

Tips:

How to pneumatically convey various materials in dense phase

Are you interested in switching to dense-phase pneumatic conveying? Or have you found that your material is difficult to convey in dense phase? Read this article for tips on how to convey various materials in a dense-phase system.

Dense-phase (slug-flow) pneumatic conveying can provide several benefits. The method moves material at relatively low velocity, which prevents material degradation and equipment wear. Dense-phase conveying also reduces segregation and promotes flow at lower air volumes, making it more efficient per pound of material conveyed than higher volume dilute-phase (stream-flow) conveying.

In a dense-phase system, dry bulk material is typically loaded into a

vessel called a *transporter*. The transporter is pressurized — usually from 15 to 60 psig — and the material is pushed out into the conveying line in one continuous slug. Optional air injectors along the line (as shown in Figure 1) can fluidize the material or break the material slug into several shorter, easier-to-convey slugs. This reduces the total system friction and promotes flow at lower pressure. The conveying velocity increases over the line's length, so the longer the system the higher the velocity at the line's end (called *terminal velocity*).

The dense-phase system moves material at a much lower velocity than a dilute-phase system. While this makes dense-phase conveying suitable for abrasive or degradable materials, it may not be right for some materials. For instance, a fibrous material such as straw or needles tends to form interlocked clumps, and a material with different particle sizes and shapes can lock together; both can plug the conveying line.

Yet many materials can be successfully conveyed in dense phase. The following information describes dense-phase conveying characteristics of different materials and how you can modify the conveying system to improve each material's flow.

Dense-phase conveying for various materials

Materials that can be conveyed in dense phase include fine powders; fine, medium, and coarse granules; mixed fine and coarse materials; abrasive materials; soft or compressible materials; and agglomerative materials.

Fine powders. When fluidized, cements, silica flour, and other fine powders generally flow easily in dense phase. But conveying a fine powder in dense phase without fluidizing the material can be difficult.

The first problem is getting the fine powder to discharge reliably from the

Figure 1

Air injector installed on conveying line



transporter. The powder typically bridges across the transporter's cone section and stops feeding into the line. The conveying line empties of material, decreasing the transporter back pressure and causing the conveying cycle to shut down while powder remains in the vessel. You can solve this problem by using aeration jets in the transporter cone section, as shown in Figure 2. The jets help to swirl and fluidize the powder in the transporter vessel, reducing or eliminating bridging across the cone section and providing consistent powder flow into the line. To ensure there's enough airflow through the jets to fluidize the powder, a pressure differential must exist between the air pressure supplied to the jets and the actual back pressure maintained in the transporter during conveying.

The second problem is that the powder in the conveying line can become very dense and require so much pressure for conveying that the powder packs. This can produce friction on the line walls, reducing the conveying rate or plugging the line. Remedy this problem by using air injectors along the line to fluidize the powder.

This will also ensure that you can restart the system if it shuts down with powder in the line.

Fine granules. Some fine granules such as calcium carbonate and certain types of soda ash are difficult to convey in dense phase because they can't be fluidized and the pressure required to move the granules can cause them to pack. Solutions are to keep the conveying line as short as possible and, in some cases, to use air injectors along the line to reduce the resistance.

Medium-sized granules. Silica sand, dolomite, granulated sugar, and other medium-sized granules can't be fluidized, but they don't require fluidizing to be conveyed in dense phase. However, they do require a higher pressure and, in a longer system, their slugging action will be more violent.

Solutions include using air injectors along the line, especially in a long system, and in some cases isolating the air injectors into zones and reducing the pressure of those zones to make the slugging less violent.¹

Coarse granules. Larger granules such as urea and ilmenite ore can be especially hard to convey in dense phase. The larger the granule, the more air per pound of material is required for conveying. At some point, the air will simply flow around the granules without developing enough pressure to convey them. Depending on the granule shape, coarse granules are more likely to plug the line when a foreign object is obstructing the line or when line sections are misaligned. You can solve the problem by increasing the line diameter, which will reduce potential plugging.

Mixed fine and coarse materials. Most mixtures with large amounts of fine particles and small amounts of coarse can be conveyed in dense phase. But if the material segregates so that many coarse particles are concentrated in one area, the line can become plugged. The fine particles tend to fill the voids between the coarse particles, which can cause an interlocked plug that is very difficult to dislodge. Such plugs are more likely to occur with a mixture that has a wide difference in particle sizes and irregular particle shapes, such as pebble lime (which includes fines and 3/4-inch particles).

Figure 2

Aeration jets installed in transporter cone section



Another mixture subject to plugging is refractory batch, which consists of proprietary fine and coarse particles mixed with zircon sand. The mixture is compressed to form bricks. While the individual materials in the mixture can be conveyed separately in dense phase without plugging, the mixed irregularly shaped particles that make it ideal for forming bricks also pack during dense-phase conveying. It's often a good solution to select another conveying method for a mixture that exhibits such a strong plugging tendency.

Abrasive materials. Abrasive materials such as calcined aluminum, silica sand, carbon fines, and flint can wear the system's components. When conveying an abrasive material, properly select all wear components — including butterfly valves,

line switches, and bends — to ensure the system functions at capacity. For instance, use a butterfly valve where the material flows by gravity, such as at the transporter inlet, vents, or discharge, but not where the material flows at higher velocities, as in the conveying line.

Also use as few bends as possible in your line, and select each bend carefully depending on its location. You can typically use a standard bend near the transporter discharge but, because the conveying velocity increases along the line, use abrasion-resistant bends for the rest of the system. The farther away the bend is from the transporter, the more important it is to use an abrasion-resistant bend.

Soft or compressible materials. Wood flour, sawdust, and other soft or compressible materials can pack during dense-phase conveying, plugging the line. To solve this problem, you can use a lower conveying pressure and higher air volume, which will prevent the material from packing.

Agglomerative materials. Some materials such as hygroscopic particles tend to adhere to each other and form chunks. These chunks can lodge in the transporter discharge and slow or stop material discharge into the conveying line. This typically causes the transporter back pressure to become low and erratic, while dropping slowly at the conveying cycle's end. The airflow passes through the material without moving

it, forming a rathole in the transporter. You can solve this problem by using aeration jets in the transporter cone section; the jets must be supplied with dry air to fluidize the material without developing chunks.

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Reference

1. Multizone Pressure Controller, Nol-Tec Systems, Lino Lakes, Minn.