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Recirculating air from dust collectors

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Key concepts

OSHA regulations apply when recirculating contaminated indoor air.

Recirculated indoor air can save energy.

Select dust removal equipment based on performance, not efficiency.

Whether dust collectors are used in a plant to control indoor air quality (IAQ), keep equipment clean, and/or recover high-value process dusts, many plants are considering recirculating the air back into the plant downstream of collectors instead of exhausting it outdoors. When using recirculating dust collection systems, special safety and performance concerns must be addressed.

Benefits

There are at least three positive reasons to recirculate indoor air.

Less regulatory paperwork

When contaminated air is exhausted outdoors, the EPA must be satisfied that the exhausted air is in compliance with current standards, a process that involves time-consuming permit applications, testing, and regulatory paperwork. By containing the air totally inside a building, the plant engineer deals with OSHA instead of the EPA — a less daunting prospect, even though OSHA indoor air quality standards are becoming increasingly stringent.

OSHA does not require permits or collector testing, but they do require a plant to meet certain indoor air quality standards, no matter how compliance is achieved.

OSHA may require the use of a personal monitor on an individual in the workplace and perform an 8-hr, time-weighted average (TWA) test to make sure contaminants are below allowable levels. Unlike the EPA, they will not test the dust collector or require that a permit be filed for the system.

In some states, the local EPA may still want to permit an indoor collector. Plant engineers should check with local agencies to find out their position on recirculating dust collectors.

ACGIH recommended indoor air quality limits

Dust type	TWA, mg/m³
Graphite, except fibers	2
Gypsum	0.5
Mica	3
Particles not otherwise classified	
■ Inhalable	10
■ Respirable	3
Silica - amorphous	
■ Diatomaceous earth (uncalcined)	
Inhalable	10
Respirable	3
■ Precipitated silica	10
■ Silica, fume	2
■ Silica, fused	0.1
■ Silica, crystalline cristobalite	0.05
■ Quartz	0.1
■ Tridymite	0.05
■ Tripoli	0.1
Silicon	10
Talc, with no asbestos fibers	2
Zinc oxide	
■ Fume	5
■ Dust	10

Substantial energy savings

When a dust collector is designed to recirculate heated or cooled air back through the plant, the cost to replace that conditioned air is eliminated — an expense that can be substantial.

Consider the example of a 10,000-cfm dust collector where the outside temperature is 10 F. Use of a recirculating dust collection system could save an estimated $1600 per month during the winter — the approximate cost to heat an equivalent amount of replacement air to 70 F, based on an energy cost of $0.60 per ccf (100 cu ft of natural gas), an 8-hr day, and a 5-day work week.

