# Choosing a bag-dump station for effective dust control and operator safety

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**Despite the rising popularity of bulk bags for economically handling powders, receiving some powders in standard 50-pound paper bags is necessary in many dry bulk solids processes. This is because many powders aren't available in bulk bags, and some users require only small quantities of certain powders and thus prefer the smaller bags. But unless you choose your bag-dump station carefully, manually slitting and dumping small bags of powder can create dust problems and put your operator at risk for injuries. This article details dust control options for bag-dump stations and gives advice on how to select equipment that handles your operation while keeping your operator safe.**

When choosing a bag-dump station for your batch operation, you need to ask two fundamental questions: How will the station control dust? And how can the station provide a safe, comfortable work environment for the operator? First, let's take a look at what dust control options are available.

Your bag-dump station can use one of two dust control methods. One integrates the bag-dump station with your plant's central dust collection system. The other requires a self-contained bag-dump station with an integral dust collection system.

### Station integrated with central dust collection system

If your plant routinely handles powders, chances are you have a central dust collection system. Using this system to capture dust at your bag-dump station is the most cost-effective way to control this dust, as long as the system is capable of handling the additional load.

***Components and operation.*** A bag-dump station that's integrated into the plant's central dust collection system typically consists of a hopper covered by a grate, with a dust-capture hood mounted over the grate. The hood, which has an inlet opening large enough to allow the operator to place the bag on the grate, is connected by a round duct to the central dust collection system. In operation, the operator places the bag on the grate, slits the bag, and lets the powder flow downward into the hopper. The airflow draws dust and air away from the operator into the hood and through the duct to the dust collection system. The grate keeps the empty bag from entering the hopper, and the powder dumped from the bag flows into the hopper and exits the hopper outlet, where a valve or conveyor meters the powder to a downstream batch vessel or other process.

Several hood designs are available for the bag-dump station. For an extremely dusty powder, the hood should be equipped with an internal baffle, as shown in Figure 1a. Located between the grate and the dust collection pickup, the baffle directs airflow through the inlet opening, down through the grate, and into the dust collection pickup. In another hood design often used for a less dusty powder, the dust collection pickup is at the bag-dump station's top, as shown in Figure 1b, and the hood has no internal baffle. With this design, the airflow is drawn through the inlet opening directly to the dust collection pickup. The result is that any dust generated in the station has an upward velocity through the grate, which may expose the operator to more dust.

***Design factors.*** You must correctly size the bag-dump station's hood to ensure that your dust is efficiently captured.

The hood's inlet opening width (Figure 1a), typically ranging from 30 to 48 inches, must comfortably handle the bag's length. The inlet opening height (measured from the top of the inlet opening to the grate surface, as shown in Figure 1a) is typically 18 to 30 inches, which allows the operator to easily place the bag onto the grate and slit the bag open.

Also make sure that your dust collection system can support the hood's airflow requirements. Typically, the hood should operate with an airflow velocity of 150 to 250 fpm through the inlet opening; this is called the *capture velocity* or *face velocity*. You can calculate this velocity using the method given in the following example, where the hood's inlet opening width ($W$) is 36 inches, its inlet opening height ($H$) is 24 inches, and the desired airflow draw is 150 fpm:

$$W \times H = \text{hood inlet opening area}$$

So:

$$36 \times 24 = \text{864-square-inch inlet opening area}$$

Converting the inlet opening area into square feet produces:

$$864/144 = \text{6-square-foot inlet opening area}$$

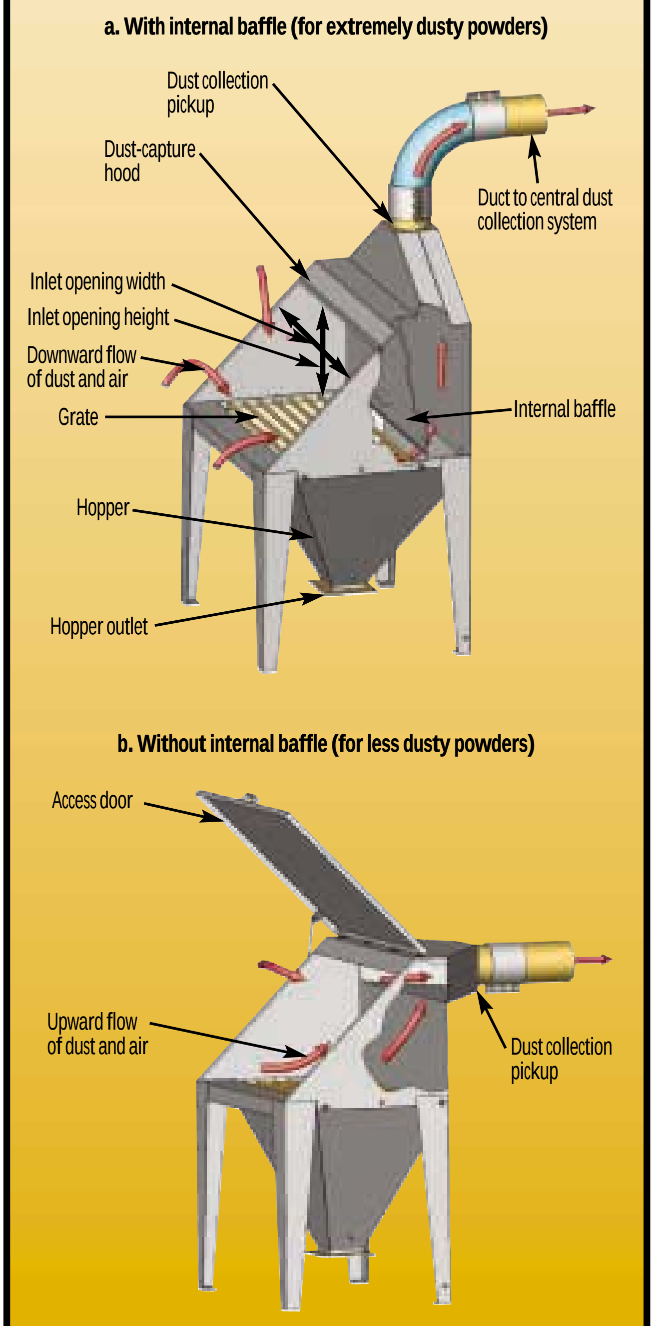
So:

$$6 \text{ square feet} \times 150 \text{ cfm} = \text{900-cfm minimum airflow draw}$$

Once you've determined the hood's required airflow draw, evaluate your dust collection system to determine whether it can support the hood's required draw. For an existing system, check that the dust collector provides sufficient filtration area and the system fan provides sufficient airflow. The duct from the hood to the dust collector should be sized to prevent dust from settling in the duct. Depending on your dust's characteristics, the airflow velocity through the duct will range from 3,000 to 4,000 fpm. You can calculate the actual pressure drop through the dust collection system once you know the duct's diameter. If you're designing a new dust collection system, refer to the handbook *Industrial Ventilation: A Manual of Recommended Practice*[1] for information on dust-capture hood requirements.

**Figure 1**

**Bag-dump station integrated with central dust collection system**




*Be aware that dust disposal can be costly, not only because of handling and landfilling costs, but because the dust represents lost product.*

A critical concern with using a central dust collection system is ensuring that the system airflow is balanced so that the airflow draw through each of the system's dust-capture hoods is correct. When the system is installed, it's typically sized to provide a predetermined amount of additional airflow draw for future needs. But in many cases, the plant's process requirements quickly eat up the additional capacity, and users often add additional hoods without considering how this will affect the system's airflow balance. As a result, the hoods may not have sufficient face velocity at the inlet opening to provide effective dust control. Adding dust-capture hoods can also create a condition in which the system becomes out of balance. In many cases, the dust collection system's airflow velocity is reduced, which can cause dust to settle in the duct. This can reduce airflow through the system and, in some cases, completely plug the system with settled dust.

