Article

Slurries: A Solid Challenge

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Slurry valves are to the mining industry what midfielders are to football (or soccer in the U.S.) teams. They're not often heralded, but hard working. Goal keepers and forwards tend to get more attention, but midfielders are no less essential to victory.

For managers of mining operations, victory means maintaining uptime in processes that often involve heavily abrasive and corrosive materials. The key to winning is understanding the specifics of your application, picking the right pumps and valves for the job and considering total cost of ownership over the life of the equipment. This article will provide a basic definition of slurry applications, the types of valves available, and considerations for choosing the right valve.

Defining slurry applications

Slurries are used to move solids through industrial and refining processes by mixing them with water. They are most common in the mining industry, although paper and chemical manufacturing and power generation also include applications for slurry valves.

An ITT F133 ported slide gate valve installed in Northern Chile in a tailings application

Nickel mining, for example, involves digging and or blasting ore and dirt out of a surface mine, transporting the ore and dirt to a processing facility to remove the nickel, and then transporting the tailings (leftovers) to a tailings pond. Depending on the particular facility, the ore and dirt may be mixed with water to form slurry. The fertile slurry can then be transported from the surface mine to the processing facility. After the nickel is removed from the slurry at the processing facility, the tailings (also a slurry) can be transported to the tailings pond for water recovery. Heavy-duty slurry pumps and slurry valves are required to move the wanted nickel, in slurry form, and the waste tailings where they need to go in the process.

The abrasiveness of the solids in the slurry is a key

consideration in determining the right type of valve for each job. When a valve is in the open position, the solids in the slurry will continuously scrape against the port of the valve, like a metal file or a sandblaster. When the valve is closing, the gate will be exposed to the same abrasion as the port of the valve. Depending on the weight of the solid and the size of the particles, the abrasiveness can be extreme.

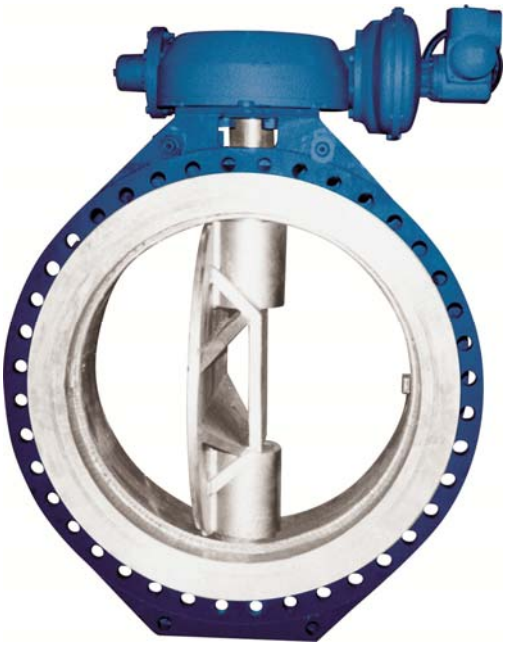
Some mining applications also involve a corrosive chemical processes. In copper mining, for example, sulfuric acid is used to attract particles of copper as part of the refining process. The acid has the potential to corrode metal valve parts.

The production of acid itself creates the need for tough slurry valves because of these same issues. The manufacture of phosphoric acid, for example, creates a build-up of waste, called scaling, around the gate and port area of the valve that makes it harder to open and close. The process involves periodic flushing of the system with sulfuric acid, which is highly corrosive and requires valves made of specially coated materials and or special alloys. Dense scaling in phosphoric acid production can cause the average valve to fail on its first closure.

Types of slurry valves

Just as every football (or soccer) coach customizes his own playbook, the managers of slurry processes can choose from a nearly limitless array of types, size and material options when selecting valves. Most can be classified into one of three categories, based on the functioning of the valve's final closure element.

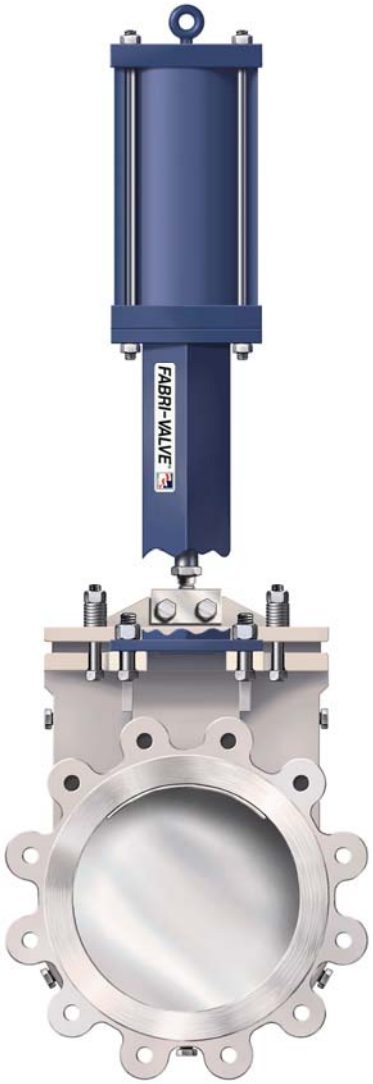
- Knife gate valves – A relatively sharp metal gate pushes down and cuts through the slurry to create closure.
- Ported slide gate – Similar to a knife gate, except with a hole or port for the media to flow through the gate in the open position. When the ported slide gate closes, the port slides out of the bottom of the valve, allowing the upper portion of the gate to stop the media flow.
- Butterfly valves – The gate remains in the slurry, parallel to the piping, allowing the slurry to pass through; the gate then turns perpendicular to shut off the flow.