Dust collecting systems for

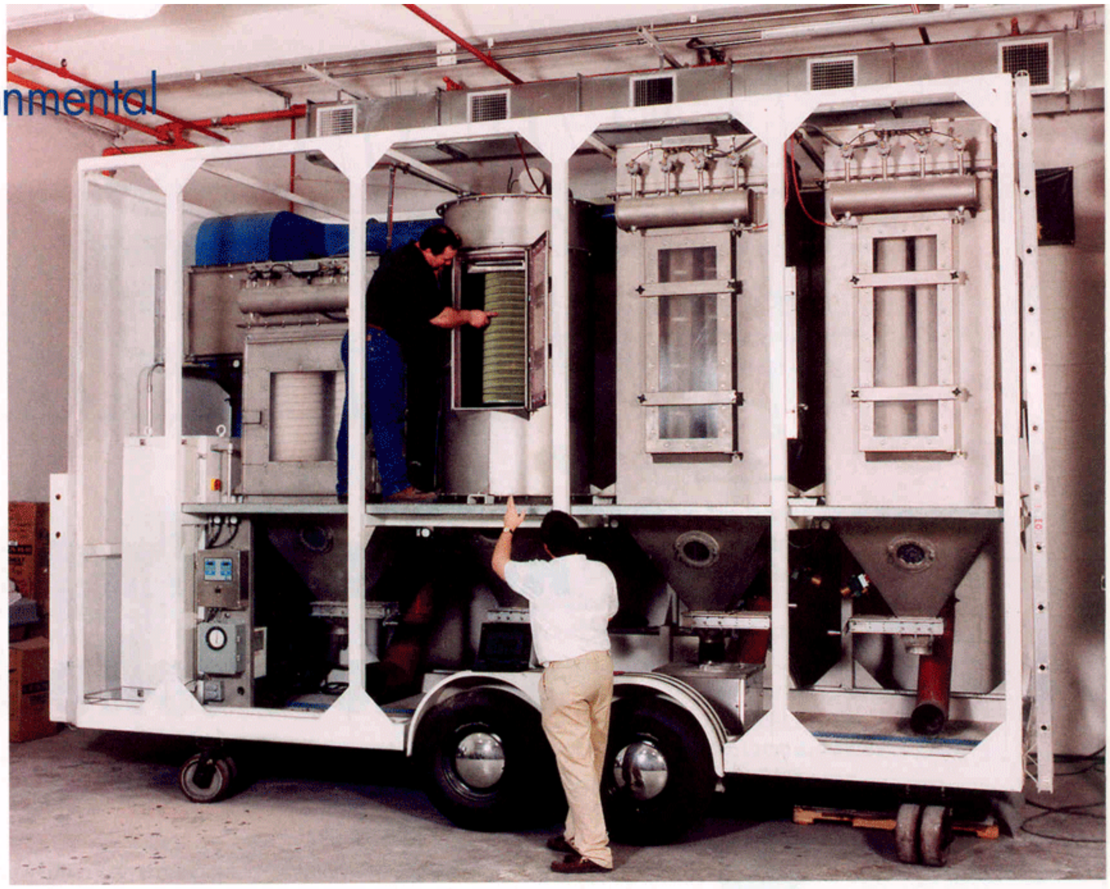

Fig. 1. A full-scale dust testing apparatus can be brought onsite to test actual conditions.

welding shops with high ceilings can often improve the efficiency of a heating system by taking hot air off the ceiling and delivering it at ground level.

Being a good neighbor

An indoor dust collection system is not subject to unneeded scrutiny by commercial or residential neighbors. Outdoor systems and exhaust stacks can be a frequent source of community concern and potential complaints. These issues are eliminated with a recirculating system.

Safety issues

Some types of contaminants must be exhausted outdoors. This includes combustion gases and unusual gas stream constituents that cannot be adequately handled by a particulate removal system. When in doubt about a given application, ask a supplier or consultant with dust collection engineering expertise three key questions:

- ❖ How can OSHA emission requirements be achieved?
- ❖ How can fire safety/explosion concerns be met?
- ❖ How should the air be recirculated for energy efficiency and worker comfort?

Meeting OSHA IAQ standards

A crucial concern with any recirculating dust collector is to ensure the system has adequately removed the dust to protect workers' health. To do so, several factors must be evaluated.

The first step is to ascertain the allowable indoor limit for the dust being captured. OSHA has set an indoor limit of 5 mg of nonspecific or nuisance dust (<10 microns in size) per cubic meter of air. Toxic dusts, such as silica, carry an indoor limit of only 0.05 mg per cubic meter — 100 times stricter than the allowable threshold for nuisance dust.

While OSHA guidelines *must* be met, plants *should* follow the guidelines published by the American Conference of Governmental Industrial Hygienists (ACGIH). The guidelines in this manual are often just a little tighter than those OSHA has adopted, and by meeting these guidelines, the plant engineer can ensure regulatory compliance (see Table 1).

Next, select a particulate removal system that meets IAQ requirements. Whatever brand or type of equipment is used, obtain a guarantee from the manufacturer for the maximum emissions rate (milligrams of dust per cubic meter of air) for the equipment over an 8-hr TWA.

Do not accept efficiency stated as a percentage, even if the manufacturer states 99.99% efficiency. OSHA only cares that the quantified amount of dust in the air is below established limits. If the established limit is an average of 5 mg/cu m, the manufacturer must provide a guarantee of something less that that, preferably at least half of the limit.

In most cases, a high efficiency cartridge dust collector will be the system of choice. These systems can be designed to produce emissions well below OSHA limits, except with the most hazardous dusts.

Today's cartridge collectors can be used for a wider range of processes than in the past, thanks to the advent of new media, improved pleat spacing, and increased application knowledge.

Pulsejet baghouses often have barely acceptable emission performance. Recirculation directly off a baghouse is generally not recommended unless a very high efficiency media is used.

To determine the best collector design for a recirculating application, dust testing is strongly recommended, especially wherever toxic dusts are involved. A qualified test laboratory can perform a series of bench tests on a representative dust sample to determine its characteristics — which can influence collector design.

For example, a particle size analyzer reveals the particle size distribution of the dust, down to the submicron range. This information can be very helpful in determining the filtration efficiency needed to meet indoor emission standards.

Additional tests can provide a visual analysis of the dust, determine its specific gravity, identify moisture content, absorbency, abrasiveness, and other characteristics. These properties aid the engineer in selecting filter media, hardware, and other components based on scientific analysis rather than guesswork.