For best results, work with a dust control engineer to calculate how much additional airflow draw your dust collection system requires to handle an additional dust-capture hood. As more hoods are added to the system, be aware that the bag-dump station's hood may not operate as designed. To monitor the hood's efficiency, regularly inspect the hood by checking the velocity at the inlet opening. Measure the hood's capture velocity by using a velocity meter at various points in the inlet opening and comparing the results with the hood's design capture velocity. Many hoods have a damper valve in the dust collection duct connected to the hood. Sometimes you can adjust the damper valve to increase the hood's airflow draw and inlet velocity.

The dust collected by the system's dust collector may have minimal or no value to your process. You may need to discard or reprocess the dust. Be aware that dust disposal can be costly, not only because of handling and landfilling costs, but because the dust represents lost product. The system can collect hundreds of pounds of dust every day, and the collected dust from a given hood often has high value — more than $1.00/lb for some titanium dioxide powders and up to $4.00/lb for some very low-bulk-density powders such as fumed silica. Rather than disposing of your bag-dump dust along with the process dust collected by the system, you may be able to use a self-contained bag-dump station with an integral dust collection system, as discussed in the next section.

## Self-contained station with integral dust collection system

***Components and operation.*** A self-contained bag-dump station is available in many types and sizes. The hood's inlet opening is sized much like that for a bag-dump station integrated with a central dust collection system. However, the self-contained station has its own integral dust collection system with a small fan, as shown in Figure 2. This dust collection system, typically located at the station's rear, uses bag, pleated bag, or cartridge filters. The fan, typically from 1 to 3 horsepower, draws air through the hood's inlet opening, downward through the grate, and toward the filters. An internal baffle separates the station's dumping area from the dust collection system. Typically, the system has a continuous pulse-jet or back-flush filter-cleaning system that uses compressed air to clean the filters.

*To ensure that the station efficiently collects dust, the selected filter media is particularly important.*

In operation, after an operator places the bag on the grate and slits it open, the bag's contents fall through the grate and the airflow created by the fan draws dust and air down through the grate and past the baffle into the dust collection system. The hood's inlet opening typically has a capture velocity of 130 to 250 fpm. Because the dust collection system is part of the station, the collected dust cleaned from the filters is returned directly to the station's hopper, eliminating a need to dispose of the dust.

***Design factors.*** To ensure that the station efficiently collects dust, the selected filter media is particularly important. Felt media is commonly used, and you can select it with various treatments and membranes to handle your dust's characteristics. The choice of bag, pleated bag, or pleated cartridge filters is also important to ensure that the filters can be effectively cleaned by the pulse-jet or back-flush cleaning system. Work with a filter supplier to determine which is best for your bag-dump station.

*Bag filters:* Most bag filters have a round cross-section, as shown in Figure 3a, and can be pulsed clean with a short (0.1-second) blast of 80- to 100-psig compressed air directed down through the filter's interior, which causes the filter media to pop outward, dislodging the dust. Normally, a bag filter can be thoroughly cleaned by a pulse-jet system.

*Pleated bag filters:* A pleated bag filter has a round cross section with pleats spaced ¼ to ½ inch apart. Unlike a standard bag filter, the pleated bag filter can't be pulse-jet cleaned. The pleated bag filter requires compressed air

**Figure 2**

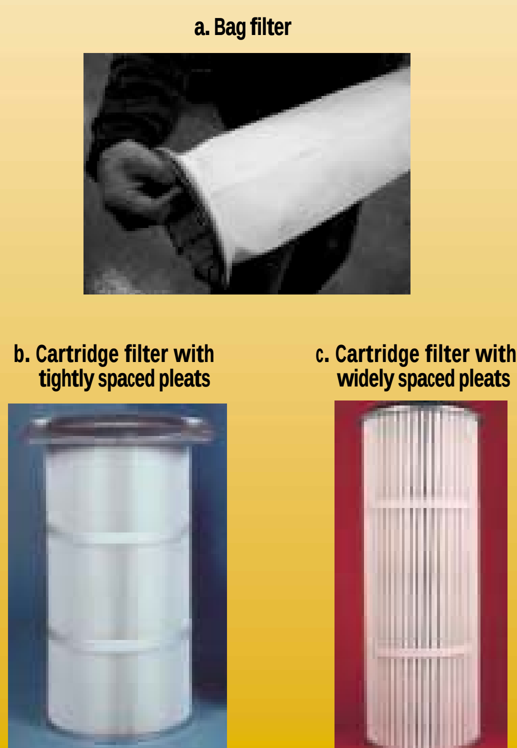
**Bag-dump station with integral dust collection system**

