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THE ALWAYS RELIABLE PLUG VALVE

FOR DECADES THE PLUG VALVE HAS BEEN A PROVEN PERFORMER—A LONG-STANDING, RELIABLE WORKHORSE IN EVERYTHING FROM WATER TO CHEMICAL SERVICE, CLEAR LIQUIDS TO MINING SLURRIES, AND MANY APPLICATIONS IN BETWEEN.

BY JIM BARKER

While the dependable plug valve has evolved since the cast iron, resilient-seated plug valve was introduced in 1928, much about it has stayed the same. One reason today's plug valve has been around so long is that once installed, it remains functional for decades of uninterrupted on-off service, throttling service, and flow diversion.

The plug valve is used for applications that require tight sealing with good wear resistance for handling fluids with some solids such as paper stock and wastewater. Applications include water and wastewater treatment plants, water distribution systems, power and chemical plants, HVAC, paper mills, and mining operations.

Design

A plug valve is a rotating motion valve used to stop, start, control, or direct flow. It receives its name from the shape of the internal plug mechanism, which is one of the plug valves' three basic components; the other two are the body and bonnet/cover. The plug is the only moving member. When turned 90 degrees from the open position, the solid part of that plug blocks the ports and stops fluid flow, or in multi-ported valves, diverts flow from one port to other ports.

Several valve industry standards govern the design of plug valves. These standards have been created and are maintained by highly reputable standards associations and organizations, such as the Manufacturers Standardization Society (MSS), the American Petroleum Institute (API), and most recently the American Water Works Association (AWWA). International standards also are available.

In North America the most frequently used standards are those developed by MSS and API. The following standards should be considered when designing plug valves or purchasing plug valves:

- MSS SP 25—Standard Marking Systems for Valves
- MSS SP 61—Pressure Testing of Steel Valves
- MSS SP 78—Cast Iron Plug Valves Flanged and Threaded Ends
- MSS SP 108—Resilient-Seated Cast Iron Eccentric Plug Valves
- API 6D—Specification for Pipe Line Valves
- API 599—Metal Plug Valves—Flanged and Welded Ends
- ANSI B16.10—Face to Face and End Dimensions of Ferrous Valves
- ANSI B16.34—Steel Valves, Flanged and Butt Welded Ends
- AWWA—Resilient-Seated Cast Iron Eccentric Plug Valves (a new draft standard currently under development by the American Water Works Association.)

Types and Styles

Plug valves are available in a variety of types and styles. The following list, while not all-inclusive, covers most types of plug valves used today:

- Eccentric plug
- Concentric plug
- Flow diversion: three-way or four-way
- Sleeved or lined
- Lubricated plug valves

There is not room here for an in-depth description for each of these valve styles; instead, this article gives a brief explanation of each and focuses on eccentric plug valves and flow diversion valves.

Eccentric Plug Valves

The eccentric plug valve (Figure 1) derives its name from the fact the plug's rotational action is eccentric in nature relative to the longitudinal axis of the plug. This rotational action allows the plug to contact the seat only in the last few degrees of rotation, which eliminates most rotational

Figure 1. Typical eccentric style plug valve

wear and friction between the seat and the plug. This design also allows the valve sealing to be controlled by the torque applied to the plug. The eccentric action allows the plug to cam into the seat and provides tight shutoff (Figure 2), which reduces wear on the plug and seat. The sealing surfaces may be metallic, elastomer, glass, or plastic lined.

When the eccentric plug rotates 90 degrees from opened to closed, it moves into a raised eccentric seat. In the open position, the plug, which is segmented, is out of the flow path. Flow is straight through, and flow capacity is high. As the plug closes, it moves toward the seat without contact with the seat or body walls, so no interference or wear occurs. Flow is still straight through, however, making the throttling characteristics of the eccentric plug valve ideal for gas, liquid, and slurry applications. The plug only makes contact with the seat in the closed position. When furnished with a resilient facing, the plug is pressed firmly against the seat in the body and provides a tight seal (Figure 2).