Slurries can cause strong corrosion problems for butterfly valves.

(Because the abrasion against the butterfly gate is constant, this style of valve is not well suited to many slurry applications.)

Roughly 90 percent of all mining industry applications employ knife gate valves; they are the most versatile and offer the highest number of options to accommodate different materials, pressure, temperature, and types of slurries.



ITT's Fabri-Valve C37

Knife gate valves can be as small as one and a half inches in diameter, all the way up to 96 inches internal diameter, and even larger depending on the application. Depending on the characteristics of the process, the valve bodies are mostly made out of stainless steel, carbon steel, cast iron and ductile iron. The gates are typically made from stainless steel, but can be made out of special materials such as titanium grade 12, Hasteloy®, Inconel, and other alloys, to withstand highly corrosive or abrasive media. For an extremely abrasive or corrosive application, gates can be heat treated or coated with a special coating that increases the life of the valve.

The seats themselves offer a wide range of choices. They include metal-to-metal seats, which are more durable but tend to allow some leakage, and several other sealing materials that can provide drip-tight shut-off, but must be carefully selected for durability and chemical compatibility. The ITT Fabri-Valve® Figure 37, for example, have some of the widest range of seats in the industry, including integral metal, replaceable hard-faced metal, rubber "D" ring, replaceable rubber, replaceable polyurethane, replaceable UHMW-P (ultra-high molecular weight polyethylene) or replaceable PTFE (polytetrafluoroethylene, aka Teflon).

Many knife gate valves with elastomer seating have seat material options that can withstand temperatures around 300 to 400 degrees Fahrenheit and pressures up to 400 psi. This makes them suited to a large majority of typical slurry applications in mining and paper processing.

Ported slide gate valves are most popularly used with very heavy solid content media, both in wet slurries and dry applications. These valves are commonly found in coal handling and in high

consistency stock in the pulp and paper industry. The sliding gate cuts through this thick slurry more easily than knife gates. These gates also cut through heavy scaling effectively and the design lends itself to a long seat life because little stress is put on the seat from the way the gate closes.

For applications involving higher pressures and temperatures, ITT Fabri-Valve has knife gate valve and ported slide gate valve designs up to ANSI Class 300 pressure limits and exceeding 1800 degrees Fahrenheit.

Slurry applications require valve designers to think about three primary forces which can cause valves to malfunction. One force is wear caused by the abrasion or corrosion of the slurry itself; the valve gates and seats must be made of materials that can withstand the materials in the process, and coated if necessary. Friction is another force – whether it's metal-to-metal, metal-to-rubber, or some other combination, the sliding of the gate against the valve seat creates friction that stresses the valve components. A third force is pressure – closing a valve under pressure is more difficult and requires harder materials. In designing slurry valves, the impact of all these competing forces must be considered together. In choosing a harder material for a valve seat to withstand abrasion, for example, engineers must recognize that harder materials are more brittle and likely to break under pressure.

Choosing the right valve

Choosing the appropriate valve requires matching the wide range of valve types, sizes and materials to the very specific needs of each application. There are a few common variables that all valve-shoppers should consider to help narrow the options.

- Slurry solids composition – The size of particles and hardness/abrasiveness of the material being processed.
- Slurry chemical composition – The specific chemical and percent concentrations greatly affect the material of construction choices.
- Percent solids – Typical slurry applications are 30 to 60 percent solid, extremes can be 60 to70 percent solid or even higher.
- Pressure and temperature – Although in many applications these factors don't create challenges, others like bottom ash handling valves in the power generation industry are forced to handle temperatures as high as 1,500 degrees Fahrenheit and high pressure tailings pipelines operate at pressures exceeding 650 psi.

- Type of seal needed – Is a drip-tight seal required at this point in the process, or is some small leakage around the valve seat acceptable?

Process managers and maintenance engineers need to document these application specifics for each valve in their process, as well as their experience with previous equipment. Because of the huge range of size and material options for slurry valves, it's usually best to discuss any new or changed applications with a valve-company representative.

The initial purchase price of the valve is, of course, another important consideration along with the needs of the process. It is important for valve purchasers to make their financial decisions based on total cost of ownership, not simply the initial purchase price of the valve assembly. Total costs include consumables, the gate, seat liner, seat/seals, and packing, the expected life of the product and the risk of downtime in the event of catastrophic failure. Like many industrial equipment markets, the valve industry is flooded with knock-off products and pirate parts that don't offer high quality assurance. Reputable manufacturers should be able to provide guidance in valve selection and total cost of ownership evaluations.

Conclusion

Football (soccer) programs must carefully choose midfielders to have winning teams, and mining managers need to take special care in selecting slurry valves to meet their production and profit goals. There are a lot of choices, but by understanding the application needs, carefully examining options available, and by considering total cost of ownership, you can find the right fit. The initial price of the valve, the consumables (including gate, seat liner, seats/seals, and packing), and the general reliability of the valve all combine to create a figure for total cost of ownership. In order to keep that total lifetime cost of the valve to a minimum, valve-shoppers need to search for a valve with the right characteristics to match their unique application.