(typically from 40 to 60 psig) to be back-flushed into the filter interior for about 0.5 to 1 second. This back-flushed air passes through the media from the filter's clean side (interior) to the dirty side (exterior), forcing the dust to separate from the media and fall downward into the station's dust hopper. The pleated bag filter works well with most powders but may retain some cohesive powder between the pleats, ultimately reducing the usable filter surface area.

*Pleated cartridge filters:* Pleated cartridge filters also typically have round cross sections and are available with tightly or widely spaced pleats. As with the pleated bag filter, both types of pleated cartridge filters must be cleaned by back-flushing. In a filter with tightly spaced pleats, as shown in Figure 3b, the pleats are typically about ⅛ inch apart. Since the pleats are so closely spaced, in many cases powder can become packed between the pleats and can't be removed by back-flushing. Even though this filter can provide a low air-to-cloth ratio, the media may plug quickly and reduce airflow. For this reason, this type of cartridge filter isn't recommended for a cohesive or sticky powder. The cartridge filter with more widely spaced pleats (¾ to 1 inch apart), as shown in Figure 3c, can be cleaned more thoroughly. While not providing as much media surface area as a cartridge filter with tightly spaced pleats, the filter with widely spaced pleats allows more thorough cleaning with back-flushing and is thus recommended for fine, cohesive powders.

**Figure 3**

**Typical bag-dump station filters**




The amount of filter surface area per cubic feet per minute of airflow draw — that is, the air-to-cloth ratio — in the self-contained bag-dump station differs slightly from that of a conventional dust collector. For a typical dust collector, the air-to-cloth ratio ranges from 6 to 8 cfm per square foot of filter media (that is, from 6-to-1 to 8-to-1). Trying to achieve an 8-to-1 air-to-cloth ratio in a self-contained bag-dump station with bag filters or cartridge filters with widely spaced pleats, however, is impractical. For example, if the station required a 1,200-cfm fan, the required amount of filter media for an 8-to-1 air-to-cloth ratio would be 150 square feet — not practical for this small bag-dump station. Instead, a typical self-contained station with a 1,200-cfm fan may have up to 80 square feet of filter area, with a 15-to-1 air-to-cloth ratio.

While 15-to-1 is typical, the air-to-cloth ratio for a specific bag-dump station varies by manufacturer, generally ranging from 12-to-1 to 30-to-1. How well a self-contained station can operate within this range depends not only on the filter media type, as previously discussed, but on your powder's characteristics. To select the right filter type and air-to-cloth ratio for your self-contained bag-dump station, consider not only your dust's particle size, but its particle density and cohesiveness and how much you will use the station.

*Powder density:* Your powder's density will indicate if the dust captured by the hood and collected on the filters will be heavy or light. Light dust can cause several problems. It can be dislodged from the filter but not fall into the hopper below; the airflow can then lift the dust toward the filter where it becomes re-entrained on the media, plugging it and quickly causing the station's dust collection system to fail. To handle light dust, you can select a larger station with more filters, which reduces the upward-flowing air's velocity (called the *lift velocity*) around the filters and allows the dust to settle into the hopper. For example, a self-contained bag-dump station with a 1,200-cfm fan and two 12-inch-diameter cartridge filters with a total of 80 square feet of filter surface area would typically have a lift velocity of about 7 fps. This may be too high for some light dusts, requiring more cartridge filters and more area around the filters to reduce the lift velocity.

