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Ask Joe! Column

Selecting Diverter Valves For Your Pneumatic Conveying System II

Guest article by Kevin Peterson of Salina Vortex

Careful Selection Can Pay Future Dividends: Selecting a diverter valve for your pneumatic conveying application can be a difficult task, especially when you consider all the different designs and manufacturers there are to choose from. Proper selection and application of diverter valves can offer improved plant efficiency, adding to a company's overall profits while reducing downtime and maintenance costs.

Many Factors to Consider

Cost Issues: The purchase price of a diverter valve is only one of many cost factors to consider. Other cost factors are freight, installation, maintenance costs (over the life of the valve) and production down time. Material cross-contamination due to internal valve leakage is another cost issue that should be considered.

System Design: System design will influence the selection of your diverter. Consideration should be given to issues such as product size or "footprint", and pressure drop across the valve. Air and/or material leakage past the diverter will affect system capacity and blower/line size calculations.

Dilute or Dense Phase: When selecting a diverter valve, consideration should be given to whether the system is designed for dilute phase pneumatic conveying (vacuum or pressure) or dense phase pneumatic conveying. Dilute phase is defined as conveying line pressures to 15 psig/1 bar, while dense phase is pressure to 90 psig or 6 bars. Some diverter valves are designed to provide service in vacuum conveying systems.

Each manufacturer will pressure rate their particular diverter design. Accordingly, valve size can also determine system pressure capabilities.

Diverter Requirements: Most two-way diverter applications require conveying materials from one source to two destinations. However, some systems may require two-way diverters (converg-ers) to convey material from two sources to a single destination. This may necessitate modification of some diverter designs.

If more than two material sources or destinations are required in the system's design, consideration should be given to how each manufacturer's product can be installed to meet the system's design criteria. Cost as well as installation constraints must be considered. Multi-port diverters (3-way, 4-way or greater) allow for a cost-effective installation compared to installation of multiple two-way diverters. Additionally, multi-port diverters tend to be compact--making installation easier with less pressure drop through the system.

Material Handled: The characteristics of the material being handled including the materials particle size, weight, hardness, abrasiveness and flowability are important factors to consider. Does the material build up? Is it pack-able? Is the material hygroscopic or sticky/tacky?

Actuators: Depending on system requirements and power availability, diverters may be selected with choice of actuators; manual, air actuated, electric motor actuators with choice of electrical enclosures and hydraulic actuators. Air control solenoids, if required, and position indicating switches may also need to be considered.

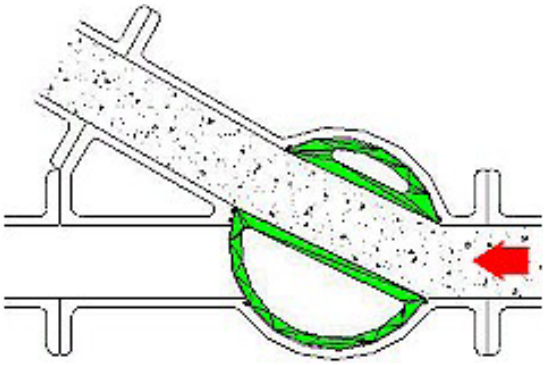
Safety: No matter which valve type is chosen for an application, make sure individual safety features are in place for each valve used. A vented ball valve installed within 12” of the air cylinder for air actuated gates used to shut off the air power source prior to valve cleaning, repair or maintenance is one example. Also, make sure approved lockout/tagout procedures are in place, explained to all employees and followed.

Selecting the right valve: Spending time addressing these factors prior to making your diverter valve purchase will net many cost savings during the life of your diverter valve. There are many different styles and types of diverters to consider. When selecting a diverter valve, please keep in mind the features of each style.

Rotary Plug (tunnel), and Blade Style Diverters

Description: Rotary plug (tunnel) and rotary blade style diverters typically have a cast housing (aluminum, stainless steel or cast iron) that is precision machined to allow a rotating internal plug or blade to divert material flow. The internal plug rotates to align the inlet and outlet. To divert material to the opposite port, the plug is rotated approximately 150° causing what was the outlet port of the plug to align with the inlet of the housing and the plug inlet port to align with the outlet port of the housing.

