Keeping Dust out of Non-Manufacturing Spaces in Industrial Plants

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Pressurizing with dust collection offers an effective, often overlooked approach to keeping dust in check to protect workers and plant equipment. This article explains the concept of pressurization, describes the industries in which it's most applicable, and offers a guide on selecting equipment to achieve the best results.

High-efficiency dust collectors are best known for maintaining cleanliness in industrial manufacturing spaces. But offices, conference areas, control rooms, server rooms, and similar spaces in these facilities also must be protected against dust infiltration from nearby manufacturing processes or from particulate present in the outdoor air. Pressurization of these spaces — coupled with the use of cartridge-style dust collectors to clean the air — can provide an effective and economical approach that is often overlooked.

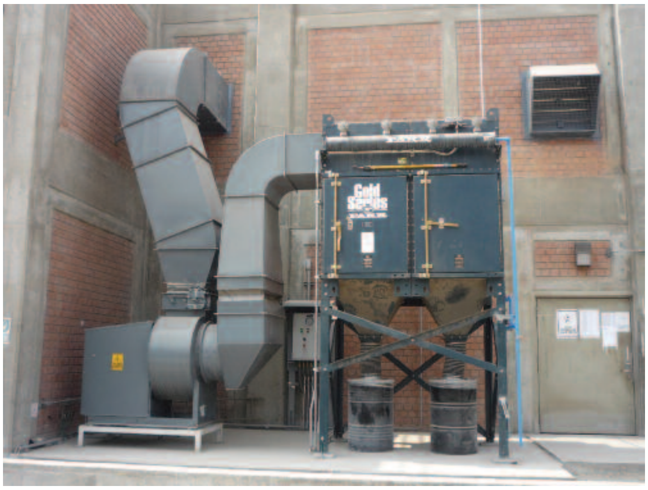
How Pressurization Works

Pressurization is a well-known ventilation technique in which a positive or negative atmospheric pressure is maintained in an isolated or semi-isolated environment. Positive pressure (known as "inflating the building") is used to keep particulate or gaseous contaminants out of a room, creating an air barrier between the outside and the inside. This makes it possible to protect the contents of the room from dirty outdoor air conditions, from dust or fumes generated by an adjacent production process, or even from excess humidity that might seep in through walls or other openings. Offices, labs, electrical rooms, and server rooms in industrial facilities are especially prone to dust infiltration, which can create unpleasant or even hazardous working conditions while causing problems with critical equipment, especially electronics.

Conversely, in a pharmaceutical facility where potent compounds are used, or a mining facility where toxic minerals are being processed, negative pressure may be applied — sometimes in conjunction with containment systems — to prevent the dust generated in a manufacturing space from cross-contaminating other areas of the plant.

Many times, the non-manufacturing sections of industrial plants will be pressurized using HVAC air handlers, which may contain ASHRAE-grade or HEPA filters capable of capturing very small particulate matter. HVAC filters, however, are not designed for the heavy dust loads generated by some manufacturing processes. In these situations, filter life can be limited to a few months or even a few weeks, resulting in high maintenance and replacement costs.

Pressurizing with industrial, cartridge-style dust collectors offers an excellent alternative to air handlers, especially in dusty conditions. Cartridge dust collector filters are designed specifically to handle high dust loads in industrial environments, so when used in a pressurization system, high-efficiency cartridge filters can last for years before needing replacement. The main difference between the technologies is that a dust collector automatically pulse-cleans its filters using very brief bursts of compressed air, which blow the dirt off the filter surfaces and down into a collection device.



A 16-cartridge dust collector pressurizes and ventilates a compressor room in a power generation plant. Wall louvers allow for air exchange and are calibrated to maintain a specific pressure inside the facility.

Which is best for your application, HVAC filtration or dust collection? To find out, you will need to compare: (a) the initial cost of the equipment/hardware and the filters; (b) the cost of electrical energy required to operate the system; and (c) life expectancy of the filters under the anticipated dust loading conditions. Based on expected change-out frequency, you can arrive at an annual cost estimate that takes into account not only the price of the replacement filters but also related labor costs, equipment downtime, inventory, disposal, etc.

