

Navigating the World of Butterfly Valves

A Guide to Selecting the Right Fit for Your Needs



Butterfly valves can be an excellent option for use in control applications, providing precise flow regulation and reliable performance. Selecting the right butterfly valve is crucial for achieving optimal control, efficiency, and longevity in operations.

Butterfly valves are increasingly recognized for their role in control applications, moving beyond their traditional perception as merely on/off valves. This white paper focuses on the use of butterfly valves as control valves. Butterfly valves have several options based on:

1. The application: on/off or control
2. The offset used: single offset, double offset, or triple offset
3. The actuator and accessories package

The appropriate selection can be made based on the specific process, piping, and application. In this whitepaper, we will explore each of these aspects in detail.

Application: On/Off and Control

Butterfly valves were originally designed as isolation valves and automated by using a positioner, meaning they could not be considered as true control valves. Butterfly valves specifically designed as control valves consider the unique requirements of the control process and gain characteristics. The Fisher™ high performance butterfly valve (HPBV) line is an example of a product designed and engineered to optimize control performance and flow characteristics.

The Types of Offset:

Conventional Butterfly Valve (No Offset):

Conventional butterfly valve bodies are often an economical choice for general service applications. The process flow is controlled by a disk that rotates within the valve body to alter the flow area. Conventional butterfly valves are rotated from 0 to 90 degrees for on/off service, but they are generally limited to 60-70 degrees of rotation for throttling service.

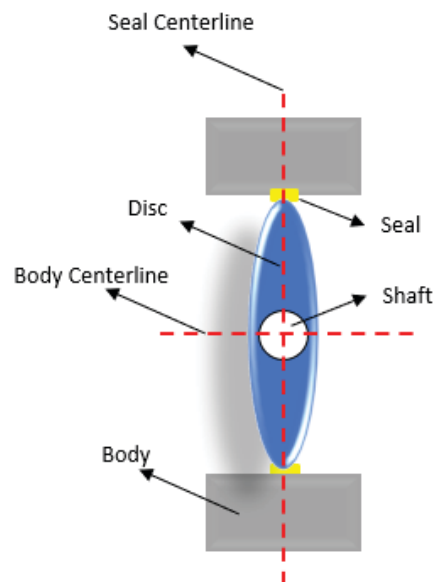


Figure 1 – No Offset

Conventional butterfly valve disks face throttling limitations due to dynamic fluid forces that create excessive torque instability between roughly 60 degrees open and the fully open position. As the valve rotates between around 60 and 70 degrees open, the fluid flowing around the conventional disk design increasingly exerts forces that tend to close the valve. However, these forces rapidly diminish once the valve travels beyond approximately 75 degrees open. Sizing an actuator to handle the varying torque is challenging, and tuning the controller to operate a conventional butterfly valve in automatic mode is difficult. The inconsistent torque requirements make it hard to control the valve's position and flow precisely.

To summarize, conventional butterfly valves do not have any offset. The shaft and disk are centered in the valve seat, which is centered in the body. The disk is in constant contact with the seat.

High Performance Butterfly Valve (Single & Double Offset):

High performance butterfly valves include shafts, disks, and bodies that are similar to conventional butterfly valves. The high-performance distinction is the result of an offset (eccentric) disk in conjunction with pressure-assisted seals. This combination offers improved throttling and shutoff capabilities. Fisher™ 8580, 8532, 8540, and 8590 are some of the Fisher High Performance Butterfly Valves on the market.

Single Offset:

In a single-offset design, the disk face is located on one side of the shaft, i.e., the shaft is offset from the seal/disk centerline as indicated in the illustration above. The shaft is located along the center line of the valve body; therefore, the disk face does not draw away from the seal as it is rotated. Fluid flow against the shaft side of the disk tends to close the valve in all positions, which reduces actuator seating force requirements. The single-offset design provides effective high-pressure and high-temperature throttling control, the cam motion of the disk with this offset reduces friction with the seal, increasing the valve's life and improving sealing.