*Powder cohesiveness:* Dust from a cohesive powder tends to build up on the filter media unless the media is specifically chosen to release the dust. The best solution is to choose a media with a slippery finish such as polytetrafluoroethylene (PTFE), which provides better dust release during filter cleaning. If your powder is cohesive, make sure that the filter you choose can be thoroughly cleaned either by pulse-jet cleaning or back-flushing.

*Station usage level:* How frequently you'll use the self-contained bag-dump station may affect your selection of the air-to-cloth ratio. Like most users, you'll probably use the station on a batch basis. But if you'll dump large quantities of bags, you may want to use a station with a larger dust collection system so it can house additional filters. This will provide a lower air-to-cloth ratio and lower lift velocity between filters to more efficiently collect your dust.

### Dust control for empty-bag disposal

Disposing of your empty bags after bag dumping can be a dusty problem. How you'll dispose of the bags is an often-overlooked but important issue to consider when selecting your bag-dump station. If you don't handle the empty bags carefully, dust can leak from the bags into the work area. Planning ahead can ensure that your station is equipped to contain the dust from empty-bag disposal. The following information applies both to stations integrated with a central dust collection system and self-contained stations.

***Open box or drum.*** Unfortunately, one of the most common ways to handle an empty bag is to manually toss it into an open box or drum near the bag-dump station. As the bag is removed from the bag-dump station, it's also removed from the hood's dust-capture area, so the dust escaping from the bags contaminates the workplace.

***Bag-disposal port.*** A better option for controlling dust from the empty bags is to install a bag-disposal port at one side of the station's dust-capture hood. The port is typically a round opening, 10 to 16 inches in diameter, to which a large plastic disposal bag is attached. After powder has been dumped from a bag in the bag-dump station, the operator pushes the empty bag through the port into the plastic disposal bag. This allows the operator to dispose of the empty bag without removing it from the station's dust-capture area. The method's drawbacks are that it's time-consuming for an operation that dumps large quantities of bags, the bags aren't compacted, and the plastic disposal bag won't hold many empty bags, requiring the operator to regularly replace the plastic bag.

***Empty-bag compactor.*** Another bag-disposal option is to use an empty-bag compactor. This unit, available in several types and from many bag-dump station manufacturers, is usually connected to one side of the station's dust-capture hood. The empty-bag compactor allows the operator to move the empty bag to the compactor without removing it from the dust-capture area near the hood. To select a compactor for your bag-dump station, consider how much floor space is available for the unit and, especially if you have a high bag-dumping rate, consider how many empty bags the unit can compact before the operator will need to empty the compactor.

### Ergonomic considerations

Consider ergonomic factors when selecting a bag-dump station so that your operator can work comfortably and safely while moving the bags to the station, placing them on the grate, and monitoring the rest of the operation. The following ergonomic factors apply both to stations integrated with a central dust collection system and self-contained stations.

***Grate height.*** The grate in your bag-dump station should be from 30 to 36 inches above the floor so the operator can lift the bag at a comfortable height that minimizes back injuries. Check Occupational Safety and Health Administration (OSHA) guidelines for more information.[2]

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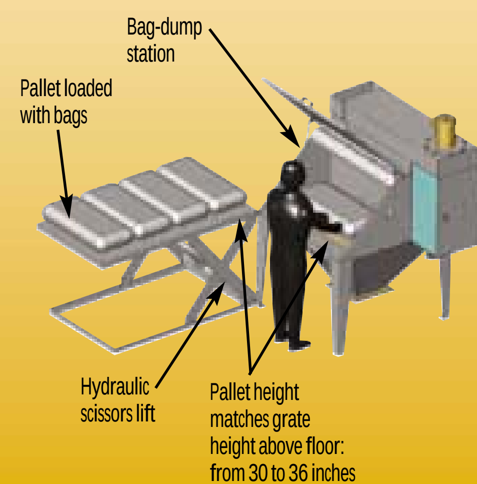
***Filled-bag position.*** To minimize bag lifting, make sure that the filled bags waiting to be dumped are positioned high enough to be lifted safely by the operator. Bags are typically positioned on a pallet next to the bag-dump station. The top bags on the pallet are close to the station grate's height, but the operator must use care to safely lift bags from lower layers. Two devices can help the operator lift the lower bags to grate height: a pallet-lifting device such as a hydraulic scissors lift, which raises the pallet as bags are removed, as shown in Figure 4, and a bag-lifting vacuum device, which uses a balanced lifting arm and suction to lift each bag from the pallet.

