Pneumatic points to ponder...

Listening to the material you want to convey

In a recent PBE webinar, I talked about how you should “listen” to the material you plan to convey when designing and specifying a pneumatic conveying system. Coinciding with that webinar, I was heavily engaged in two specific field installations in which the end users were experiencing significant problems and added costs to operate their plants because their conveying systems didn’t completely match the way their materials needed to be conveyed.

Listening to a material involves finding out as much as possible about its physical and chemical properties to ensure that the system type and conveying mode selected are ideally suited to that material. Note that system type and conveying mode are two different things. System “type” typically refers to whether the system operates under vacuum, pressure, or a combination of the two. A vacuum system operates below atmospheric pressure, and the gas mover (typically a fan or blower) is located at the system’s end. A pressure system operates above atmospheric pressure, and the gas mover is located at the system’s beginning. A combination system combines the two and contains both a vacuum leg and a pressure leg. The most suitable system type primarily depends on application requirements, including:

- Whether the system may need to be expanded in the future

Conveying mode, on the other hand, has to do with the dynamics between the bulk solid material and the conveying gas inside the conveying line. The three basic pneumatic conveying modes are dilute phase, permeable dense phase, and nonpermeable dense phase. Pneumatic conveying system suppliers may refer to these modes by different marketing names that they’ve chosen to complement the names of their system’s components, but the conveying dynamics are the same.

Dilute-phase conveying uses a low material-to-gas ratio and a high gas velocity to convey the material suspended in the gas stream. Permeable dense-phase conveying uses a high material-to-gas ratio. The material isn’t suspended in the gas stream but forms a series of pistons that move along the conveying line like waves, allowing some gas to pass through the material. Nonpermeable dense-phase conveying also uses a high material-to-gas ratio, but the pistons that form in the conveying line don’t allow gas to pass through the material. The pistons are moved through the conveying line by the gas pressure differential across the piston.

You can find more information on pneumatic conveying system types, conveying modes, and system components in previous “Pneumatic Points to Ponder...” columns (See “For further reading”). In this column, I want to focus on the physical and chemical material characteristics that you should consider when selecting a pneumatic conveying system and how “listening” to what these characteristics tell you about your material can help you choose the best system for your plant.

Material characteristics that affect pneumatic conveying system selection

Physical characteristics that generally affect conveying mode and system type include:

- Particle size
- True density
- Bulk density
- Particle shape
- Fluidizability
- Cohesiveness
- Temperature
- Friability
- Abrasiveness
- Free moisture content
- Electrostatic charge

Chemical characteristics that can affect both system type and the system’s materials of construction include:

- Toxicity
- Combustibility/explosivity
- Hygroscopicity
- Corrosiveness

Not all characteristics will impact system selection in the same way or to the same degree. Expect to work with a supplier to determine the most significant material characteristics for your application. Here are some common examples of how material characteristics may impact your conveying system design:

Cohesiveness. If your material is cohesive, your system may require blow-through rotary airlocks to effectively feed material into the conveying line. You may also want...
to consider nonpermeable dense-phase conveying, such as a pulse-piston type system, which is less likely to suffer from cohesive blocking in the conveying line. Using flexible rubber hose rather than rigid pipe for conveying-line bends can also prevent material buildup.

**Combustibility.** If your material is combustible or explosive, you’ll need to follow OSHA and NFPA guidelines for handling combustible materials (available at www.osha.gov and www.nfpa.org). Some materials may require a closed-loop conveying system that uses an inert conveying gas, such as nitrogen, instead of air. If you’re using an open system, be sure to include adequate safety devices in the system specifications.

**Moisture content.** Moisture tends to cause material discharge problems from the feed source rather than flow problems in the conveying line. Generally, a moist or wet material can be conveyed in a conventional pneumatic system as long as the material can be fed into the conveying line and doesn’t contain too high a percentage of fines. Material buildup in the conveying line or bin vent filters can potentially be a problem, however.

**Electrostatic charge.** If your material is prone to electrostatic charge, you should ensure that the conveying line and other system components are electrically grounded. You may also need to humidify the conveying gas or add an electrostatic charge removal device to minimize charge buildup.

**Abrasiveness.** For abrasive materials, you should avoid line chargers that are subject to abrasive wear, such as rotary valves (unless the valves include wear-resistant features), and consider using a pressure tank or double gate valve to feed the system instead. To avoid excessive wear in the conveying line, consider a system with a low conveying velocity and be sure to use wear-resistant conveying-line elbows.

**Particle size.** Materials with granular particles will typically convey well with any system type or conveying mode as long as the material flows well from the feed source. Dense-phase conveying will result in less particle degradation, however, for granular materials that are subject to breakage. Materials with very fine particles in the sub-micron range may have a tendency to coat the inside wall of the conveying line. To minimize this coating, consider using flexible conveying line or hose, particularly for elbows.

**Toxicity.** If your material is toxic, you may need to use a closed-loop conveying system. Vacuum systems work better than pressure systems with toxic materials because any leaks will draw outside air into the conveying line rather than forcing potentially toxic conveying gas out into the workspace. Keep in mind, however, that some material may still escape a vacuum system due to particle momentum during conveying.

**Hygroscopicity.** Hygroscopic materials may require that the upstream silos or storage vessels feeding the system be blanketed to prevent moisture absorption from temperature fluctuations during storage. Either dilute- or dense-phase conveying may be suitable, but the conveying gas should be dried to reduce its moisture level prior to exposure to the material.

**Temperature sensitivity.** For temperature-sensitive materials, you may need to use a cooler to reduce the conveying gas temperature prior to exposure to the material. For many grades of plastic pellets, a conveying line with treated interior walls can help minimize heat-generating friction between the material and the conveying line.

These are just some of the ways material characteristics impact conveying system design. Many pneumatic conveying system suppliers have a large database of material properties from years of experience and operate test labs for characterizing new or unfamiliar materials. An independent testing facility can also analyze a sample of your material to establish most of the necessary system parameters. By listening to your material and using this information, you should be able to work with your supplier to design a reliable and efficient pneumatic conveying system that matches how your material really wants to be conveyed.

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**References**

1. *PBE* For more information about upcoming *PBE* webinars, visit www.powderbulk.com/webinars.

**For further reading**

Find more information on this topic in previous “Pneumatic points to ponder…” columns or in articles listed under “Pneumatic conveying” in *Powder and Bulk Engineering*’s article index in the December 2016 issue or the Article Archive at *PBE*’s website, www.powderbulk.com. (All articles and columns listed in the archive are available for free download to registered users.)

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