In some cases, after bench testing is completed, full-scale testing, using one or more actual dust collectors, may be needed (Fig. 1). Full-scale testing is sometimes used to predict the behavior of an unusual or difficult dust. It can help ensure compliance with strict emission standards for processes that generate toxic dust and fumes — for example, the cutting or welding of galvanized material.

Tests can be run using either real-time or accelerated testing that simulates actual operating conditions.

Dust cloud ignitability and explosibility

Dust type	Particle size distribution Weight %<Size (um) 500	250	125	71	63	32	20	Median size um	Kst Bar*m/s
Fat powder (48% fat)		100	75		24	7		92	20
Fish meal	68		23		12			320	35
Fructose from filter	99		39	17				150	102
Fructose	92		15					200	28
Barley grain dust		79	51	25		8	3		240
Oats grain dust	64		24		8			295	14
Wheat grain dust				48		30		80	112
Coffee from filter				100		99	89	<10	90
Coffee refined					100				11
Cocoa bean shell dust					100				68
Cocoa/sugar mixture	53		20					500	43
Potato granulate					100				21
Potato flour			86	53		26	17	65	69
Rice flour					100				57
Rye flour			94	76		58	15	29	79
Soy bean flour				85		63	50	20	110

Many performance variables can be evaluated in this manner — including different media types, filter configurations, air-to-cloth ratios, temperatures, airflows and dust loading conditions. Plant engineers may view the testing and make changes in a "what if" context to evaluate the impact of different variables.

Filter media

Selecting the right filter media is critical to meeting emission requirements. The most commonly used media is a nonwoven cellulose/synthetic blend that provides an economical choice for dry dusts and operating temperatures up to 240 F.

Polyester/silicon blended media with a melt-blown synthetic applied to the surface deliver superior efficiencies — achieving emissions as low as 1 mg/cu m or less, far below the OSHA threshold for nuisance dusts. They also feature a smooth surface that offers better dust release characteristics, for more efficient cartridge cleaning.

Spun-bond media are excellent performers where there are hot, moist gas streams, sticky dusts, or the need for frequent wash-down of cartridges. Spun-bond filters do have a place in recirculating systems. But due to their higher cost, they are usually limited to use with difficult dusts.

Filter suppliers can provide efficiency curves to help compare performance of different filtration media on various size dust particles. When evaluating media, the plant engineer should avoid placing too much emphasis on efficiency claims stated in percentages. These claims say little about actual emission performance.

No matter what goes into a dust collector, the air that comes out must meet OSHA requirements. A reputable dust collector manufacturer should be able to guarantee the emission performance of a system handling a specific dust.

Monitoring

What if a cartridge should rupture, releasing dust back into the plant? In this event, workers may be exposed to unacceptable contaminant levels. To avoid this possibility, the use of a safety monitoring system is recommended with recirculating dust collectors.

Such systems typically include a side-access housing, prefilter, and high efficiency ASHRAE filter, which together form a backup system to keep emissions at acceptable levels in the event of a dust collector failure.

Where toxic dusts are present, a safety monitoring system is mandatory and should always use a HEPA filter as the final filter. HEPA filters, commonly found in critical applications, achieve near-zero emissions and allow plant engineers to meet even the most stringent indoor air requirements.

A remote monitoring and control system is an option worth considering, especially for large pollution control systems with multiple collectors. These control systems can electronically monitor an entire network of dust collectors, providing automatic alarming of fault conditions and troubleshooting problems as soon as they occur. They can also help to lower emissions and extend filter life through electronic control of cleaning cycles.

Fire safety and explosions

If the dust being captured is explosive or flammable, special safety concerns must be addressed. While highly explosive dusts such as aluminum powder should be exhausted outside, many other flammable dusts can be handled with a recirculating dust collector, as long as adequate safety precautions are taken.

Explosions are a big concern. The explosive power of a dust is denoted as Kst, the rate of pressure rise (see Table 2). Both NFPA and Factory Mutual use this