***Inlet opening area.*** To reduce accidents and injuries, ensure that the operator has a comfortable, user-friendly work area at the station. To do this, make sure that the

**Figure 4**

**Hydraulic scissors lift for raising pallet to station's grate height**



hood's inlet opening area not only handles the requirements of your pallet- or bag-lifting device, but easily handles the filled bag's size, the number of bags dumped per batch, and the number of batches per day or the batch operation's speed. A filled 50-pound bag is typically 30 to 36 inches long and 15 or 20 inches wide. To see how bag size, bag number, and batch speed affect the operator's work comfort and the hood's inlet opening area, consider the following examples:

- In a batch operation that requires dumping 100 36-inch-long-by-18-inch-wide bags per hour, the operator must lift the bag, position it on the grate, slit the bag's length with a knife, dump the contents, and remove almost 2 bags per minute. In this case, a large station with an inlet opening area at least 42 inches wide will provide a work area larger than the bag's length and help the operator work quickly.

- In a batch operation that requires dumping 5 36-inch-long-by-18-inch-wide bags per batch with no time limit, a much smaller station with an inlet opening area from 24 to 32 inches can be used. The smaller opening area doesn't allow the operator to work as quickly, but the operator can still meet the batching operation's speed and the station will cost less to install and operate while consuming less floor space.

*Because the bag-dump station is usually a vital part of a process, it must be designed properly to avoid becoming a bottleneck in your operation.*

***Hopper.*** To provide a safe work environment, the bag-dump station's hopper must be designed to handle your powder's flow properties and function properly with downstream equipment. If the hopper is incorrectly designed, powder can stop flowing from it, tempting the operator to induce flow by poking a rod down into the vessel or, worse, override the station's safety interlock to remove the grate and push powder by hand down the hopper. Contact with the discharge device (often a rotary valve or screw conveyor) that's mated to the hopper outlet could severely injure the operator's hand or arm, making the plugged hopper a serious safety hazard.

To provide a properly functioning hopper and safe environment, know your powder's flow properties and design the hopper to accommodate them. A free-flowing powder may flow easily in a hopper with a relatively shallow wall angle. A cohesive powder can require more steeply angled walls, special nonstick wall liners or finishes, or walls mounted with flow aids such as fluidization pads or vibrators. In the previous batch operation example where the operator has to dump about 2 bags per minute, the powder must flow smoothly from the hopper to the downstream process to accommodate the next bag's contents. If the powder is cohesive and the hopper doesn't empty reliably, the lack of flow can halt the process, or the operator will have to work around the hopper's limitations, which could create a safety hazard if the operator tries to poke something into the hopper to speed discharge.

The hopper must also be designed to work well with the rest of your process equipment. Because the bag-dump station is usually a vital part of a process, it must be designed properly to avoid becoming a bottleneck in your operation. If a rotary valve or screw feeder is mated to the hopper outlet to meter powder to your process, the hopper will serve as a holding hopper and retain the powder for a short time. In this case, the hopper walls must have a steep enough angle to allow the powder to discharge when the valve or feeder starts. If the hopper walls don't have sufficient slope, you can install flow aids to induce powder flow. **PBE**

## References


1. *Industrial Ventilation: A Manual of Recommended Practice* (24th edition), American Conference of Governmental Industrial Hygienists, 2001. Available from American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240; 513-742-2020 (www.acgih.org).

2. Find information about ergonomics in industrial plants on the US Department of Labor's OSHA Web site: www.osha-slc.gov /SLTC/ergonomics.


## For further reading

Find more information on dust control and bag dumping in articles listed under "Dust collection and dust control" and "Bagging and packaging" in *Powder and Bulk Engineering*'s comprehensive "Index to articles" (in the December 2002 issue and at www.powderbulk.com).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