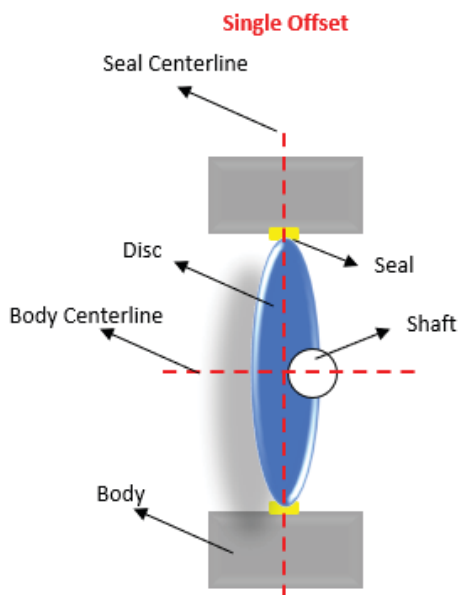


Figure 2 – Single Offset

Double Offset:

Double offset valves have their shaft offset from the seal/disk centerline and valve body centerline. This double offset design swings the disk face away from the seal during the initial 10 to 15 degrees of rotation, and it minimizes disk-to-seal contact throughout the remainder of the rotation. Furthermore, retracting the disk from the seal prevents the formation of permanent depressions in the seal, which can occur due to prolonged contact between the disk and the seal. These features minimize seal wear and enhance the longevity of the seal.

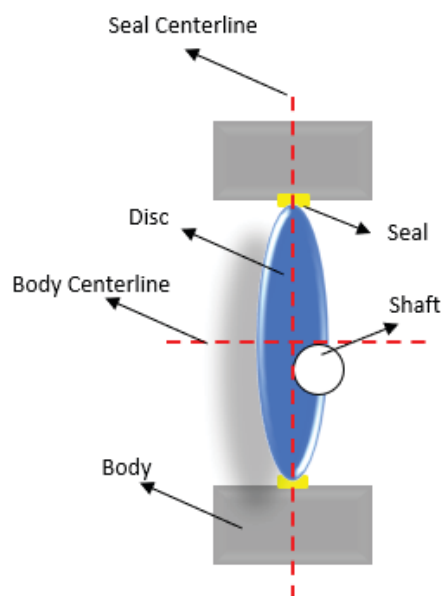


Figure 3 – Double Offset

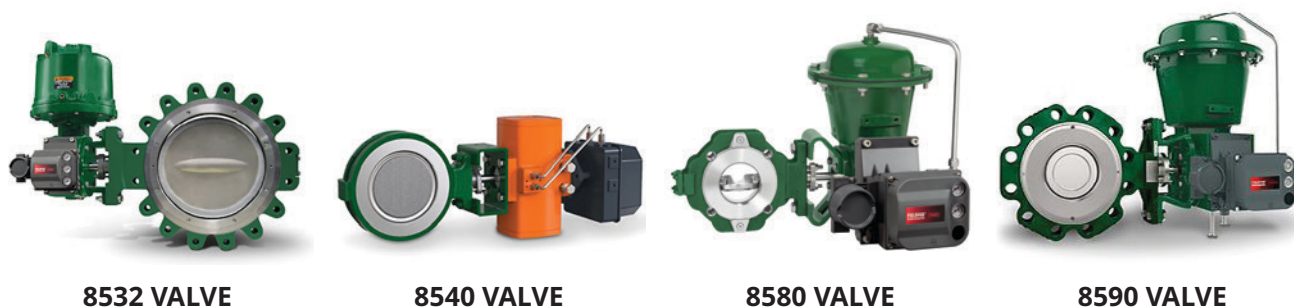


Figure 4 – Fisher™ High Performance Butterfly Valves

Pressure-Assisted Seal:

High performance butterfly valves utilize pressure-assisted seals to achieve a tight shutoff. These seals are typically engineered so that the process pressure from either direction enhances the contact load between the seal and the disk. As the process pressure rises, the pressure-assisted seal becomes increasingly effective at resisting leakage.