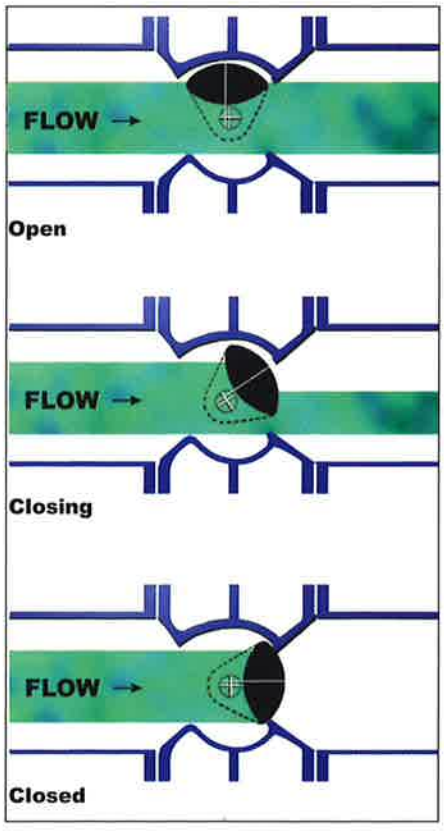

Figure 2. Eccentric plug flow control

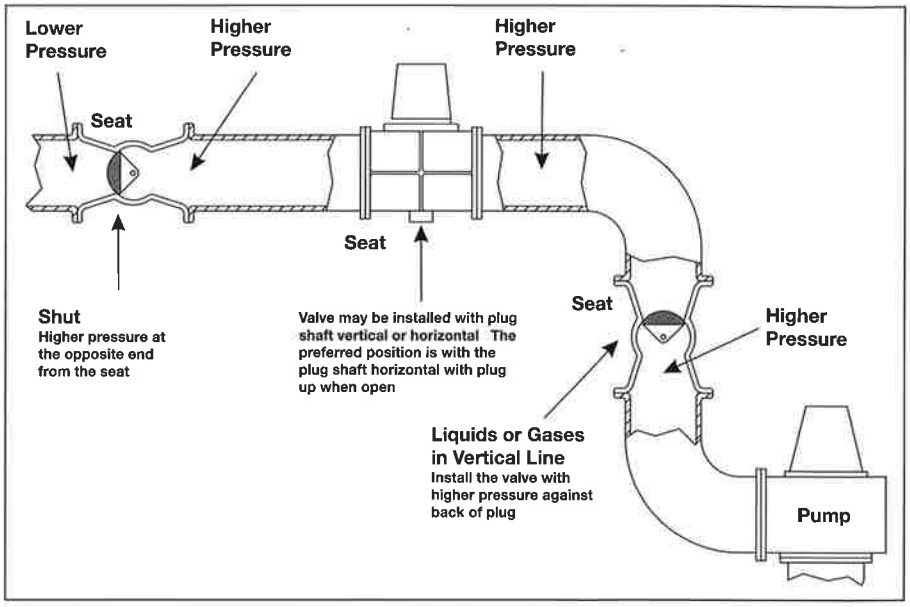

Figure 3. Eccentric plug valve installation in liquid or gas applications

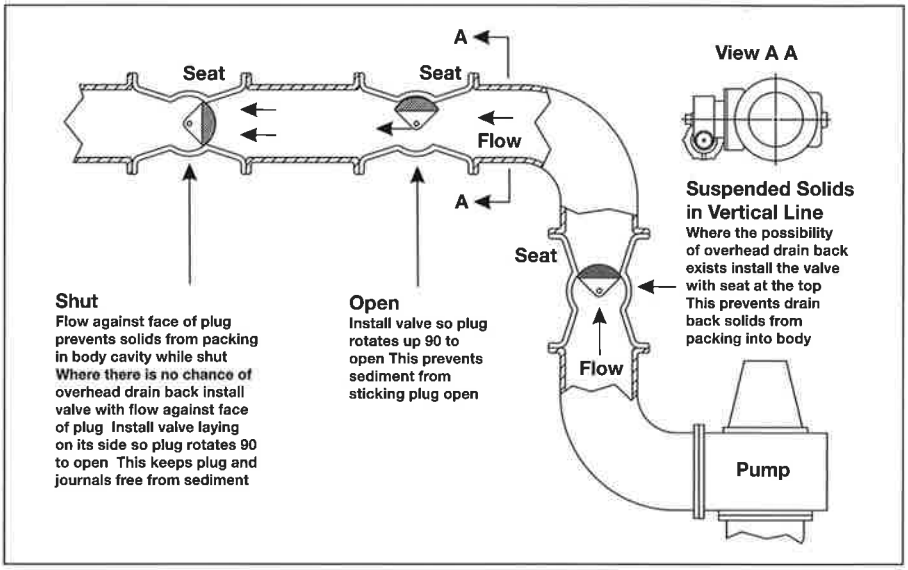

Figure 4. Eccentric plug valve installation in suspended solids applications

Installation of Eccentric Plug Valves

The correct installation procedure for the eccentric plug valve is determined by the type of materials carried in the pipeline and the location of the valve in the piping configuration. If the medium is liquid or gas, the valve should be installed as shown in Figure 3. Note that the high-pressure side of the valve is opposite the seat, which assists the seating by engaging more as pressure increases. Valves may be installed with the plug shaft vertical or horizontal; however, the preferred position is with the plug up when open.

