WHERE VALVES ARE USED

AWWA ball and butterfly valves are used to pump reuse water in Waco, TX.

Wastewater Treatment

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Society's desire for a clean environment shines light on the importance of understanding the essential role wastewater treatment plants have in our communities. Congress passed the Clean Water Act in 1972 to control the discharge of effluent into water systems and waterways, and provided grants to allow municipalities to meet these new requirements. Since then, technologies such as optimized treatment systems and automated valves have been used to make our country's wastewater plants technical marvels. The purpose of this article is to explain the various critical roles that valves play in the operation of typical wastewater plant processes.

THE BASICS

A place to begin this understanding is to look at the overall purpose of a typical municipal wastewater system, which is to collect wastewater generated by residents, businesses and industries, and

Executive Summary

SUBJECT: Valves in wastewater must deal with the challenges of turning what makes its way into our nation's sewers into water free of disease and ready for redistribution into waterways.

KEY ISSUES:

- Today's plant processes
- The valves and where they work
- Primary, secondary and tertiary control

TAKE-AWAY: Special valves are required to handle the debris and suspended matter in wastewater. However, other valves are used after the waste is removed—so the industry has a wide range of valve possibilities.

to process that wastewater into final outflow that meets federal and state water quality standards. Treated water meeting Environment Protection Agency requirements then can be safely discharged into water reuse systems or waterways. A successful wastewater system depends on cooperation and support from residents, municipalities, industries and regulators.

MEANS OF COLLECTION

As cities grew in size in the U.S., installing wastewater collection systems became a necessity for preventing waterborne disease. Achieving this, in turn, facilitated accelerated growth of those cities. By the year 2000, about 208 million people in the U.S. were served by centralized wastewater collection systems.[1]

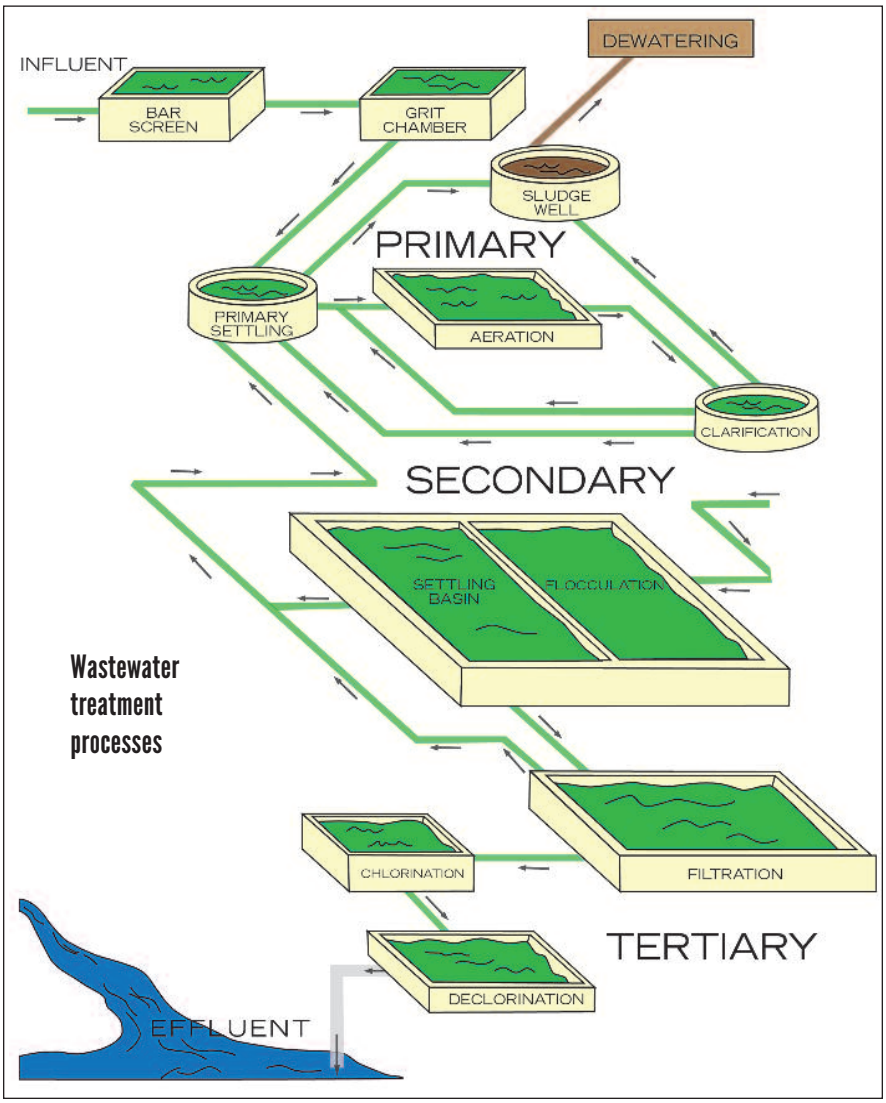
Depending on the geography of the area, collection systems use gravity to pass flow through sewers or use lift stations and force mains to transmit wastewater over elevations and great distances to a centralized treatment plant. When a plant is fed by gravity sewers, it also may be equipped with station pumps to lift the wastewater and start the gravity flow process through the plant.