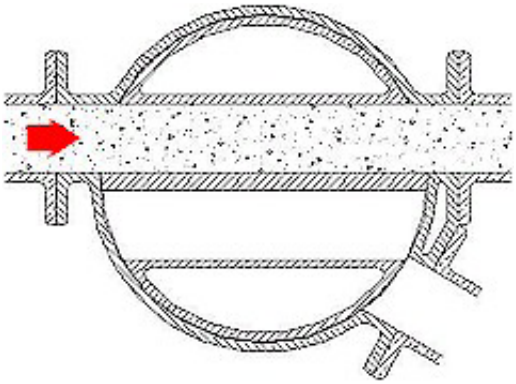
In some designs, parallel tunnels are rotated to align the inlet and outlet ports. The parallel tunnel design requires less rotation (~45є) which reduces valve wear. Heavy pipe flange connections are provided for connection to the conveying line.



Rotary Plug: Most manufacturers rate this style of diverter for up to 15 psig conveying line pressure. With modifications (resulting in higher pressure ratings) this valve is the valve of choice for diverting materials in high pressure, abrasive material dense phase applications. With a shallow angle of deflection, this style of valve has minimal conveying line pressure drop across the valve. The smooth bore design eliminates material cross contamination when handling non-dusty granular or pelletized materials if the stream is purged prior to conveying different materials.

Things To Consider: This style of valve is costly to produce and usually demands a higher price. Repair parts can also be costly and should be considered in any “life cycle” cost analysis. The heavy cast assembly needs to be fully supported which will add to the installation costs and future maintenance costs associated with handling the valve.

The rotating plug requires clearances for actuation. The seal materials used in sealing these clearances will wear with each actuation of the valve. When conveying powders, there is the potential of packing material between the rotating plug and external housing. The packing of powders, once seal abrasion occurs, can cause the plug style diverter to bind--requiring removal of the valve, internal cleaning and seal or housing replacement.



Rotating Blade: The rotating blade style diverter is usually recommended when handling granular and powdered materials. This diverter avoids the material packing problems associated with the plug style diverter.

Things To Consider: The blade style diverter requires clearances between the housing and blade sealing surfaces in order to actuate. The sealing surfaces and clearances are exposed to conveyed materials and tend to abrade as a result of the material moving across them with some velocity.

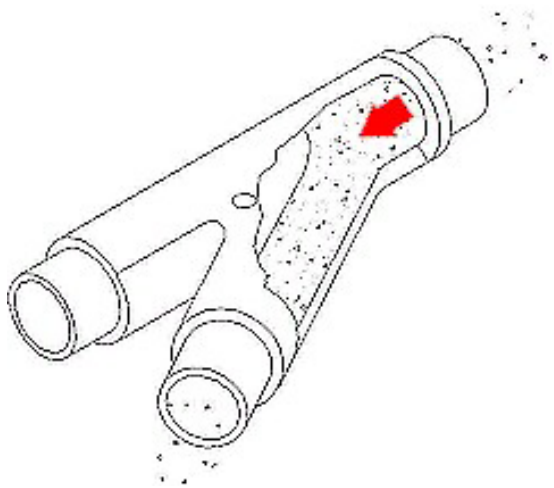
Seal abrasion in either the rotating plug or blade style diverters will result in loss of conveying air pressure. Any material migration into the “shut off” conveying line may result in cross contamination. The possibility of a line plug exists when the diverter is shifted back to the “shut off” leg.

Additional Considerations: Continuous material conveying while shifting the valve is not recommended with these style diverters. The conveying line is completely blocked when the plug style diverter is shifted. The blade style diverter can readily trap material in the sealing areas during the shift.

System blowers and fans are constantly started and stopped to allow the diverters to shift. This increases energy costs and undue wear on system components. Consideration needs to be given to this limitation when establishing system operation procedures.

