

Diaphragm Metering Pumps for Corrosive Liquids

By Ken Underwood

The harsh nature of acids makes them difficult fluids to pump.

No life form—human, animal or plant—can survive without water. The same can be said for many industries—whether mining, food and beverage processing or steel manufacturing. In most instances, water is used to help facilitate and optimize the production process, from cooling equipment to cleaning totes, barrels and storage tanks.

When used in these types of applications, clean water is quickly transformed into wastewater that is full of impurities. With increasing regulatory vigilance regarding how this wastewater is handled, it must be disposed of or recycled in the most environmentally safe way possible. Aiding in the cause of wastewater disposal or recycling is a wide range of acids that are used to help process wastewater and make it safe to either be reused or introduced to the environment.

This article highlights the pumping technology—specifically, diaphragm metering pumps—that most successfully meets the challenges inherent in most wastewater applications that require the use of acids.

The Challenge

Acids are an industrial jack-of-all-trades and are used in many unique applications and processes, including the manufacture of agricultural fertilizers, cosmetics production, fluoridation of drinking water, pH adjustment in cooling towers and boiler water pretreatment. This versatility also makes acids a critical component in water and wastewater operations.

A few commonly used acids in these applications and their characteristics are:

- **Hydrofluosilicic Acid**—Occasionally referred to as “silly” acid, hydrofluosilicic acid is often used in

the fluoridation of drinking water, as a wood preservative agent and in the production of ceramics.

Hydrofluosilicic acid is corrosive to most metals and has a tendency to find leak paths.

- **Hydrochloric Acid**—This acid is also known as muriatic acid. It is used to remove scale from boilers, in chemical cleaning and to regenerate water used in treating deionization units.
- **Phosphoric Acid**—This acid is used in metals processing, as an etching agent in semiconductor processing and as a nutrient for biological growth.
- **Sulfuric Acid**—Commonly used for pH adjustment in water treatment, it is also used in the manufacture of car batteries and in the pickling, cleansing and plating of metals. Because sulfuric acid is highly exothermic, it is one of the more challenging acids to pump.
- **Citric Acid**—A rather weak acid, it is used as a preservative and flavoring agent in food and beverage processing and as an ingredient in the manufacture of cosmetics, pharmaceuticals and household cleaning products.

What these acids have in common is that safety in containing, controlling and handling them is a critical concern, to protect the health and productivity of workers and to ensure zero impact on the environment. Some acids are more aggressive than others, and their corrosive nature and temperature can change dramatically at different concentrations. Sulfuric acid, for example, becomes more corrosive when diluted and has a high specific gravity relative to water, so slower pump stroke speeds are desired.

Because of the aggressive nature of acids and the need to accurately control the dosage rate to avoid overfeeding,



Sulfuric acid is one of the more challenging acids to pump, but some metering pumps are designed to handle this dangerous liquid.

they need to be fed via a metering pump that has a high level of repetitive accuracy, generally +/-1 percent. The pump's materials of construction also require consideration. While C-20, polyvinylidene fluoride (PVDF) and polyvinyl chloride (PVC) are the most commonly used materials in acid metering pumps, care must also be taken that all the wetted components are compatible with the specific acid being handled because no one material works well with all acids. Choosing the wrong materials of construction can lead to, at a minimum, pump failures and, at worst, acid leaks that can harm personnel or the environment.

The Solution

As mentioned, the best choice for acid injection in wastewater applications is hydraulic, mechanical or electronic diaphragm metering pump technology. These types of pumps help safely, efficiently and reliably handle acids in wastewater applications.

Some hydraulic metering pumps are ideal for acid handling because they can inject a precise and controlled amount of chemical, feature an internal relief valve, have leak-free operation, can handle higher pumping pressures, require minimal maintenance, can be constructed with an automatic stroke control actuator or variable-speed motor, have low energy usage and feature an easily adjustable micrometer dial that can be adjusted whether the pump is running or stopped. Hydraulic diaphragm pumps also have a flow-rate deviation of less than 1 percent. Some feature a 10-turn micrometer dial that can be calibrated to 1 percent increments from 10 percent to 100 percent of flow capacity. Additionally, the pump's stroke mechanism moves only when adjusted, which eliminates unnecessary wear, while the piston is powered through the complete stroke length at all capacities to remove any concerns about excessive stress, wear or shock.

Some pumps also feature a stroke adjustment option that delivers better valve performance than metering pumps with variable-linkage designs. The valve checks optimize performance because they have extra time to seat since they are idle during the by-pass portion of the suction and discharge strokes.



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To quell material-compatibility concerns, many metering pumps are available in a choice of materials of construction for the pump body, valves and seats, including:

- 316 stainless steel
- C-20
- PVC
- Fluoropolymer resins

Many metering pumps are capable of producing up to 94 gallons per hour (303 liters per hour) of flow at 100 pounds of pressure (60 gallons per hour/227 liters per hour if the pump is duplexed). Operational temperatures range from 125 F to 200 F (52 C to 93 C) with maximum pressures from 150 to 3,000 psi (11 to 210 bar).

When choosing between a hydraulically or mechanically actuated diaphragm metering pump, operators must consider the specific needs of their operations. Some pumps use a polytetrafluoroethylene (PTFE) disc that flexes between two perforated plates. Because the diaphragm is hydraulically balanced, the pumps are capable of operating against higher discharge pressures than a mechanical diaphragm pump. The tradeoff is that the pump does not have the same suction-lift capabilities as a mechanical diaphragm pump. On

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the other hand, hydraulic diaphragm pumps offer built-in relief protection, which is especially desirable in high-pressure applications.

Finally, electronic metering pumps are a viable option in acid handling because they are able to offer stroke length and speed adjustments that make them particularly suited for low-flow, acid-feed applications, which can require the pump to possess a wide turndown capability.

When feeding acids, ancillary piping and accessory components must also be carefully considered and selected, including:

- **Skids**—When practical, acid-feed skids should be constructed of corrosion-resistant structural fiber-reinforced plastic (FRP) or polypropylene. If metallic skids are required, they should include a paint coating that resists the acid. Integral or secondary containment is also desired.

- **Strainer**—Diaphragm metering pump check valves operate best when the acid being pumped is clean and free of particulates. The suction piping system should always include an appropriately sized strainer. When pumping concentrated sulfuric acid, a sludge trap is suggested for removing sludge particles, which will help minimize the possibility of pump failure.
- **Calibration columns**—These provide an inexpensive, yet reliable and accurate, way to verify the pump's flow rate. A calibration column of clear PVC is suitable for many acids, although borosilicate glass columns are available and required for use with some acids. A notable exception is hydrofluosilicic acid, which will etch glass.
- **Injection quill**—An injection quill or corporation stop injects the acid into the center of the pipeline, tank or process for more rapid and uniform chemical dispersion. This helps protect the pipe or tank walls from the corrosive effects of the acid.

Conclusion

Water is critical to life and the successful operation of a wide range of industries. In conjunction with its use, the safe, clean and responsible treatment, conservation and disposal of water is a critical global issue. Acids in many forms

play a correspondingly important role in treating water and wastewater.

Like water itself, proper care and handling of acids must be observed. While operators of wastewater treatment facilities are aware of the responsibilities they have in ensuring safe water sources, they also know that they must take every measure to optimize the cost-effectiveness of their operations. Diaphragm metering pumps can be an important part of this endeavor.

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