Recirculating the air from your dust collector: Benefits, cautions, and equipment selection advice

Lee Morgan  Farr Air Pollution Control, Inc.

Are you sending your plant air out the stack after it’s been filtered by your dust collection system? If so, you not only have to spend a lot of time dealing with EPA regulations, but you’re probably sending energy dollars up the stack along with your cleaned air. This article explains how to overcome these problems by recirculating that cleaned air back into your plant. Sections cover recirculation basics and provide advice on designing a recirculating dust collection system.

Whether you use a dust collection system to control your plant’s indoor air quality, keep your equipment clean, or recover high-value process dusts, chances are the system exhausts the cleaned air outdoors. But in many cases you can reduce regulatory paperwork, save a substantial amount of energy, and even become a better neighbor by recirculating the cleaned air back into your plant.

Reducing regulatory paperwork. When you exhaust contaminated air outdoors, the EPA must be satisfied that the exhaust air complies with current air quality standards — a process that involves time-consuming permit applications, collector testing, and regulatory paperwork. However, if you totally contain the exhaust air inside your plant, you can deal with OSHA instead of the EPA — a less daunting prospect, even with OSHA’s increasingly stringent indoor air quality standards.

OSHA doesn’t require permits or collector testing, but it does require your plant to meet certain indoor air quality standards, no matter how you achieve compliance. For instance, OSHA may require that one of your workers wear a personal monitor in the workplace to perform an 8-hour time-weighted-average emissions test to ensure that contaminants are below the allowable level. But unlike the EPA, OSHA won’t require you to file a permit for the collection system or test your dust collector.

In some states, the local EPA may require you to file a permit even for a dust collector that recirculates cleaned air to your plant. Check with your local agency to find out whether this is true in your state.

Saving energy. When a dust collector recirculates heated or cooled air back to your plant, you’ve eliminated the cost of replacing that conditioned air — and saved what can add up to thousands of dollars per year or even per month.

Consider the example of a 20,000-cfm dust collector that operates at a site with an average winter temperature of 40°F. By using a recirculating dust collection system, this plant can save an estimated $1,925 per month during the winter, based on the approximate cost to heat an equivalent amount of replacement air to 65°F, an energy cost of $0.07 per kWh, an 8-hour day, and a 5-day workweek. A dust collection system in a high-ceilinged work area can even improve the heating system’s efficiency by taking the hot air off the ceiling and delivering it back to floor level.

Being a better neighbor. Your plant’s commercial and residential neighbors won’t be concerned about air contaminants from your plant if you use a dust collection system to recirculate exhaust air indoors. With an indoor system, your plant can eliminate the exhaust stack that frequently attracts neighbors’ scrutiny and can lead to complaints.
Collectors for handling indoor air recirculation

Typically, you’ll need a high-efficiency cartridge dust collector to recirculate your cleaned air indoors. This collector can limit emissions to well below the required thresholds as long as your dust isn’t extremely hazardous. It can also handle a wide range of processes, thanks to the advent of improved media, better filter pleat spacing, and collector suppliers’ growing expertise in recirculation applications.

Pulse-jet baghouses often perform just at the margin of acceptable emissions control for recirculation applications. So unless you use bag filter media with extremely high efficiency, a baghouse is generally not going to provide adequate filtering for recirculating air to your plant.

When recirculation isn’t an option

Some contaminants must be exhausted outdoors. For instance, air exhausted from a spray dryer that generates high heat, humidity, and combustion gases can’t be adequately handled by a recirculating dust collection system. Other dusts, such as aluminum, can be highly explosive. When in doubt about an application, ask a dust collector supplier or consultant with dust collection system engineering expertise to answer these three key questions:

1. How can the proposed recirculating system achieve OSHA emissions requirements?
2. How can the system provide fire safety and explosion protection?
3. How can the system recirculate the air for maximum energy efficiency and worker comfort?