If the pipeline carries suspended solids—such as paper stock with consistency of 2% or higher, mining slurry, or raw sewage—the valves should be installed as shown in Figure 4.

In horizontal pipelines the valves should be installed so the plug is horizontal and rotates upward as the valve opens. Flow against the plug face prevents solids from packing in the body cavity when shut. When there is no chance of overhead drain-back, the valve should be installed with flow against the face of the plug. Installing the valve so that it is in a horizontal rotational axis keeps the journals free from sediment. The valve also

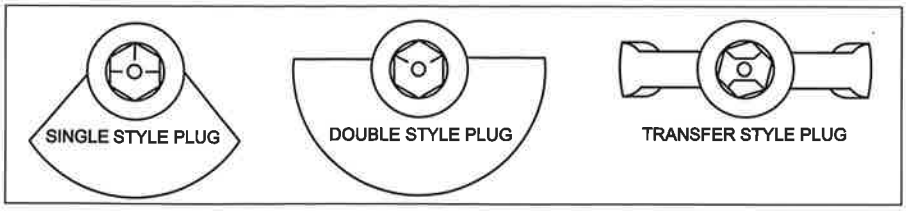

Figure 5. Common plug styles

should be installed so that the plug rotates upward 90 degrees to open. This forces sediment to settle away from the open plug and prevents the plug from sticking open.

For vertical pipelines in which overhead drain-back can exist, the valve should be installed with the seat at the top. This prevents drain-back solids from packing into the valve body.

Concentric Plug Valves

The concentric plug valve is similar to the eccentric plug except the plug rotational action is concentric, rather than eccentric. In other words the plug rotates symmetrically about its own centerline. Concentric plug valves are used primarily in throttling applications.

Flow Diversion Valves

Flow diversion valves (Figure 7) typically have three or four ports and are also available with a variety of plug styles, which are chosen based on the desired flow diversion. The most common plug styles (Figure 5) are: single-style, double-style, and transfer-style.

The single- and double-style plugs can be arranged into different flow combinations (Figure 6). Resilient-seated plugs are used for tight shutoff, and in high-temperature and throttling applications, the plugs are all metal. The transfer-style plug is used in four-way diversion valves designed to shut off the flow of two ports and allow the flow through two other ports (Figure 6—Combination 4).

Flow diversion valves are designed for throttling and diverting clean, dirty, viscous, and corrosive liquids; sludge, abrasive, and fibrous slurries; and clean, dirty, and corrosive gases.

Some multi-ported valves feature lift, turn and reseat, which allows the plug to be moved away from the sealing surface of the body prior to rotating. Because the plug lifts first, plug and seat wear is reduced or eliminated and the valve has longer life. Lift, turn and reseat double hand wheel actuators (Figure 7) provide tight shutoff when used on valves with resilient-faced plugs. A lift, turn and reseat valve with lever actuator is shown in Figure 8. The lever is used to lift the tapered plug away from the seat, providing easy operation. With the plug unseated, no binding or scraping between the plug and seat occurs. At the desired flow position, the plug is reseated.