Always keep in mind that if you are dealing with pharmaceutical-grade or some food-grade applications, these highly regulated industries also may place some restrictions on the types of filters or level of filtration needed to comply with industry standards.

Determining Whether to Pressurize

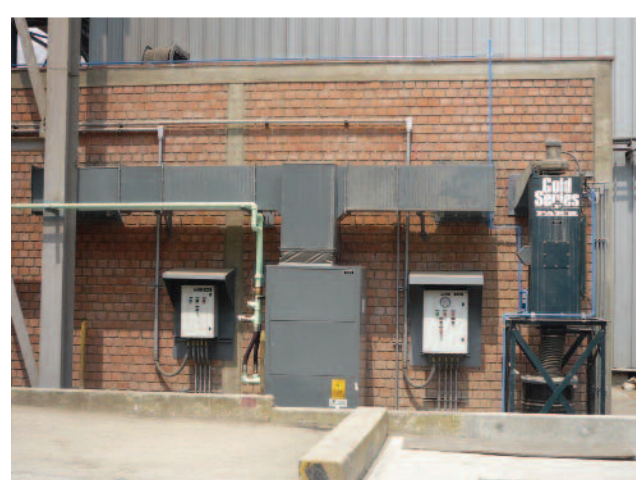
How do you decide whether pressurization is a good choice for your facility? The decision can't be based solely on the volume of dust to be controlled because other factors, such as the type of dust, conditions inside and outside the space, and what (or whom) you are trying to protect, also must be considered.

If there is nothing much of value inside the space, pressurization may not be worth the expense. But, if you are protecting expensive electrical equipment from damage or from creating a safety hazard due to contact with dust, investing a fraction of that equipment's cost in a pressurizing system to ensure that the equipment is protected is well worth the expense.

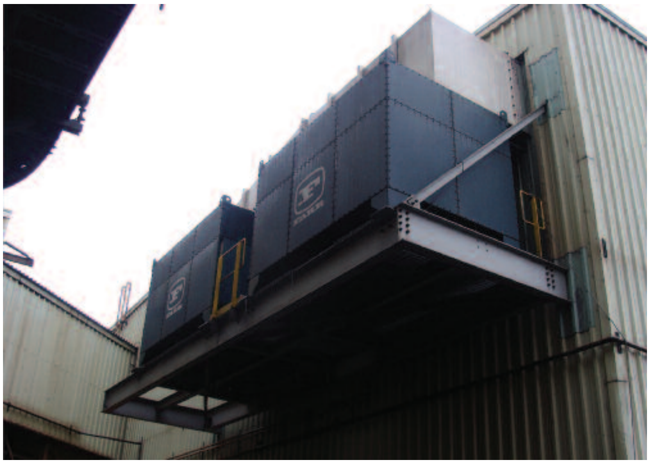
Similarly, if workers in an office area are exposed to unhealthy levels of dust or fumes, you will want to keep the area clean to protect employees and comply with Occupational Safety and Health Administration (OSHA) regulations for exposure. The importance of this cannot be understated. Though we have long known that dirty air is hazardous to health, the International Agency for Research on Cancer (IARC), the World Health Organization's cancer agency, recently announced that both air pollution and particulate matter — a major pollution component — would now be classified among Group 1 human carcinogens.

Climate considerations also might impact your cost analysis. In the tropics, if you inject large amounts of warm, moisture-laden air from outside to pressurize a building, the additional air conditioning load could be cost-prohibitive. In colder climates, however, or during the winter season, you can take advantage of the "free cooling" and use your pressurizing system for conditioning, saving substantially on air-conditioning costs required to keep servers and electrical equipment from overheating.

Typically, return-on-investment should be less than two years for pressurization to be cost-effective. Experience shows that the payback is often much faster. Though — as previously stated — in many cases the main justification is to guarantee a certain air quality in a space to protect something or someone. Besides the health benefits, a clean work environment also will enhance morale and boost productivity.



