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Ask Joe! Column

Increasing Conveying Rates in Pneumatic Systems

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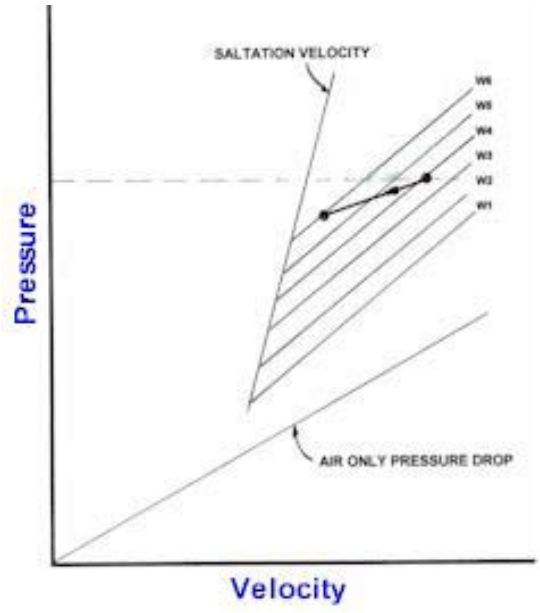
Introduction

Low conveying rates are a common problem in pneumatic conveying systems, particularly in systems that handle a variety of products through the same system. In many cases, a few minor changes in the conveying system can increase these rates appreciably. But before making these changes it is necessary to understand the reasons for the low conveying rates. Low conveying rates are generally caused by the following conditions:

- Rotary valve speed is too high, or its fill efficiency is too low, resulting in a “Feed Limit”.
- System pressure drop is near the maximum discharge pressure rating of the conveying blower, resulting in a “Pressure Limit”.
- Solids start to salt out when the conveying rates are increased or a “Velocity Limit”.
- One or more new materials are being conveyed but the system was not designed for these materials or “System Design Limit”.

Diagnostics and Solutions

Feed Limitations - Rotary Valve Speed and Leakage



In vacuum-type conveying systems, one can check the speed of the rotary valve and find out if it is flood-fed or starve-fed. The speed of the rotary valve can be determined by counting the number of revolutions per minute of the drive shaft. A normal speed range for a typical rotary valve is 15 to 25 RPM. At speeds higher than this rotor pockets don’t have enough time to empty out completely and the capacity of the rotary valve decreases instead of increasing (See Figure 1).

Maximum speed of a rotary valve can also depend upon the size and density of the solids. For example, the maximum rotational speed will be higher for plastic pellets than for powdery materials. As most of the rotary valves will have chain and sprocket drive, one can change sprockets and increase the speed of the rotary valve beyond which its capacity starts to reduce. An easy way to check the capacity is to monitor the blower discharge pressure.

For pressure-type conveying systems, the rotary valve “pocket-fill” efficiency depends greatly upon how the return leakage and displacement gases are vented out from the rotary valve. If they vent out directly from the rotary valve inlet, fill efficiency will reduce whether the rotary valve is flood fed or starve-fed. When conveying fine powders this fill efficiency will fall dramatically. Therefore, it is vital to have a correctly designed venting system for the rotary valve. Good venting systems have gas flow channels separate from the solids flow channels, and for powdered materials have body vents in the rotary valve to an external vent line.

Pressure Limitations - Blower Performance and Pressure Drops

Most of the conveying systems have pressure gauge at the discharge of the conveying blower. Very few conveying systems have pressure indicators or recorders in the control room or on a central control panel. Pressure gauges located outside, near the blower, are often unreliable because of poor maintenance or weathering. For diagnostics, it is necessary to find out the correct pressure reading of the blower. If the existing pressure gage does not seem to be in a good condition, it should be replaced by a new gage.

Get a good reading of the blower discharge pressure including any changes or pulsations in the pressure. From the nameplate that should be mounted on the blower's body, find out the design pressure of the blower. Also, check the set point of the blower safety valve.

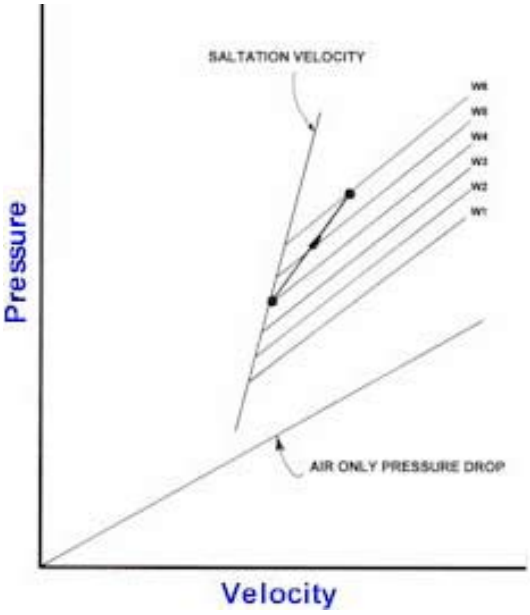
Get the performance curve for the blower. It should be easily available from the blower vendor if it is not available at the plant site.