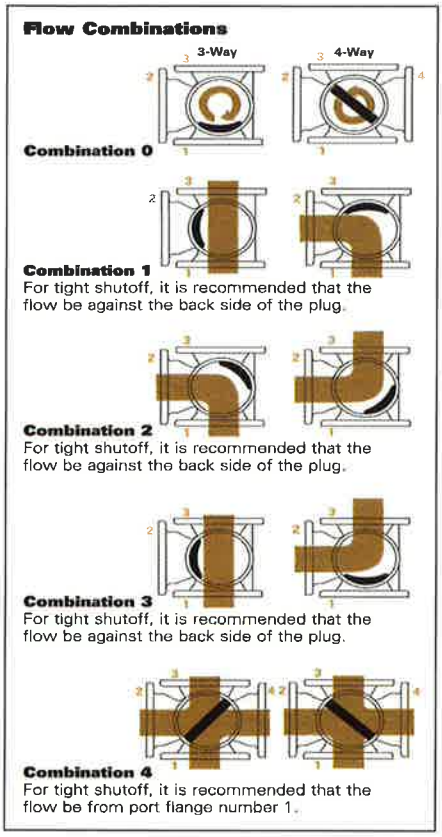

Figure 6. Flow diversion control

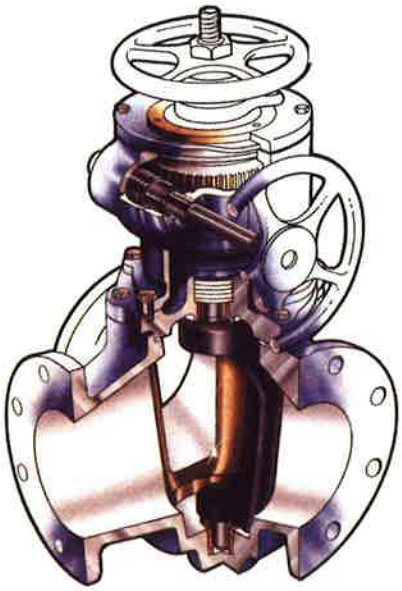

Figure 7. Typical multi-ported flow diversion valve

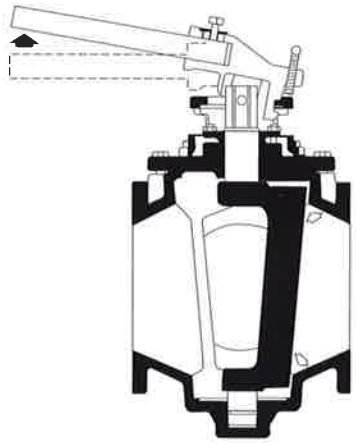

Figure 8. Lift, turn and reseat operation

Sleeve or Lined Plug Valves

As the name indicates, these plug valves have a sleeve or lining in the body of the valve to provide corrosion and erosion protection. The valves typically have a tapered plug with a port through the center of the plug. When the plug is in the closed position, the port is perpendicular to the flow through the valve body, thereby blocking the flow of the media and creating an effective seal. When the plug is rotated 90 degrees to the open position, the port is aligned along the same axis as the ports in the body, allowing full flow through the valve.

Lubricated Plug Valves

Lubricated plug valves use a lubricant to assist in tight shutoff. A series of grooves are manufactured around the port openings in the plug. Grease is injected through a fitting and check valve at the top of the plug stem. The grease travels down the stem to the grooves in the plug, then to a reservoir at the bottom end of

the plug. The grease lubricates the plug and provides the seal between the body and the plug. This means the lubricant must be compatible with the temperature and the makeup of the media flowing through the valve. Lubricated plug valve manufacturers have developed lubricants over the years that are compatible with different media.

Actuation

Actuation for plug valves typically falls into one of three general categories:

- Manual—either lever/handle or manual gear actuators with hand wheels, chain wheels, or nut operators
- Pneumatic/hydraulic—either cylinder-driven gear units or vane-type actuators
- Electric—gear units driven by electric motors.

Actuator selection is based on application and service conditions such as throttling or on-off, velocity, pressure drop, frequency of operation, control, and many other considerations.

Applications

Applications for plug valves are numerous. For example, here are just a few:

- Sewage intake
- Grit removal
- Digester gas
- Effluent
- Pump check control
- Paper
- Sewage transmission
- Process
- Primary and secondary treatment
- Mining slurries
- HVAC
- Water
- Power
- Chemical

As with any valve the function and long-term success of the installation lies with properly and accurately defining the service conditions upfront so that the proper size, style, materials, and actuation are selected.

Future

The plug valve is a proven durable and reliable performer, which is why one focus going forward will be maximizing the flow to minimize and accurately size the valves for each application. Another area of focus will be containing costs of the product and its installation. Plug valve markets are price competitive, and manufacturers will need to continue diligent product cost containment. On the installation side, the more accurately these valves are sized and selected, the less upfront costs are involved, and the less it will cost to operate the systems.

While the plug valve has evolved somewhat in the century it's been around, the basic principle of its operation remains the same. So has its reputation as a proven performer and a long-standing, reliable workhorse. Because of this, the outlook for the plug valve is positive, and we can expect to see its continued use in a number of applications decades into the future. VM