Ensuring that your recirculating system meets OSHA standards

To protect your workers’ health, your recirculating dust collector must adequately remove the dust you need to capture. To ensure that the collector can do this, you must determine your dust’s allowable indoor limit, consider collector efficiencies, and test your dust and in some cases the collector.

Determining your dust’s allowable indoor limit. OSHA has set the indoor limit for nonspecific (nuisance) dust, with an average particle size less than 10 microns, at 5 milligrams of dust per cubic meter of air (expressed as 5 mg/m³). However, for toxic dusts such as silica, the indoor limit is only 0.05 mg/m³ — 100 times stricter than the nuisance dust’s allowable limit. The allowable indoor limits for other common dusts are listed in Table I.

Don’t accept the supplier’s statement of the collection efficiency in terms of a percentage, even if it’s given as 99.99 percent efficiency. OSHA only cares that the quantified amount of dust in the air is below established limits. For instance, if the established limit for your dust is an average of 5 mg/m³, the collector supplier must guarantee that the unit will control emissions to something less than that — preferably one-half of the limit or less.

Testing your dust and collector. An important step in choosing the collector is to test your dust, especially if the

<table>
<thead>
<tr>
<th>Dust</th>
<th>Indoor air quality limit (8-hour time-weighted average in milligrams of dust per cubic meter of air)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain dust (oat, wheat, barley)</td>
<td>4</td>
</tr>
<tr>
<td>Graphite (all forms except fibers)</td>
<td>2</td>
</tr>
<tr>
<td>Gypsum</td>
<td>0.5</td>
</tr>
<tr>
<td>Mica</td>
<td>3</td>
</tr>
<tr>
<td>Particulates not otherwise classified (PM10)</td>
<td></td>
</tr>
<tr>
<td>— Inhalable</td>
<td>10</td>
</tr>
<tr>
<td>— Respirable</td>
<td>3</td>
</tr>
<tr>
<td>Silica (amorphous)</td>
<td></td>
</tr>
<tr>
<td>— Diatomaceous earth (uncalcined)</td>
<td></td>
</tr>
<tr>
<td>— Inhalable</td>
<td>10</td>
</tr>
<tr>
<td>— Respirable</td>
<td>3</td>
</tr>
<tr>
<td>— Precipitated silica</td>
<td>10</td>
</tr>
<tr>
<td>— Fume silica</td>
<td>2</td>
</tr>
<tr>
<td>— Fused silica</td>
<td>0.1</td>
</tr>
<tr>
<td>— Crystalline silica (crystalline)</td>
<td>0.05</td>
</tr>
<tr>
<td>— Quartz</td>
<td>0.1</td>
</tr>
<tr>
<td>— Tripoli</td>
<td>0.1</td>
</tr>
<tr>
<td>Silicon</td>
<td>10</td>
</tr>
<tr>
<td>Talc (containing no asbestos fibers)</td>
<td>2</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td></td>
</tr>
<tr>
<td>— Fume</td>
<td>5</td>
</tr>
<tr>
<td>— Dust</td>
<td>10</td>
</tr>
</tbody>
</table>
dust is toxic. You can send a representative sample of your dust to a qualified independent test lab for testing. The lab will perform a series of bench tests on the sample to determine its characteristics so you can choose a collector that will effectively capture the dust.

For instance, a particle size analyzer measures the dust’s particle size distribution down to the submicron range. This information can help you determine the efficiency the collector needs to meet your indoor emissions limits. Additional tests can visually analyze the dust, determine its specific gravity, and measure its moisture content, absorbency, abrasiveness, and other properties. The results can help you select the collector’s filter media, hardware, and other components based on scientific analysis rather than guesswork.

In some cases, you may also need to run full-scale tests with one (or more) production-size dust collector to predict your dust’s behavior. The tests, available from a handful of labs (most of them run by dust collector suppliers), measure the ability of a given collector to filter your dust. Such tests are often required for predicting the behavior of an unusual or difficult-to-handle dust in a particular collector and can help ensure compliance with strict emissions standards for toxic fumes and dusts. Examples are fume silica, which is highly toxic, and titanium dioxide, which is a fine, sticky dust that requires special filtration media.