A small cartridge collector is used to pressurize an electrical room. Located in a warm climate, the room has its own backpack-type air conditioning unit for cooling, and the dust collector is sized for 10 percent of the capacity of this unit.



A large 24-cartridge collector plays a critical role in pressurizing an MCC room at a U.S. iron mine, protecting the electronic equipment from possible short circuits created by dust infiltration.

Pressurization is applicable to many industries, including cement and lime production, metal and coal mining, pharmaceutical processing, grain processing, or potentially anywhere that high volumes of dust are generated. Areas that are most commonly protected using this technique include control rooms, clean rooms, compressor rooms, offices, quality control labs, substations, electrical equipment and motor control center (MCC) rooms, and server rooms.

Pressurizing with dust collection can be applied whether the site is a new construction, an expansion, or a renovation project. Retrofitting of air handling units, although possible, can be more costly and complex depending on the set-up and location.

Equipment Selection Guidelines

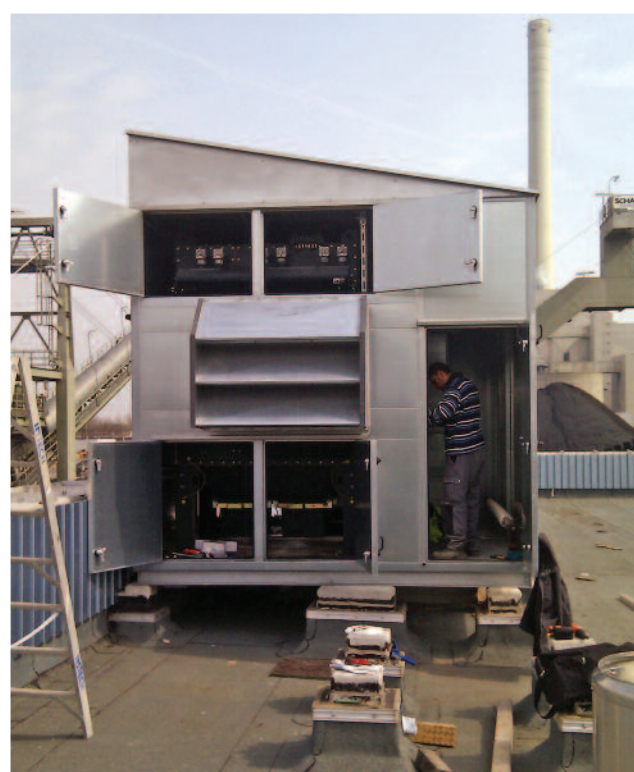
Cartridge-style dust collectors are the system of choice because they deliver much higher filtration efficiencies than baghouses, a necessity when protecting workers or sensitive equipment from high levels of fine dust. Cartridge collectors also operate at lower pressure drop for more efficient performance. Dust collectors in these applications will be located outdoors, so they must be equipped with weather-resistant components and controls.

A very *high-efficiency, nanofiber filter media (MERV 15 or 16)* is the best choice for pressurizing applications. Typically, an outer layer of extra filtration fibers will ensure maximum efficiency of the media from day one. This technology increases the efficiency and allows maximum filtration with low pressure drop, thus improving the energy performance of the system.

Don't rely solely on MERV values or filter efficiency percentages in choosing a filter media, however. While these measures are useful for comparing different filters, verifying that emissions will be at or below required thresholds is more important. Ask the filter manufacturer to provide a written guarantee of emissions performance stated as grains per cubic foot.

As noted, cartridge filters need only infrequent change-out in pressurizing applications, but recommendations are to replace filters every two to three years at the very least. An older filter may develop a hole or leak as time passes and will no longer deliver the guaranteed efficiency.