COURTESY OF ROMTEC UTILITIES

Submerged wastewater pumps in a wet well lift station with a separate valve vault

Lift stations collect the wastewater from a township or subdivision by gravity and then pump that wastewater through a force main to a centralized wastewater plant. These stations can be designed as either a wet well or a wet and dry well design where the dry well contains the pumps and related equipment.

The valves in a lift station are located in the wastewater basin, dry well or a separate valve vault. The three types of valves typically found in lift stations include check valves, shutoff valves and air valves. The purpose of the check valve is to prevent reverse flow when the pump is turned off. Shutoff valves are used for isolation when repair or maintenance is needed. Air valves expel air from the pump column and the force main to provide flow efficiency and minimize surges. Selecting valves for wastewater applications is similar to that of selecting pumps in that consideration must be given to the solids content of the flow media.[2]



Wastewater treatment processes

CHECK VALVES

Check valves are essential in lift stations for preventing reverse flow when the pumps are not in operation. There are as many types of check valves as pumps, so it is important to understand the essential characteristics that affect performance in wastewater service. The swing check valve is the traditional choice and is produced in accordance with American Water Works Association (AWWA) C508. These valves are made of iron with corrosion-resistant internal mechanisms. Swing check valves use a 90-degree seat and are typically provided with a lever and weight to assist with closure and provide position indication. The valves also can be equipped with springs, air cushions or oil dashpot arrangements to reduce the valve's propensity to slam.

A variation of the traditional swing check is the resilient hinge design, which has a much shorter disc stroke that can greatly reduce the slamming problems, especially for higher head applications. Additional benefits of the resilient hinge design include a corrosion-resistant disc, an encapsulated hinge pin, the option for position indication and a top access cover for ease of maintenance.

A ball check valve is commonly

used on smaller systems where economy is important. This valve uses a ball (as compared to a disc) as its closure member. The ball is lifted up and away by the flow during system operation and falls back to the closed position when the pump is shut down. Ball checks can be mounted in both horizontal and vertical applications.

PUMP CONTROL CHECK VALVES

When main pumping stations operate at high head or pump fluid through a very long force main (i.e., five miles), pump control check valves and special surge equipment may be needed instead of traditional check valves. Quarter-turn plug or ball valves equipped with electric, pneumatic or hydraulic-powered actuators and electrically connected to the pump circuit are used as pump control check valves. Pump control valves open and close over several minutes to slowly change the fluid velocity, thereby preventing surges in long force mains. Moreover, the use of pump control check valves can significantly save power consumption due to their low head loss.

SHUT OFF VALVES

All pumps and check valves should be equipped with a shutoff valve to allow isolation of the system and maintenance of the lift station components. Isolation or shutoff valves for wastewater service come in many varieties; however, they all must be designed to prevent clogging and wear from the flow of grit-containing fluid.

For small-diameter applications, threaded quarter-turn ball valves are an economical choice. The threaded or flanged body contains a floating ball that seals against non-metallic seats in both directions.

For larger applications, multi-turn knife or wedge gate valves are commonly used. Gate valves are usually constructed of iron with flanged connections. These valves are produced in accordance with several AWWA standards, including AWWA C500, C509 and C515, and are available in both rising stem and non-rising stem models. Rising stems are preferred because they provide indication of the valve position at all times.

A compact or short version of the gate valve is the knife gate, which is produced in accordance with AWWA C520 and gets its name because the gate is a thin metal plate or blade. With wastewater, this gate can cut through sediment. Knife gates are commonly used for suction isolation of wastewater pumps because flow control is not required. No gate valves should be used for throttling or flow control because vibrations while the gate is partially open can damage the valve.

Another shutoff valve for wastewater service is the quarter-turn eccentric plug valve, which is built in

☐ Wastewater air valves isolated by gate valves are installed in a wastewater treatment plant.

accordance with Manufacturers Standardization Society (MSS) SP-108 or AWWA C517. The seat and plug face of an eccentric plug valve is located offset from the valve shaft and port so that, as the plug is rotated out of the seat, it is pulled away rather than scraping against that seat. This eccentric action prevents wear in abrasive service. Moreover, if wear does occur, the actuator can be adjusted, further closing the plug to provide new seating surface and a tight seal.

