Check Valve Installation Considerations to Maximize Process Performance

Key considerations in successful check valve performance.

BY LEA CLAUSON

Check valves are critical in backflow prevention. They protect pumps and compressors in a process system and prevent wet wells from flooding. Proper check valve selection and installation will prevent premature wear of the valve and an unscheduled shutdown. The keys to successful check valve performance are valve selection, size, pipeline installation and cost of ownership. Time spent evaluating these key considerations will maximize check valve operational performance.

EVALUATION BEFORE VALVE SELECTION

The design of the pumping system should be evaluated before selecting a check valve. First, consider whether the pump system design has potential surge issues. If surge issues are a concern, then a surge investigation should be performed by a valve manufacturer. The surge investigation may determine whether a pump control valve is better suited for the application than a check valve.

KEY CHECK VALVE CONSIDERATIONS

Valve Style: Selecting the appropriate style check valve starts with understanding the process media. The type of media — whether it is clean, abrasive, corrosive or slurry — determines what style of check valve should be selected.

60-inch swing check valve for critical backflow prevention.

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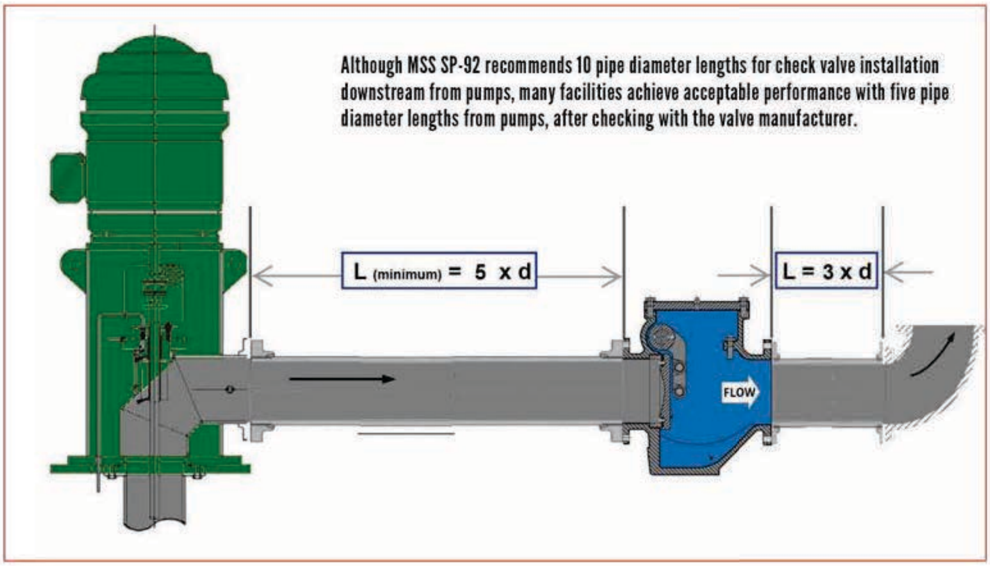
For clean service, check valve styles such as slanting disc, double door and silent are most common for low head loss, large pipe or quick closure requirements. Although rubber flapper and swing check valves can be used in clean service, they are typically used in wastewater service. These valves are more suitable for abrasive/corrosive/dirty applications and rapid flow reversal. Swing check valves are commonly used for pump discharge applications due to control options that accommodate varying forward and reverse flow conditions.



Valve Size: Correct valve size is important to valve performance and may or may not be the same as the pipeline size. For best valve performance, sizing calculations for minimum, normal and maximum flow conditions are necessary to optimize valve life and minimize valve maintenance. The American Water Works Association standard (AWWA C508) for swing check valves states: "Valves may be subjected to excessive wear if there is insufficient flow to open the valve."

Rubber flapper valves are typically sized to be fully closed or fully open with sufficient flow. Conversely, full waterway swing check valves are not typically sized for full open but are sized for the lowest acceptable head loss per the design. If the valve is sized too large and normally operates nearly closed, the disc connection can be worn. Premature wear can occur on the disc connection through vibration, oscillation and force until the metal connection is ground away and no longer allows the disc to seat properly in the valve body.

Valve Installation: Valve installation in the pipeline is a critical consideration to the success of the check valve. The recommendation by Manufacturers Standardization Society of the Valve and Fittings Industry (MSS SP-92) is to install a check valve at a minimum of 10 pipe diameters of straight pipe on the downstream side from tees, fittings, increasers or pumps and five pipe diameters from elbows to ensure laminar flow with minimum turbulence to minimize disc movement and premature wear. However, many facilities with smaller footprints have achieved acceptable performance in systems with the check valve installed five pipe diameter lengths of straight pipe from the downstream side of tees, fittings, increasers or pumps and three pipe diameters lengths from elbows, as shown in the illustration above. Consult the valve manufacturer for design pipe distances less than the recommendation by MSS.

Cost of Ownership: When selecting the proper check valve, it is important to consider the cost of ownership. The cost of ownership includes initial cost, operating cost and maintenance cost. An inexpensive check valve may end up costing less at startup but may cost more in the long run with unscheduled maintenance and downtime than a valve that is better suited for the application. The more suitable valve will perform better, require less maintenance, and provide system longevity.