For critical applications, *HEPA or after-filters* — also known as *safety monitoring filters* — may be installed in the ductwork downstream of the collector to provide backup protection in the unlikely event of an air leak through the dust collector filters. In certain cases, HEPA filters will be required to comply with regulations of a specific industry. *Carbon after-filters* are another option for use when

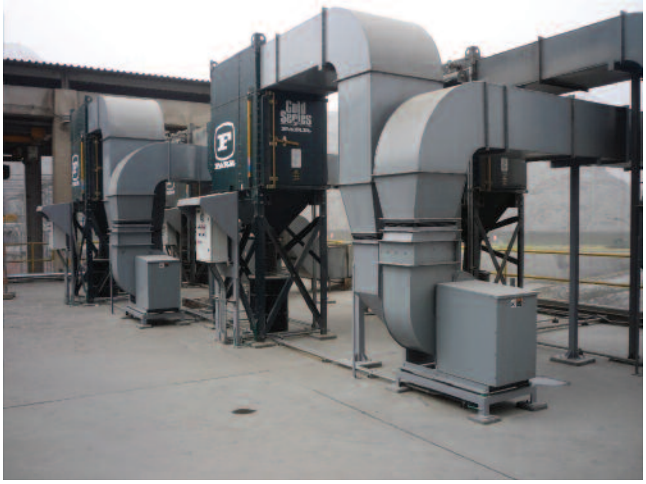


A cartridge dust collection pressurizing system is installed on the roof of a maintenance building in the harbor of a European coal-fired power plant to prevent ambient coal dust from entering the building. The unit is installed in front of a ventilation system and uses a water and moisture eliminator filter at the intake to keep rain from entering the unit.

odor control is desired — for example, to prevent outside odors from entering an occupied pressurized space.

A variable frequency drive (VFD) ensures precise control of dust collector fan speed, efficiently maintaining the desired airflow through the collector. VFDs are a must for pressurized applications and should always be used in tandem with a *pressure sensor* in the room. The two devices will work together to monitor and control pressure.

If you are pressurizing to protect a space from gaseous contaminants, a *wet scrubber system* will be needed to remove these contaminants. If dust is present, however, you will still need a cartridge dust collector, installed upstream of the wet scrubber, for particulate filtration.



Multiple dust collectors, each containing six high-efficiency filter cartridges, are used to pressurize electrical rooms at a copper mine. The units have been operating for more than two years without a filter change. Blowers are controlled by VFDs and pressure sensors inside the room.

Pressurizing Air-Conditioned vs. Non-Air-Conditioned Spaces

A final consideration in pressurizing is whether or not the space to be pressurized is air-conditioned.

If the space does *not* have to be heated or cooled, dust collector airflow calculations should be based on the ventilation requirement for indoor air quality, plus air leakage through cracks and openings (i.e., using standard formulas for infiltration). False ceilings, raised floors, and other construction details also may impact the calculations. For suggested velocities across openings and their corresponding pressures, see Table 7-1 of the American Conference of Governmental Industrial Hygienists (ACGIH) "Industrial Ventilation: A Manual of Recommended Practice."

If the space to be pressurized requires heating or cooling, dust collector airflow should average between 10-20 percent of the HVAC unit airflow at a given capacity. This approach assumes the HVAC system has been properly sized to account for infiltration and will ensure that you do not overwork the HVAC system by injecting too much humidity. Heavy-duty air handling components, designed to withstand the dirty conditions, are recommended.

General ventilation guidelines for industrial applications recommend a difference of 5 percent between supply and exhaust airflow. In most cases, a good standard is to set a pressure differential of 0.04 +/- 2" w.g. (For more details see Section 7.5 of the ACGIH industrial ventilation manual mentioned earlier.) Uncontrolled pressure could create high velocity conditions that result in back-drafts and slamming doors. That is why using a pressure sensor inside the room and a VFD on the fan of the pressurizing unit to adjust the supply air is important.

Example: To treat an area that houses office workers using an extraction system mounted on top of a building, you will need a certain number of air changes per hour, which will determine the airflow. You should then add 5-10 percent more on top of that airflow to create pressurization. So, if the goal is to extract 1,000 cfm from the room, the dust collector should be sized with 1,100 cfm capacity to make sure you are injecting more air than you are extracting. If there are any openings or other leak paths, a good idea is to oversize the dust collector slightly or to calculate infiltration and add it to the formula. And, as noted, a VFD and pressure sensor again should be used as controls. **APC**

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