

Gates

Basic Concept

At the most basic level, a gate is an object which permits passage into or through an enclosure. Gates as they apply to pneumatic conveying/material handling are no different. At the most basic level, Gates open and close a path of material flow. The most effective means of accomplishing this task is through the use of a sliding blade which moves across the gate opening to block the path of material flow. The most basic gates are simply just this.

A basic shut off gate consists of a thin blade which is enclosed inside a body. The body creates an enclosed space which can be open and closed by the blade. This type of gate is simple to construct and operate, however it is not perfect and can only be used in certain applications. Other applications demand that the gate be able to provide seals against product leaks, seals to prevent pressure loss (or vacuum loss) or special considerations to reduce wear.

Leaks

A simple shut off gate is prone to leaks in certain situations. It will adequately perform its function if the material is coarse (large enough to bridge the small gaps inside the gate), and is installed in a gravity feed line. If the material is fine and/or the line is under pressure (or vacuum), there will be leaks. This is the reason why a number of other gates exist for pneumatic conveying and material handling applications. Each type provides a different configuration to offer a various seals in order to match the requirements of the system they are to be installed into.

Around Blade (top to bottom)

Seals are often necessary in order to prevent material or air leakage between the inlet of the gate or outlet of the gate. This is important especially in low pressure pneumatic conveying systems, as the air pressure at the inlet, will tend to drive material through any available openings, resulting in potential product loss, as well as a loss of air pressure within the conveying line. In such cases, a gate with a tight seal around the blade opening would be required.

Along Blade (internal to external)

As the blade slides back and forth, it will be prone to drag material along with it, from inside the gate opening to the outside. This results in product loss. When inside a pressure system, the losses will be greater as material will be driven through any gaps between the blade and the slot it passes through in the gate body. To prevent these leaks, scrapers can be placed in advance of the blade opening to clean the blade and prevent material from being pulled out, while a tight seal on the top, bottom and sides of the blade will eliminate any gaps through which material can pass under pressure.

Air Purge

In situations where the leakage of material from the gate orifice to the body (along the blade) may be especially problematic, an Air Purge System can be incorporated. This system, applies a positive pressure to the gate body. The pressure is set slightly higher than what the conveying system is run at. This creates a differential pressure between the gate body and the gate orifice. Since air will tend to pass from the region of higher pressure (body) to the region of lower pressure (orifice), material will be prevented from leaking, as well as from being pulled through any seals along the blade as there will be a constant flow of air in the opposite direction.

Through Body (internal to Atmosphere)

Material or Air pressure leakage from the interior of the valve (orifice) to Atmosphere also needs to be addressed. This can be a concern since material leaking out often becomes waste (cannot be reintroduced into the process). Create a potentially dangerous dust hazard and can contaminate the surrounding environment. This issue can vary with the varying gate construction method and the methods used to seal any joints or seams.

Reactions to Material Flow

Blade Deflection

The most critical and most vulnerable part of the gate is the blade. If the gate is required to cut through a static or moving head of material, the blade can be subject to a variety of forces which could cause the blade to deflect from its intended path, or even permanently bend. It is very important to know if the gate will be closing on a head of material, as this will influence the selection of the gate and any necessary options.

Another important consideration when selecting a gate is the weight of the material which will be passing through it, and if the gate will be required to support a column of this material in the closed position. This is very important since if overlooked, the weight of the material resting on the blade may cause the blade to bend causing leaks, or worst case, fail completely, which could not only create material wastage, but also pose a significant safety risk.

In order to combat both problems various methods of support are used. Some gates utilize full length blade supports and guides, which support the blade along the edges along the entire length. The supports/guides can be metal, or a low friction plastic. These supports/guides can also be an integral part of the sealing mechanism to prevent pressure and material loss. Due to the design, these types of supports introduce an element of friction on the blade. Typically this is not a major concern as the gate manufacturer will have compensated for this in their valve design, however can lead to problems if the gate is cycled at a rate higher than it is intended for.

Rollers can also be used to support the blade. Rollers tend to be more robust and are used in applications which require additional support such as those for the aggregates industry. Rollers can be constructed from various materials such as Teflon, Nylon or Steel, and are intended to provide support to the blade while also eliminating the friction that is present if using solid guides.

Wear

Anytime a material moves in contact with another there will be wear. Depending on the materials in contact, the wear may occur on one surface or another, or on both. This is true for gates as well. Wear will occur on the gate surfaces or on the material passing through it, or on both; however steps can be taken to reduce the amount of wear, or to control the wear.

The blade is the central component of the gate and due to its operation, is exposed to the material stream and is subject to wear. Gates are designed to reduce the amount of wear on the blade in order to increase the life of the gate. When in the open state, the blade should be fully retracted outside of the material path, so that no material comes into contact with the blade.

The tip of the blade can be cut with a bevel, so as to part the material stream more effectively (a sharp edge vs. a blunt edge.)

Wear will also occur on the sides of the gate. Wear Liners, which are made from the same material as the gate or a more resilient material, can be incorporated into the gate. Wear Liners are typically replaceable, so when they do eventually wear, they can be replaced easily without replacing the entire gate. Internal Deflectors and Dead Pockets can also be incorporated to help manage wear.

Other Considerations

Sticky Materials

If the material being conveyed through the gate is sticky, it may tend to build up on the blade. This buildup, if not dealt with, will cause the gate to malfunction. It will fail to open and close properly, leading to the reduced material flow, or stopping it all together. It is important to consider this when choosing the gate, as certain types and models are more susceptible than others, and gate manufacturers have various options available to combat this problem and will be able to determine which is best for the particular application.

Actuation

Gates can be actuated by a variety of means. Often the simplest and lowest cost method is manual actuation. This can take the form of a hand wheel, hand crank, chain wheel etc. Typically, these types of gates utilize either rack and pinion arrangement, or a threaded rod arrangement to open and close the gate. Gates with a rack and pinion arrangement typically require fewer turns to open and close than a threaded rod, however, the rack and pinion is difficult to seal, and tends to require more space. The threaded rod arrangement requires less space, but requires more turns to open and close. These gates rely on the force a person is able to exert on the manual operator to open and close. In certain situations, this may be prohibitive due to the size of the gate or the force required, or due to inaccessibility.

For situations requiring large amounts of force or remote operation, gates can be actuated using Pneumatic, Hydraulic or Electrical actuators. Each type has its advantages and disadvantages and should be selected with consideration given to the operating environment (indoor or outdoor, temperature etc.), what power sources are available (What is used in the plant) and how actuation speed (pneumatically actuated gates can open and close much quicker than hydraulic or electric). Gate manufacturers will size the actuator for the specific gate and its intended application, however will offer an oversize option if extra force is required (such as if cutting through a head of material).

Gates come in many different shapes and forms and each application is different. It is important to consult with the gate supplier or manufacturer in order to properly select the gate for a particular situation and to select the necessary options to ensure that the gate functions as desired.