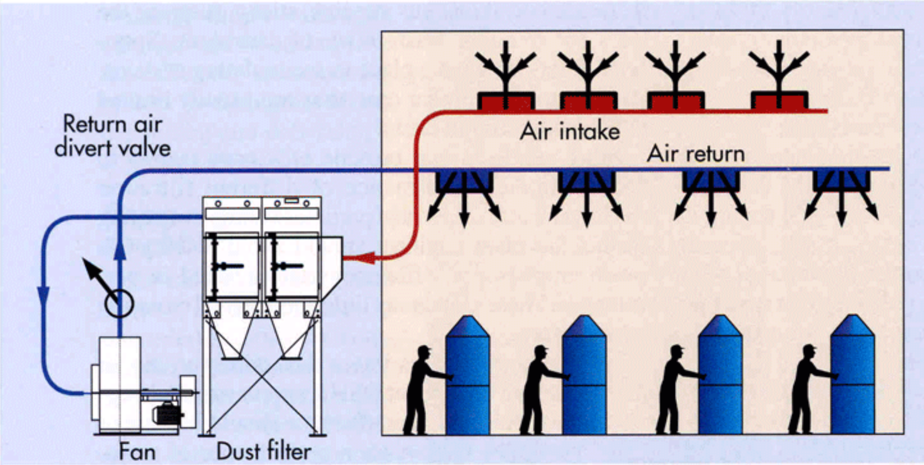

Fig. 2. General ventilation arrangement with zone returns captures ambient air for filtration.

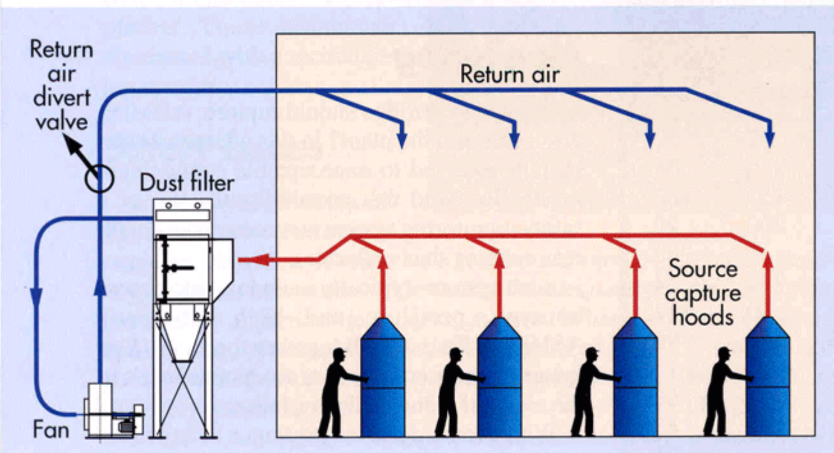

Fig. 3. Source capture ventilation with zone returns uses hoods for capturing dust where it is generated.

value in formulas to calculate the amount of explosion vent area required for a dust collector. Collectors requiring explosion vents should be located outside and vent away from buildings and populated locations.

If the collector must be located inside, the plant engineer can duct an explosion outside through a very short duct (9 ft or less). This design adds back-pressure and usually requires reinforcing the collector to handle the increase in pressure. If it is not feasible to duct to the outside, the collector should be outfitted with an explosion suppression system. An indoor suppression system may cost more than the dust collector itself.

Fire is another safety concern with a dust collector. Welding, metal grinding, and similar operations can cause sparks to enter the collector inlet and start a fire. To prevent this, a spark suppression and detection system should be installed in the inlet ducting to sense and extinguish sparks or flames. Several different suppression systems are available utilizing water, chemicals, or inert gas.

A diversion system that incorporates spark detection and diversion valves called "abort gates" is also available. When a spark is detected, the abort gate diverts the recirculated air stream to the outside, arresting the flame front before it reaches the dust collector. Companies that specialize in this equipment can help design a spark detection and extinguishing system.

Recirculation

After the air has been adequately cleaned and safety issues addressed, how should the air be recirculated downstream of the dust collector? Ideally, to maintain balance and optimize energy conservation, the return air duct should allow distribution to the same areas from where the air was originally exhausted. A common mistake is to draw the air out of one room and recirculate it elsewhere, creating areas of negative and positive pressure.

A well-designed recirculating system not only saves energy; it can actually enhance worker comfort. For example, a system that serves multiple welding stations might consist of one long duct with adjustable diffusers at each station. This design allows personnel to use the diffusers like individual fans, directing the air toward or away from their workstations as desired. The *Industrial Ventilation Manual* (see "More info" box) expands on this area in great detail, and its use is recommended.

There are two possible return air configurations. A general ventilation system with zone return, used in cold climates, will recover heat from the ceiling and return it to the work area (Fig. 2). This configuration is also useful when the process does not allow the use of source capture hoods. A major disadvantage is that a general ventilation dust collection system requires larger airflows, fans, and filters, resulting in higher equipment and operational costs.

In a source capture system with zone return, hoods are added over each workstation (Fig. 3). This is a more efficient air distribution system with lower airflow, fan, and filter requirements. However, it can only be used with stationary processes.

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