Flapper Style Diverters

Description: Flapper style diverters are generally available in a choice of cast aluminum, carbon steel or stainless steel housings. They are lighter in weight than the plug style diverters and are available for in-line connection with either pipe flanges, or stub ends for compression coupling connections.



The standard flapper diverter uses a metal flapper that shifts to block one port and divert material and air to the open port. In some models, the flapper seals against a replaceable polyurethane liner. In others, polyurethane is sandwiched between two metal plates to create a better seal. These diverters are primarily used in pressure conveying systems where materials are being conveyed from a single source to two destinations, or from two sources to a single destination. The source to destination configuration needs to be specified when the diverter is ordered.

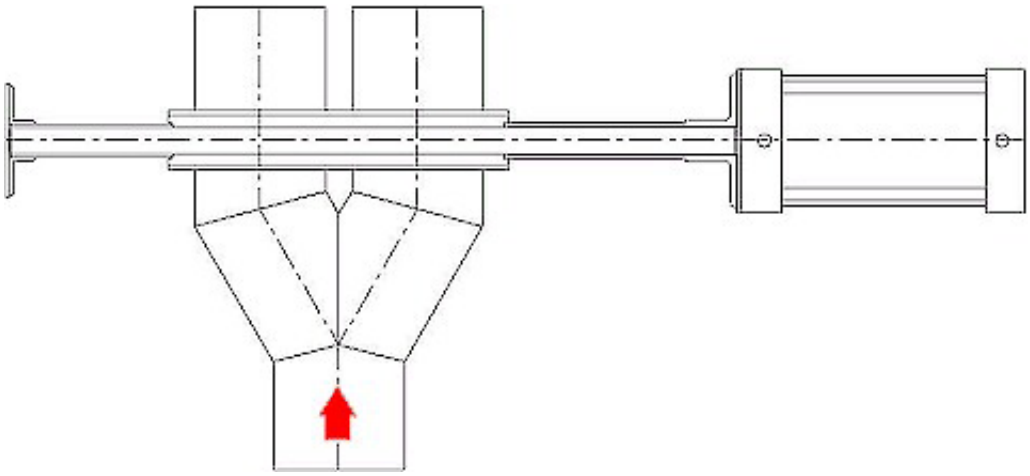
Things To Consider: Inherent in design, the flapper diverter seals are in the material stream and exposed to material abrasion. Flapper seals wear rapidly when handling even mildly abrasive materials. As the seals wear, conveying line air and fine material leak past the seal to the closed conveying line. System pressure drops, possible cross-contamination, and potential line plugs may result.

Flapper diverter seal replacement will result in added maintenance costs and lost production time. If a flapper diverter is desired, select a design that can be maintained without removing the diverter from service. In some instances, flapper diverters can be diverted on a material stream because both ports are not blocked during the shift. However, conveyed material can become trapped between the flapper and the sealing surface. Should this occur, conveying line air and material will then leak into the closed line.

Additional Considerations: In vacuum conveying applications, most flapper diverters are limited to low vacuum service. Under higher vacuum service, the flapper loses its seal as the flap is “lifted” from the internal sealing surface.

