This article provides advice on choosing vacuum conveying system components that can help you successfully transfer a non-free-flowing powder. The information includes two case studies showing how bulk solids plants have chosen vacuum system components to overcome flow problems with their difficult powders.

A vacuum pneumatic conveying system has a relatively simple design, but ensuring that the system reliably conveys your material can be challenging. The challenge can be even greater when you’re handling a non-free-flowing powder.

If you need to vacuum-convey a powder with poor flow characteristics, the primary problems are feeding the powder into the conveying line at a constant rate and discharging it smoothly from the vacuum receiver (typically a filter-receiver) at the system’s end. To prevent or remedy these problems, you need to select a feed device and a filter-receiver with filters that can successfully handle your troublesome powder.

Choosing a feed device

With a vacuum conveying system, the powder entering the system’s pickup point is often discharged from a bulk bag unloader, bag-dump station, drum (via a pneumatic wand inserted into the drum by an operator), or other container. However, a non-free-flowing, cohesive powder tends to stick or clump together and easily bridges in bulk bags, small bags, drums and other containers, as well as in hoppers. This can prevent the powder from flowing at a constant rate into the conveying system’s pickup point.

Without constant powder flow, the material-to-air ratio in the conveying line can be too high, which will plug the line, or too low, which means the system is just sucking air without transferring much powder. Using an appropriate feed device to assist powder flow at the pickup point will keep your powder flowing into the conveying line at a constant rate. A vibratory or agitating feed device, or, in some cases, a screw feeder, can promote and regulate the flow of a cohesive powder into the system’s pickup point. The best way to select a feed device is to have your powder tested in various devices.

Choosing a filter-receiver and filters

In the vacuum conveying system’s filter-receiver, bag or cartridge filters separate the powder from the conveying air; the powder is removed from the filters during cleaning cycles and drops to the filter-receiver’s bottom section (typically a hopper) for discharge, while the cleaned air travels back to the system’s vacuum pump (or other vacuum producer). Providing a steady powder discharge from the filter-receiver to downstream processing or packaging equipment is just as important as achieving a constant flow rate at the system’s pickup point. But achieving good release of a non-free-flowing powder from the filters so it can discharge smoothly from the filter-receiver’s outlet can be challenging, so you need to carefully select both the filter-receiver’s design and the filters.
**Filter-receiver design.** A filter-receiver that has a hopper with sloped walls, particularly walls with a shallow angle, will provide areas where a cohesive powder can bridge or build up. Solving this problem often requires using a vibrating or agitating flow-promotion device on the hopper to promote smooth discharge from the outlet. Another option is to use a straight-walled filter-receiver that eliminates these sloped surfaces and the need for any flow-promotion devices. The straight-walled filter-receiver’s outlet is usually an automatic knife-gate, dump-gate, or butterfly valve with the same diameter as the downstream conveying line, allowing rapid discharge of even the most cohesive powder.

**Filters.** Choosing the right bag or cartridge filter media, number of filters, filter spacing, and filter-cleaning cycle are particularly important decisions when you need to separate a cohesive (and, in particular, ultrafine) powder from the conveying air. Without the right filter media, with too few or too many filters, or with poorly spaced filters, the filters can become coated with fine, sticky dust, hindering airflow through the filter-receiver and even choking it, which will bring the conveying system to a halt. Too-seldom or too-frequent filter-cleaning cycles, or cycles that are too long or too short, can have the same effect.

*Note:* If your conveying system’s location doesn’t have enough headroom to allow the vacuum receiver to contain filters, you can use a vacuum receiver without filters. In this case, the filters are placed downstream from the receiver but at a safe distance from the vacuum producer to keep dust particles from entering and damaging it.

**Case studies**

*Agitating feed device gets sticky powders flowing.* A plant uses iron oxide and zinc oxide as ingredients in a tape-manufacturing process. Transferring these fine, cohesive powders from 50-pound bags to a mixer-reactor requires an operator to place each bag on a shelf in a bag-dump station and then slit the bag open.

In the past, after the powder was discharged into the bag-dump station’s collection hopper, the operator used a pneumatic wand to move the powder to a vacuum conveying system’s pickup point so it could be conveyed to the mixer-reactor. But the iron oxide was so sticky and flowed so poorly that the operator couldn’t pick it up with the wand and get it into the conveying line.

The solution? The plant replaced the bag-dump station’s collection hopper with a live bin agitator. This device, which rests on rubber isolation mounts, consists of a hopper mounted with an oscillating vibrator. The vibratory action imparted by the vibrator shakes the hopper, promoting the iron oxide’s flow into a specially designed pickup point adapter so it can flow at a constant rate into the conveying line.

The plant’s bag-dump station also has an integral dust collector, equipped with bag filters, that draws ambient air into the station to prevent dust from the dumping operation from escaping into the workplace. However, the operator found that the other ingredient, zinc oxide, was clogging the bag-dump station’s filters. To remedy this problem and maintain proper airflow through the station, the plant switched to filters with a media that could easily release the powder during cleaning cycles.

*Fewer, widely spaced filters improve vacuum conveying of carbon black.* Getting carbon black to flow smoothly is notoriously difficult because of the powder’s ultrafine particle size — the old joke being that carbon black gets into the wrinkles of your wrinkles. A tire plant faced the challenge of recovering residual carbon black from the bottom of railcars after the bulk vacuum-unloading operation was completed. The residual carbon black was discharged by gravity from each railcar into the pickup pan of a vacuum conveying system, which conveyed the powder into bulk.
sign with a feed device, filter-receiver, and filters that will reliably handle your powder's stubborn flow properties. The supplier's experience and advice are just as important when choosing components to fix problems in an existing vacuum conveying system. Again, testing is key, especially when your powder is sticky, ultrafine, or has other characteristics that prevent it from flowing well.

**For further reading**
Find more information on this topic in articles listed under “Pneumatic conveying” in *Powder and Bulk Engineering*’s article index (in the December 2013 issue and at PBE’s website, www.powderbulk.com) and in books available on the website at the PBE Bookstore. You can also purchase copies of past PBE articles at www.powderbulk.com.

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