Compare the blower discharge pressure with the maximum pressure rating of the blower. Allow 10% margin to prevent pressure fluctuations from too frequent lifting of the blower's safety valve. As most of the lobe-type blowers have a pressure rating of 15 psig, the maximum operating pressure should not exceed 13.5 psig.

If the blower's discharge pressure has reached 13.5 psig, it is not possible to increase the conveying rates any more. This condition is called "Pressure Limit". It means that the maximum pressure that is available from the conveying blower is the reason for the low conveying rate.

The solutions for this rate limit are either to increase the available conveying pressure or to reduce the conveying system pressure drop. One solution for pressure-type systems, using a suction blower at the discharge of the conveying system can increase the available conveying pressure.

For reducing the conveying system's pressure drop, the first thing to find out is the conveying velocity. This can be calculated easily by using the well-known Darcy Equation. Calculate both the velocity at the pick-up point and at the end of the conveying line. Reduce these velocities if they are much higher than necessary for the line diameter and materials being conveyed. Since the pressure drop is a function of the square of the velocity, reducing the velocity by 10% can reduce the pressure drop by about 20%.



To reduce the velocity, the simplest change is to reduce the blower speed. Change the sheaves on the blower to reduce the blower speed. If the blower has a variable speed drive, blower speed can be reduced without making any changes. Another option to reducing the velocity is to blow off a measured flow of the conveying gas from the blower outlet. Use a vent line after the blower and a flow control valve in this line to do this. The effect of reducing the velocity on the solids conveying capacity is shown in Figure 2.

Other options to reduce the pressure drop are to reduce the number of bends in the conveying line, especially if two or more bends are located very close to each other. Solids velocity is always less than the gas velocity and this difference becomes greater when the solids pass though a bend. The result is that a higher pick up velocity or initial gas velocity is needed to prevent solids from salting out after a bend. This higher velocity then increases the line pressure drop. Another option is to use a stepped pipeline, i.e., to increase the line diameter along the route of the conveying line so that the

velocity us reduced. In general, try to reduce the overall length of the pipeline and the number of bends.

Velocity Limitations -

Velocity limit means that at the existing conveying rates, any increase in the conveying rate solids, in the conveying line, will start to “salt out”. Consider the following changes to solve velocity limitations:

1. Leakage: Make sure that there is no gas leakage from the conveying line due to erosion of bends or worn out pipeline or poor alignment or poor design of pipeline joints or diverter valves.
2. Blower Speed: Increase the blower speed, provided the resulting pressure is within the pressure limit of the blower. This will result in a higher gas flow from the blower and a higher gas velocity. The higher gas velocity will be able to increase the solids conveying rate.
3. Bend usage: Relocate bends in the conveying line if they are located too close to each other. Do not use more than two bends next to each other. This is because the solids velocity reduces when the solids pass through a bend and need sufficient length of straight pipe after the bend to reaccelerate to the original conveying velocity. Make sure that there is sufficient straight pipe after each bend. In general, provide at least 20 pipe diameters of straight pipe after each bend.
4. Pipeline changes: Reduce the pipeline diameter at the beginning of the system. This will increase the conveying pressure so make this change only if the resulting pressure is within blower’s pressure limits. If the pipeline diameter is constant, higher velocity at the beginning will result in higher velocity in the pipeline.
5. Feed point piping: Make sure that there is sufficient straight section of the pipeline after the material feed point. This is important because material must be accelerated from its zero velocity at the pick up point to its minimum conveying velocity.
6. Piping alignment: Check alignment of the pipeline at the joints to make sure that the pipeline’s interior is concentric and the pipe is not obstructing the flow of solids and thus reducing the solids velocity.
7. More blowers: Use a second blower in parallel with the existing blower. This second blower will increase the conveying velocity. As this will increase the conveying pressure, consider this only if the blower is not pressure-limited.

System Design Limitations - Get Professional Assistance

If the conveying rates are low because some new materials are being conveyed in an existing system, the overall design of the conveying system must be re-evaluated to find the changes that are needed. Difficult conveying conditions may occur because the conveying properties of the new materials may be different from the previous materials.

For this evaluation, the best option is to obtain actual operating data for the new materials by running a few tests on them at low conveying rates. Then use this data to find out the maximum conveying rate that the existing conveying system can handle. Sometimes, a simple change such as a higher blower speed may be enough to run the existing system at a higher conveying rate.

Other options would be to optimize the conveying line route by eliminating a few bends or by shortening the pipeline. If these options are not enough, an increase in the pipeline diameter for a portion of the pipeline may have to be considered. In these cases, it may be a good idea to seek the help from people who are knowledge-able in pneumatic

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Welcome to Ask Joe!, a monthly column by our resident materials handling guru, Joe Marinelli of Solids Handling Technologies. Joe addresses the issues that bug you the most. And Joe knows!! Formerly with Jenike & Johanson, Solids Flow and Peabody TecTank, Joe is an expert on materials handling.

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