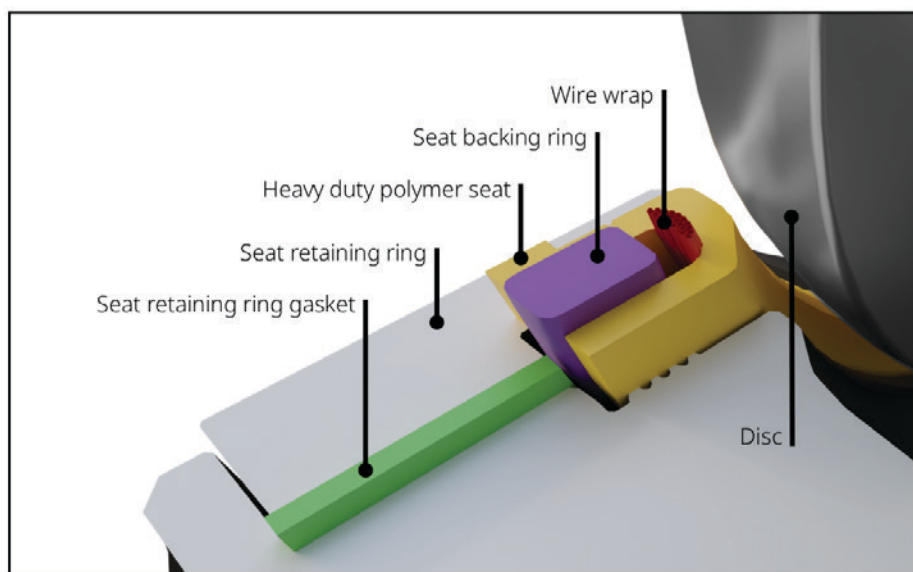


Figure 5 – Pressure-Assisted Seal

Polytetrafluoroethylene (PTFE) seats are generally used for shutoff up to ANSI Class VI at temperatures up to 450 °F (232 °C). The seals are supported by stainless steel springs, which provide resilience to the PTFE material to compensate for wear and distortion.

Metal seats are generally specified for high-temperature service. 316 stainless steel seals are effective at temperatures up to 1000 °F (538 °C). Metal seals are installed in conjunction with gaskets or backup rings with equivalent temperature ratings.

Triple Offset Control Valve:

The high performance butterfly valve was developed to improve the resilient-seated butterfly valve in relation to pressure, temperature, and cycle life. The high-performance valve used a double-offset design, which allowed the disk to have less contact with the seat. While this was a vast improvement, some manufacturers worked to develop a valve that would reduce seat wear even further. This research led to the triple offset butterfly valve (Emerson's Vanessa™ 30,000 Series), introduced in the late 1970s. The introduction of the triple offset valve has significantly enhanced the butterfly valve design. With capabilities to handle high temperatures and high pressures, these valves offer superior performance, tighter shutoff, and a more reliable stem seal. In contrast to resilient-seated or high-performance butterfly valves, which utilize a position-seated design with an interference fit, the triple offset valve employs a torque-seated mechanism. This innovative design incorporates the same two offsets found in high performance valves while adding a third offset seal for improved sealing and performance.

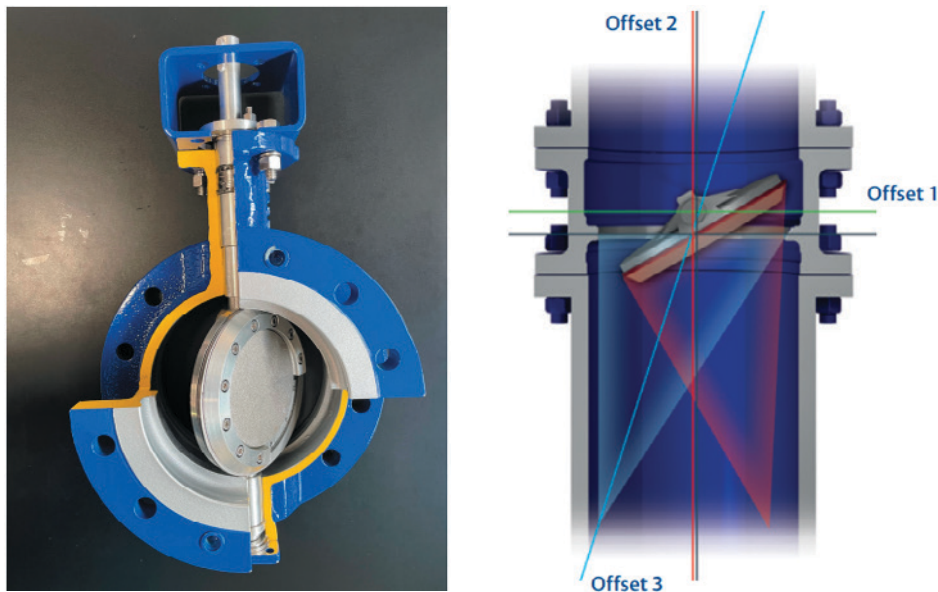


Figure 6 – Vanessa 30,000 Series Triple Offset Valve

The first offset is achieved by placing the disk away from the seal centerline. The second offset is achieved by placing the shaft offset to the body centerline. The third offset is achieved by inclining the seat and seal cone centerline to the pipe and valve centerline. This offset keeps the disk from touching the seat until it is in the fully closed position, which eliminates rubbing.

Rotary Control Package:

Fisher HPBVs, when paired with Emerson's rotary control actuators, provide a complete solution for throttling applications requiring precise control. This combination eliminates lost motion and backlash by using a clamped splined shaft connection between the valve and high-end rotary actuators like the Fisher 2052 spring-and-diaphragm rotary actuator. It's important to note that simply pairing a standard on/off butterfly valve with an actuator and positioner does not make it a true control valve system. Many times, this setup is marketed as a control solution, but it is not truly designed to deliver the performance required for precise throttling control. The Fisher HPBV and actuator combination is engineered to provide reliable, precise control. Attempting to adapt an on/off valve for control is a compromise that often leads to poor performance. Table 1 lists some of the elements and features of the Fisher rotary control valve package and the consideration that must be put in for the butterfly valve in control applications.

