Specifying a slide-gate valve for tough applications

While a slide-gate valve may be one of the simplest valves used in bulk material handling systems, the valve must be carefully specified for the application to ensure that it operates as desired, especially with demanding materials and operating conditions. This article explains how to choose a slide-gate valve that will open and close reliably when handling fine particles, working under pressure or vacuum in a pneumatic conveying system, or handling other challenging applications.

One of the most effective ways to close a flow path in a material handling line is to use a slide-gate valve (also known as a knife-gate valve, shutoff gate, or sliding-gate valve), as shown in Figure 1. The typical slide-gate valve body has a center opening the same diameter as the material handling line and a blade (or gate) that, when actuated, slides across the opening to block the material flow.

When you’re in the market for a slide-gate valve, you need to work closely with the supplier’s trained engineering staff to ensure that the valve you choose is right for your application. This is especially true when the valve must handle a fine material, operate under pressure or vacuum in a pneumatic conveying line, close on a head of material, or handle another tough application. In these cases, you can rely on the staff’s experience with hundreds of applications to help you select special valve features that can handle your challenging requirements.

The following sections provide advice on selecting a slide-gate valve with features that prevent leaks and blade deflection, resist material buildup, control wear, and ensure fast actuation.

Preventing leaks
The most basic slide-gate valve is suitable for use as a shutoff gate in a gravity-feed line handling a coarse material. In this application, the particles are too large to pass through any gaps inside the valve, preventing significant leaks.
Choosing the right seal material for your slide-gate valve

Which construction material is right for a seal in contact with the slide-gate valve’s blade depends on the bulk solid material you’re handling.

While nylon is good for many general applications, it’s not suitable for handling a moist material because nylon absorbs moisture and swells. Ultrahigh-molecular-weight polyethylene (UHMW-PE) is a good substitute for nylon in this case, and UHMW-PE is also suitable for a food-grade application. PET is a good choice for handling sticky materials, like sugar, or for an application that requires washdown between batches. A molybdenum-impregnated nylon seal will reduce friction and provide greater wear resistance in a valve that handles minerals. For handling a high-temperature material, Teflon and Viton seals offer better heat resistance than other seal materials.

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Material and air leaks around the blade (between the valve inlet and outlet). Especially in a pressure pneumatic conveying system, air pressure at the valve’s inlet tends to drive material through any available opening between the blade and the valve body. Specifying a valve with a tight seal above and below the blade will keep material from leaking around the blade and prevent pressure loss in the conveying system. The seal is typically made of a low-friction plastic, which can be nylon, ultrahigh-molecular-weight polyethylene (UHMW-PE), polyethylene terephthalate (PET), or polytetrafluoroethylene (PTFE [Teflon]), depending on the application. [Editor’s note: Find more information on seal materials in the sidebar “Choosing the right seal material for your slide-gate valve.”]

Material leaks along the blade. As the slide-gate valve’s blade slides back and forth across the valve opening, the blade tends to drag particles from inside the valve opening along with the blade, resulting in material loss. If the valve is in a pressure conveying system, more material can be lost because the particles will be driven through any gaps between the blade and the slot for the blade in the valve body.

If material leaks along the blade are likely to be especially troublesome in your application — for instance, if you’re conveying a very fine lightweight material such as flour or carbon black under pressure — you can specify a valve equipped not only with seals but with an air-purged valve body. In this valve, purge air at a slightly higher pressure than the conveying system pressure is applied to the valve body, creating a differential pressure between the valve body and the blade.
Material leaks through the valve body (from inside the valve to the atmosphere). Material or air can also leak from the slide-gate valve’s interior to the atmosphere, depending on the valve’s construction. For instance, most slide-gate valves for pneumatic conveying applications consist of two or more components that are sandwiched together, and the joints between these components can leak if they’re improperly sealed. The material that leaks into the atmosphere is often wasted because it can’t be recycled to the process, and it can become a dangerous dust hazard in your workplace. The air leaks can result in a conveying system pressure or vacuum loss.

To prevent these problems, specify a slide-gate valve that has well-sealed joints between components and between the valve body and the blade seals. This includes using resilient seals made of rubber (Figure 2) between the valve body and the seals that contact the blade; the rubber seals are slightly compressed when the valve is assembled to provide active loading on the seals that contact the blade. A foam filler may also be used between the rubber seals and blade-contact seals to fill the valve cavity and provide better loading on the seals.

Preventing blade deflection

The blade is the most vulnerable component in the slide-gate valve. Whether it closes on a static or moving head of material in the handling line, the blade is subject to many forces that can cause it to momentarily deflect from its path or even permanently bend, which can lead to leaks and prevent the valve from operating properly.

The blade can deflect when it’s in the closed position and supporting a column of material in a gravity-feed line. Depending on the material’s weight, the blade can bend to the point that the valve leaks material, or the blade can fail completely, not only wasting material but posing a major safety risk for your workers.