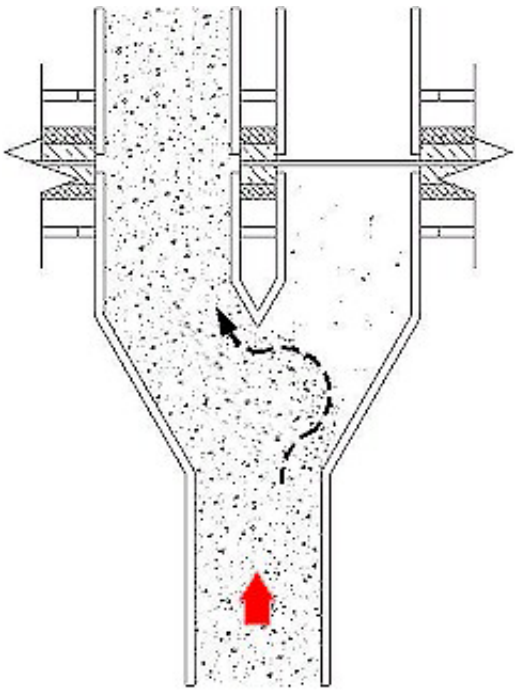
Sliding Blade Diverters

Description: The sliding blade diverter is a precision fabricated valve with a structural frame and fabricated tube or pipe inlets and outlets called weldments. The inlets and outlets are typically available in carbon steel, aluminum or stainless steel. Weldments can be easily replaced if abrasive materials wear through the tube or pipe. The sliding blade diverter is light-weight and easy to install.



This type of diverter may be placed in-line using compression couplings or the diverter can be fabricated with flanges, ferrule-type or Victaulic mounts. The inlet and outlet weldments are designed to shield the seal plates from material blast abrasion. The stainless steel blade has an orifice machined into it the size of the conveying line I.D. and is shifted from port-to-port.

The key design feature of this valve is the “live loaded” wear compensating seals that are compressed against the stainless steel blade. This design eliminates clearances where materials lodge and remain trapped or promote accelerated wear. The simple design of this valve allows for inexpensive maintenance and seal adjustment.



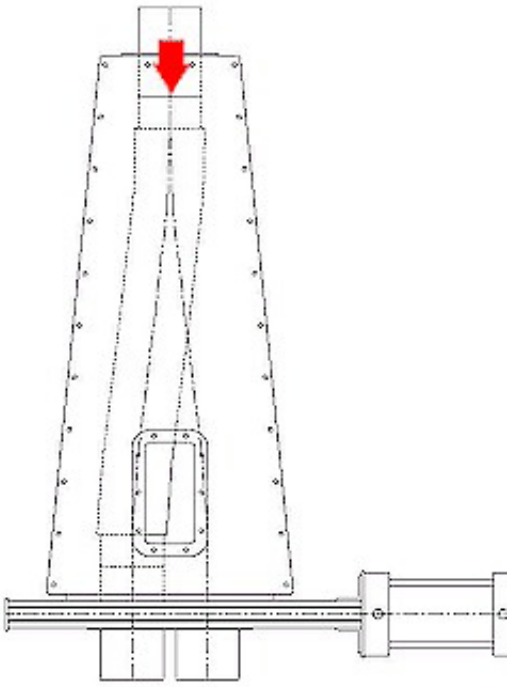
Solid pressure plate seals and the sliding orifice blade isolate the closed port to eliminate conveying air loss and material leakage across the closed port. The design of the sliding orifice permits shifting on a material stream, when required, without the need to shut down system blowers or fans.

The diverter is bi-directional, being used in a one-to-two or a two-to-one configuration and can be used in pressure or vacuum applications.

Things To Consider: The transition from inlet to outlet creates slightly more pressure drop across the valve than other designs. The closed “off leg” creates a high-pressure airfoil effect, which minimizes material entering the “off leg” and associated material abrasion. However, some materials may not purge out of the closed “off leg” if the valve is installed in a horizontal position. Installing the diverter in a vertical line with the inlet down usually eliminates any material remaining in the “off leg.”

Flexible Tube Diverters

Description: Flexible tube or hose style diverters utilize the basic sliding orifice blade design. A tube stub is welded to an orifice style blade, and a flexible hose is then attached to the tube stub. As the diverter blade is shifted, the conveying line, a flexible hose, moves from one port to the other. Flexible hoses are normally made of an abrasion resistant rubber, or flexible steel. These diverters can be used to convey material from one source to two destinations or from two sources to a single destination. They are capable of handling either pressure or vacuum.



Typically, there is very little pressure drop across a flex tube diverter. This diverter provides positive air and material shut off to diverter's "off leg." Purging the conveying line prior to shifting the diverter eliminates material cross contamination.

There are two basic types of seal arrangements on flex tube style diverters. The first type is a compression loaded, wear compensating seal. A positive material and air seal is maintained when the diverter is shifted. Accordingly, neither the material or conveying line needs to be stopped prior to shifting the diverter. This type of diverter seal is capable of handling dilute phase conveying pressures to 15 psig, depending on line size.

