WHITE PAPER

10 Tips on Selecting Cartridge Dust Collection Equipment for Tablet Presses

Though tablet compression does not generate large volumes of fugitive dust, safe and efficient collection of whatever dust is created by this process is critical. The dust collector linked to the press can contribute to reliable, consistent performance – or detract from it, if components are not properly designed. These 10 tips will help you choose the best dust collection system for a tablet press application.

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AIR POLLUTION CONTROL

Though tablet compression does not generate large volumes of fugitive dust, safe and efficient collection of whatever dust is created by this process is critical in achieving the widely held goal of "error-free performance." A tablet press depends on a delicate balance of specified airflow and static pressure, climate control, precise material handling and compression force to run properly. The dust collector linked to this press can contribute to reliable, consistent performance – or detract from it, if dust collector components are not properly designed.

High-efficiency cartridge-style dust collectors offer excellent dust removal efficiencies and a relatively small footprint, making them the system of choice for tablet compression applications. But the dust collector must often serve many masters with varied concerns: the FDA for delivering safe products to patients; the NFPA for explosion protection; OSHA for explosivity, indoor air quality and other safety issues; the EPA for outdoor air; and the end user, whose goal is to satisfy all regulatory bodies while also maximizing quality and productivity. Here are 10 tips on the most important factors to consider when choosing dust collection for a tablet press.

1. Use a conservative air-to-cloth ratio

Air-to-cloth (air-to-media) ratio, defined as the cubic feet of air per minute to square feet of filter cloth/media, is an important and often misunderstood element in dust collector selection and sizing. The recommended air-to-media ratio for cartridge filters used in tableting applications is in the range of 2:1–2.5:1.

Some equipment suppliers will use air-to-media ratios as high as 5:1 to allow use of a smaller collector that requires less space and carries a lower initial cost. Overly high ratios can often result in inconsistent airflow, which in turn generates multiple problems: (1) static pressure can be out of specification, causing the press to malfunction; (2) filter life is shortened, creating lost production time and high change-out costs; and (3) the pulse cleaning system will be triggered too frequently, further shortening filter life and hampering reliable operation of the dust collector.

The use of a more conservative (i.e., lower) air-to-media ratio can minimize these problems and help allow the tablet press end user to operate for 1–2 years between filter changes. Though the initial cost outlay will be higher, this approach offers a rapid payback in maintenance savings while improving overall reliability.

Dust collector for tablet press application is readied for installation. It contains two high-efficiency filter cartridges, bag-in/bag-out safe-change filter system and safe-change continuous liner discharge using an explosion vent on the back of the collector.

2. Determine the need for containment

It is critical to understand the toxicological properties of the material to be captured – i.e., the potent, toxic or allergenic properties of the compound. This is an important part in determining the Occupational Exposure Limit (OEL) of the active pharmaceutical ingredient (API). The OEL is defined as the amount of material determined to be the maximum air concentration – expressed as a time-weighted average in micrograms per cubic meter of air

(μg/m^3) – to which a worker can be safely exposed for an 8-hour shift, 40-hour work week, without potentially suffering adverse health effects. A risk-based exposure evaluation should be performed to determine the methods for proper control.

In most cases, some level of isolation and containment is required due to the fact that the pharmaceutical dust is hazardous and cannot be released into the surrounding environment. HEPA after-filter systems are typically recommended to provide backup protection for the dust collector and to allow release of the filtered air directly outdoors. In highly potent applications, or in multiproduct manufacturing facilities where cross-contamination is a concern, a contained dust collection system should be specified. A typical containment system will utilize bag-in/bag-out technology at the filter cartridges to ensure safe filter change-out, and continuous liner technology at the discharge system to contain the dust released from the cartridges to the hopper during automatic pulse cleaning of the system.

Bag-in/bag-out (BIBO) filter change is performed as part of a surrogate test. Surrogate testing helps predict real-world performance of dust collection equipment in containment applications.

3. Consider surrogate testing for containment applications

When containment is necessary, a surrogate test program can aid and support the risk assessment. Surrogate testing, which involves the use of a substitute or surrogate compound to simulate an API, is increasingly used to verify the effectiveness of isolation and containment equipment and to predict real-world performance. Test conditions are designed to mimic workplace operations as closely as possible without incurring the expense or health concerns of handling the actual API.

Testing can be performed on equipment handling an API with unknown toxicological properties or for verification of existing systems. Surrogate testing can also be performed during factory acceptance testing (FAT) and/or site acceptance testing (SAT) after equipment has been purchased to ensure proper performance once installed. By validating equipment performance during the engineering phases of a project, manufacturers stand to reduce costs while also ensuring the proper selection of the equipment for a particular project.