Plug valves can be furnished as a direct nut type for wrench operation or, in larger sizes, equipped with a quarter-turn worm gear actuator. An additional advantage of a plug valve is that the valve can be used as a pump control valve by using electric/hydraulic actuation. These valves are also excellent in throttling applications for controlling the rate of flow.

AIR VALVES

Automatic air valves are installed on the pump discharge and at high points on the force main to prevent air pockets or vacuum conditions from forming in the force main. These valves are automatic devices with floats that open to expel air when it collects in the valve body. When wastewater enters, the float lifts by buoyancy and closes the orifice in the outlet of the valve so the fluid is not expelled. Wastewater air valves often feature elongated or conical bodies to prevent clogging, a sloped bottom to facilitate drainage and Type 316 stainless-steel internal components to withstand the corrosive nature of wastewater and wastewater gasses.

The importance of air valves cannot be overlooked. They not only maintain the flow efficiency of a pipeline by venting accumulated air, but also perform many other functions, including surge control after pump power failure by admitting air rapidly to prevent the formation of a vacuum pocket during column separation. Note, however, that maintaining equipment in wastewater service is always a challenging and dirty job. One field study demonstrated that air valve maintenance can be reduced by the use of fusion-bonded interior coatings and Type 316 stainless-steel trim.[3]

Centrifugal pump and resilient-hinge check valve in wastewater lift station dry well

TREATMENT FACILITIES

Domestic and industrial wastewater collected from sewer systems and lift stations flows to a centralized wastewater treatment facility. The wastewater process is typically segregated into three phases: primary, secondary and tertiary.

The primary treatment includes inlet bar screens to exclude physical debris such as rags and sticks from the wastewater flow stream. Often, several submerged wastewater pumps lift the wastewater into grit tanks that slow the velocity of the fluid so grit settles to the bottom of the tank. These pumps and associated valves need to have all of the characteristics associated with lift stations.

The wastewater at this stage still contains sediment and organic constituents that are removed in a primary settling tank using chemical coagulants. The constituents settle to the bottom of the tanks as wastewater primary sludge. Sludge is pumped from the bottom of the tank at regular intervals to dewatering facilities. The valves associated with this process must be designed to handle slurries with over 90% suspended solids. Industrial ball valves or eccentric plug valves are used to stand up to this challenge.

Some plants are faced with a serious struvite (magnesium ammonium phosphate) deposit problem in their digested sludge lines. Struvite crystals can grow rapidly and form a concrete-hard crust on the inside of pipes and equipment, choking flow. Pipe and equipment subject to struvite service should be glass-lined, which consists of applying a 10-mils-thick ceramic coating using a special high-temperature process (1400°F or 760°C) for pipes, valves and pumps.[4]

The remaining organic matter is

Butterfly valves supplied in accordance with AWWA C504 are often used [in tertiary treatment] because of their compact size and low cost, especially in large pipe sizes.

then removed during the secondary treatment using biological processes, often either a fixed film or a suspended growth process. In a fixed film process, the biological treatment occurs while immersed over filter media such as ground rock, plastic balls or corrugated plates. The organic matter is consumed by bacteria, algae and fungi, and converted into a biomass. A suspended growth process uses injected air added to the mixture to support microbial growth and a corresponding consumption of organic matter.

Aeration systems frequently use high-power centrifugal air blowers and power-actuated control valves, typically wafer butterfly valves. The control valves for air service are designed for dry fluid service and high temperatures approaching 300°F (150°C). Additionally, blowers should be fitted with check valves that have low opening or cracking pressure and are sized so they will not chatter during low-flow operation.[5]

Tertiary treatment processes may include biological or chemical treatment for nutrient removal or tertiary filtration for particulate removal. Tertiary treatment also includes disinfection of the effluent by prolonged contact with a chemical such as chlorine in a contact basin before the output water is discharged. The final output water will be dechlorinated and may be pumped for reuse or simply discharged to a waterway. Since the sediment has been removed from the wastewater, other types of waterworks valves may now be used. For example, butterfly valves supplied in accordance with AWWA C504 are often used here because of their compact size and low cost, especially in large pipe sizes. Waterworks gate valves also are employed.

An eccentric plug valve (far right) isolates a wastewater pump and check valve.

When pumping effluent for reuse, waterworks pumps, check valves and shut off valves can be used. Both butterfly and ball valves are quarter-turn valves that are reliable and simple to automate for this service. Quarter-turn ball valves supplied in accordance with AWWA C507 are used when head loss and energy savings are considered important. A full port ball valve has a head loss similar to a pipe of the same length.

CONCLUSION

While many types of valves are used in wastewater treatment, one thing they have in common is that they all must be suited for fluids containing suspended solids. Some common valves such as silent check valves and butterfly valves should not be used in raw wastewater service. Instead, specially designed valves such as knife gate valves and eccentric plug valves are the go-to workhorses for wastewater applications. VM

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