The second type of seal is a pneumatic seal arrangement. The seals are inflated when conveying material through the valve. Pneumatic seals allow this diverter the ability to handle high pressures associated with dense phase conveying. The drawback to this type of seal arrangement is prior to shifting the diverter, system blowers and fans must be stopped while the seals are deflated and the shift is made. After shifting, seals must be re-inflated before conveying line air and material flow are restarted.

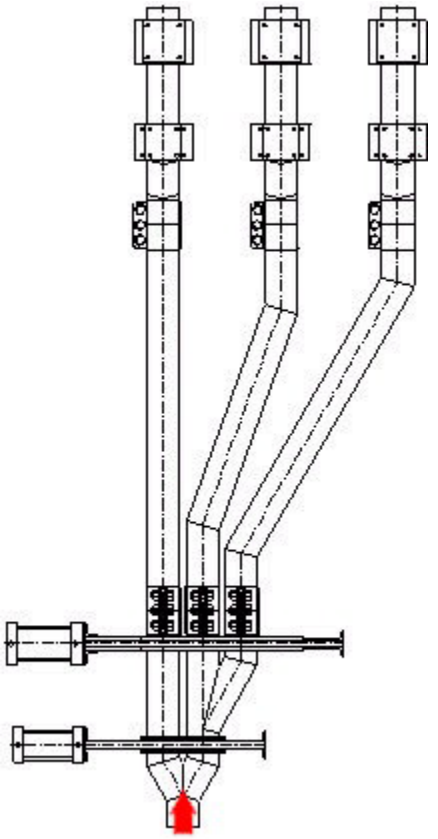
Things To Consider: Severely abrasive applications are generally not suited for a flexible tube style diverter, due to hose wear. Overall stack up height and hose support may also be a concern. Some models offer a hose support frame to minimize torsional loads on the sliding blade.

Additionally, the frame can be enclosed to serve as a safety and weather shield for the sliding mechanism and as a "containment area" for conveyed material should the hose break.

Multi-Port Diverters

Description: In many processes, there is a need to convey material from multiple sources to multiple destinations. Historically, this has been done through hose and manifold stations. Personnel are required to couple and uncouple flexible lines from required sources to required destinations. Greater interest to automate this process, through the use of multi-port diverters, has occurred recently due to several factors. Among these factors are:

- Environmental concerns should spillage occur when conveying lines are uncoupled.
- Cross-contamination when lines are wrongly coupled
- Injury risk to personnel when coupling and uncoupling lines
- Production loss while lines are being switched.



Combining and stacking 2-way, 3-way and 4-way diverters is a logical progression to multiport diverters. Standard flapper and tunnel/plug style diverters do not readily lend themselves to these configurations. More easily adapted to multiple stacks and configurations are the sliding blade style of diverters.

Typically, multiport diverters are custom built to fulfill specific needs. There are several advantages to multiple diverter assemblies. Generally, they are independently mounted to a stand-alone frame, ready for transport and installation as a single unit. Additionally, single connections for compressed air, electrical and controller connections are included in the assembly. Significant on-site installation costs and greater plant efficiency are realized with the multiport diverter.

Things To Consider: The initial cost of this type of diverter may be a drawback at first. Consider the safety and efficiency advantages the multi-port will offer your operation. Obtain references and discuss any issues you may have with companies currently using multi-ports. They can offer you a tremendous advantage with your production process.

About the Author

Kevin Peterson and the staff of Salina Vortex Corporation, Salina, Kansas, contributed to this article. Salina Vortex Corporation manufactures slide gates, diverter valves and iris valves for handling dry bulk material in gravity flow or dilute phase pneumatic conveying.

You can contact Kevin and his staff at:

Mr. Kevin Peterson
Salina Vortex Corporation
3024 Arnold Avenue
Salina, Kansas 67401-8105
Tel: 785.825.7177
Fax: 785.825.7194
Email: kevinp@svortex.com
Web site: Salina Vortex

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