To prevent blade deflection problems in a gravity-feed application, you can choose a valve with narrow full-length blade guides that will both support and seal the blade edges along its entire length. For a pressure pneumatic conveying application, a better option is a valve with blade guides that support and seal the blade across its entire surface, not just at the edges (Figure 2); these full-width guides are also called pressure plates. Both the narrow and full-width guides are typically made of low-friction plastic, such as nylon, UHMW-PE, PET, or Teflon, depending on your application. A caution: The guides are often integral to the valve’s sealing mechanism, but this design introduces some friction between the blade and the guides. While the valve supplier will compensate for this in the guides’ design, be aware that the friction can lead to problems if the valve operates more frequently than initially intended.

Resisting material buildup

A sticky material tends to build up on the slide-gate valve’s blade. If this buildup isn’t removed, the blade won’t be able to open or close properly, which can reduce material flow through the valve or even completely stop flow. Some slide-gate valves are more susceptible to buildup problems than others, so if you have a sticky material, make sure that the valve you choose is equipped with features to handle this problem. For instance, the valve’s material-contact surfaces can be made from a material that resists buildup and can handle frequent washdowns, such as PET. The blade and other valve surfaces can also be polished with grit or electropolished to resist buildup.

Controlling wear

Even though the slide-gate valve is designed to resist wear for long service life, material passing through the valve will eventually wear any valve surface it contacts. More abrasive materials, such as sand, gravel, and grain, will wear these surfaces more quickly.

The blade surface is especially subject to wear because as the blade moves across the valve, it’s directly exposed to the moving material. To reduce this wear, make sure that the valve you choose fully retracts the blade from the material path, which prevents particles from contacting and wearing the blade surface when the valve is open. When the valve closes, the blade tip can also wear as it moves across and parts the material stream. A good way to reduce tip wear is to select a blade with a beveled tip, rather than a blunt tip. The beveled tip will cut through the material stream more effectively and reduce wear.
Material can also wear the valve’s interior surfaces. To help these surfaces resist wear, select a valve with a wear liner, which can be made of the same material as the valve, a more resilient material such as UHMW-PE or PET, or abrasion-resistant steel. Typically the liner can be easily removed and replaced when it becomes worn, eliminating a need to replace the entire valve.

To further control wear, you can select a valve with an interior deflector, which deflects the material stream toward the valve opening’s center, away from the opening’s edges and the seals around the opening. Or you can specify a valve with a dead pocket around the valve opening; material collects in the pocket so that passing material contacts the collected material and is deflected back toward the valve opening’s center and away from the opening’s edges and seals.

### Ensuring fast actuation

Making sure that your slide-gate valve opens and closes quickly requires selecting the right actuation method for it, especially when you have a challenging application.

While manual actuation with a hand wheel, hand crank, chain wheel, or similar device is often simplest and has the lowest cost, these devices have drawbacks. They typically rely on a rack-and-pinion or threaded-rod mechanism. The rack-and-pinion device requires fewer turns for opening or closing the valve, but the rack (which is directly attached to the blade) is difficult to seal and tends to consume more space than the threaded rod; the threaded rod requires more revolutions to operate the valve but needs less space. These devices also require a lot of maintenance. The major drawback, however, is that a manually actuated slide-gate valve relies on the force the human operator is able to exert on the actuating device. The slide-gate valve’s size or the amount of force the operator must apply can make manual actuation impractical for demanding applications.

For these applications, the slide-gate valve’s actuation can be powered by a pneumatic, hydraulic, or electrical actuator. Besides allowing the valve to be actuated remotely when it’s not easily accessible to the operator, powered actuation is typically a better choice when the valve will operate frequently or very quickly or operate as part of an automatically controlled material handling or pneumatic conveying system. Powered actuation is especially effective when the blade requires a lot of force to cut through a head of material.

Each type of powered actuator — pneumatic, hydraulic, and electrical — has its pros and cons. For instance, a pneumatically actuated slide-gate valve can open and close much faster than a hydraulically or electrically actuated valve and has a relatively low cost, but is susceptible to freezing in low temperatures. A hydraulic actuator operates at a higher pressure than a pneumatic actuator and so can provide more force, but the hydraulic actuator is slower, is more expensive to set up and operate than a pneumatic actuator, and increases the valve’s complexity. An electrical actuator is slow and can be expensive, but isn’t susceptible to freezing in a low-temperature application.

Which actuator is right for your application depends on several factors, including the slide-gate valve’s operating environment (whether the valve is located indoors or outdoors and what temperature range it will operate in), your available power sources (such as whether compressed air or electrical power is available at the valve’s location), and your valve’s required actuation speed. The valve supplier can help you choose an actuator that meets your requirements. The supplier may also recommend an oversized actuator if extra force is required to open and close the valve in your application.

### For further reading

Find more information on this topic in articles listed under “Valves” in Powder and Bulk Engineering’s article index (in the December 2012 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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