Continuous liner discharge system contains dust released from the cartridges to the hopper during automatic pulse cleaning of a dust collector.

4. Consider negative pressure requirements

In tableting applications, dust is most often exhausted to the collector from a local pick-up point where the material is fed into the die. Sometimes it will be necessary to maintain a negative pressure in the turret enclosure, requiring that

the dust be captured inside the tablet press housing. For contained tablet press systems handling a hazardous API, the latter approach will be needed to ensure a controlled environment. Using a contained dust collector sized appropriately with the correct air-to-media ratio will help to ensure the negative pressure environment inside the tablet press housing is maintained.

Also, having precise control over the reverse pulse cleaning system of the dust collector filter cartridges is critical in order not to create a positive pressure situation in the tablet press housing. This can lead to a breach in containment, improper operation of the tablet press and ultimately downtime on the operation to correct the situation.

5. Locate the dust collector outside the GMP space whenever feasible, especially in combustible dust applications

What about the location of the dust collector itself? In the majority of cases, for reasons of functionality, cost and convenience, it will be located in an indoor maintenance or mechanical area adjacent to the Good Manufacturing Practice (GMP) space, or sometimes outdoors. Either way, you will need to determine required duct lengths and the best way to run ducting to the adjacent room or outdoor location. This will ensure proper and consistent airflow to the tablet press, a critical factor for proper operation.

If it is necessary to locate the dust collector within the GMP space, compliance with FDA requirements will impose tight controls on the collector as they do on all equipment within that processing area. If a combustible dust is involved, chemical suppression and isolation will usually be the default technologies, and these are typically the most costly methods for explosion protection.

6. Establish whether your dust is combustible

Another major area of concern in dust collection involves deflagration and explosion potential of the material being collected. The degree of risk depends on the physical characteristics of the dust relating to Kst (the rate of pressure rise), Pmax (the pressure developed inside the collector) and minimum ignition energy. To determine whether the dust is combustible, it must undergo explosibility testing in accordance with ASTM test methods as stipulated by the National Fire Protection Association (NFPA).

Unless the dust is found to be completely inert (Kst 0), some form of explosion protection must be incorporated into the dust collection plan. The pharmaceutical industry typically deals with materials with higher Kst values than standard industry, so risks are higher and equipment decisions are more complex.

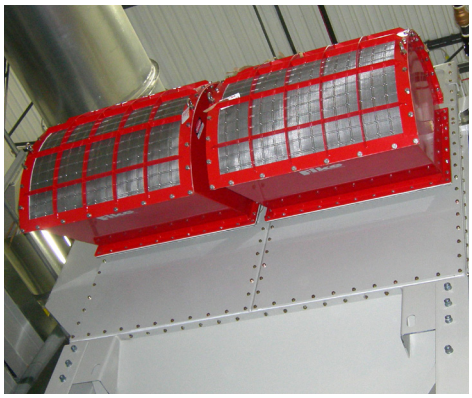
Staged explosion is performed to test whether a dust collector explosion vent will work as intended. The vent has popped open to relieve internal combustion pressure, keeping the collector from blowing up in a combustible dust explosion.

7. Identify the best type of explosion protection equipment for the application

The most common equipment options for the dust collector itself are an explosion vent or a chemical suppression system. Explosion venting is the most basic and cost-effective choice, but it may not be an option if the collector is located within the GMP space, in which case chemical suppression with isolation will most likely be used (see #5, above). The same scenario holds true for a dust collector in a mechanical area if a hazardous or potent material is being processed; hazardous material cannot be released directly to the atmosphere. If these conditions do not apply, explosion venting will likely be feasible, and you will need to determine proper sizing of components and whether to vent to the outside by placing the collector outdoors or ducting the vent exhaust a specified distance through the building structure.

The ductwork itself must also be protected against the possibility of explosion. If chemical suppression is being used for the dust collector, chemical isolation will most often be used for the ducts, although mechanical isolation is also possible. Various dampers and valves are available for this purpose. All of these options carry limitations and can vary widely in price.

Given the importance and complexity of combustible dust issues, an independent professional engineer should be engaged to specify the best explosion protection approach to ensure compliance with NFPA, ATEX and/or the requirements of your insurance carriers.



Explosion vents and flameless venting are two types of explosion protection system that mitigate combustible dust explosions in dust collectors.

8. Find out if the dust collection supplier can provide “real-world” destructive test data for explosive dust applications

The NFPA uses relatively conservative textbook calculations in developing standards for explosion protection equipment, and justifiably so. However, the NFPA also allows real-world destructive test data to be used in place of its own standard calculations, provided the dust collection supplier can provide adequate data to prove that the collection system is designed to meet a specific set of criteria for a given situation. The use of real-world destructive test data is thus a permissible and sometimes overlooked strategy.