Design Goal: The goal of design planning is to minimize

Case Study 1

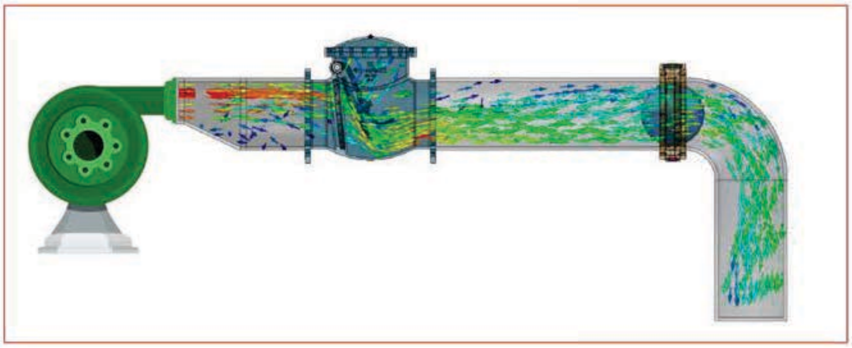
In one installation, a swing check valve was oversized because they planned for future growth. The low flow rate of the valve resulted in the valve only being open 17 degrees. The near-vertical disc was subjected to high-velocity water flow near the top of the disc and low-velocity swirling water at the bottom of the disc. The unbalanced dynamic forces on the disc caused the disc to wobble and wear the connecting parts. The pin and connections were worn down and the center hole in the disc was worn out, not allowing the disc to close properly. In time, the disc became loose and failed to close.

Case Study 2

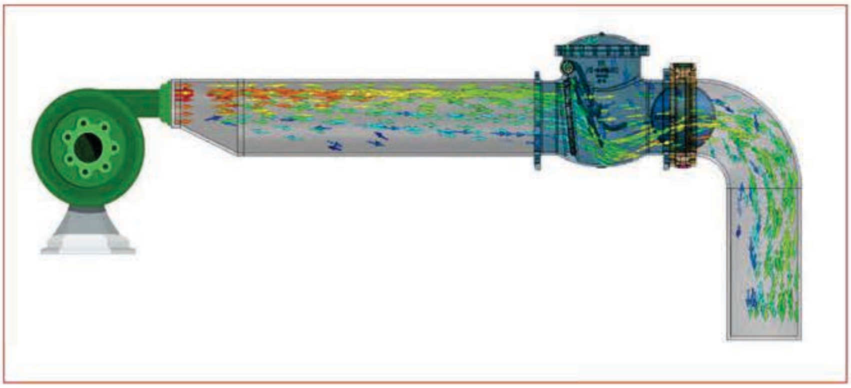
In another installation, because of the facility's extremely compact footprint, the check valve was installed immediately after the pump and increaser with little pipe length distance between the check valve and pump. The high-velocity pump discharge focused a jet of water directly at the check valve disc and pin connections, prematurely wearing out the valve components and causing improper seating of the disc.

the facility footprint without compromising equipment performance. Equipment will last longer under laminar flow and with no sudden changes in flow velocity. Sudden changes in flow velocity occur during a sudden pump shutdown when the flow reverses and is stopped by the closing of the check valve. This sudden stop in fluid flow or flow velocity change instantly reduces the pressure below the vapor pressure and may cause momentary column separation. The vacuum created by the column separation draws the two columns together violently. When the columns rejoin it creates a high-pressure shockwave, also known as water hammer. Water hammer creates a loud banging sound which is disruptive and the accompanying pressure surge could be destructive if left untreated.

AWWA C508 states: "Conditions of water hammer, hydraulic pulsation, and excessive operating noise are results of system design rather than valve design and are beyond the scope of this standard and require special design and construction considerations."



Unbalanced dynamic forces on the check valve disc caused the disc to wobble and wear.



Moving the check valve further from the increaser decreased turbulence and allowed flow to become more laminar.

Pump station design with silent check valve installed five pipe diameter lengths from pump discharge.

Flow Characteristics: Shown on the left is Computational Fluid Dynamics (CFD) analysis of a check valve near an increaser. Eddies formed at the bottom of the increaser and created turbulent flow through the check valve. Moving the check valve away from the increaser removed the eddies and created a more laminar flow through the check valve, as shown in the second CFD image.

Increaser: Another way to ensure more laminar flow is to limit the size of the increaser between the pump and check valve so it is not greater than two pipe sizes. For example, if the pump discharge is 12 in. it would be acceptable to use an increaser to a 14- or 16-in. check valve size, but any larger would be too extreme.

FIELD EXPERIENCE

Issues: Failing check valves are often caused by installations too close to pumps and increasers. In addition, there is a tendency in design planning to oversize discharge pipes for future expansion which then require extreme reducers to fit the pump size. Both these issues create turbulent flow that can wear the disc and pin connections and cause premature check valve failure.

Solutions: Ideally, the pipe distance between the pump and check valve should be calculated during the design phase of the project. For existing facilities, one solution is to move the check valve further away from the pump to achieve a more laminar flow, preferably five pipe diameters. If there are space limitations and moving the valve is not an option, then consider another style of check valve. Another solution is verifying the check valve is properly sized for the process conditions and, if possible, avoid utilizing extreme increasers.

Keys to Successful Check Valve Performance: The role of the check valve is to prevent backflow from damaging pumps in the process system. Check valves play a vital role in the successful operation of a facility. When designing a pumping system, it is beneficial to request a surge investigation from the valve manufacturer to determine whether the process conditions require a check valve or a pump control valve. If a check valve is required, then valve selection, size, installation and cost of ownership should be considered before specifying the valve. These key considerations will extend the life of the check valve, ensure proper protection of process equipment, and prevent an unplanned shutdown. VM

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