed air and lead to shorter filter life.

3 Reliably meeting environmental permit requirements

Because environmental permits generally allow very low dust collector emissions, even relatively small leaks in a collector result in permit violations.

Common leak sources. The most common leak sources in collectors are poor filter installation, filter wear, and defective filters.

• Poor filter installation: Each filter type must be installed on the collector’s tubesheet according to the manufacturer’s instructions to achieve a good seal between the filter and tubesheet. Eliminate leaks between the filter and tubesheet by training your maintenance workers to properly install the filters in your collector.

• Filter wear: In a baghouse, filter cleaning rubs the bag filter fabric against the supporting metal cage and eventually wears a hole in the filter. A rough spot on the cage will accelerate this process. You can minimize such wear by choosing bag filters that meet your original equipment manufacturer’s specs, checking for and correcting cage rough spots during filter installation, and setting the filter-cleaning system controls for the longest possible interval between cleaning cycles to extend filter life.

• Defective filters: Although quality control in filter manufacturing is high, a defective filter occasionally gets past the manufacturer’s inspection. Your workers can spot obvious defects by visually inspecting the filters before installing them.

Detecting leaks. Because dust leaks large enough to cause excessive emissions usually aren’t visible in your plant’s exhaust plume, the EPA recommends using a filter-leak detection system (also known as a broken-bag detection system) to help locate leaking filters. The most common systems are triboelectric or inductive, and they work by using a triboelectric or inductive sensing probe on the collector’s clean-air outlet duct to detect the tiny electric currents produced by particles colliding with the probe or passing nearby. The probe for an inductive filter-leak detection system is shown in Figure 3. The probe is linked to a controller with an operator interface panel; the controller is also linked to the filter-cleaning system’s timer board. Each time a filter row is cleaned, a small amount of dust is released into the collector; the controller monitors and records this spike in the number of dust particles passing through the clean-air outlet duct in the airstream. When a spike in dust particles exceeds a preset threshold value, the controller sounds an alarm to indicate that a filter in that row has a leak. The data is stored in the controller’s memory so an operator or maintenance worker can use the interface panel to identify which row has a leaking filter (or filters).

Pinpointing a leaking filter. Checking for a dust trail left by the leaking filter along the clean-air plenum’s inside wall is a good way to pinpoint a leaking filter’s location, as long as the plenum was cleaned after the filters were last changed. Another method is to inject fluorescent powder into the collector’s dirty airstream and then use a black light, as shown in Figure 4, to highlight the powder as it leaks from a problem filter (or filters) in the dark clean-air plenum.

Strategies for replacing leaking filters. Replacing a few leaking filters with new ones will cause the new filters to

![Figure 3: Inductive filter-leak detection system](image)
blind very rapidly and shorten their life. Why? Consider the example of a baghouse containing 100 filters with a dust cake that produces a differential pressure of 3 to 4 inches water column. When 3 filters develop leaks, only these 3 are replaced. The 97 older filters will still have a dust cake producing a differential pressure of 3 to 4 inches water column, but the new filters have no dust cake, yielding a differential pressure of just 0.5 inch water column — a very low resistance to airflow. This will allow airflow through the new filters well in excess of the baghouse’s design air-to-cloth ratio, driving the dust into the filter fabric so deeply that the filter-cleaning system won’t be able to dislodge it. This will turn the new filters into plugs — probably making it more cost-effective to simply plug their openings in the tubesheet rather than replace them.

Prevent filter blinding and extend filter life by replacing all the filters in the collector, even when only one or a few filters leak. Because replacing all the filters takes time, plan this procedure carefully so you can replace the filters efficiently and minimize the required downtime. Start by ordering a complete set of replacement filters and scheduling downtime to take the collector offline. Next, train your maintenance workers in how to install the filters the right way. This includes wearing personal protective equipment to protect them from dust exposure during this very dusty procedure, installing each filter to ensure a good seal between it and the tubesheet, and determining in what order to replace the filters. (For larger collectors, there’s a real choreography in efficiently removing and replacing all the filters; with one large baghouse I know of, a three-shift team replaced 1,000 bag filters in just 24 hours by carefully planning what replacement order to follow. For help determining what filter replacement order will be fastest for your collector, consult the collector supplier.) After the filters are installed, the workers should also vacuum the clean-air plenum to remove any accumulated dust and make it easier to locate future filter leaks. Finally, the operator should use the collector startup procedure described in the following subsection.

**Startup procedure after installing new filters.** To prevent blinding the new filters, which have low resistance to airflow, the operator must start up the dust collector before introducing any dust into it. The operator should follow these steps: First, if the collector’s filter-cleaning system is controlled by a timer, turn it off. Start the dust collection system fan and measure the airflow volume through the collector with a pitot tube, located on either the clean-air outlet duct (test point 1, as shown in Figure 5) or any section of straight dirty-air duct at least five duct diameters in...
length where all dirty-air streams are combined before entering the collector (test point 2). Adjust the fan inlet damper or the fan’s variable-frequency drive so that the airflow volume is within ±10 percent of the collector’s design airflow volume. Start your process so the collector can begin to collect dust. Watch the differential-pressure gauge as the differential pressure across the filters rises, and adjust the total system airflow volume again to ±10 percent of the design level. Turn the filter-cleaning system back on when the differential pressure reaches 2 inches water column. The differential pressure will settle to normal operating levels within a day, indicating that the filters have developed a dust cake.

In my experience, using this startup procedure in depth-filtration applications will extend filter life anywhere from 6 months to as much as 3 to 5 years. In surface-filtration applications, this procedure can also extend filter life as long as the new filters require the same differential pressure as the old ones or the system fan is adjusted to prevent overwhelming the collector’s design air-to-cloth ratio at startup.

Next month: Part II will cover the final three keys to reliable dust collector operation.

For further reading
Find more information on dust collector operation and related topics in articles listed under “Dust collection and dust control” in Powder and Bulk Engineering’s comprehensive article index (in the December 2011 issue and at PBE’s website, www.powderbulk.com) and in books and CDs available on the website at the PBE Bookstore. You can also purchase copies of past PBE articles at www.powderbulk.com.

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Johnson to present at PBE’s 2013 Midwest Conference & Exhibition
Gary Q. Johnson will present information on dust collection and dust control at PBE’s Midwest Conference & Exhibition in Columbus, Ohio, May 21-23, 2013.