With a full-scale test apparatus, as shown in Figure 1, the lab can run tests in real time or at an accelerated rate that simulates your operating conditions. The lab can alter many variables — including the filter media type, filter configuration, air-to-cloth ratio, operating temperature, airflow rate, and dust loading — to evaluate their effects on the collector’s performance. You can view the tests and change the variables in a “what if” context to evaluate the impact of different variables on collection efficiency. The full-scale test results will help you determine not only which collector to select but which features it should have to meet your indoor emissions limit.

**Designing your recirculating dust collection system**

Once you’ve selected the dust collector, you’re ready to work with the collector supplier to design the rest of your recirculating system. The typical recirculating system is very similar to a conventional collection system that exhausts the cleaned air: Both include source capture hoods over dust-generation points and workstations in the plant, ductwork leading from the hoods to one (or more) collector, and one (or more) fan that draws dust-laden air from the hoods into the collector and then exhausts the cleaned air. But there’s one important difference: The recirculating system includes return-air ductwork that directs the cleaned air back into the plant instead of exhausting it outdoors. An example is shown in Figure 2.

The collector supplier can help you evaluate three important system design factors: how to recirculate the cleaned air to your plant, how to select the collector’s filter media, and how to monitor the system’s operation.

---

**Figure 1**

*Full-scale test apparatus for dust collection systems*
ated, including bag-filling and -emptying stations, mixers, conveyor transfer points, and screeners. This use of a recirculating system is covered in detail in ACGIH’s *Industrial Ventilation: A Manual of Recommended Practice*.

In some cases, you may not want to recirculate the plant air year-round. Your plant may be like many others in which the air is heated during winter but used at ambient temperature, rather than air-conditioned, during the summer. In this case it makes sense to recirculate the cleaned air in the winter to conserve energy, but to exhaust the cleaned air during the summer. You can easily accomplish this by installing a return-air diverter valve on the exhaust stack, as shown in Figure 2. In summer, along with opening doors to draw fresh air inside your plant, you can set the valve to exhaust the cleaned air. In winter, you can set the valve to recirculate the cleaned air via your return-air ductwork back into the plant.

**Selecting the collector’s filter media.** No matter what dust goes into your recirculating system’s dust collector, the air exiting it must meet OSHA indoor emissions requirements. Choosing the right filter media is key to achieving this goal. Your collector or filter supplier can provide collection efficiency curves to help you compare the performance of different media for various dust particle sizes. Again, avoid placing too much emphasis on the supplier’s efficiency claims — instead, concentrate on the media’s actual emissions performance. You may need to test your dust with different media before determining which media is best for your recirculating application.

Three types of cartridge filter media are commonly used in recirculating systems:

- **Nonwoven cellulose-synthetic blend media** is the most common and economical choice for cartridge filters handling dry dusts and operating temperatures up to 240°F. It can limit emissions to 5 mg/m³ or less.

- **Polyester-silicon blend media with a melt-blown synthetic applied to its surface** delivers superior collection efficiencies, achieving emissions as low as 1 mg/m³ or less, far below the OSHA threshold for nuisance dusts. The media also has a smooth surface that provides better dust-release for more efficient filter cleaning.

- **Spun-bond polyester media** is a good choice for handling a hot, moist airstream, a sticky dust, or an application that requires frequent filter washdowns (such as in a food processing plant). The media can limit emissions to about 5 mg/m³ or less. Because this media is expensive, it’s used...
in recirculating systems typically only to handle difficult dusts.

Monitoring the system’s operation. If a cartridge filter ruptures in your dust collector, the recirculating system can carry the dust back into the plant, exposing workers to unacceptable contaminant levels. To avoid this, you should install a safety-monitoring filter or a remote monitoring and control system in your recirculating dust collection system.