Vessel strength is an important factor in sizing explosion protection equipment. A heavy-duty dust collector, constructed of thicker-gauge metal and with a higher pressure rating, will stand up better in the event of a combustible dust explosion and will often allow use of a simpler and less costly explosion protection system to achieve compliance. This approach also provides more flexibility in regard to equipment placement, potentially saving space inside the facility. Find out if your dust collection supplier can provide real-world test data to assist in this strategy.

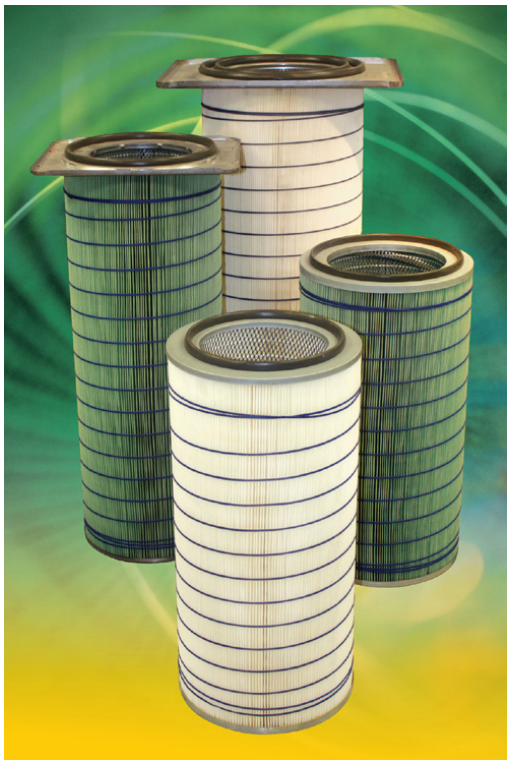
9. Determine the best filter media and pleat configuration for the job

Tablet presses typically generate fine dry and potentially hazardous dusts which require the use of high-efficiency filtration media in the dust collector. A typical example is a polyester-cellulose blend with a microfiber synthetic melt-blown laminate or nano fiber surface layer that provides filtration efficiencies up to MERV 16 per ASHRAE 52.2.

Since temperature and humidity are well controlled in the GMP space, they do not pose a challenge unless the collector is located outdoors, in which case the media should be able to handle a wide range of environmental conditions. Furthermore, if the manufacturer uses a clean-in-place (CIP) or wash-in-place (WIP) system on the press, a high-efficiency spun-bond polyester media with an oleophobic treatment might be specified so that filters can withstand the excess moisture generated by the cleaning process. A bypass damper may also be used to reduce or eliminate the moisture content in the airstream before it reaches the collector. This will allow cleaning to take place without requiring shutdown of the dust collector. A carbon-impregnated media may also be required if the material being collected is highly combustible and static dissipation is needed as determined by a risk assessment.

A filter pleat style designed to promote optimum airflow through the system is also recommended. Some cartridge filters utilize open-pleat spacing that allows better utilization of the media pack, resulting in more uniform airflow through the cartridge, for more efficient performance at a lower average pressure drop. Wider pleat spacing also allows dust to release more readily during pulse cleaning. As a result, overall performance is enhanced, leading to consistent, uniform airflow, and filter life is extended, reducing maintenance costs and preventing costly production shutdowns.

Filter cartridges with wide pleats stay open during use, providing superior airflow and greater dust loading.



Open-pleat style high-efficiency filters with nano fiber surface area.

10. Consider air recirculation downstream of the dust collector

In regions with very hot or cold outdoor environments, air recirculation should be considered. By recirculating heated or cooled air back through the plant, the cost to replace that conditioned air is reduced and/or eliminated. The energy savings can be considerable. Most dust collection equipment suppliers can provide cost calculation software that enables engineers to project savings based on system airflow, geographic location, local utility costs and other factors.

When recirculating air downstream of the collector, the addition of a HEPA after-filter system is recommended for all applications and is required when filtering hazardous or toxic dusts. The HEPA filters provide backup protection as well as a final scrub of the air before it goes back into the facility. Ductwork and a transition section are usually required to connect this secondary filter module to the dust collection system. For some applications, integrated designs are available in which the after-filter is mounted on top of the collector so that no additional floor space is required. Safe-change containment HEPA filter systems are also available depending on the application and the need. Design and selection of after-filter compoments should be based on a risk assessment. When a HEPA after-filter is used on a collector handling an explosive dust, this system – along with the dust collector and ductwork – must also comply with NFPA standards for combustible dust handling.

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