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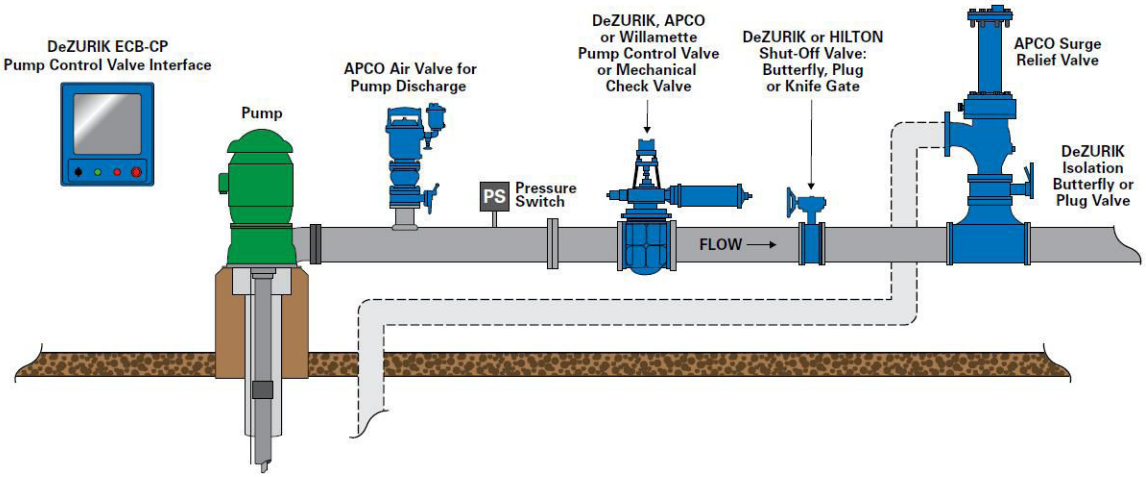
VALVE SELECTION FOR THE SAFE OPERATION & PROTECTION OF THE PUMP STATION



A variable speed pump station design will require additional considerations.

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Proper valve selection that helps ensure safe operation and protection of the pump station can present a challenge to the engineer and owner. Common considerations include preventing the damaging consequences of surge pressure transients (water hammer), related safety issues, pipeline breaks, fitting failures, cross connection, flooding and water loss. Additional concerns may include minimizing check valve slam, elimination of air pockets and vacuum conditions, surge relief valve necessity and size, pump control valve considerations and options, valve operating speeds, reducing pumping energy costs and dependable isolation valve service.

Early in the pump station design process, the technical parameters of the pumping application should be collected to develop an understanding of the system. The nature of the fluid, pressure ranges, flow ranges, valve sizes, industry standards, and owner and consulting engineer preferences are considered. The potential for surge pressure transients (water hammer) can then be examined using governing fluid mechanics equations. Items to be reviewed and considered include the maximum surge pressure potential, the surge period, line velocity, surge wave speed, pipeline constant and total system head potential during a surge event. Investigation of these results will provide guidance for applying check valves, pump control valves, surge relief valves and air valves to minimize surge pressure.

Evaluation of the results can also provide guidance in selecting a check valve or pump control valve. The potential for check valve slam can be assessed and valve solution options determined. Pump control valve actuation options can also be evaluated. The need for surge relief valves can be investigated and surge relief valve sizing completed if applicable. Operating costs can also be considered and compared to the initial purchase price. This comparison should account for pumping costs (head loss), valve budgetary pricing and relative maintenance costs of different valve types and lead to valve selections that provide the lowest cost of ownership over the project life.

Pump control valves:

A pump control valve is normally closed to prevent reverse flow when the pump is off. It then opens at a controlled rate of speed just after pump start, gradually accelerating the fluid to minimize pressure surges. To initiate a normal pump shutdown, the pump control valve is closed against a running pump at a controlled rate of speed, gradually decelerating the fluid to minimize pressure surges. Upon seating, a limit switch on the pump control valve turns off the pump. When an electrical power failure occurs during pumping, the pump control valve automatically closes, usually at a faster than normal rate to minimize backflow.

Pump & control valve interface:

A pump and control valve interface is a preprogrammed controller that properly sequences and controls the pump and pump control valve startup and shutdown procedure for normal operation. It includes a special sequence with a time delay to protect the pumping system from damage due to mechanical, hydraulic or power failure.

Check valves:

Check valves are used to prevent the backflow of fluid through the pump by closing before flow reversal can occur. Check valves are installed on clean and dirty applications. Various closure devices are available that include air cushion, oil control, bottom buffers, lever and weight, external lever and spring or internal spring.

Surge relief valves:

Surge relief valves are typically installed downstream of the check or pump control valves on the pump discharge header with the valve inlet connected to the side outlet of a tee and the valve outlet piped back to the sump. The normally closed surge relief valve opens quickly when the system pressure rises above its adjustable relief-pressure setting, allowing fluid to be discharged from the system through the open surge relief valve to a controlled, contained location—typically some form of sump. While the surge relief valve is open, the system is no longer contained, fluid compression is limited and surge pressure is controlled. The valve will remain open as long as the system pressure exceeds the valve's relief-pressure setting. The valve will slowly begin to close at an adjustable rate as the surge pressure subsides and the system pressure falls below the valve's relief-pressure setting.

Air valves:

Air release valves remove small air pockets that form at the high points of a pipeline and restrict flow. Air and vacuum valves expel large amounts of air when filling the pipeline and admit air to relieve a vacuum when draining the pipeline.

Isolation valves:

Isolation valves are typically one of three types—butterfly, plug or knife gate. Selection of an isolation valve depends on various factors including full flow requirements, media type and solids content, temperature, etc. An isolation valve will usually be located after the pump control valve or check valve to isolate both the valve and the pump for maintenance capability. An isolation valve is also required for the pressure relief valve.

Valve considerations with variable speed pump design:

The diagram and valve equipment described above are based on a constant speed (C/S) pump station design. In a variable speed (V/S) pump station design, the valve requirements for the pumping station will require additional consideration but still incorporate most, if not all of, the same valve applications. A V/S pump design will consider surge prevention by ramping up the pump speed during startup and ramping down the speed during shutdown. A mechanical check valve would normally be used to prevent draining the line back to the sump when the pump is off. In a C/S pump design, surge protection would normally be accomplished by the pump control valve and the control interface. Limitations in the range of ramp times of V/S pump equipment may not provide acceptable surge prevention and may still require a pump control valve. A V/S system design cannot respond to a power loss, as it would create a potential pressure surge that is greater than the piping design and would require a surge relief valve to relieve pressure for both a V/S and C/S system. Air valves are needed to remove entrained air bubbles and allow air into the system under vacuum conditions. Isolation valves are also required in the V/S system design to isolate components for maintenance.

Conclusion:

There are a number of specialized design considerations within a pump station system. Safe operation and system protection are two critical points requiring careful thought and engineering expertise. Be sure to partner with a manufacturer that understands the intricacies and engineering for proper equipment selection in your unique pump station application.

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