The safety-monitoring filter (often called a secondary filter or afterfilter) typically includes three components — a housing, prefilter, and high-efficiency final filter (as rated by the American Society of Heating, Refrigerating and Air-Conditioning Engineers [ASHRAE]). Sometimes the housing is equipped with side access so the filters inside it can be easily replaced; this is useful when the unit can’t be installed after the fan and must be installed in the harder-to-access space after the dust collector and before the fan. The safety-monitoring filter’s components together form a backup system to keep emissions at acceptable levels when a dust collector filter ruptures or another failure occurs. If your dust is toxic, you must use such a system, and the final filter must be a high-efficiency particle arrestor (HEPA) filter. A HEPA filter achieves near-zero emissions, allowing your plant to meet even the most stringent indoor air quality requirements.

The remote monitoring and control system is especially suitable for a large recirculating system with multiple dust collectors. Consisting of a network of several detectors and a controller, this system can electronically monitor several collectors at once to detect excessive dust in the cleaned air exiting the collectors. It automatically triggers alarms and troubleshoots problems as soon as they occur. The system can also help reduce emissions and extend filter life by precisely controlling filter-cleaning cycles.

One way to handle an explosive dust is to install the recirculating system’s dust collector outside and equip it with an explosion vent.

Explosion and fire safety concerns. Some highly explosive dusts, such as metal powders, can’t be safely controlled by a recirculating dust collection system and instead must be exhausted outdoors. But as long as you take adequate precautions, your system can safely recirculate many other explosive or flammable dusts, such as wood particles.

One way to handle an explosive dust is to install the recirculating system’s dust collector outside and equip it with an explosion vent that will vent explosion forces away from the plant building and populated areas. Determining the amount of explosion vent area the collector will need requires using a formula that considers your dust’s explosive power. This value is denoted by $K_{st}$, the dust’s rate of pressure rise. If your dust is fairly common, your collector supplier may be able to obtain its $K_{st}$ value from published tables; otherwise you can determine this value by having your dust tested by Factory Mutual or an independent lab. The dust collector supplier can use this information to help you select an appropriate vent.

If your collector must be located inside your plant, you can vent explosion forces outdoors through a very short (9 feet or less) duct. However, this adds back pressure to the collector and usually requires reinforcing the collector so it can handle the pressure increase. If you can’t duct the collector outdoors, you’ll need to equip the collector with an explosion-suppression system. But be aware that such a system can cost more than the collector itself.
You may also need to equip your recirculating system to handle fire hazards. Size reduction equipment, mixers, and dryers (particularly those lacking adequate controls) can generate heat or cause sparks to enter the collector inlet duct and start a fire. You can prevent this by installing a spark-detection-and-suppression system in the dust collector’s inlet duct to sense and extinguish a spark or flame. Such a system is available in several types and can release water, chemicals, or inert gas as a suppression agent. Expect to work with a safety equipment supplier to select an explosion-suppression or spark-detection-and-suppression system for your recirculating application.

A final word

A dust collection system that recirculates cleaned workplace air isn’t right for every plant. Such a system requires a higher investment — in higher-efficiency filters and required safeguards — than one that simply exhausts air outdoors. But in many cases a recirculating system can provide long-term benefits that far exceed your initial investment. If Alexander Pope were alive today, perhaps he would sum it up this way: “To air is human...to recirculate is divine.”

References

1. American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, OH 45240; 513-742-2020, fax 513-742-3355 (www.acgih.org).


For further reading

Find more information on dust collection systems in articles listed under “Dust collection and dust control” and “Air pollution control” in Powder and Bulk Engineering’s comprehensive “Index to articles” (in the December 2001 issue and at www.powderbulk.com).

Lee Morgan is general manager of Farr Air Pollution Control, Inc., 3501 Airport Road, Jonesboro, AR 72401; 800-479-6801, fax 870-933-8380 (morganl@farrapc.com or www.farrapc.com). He holds a BS in mechanical engineering from South Dakota State University in Brookings.