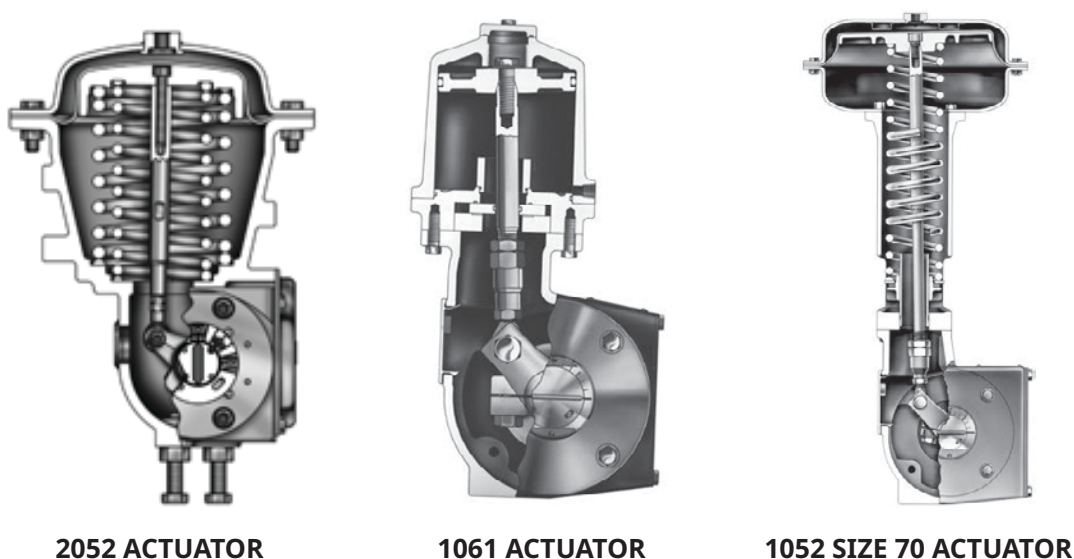


Figure 7 – Fisher 2052, 1061, and 1052 Size 70 actuators

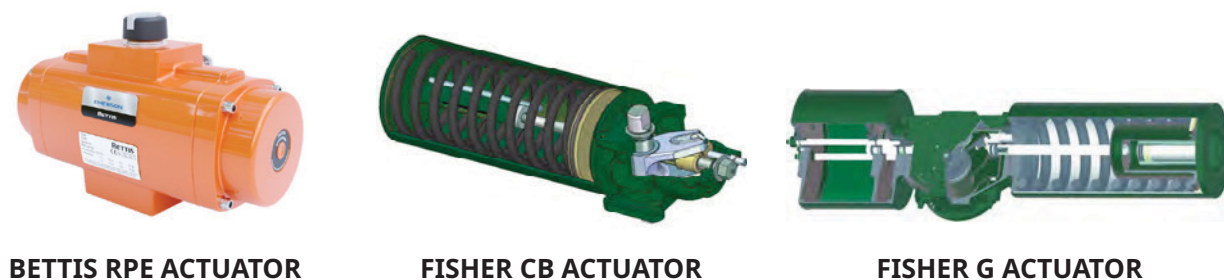


Figure 8 – Bettis™ RPE and Fisher CB- and G-Series actuators

When precise control is critical, the entire valve package must be considered for optimal performance. The system is only as effective as the components selected for use in the valve assembly. To ensure the highest level of controllability, several key factors must be considered:



Figure 9 – Fisher™ FIELDVUE™ Digital Valve Controllers



Figure 10 – Drive train

<i>Element</i>	<i>Features</i>
Selecting the right control valve	The valve should be carefully chosen depending on the application and requirement. • Choose a valve specifically designed for control applications. • Avoid using on/off valves adapted for control, as they lack the necessary design features to utilize the optimal shaft design.
Drive train	The drive train of a rotary valve is the backbone of the product. Its ability to withstand high torque, friction, high temperature, and flow media without wind-up, fatigue, or corrosion is important. • Splined shafts provide the best precision and minimal backlash for control applications. • Keyed shafts are more suitable for on/off service. • Pair the valve with a high performance actuator. • Clamped spline connections eliminate lost motion between the valve and actuator.
Bearings	The PTFE-lined PEEK (polyetheretherketone) bearing is a low-friction, low-wear bearing. It allows the valve to operate under high-pressure drops for a high-cycle life while maintaining low torque. There are other bearing materials available as per application needs.
Shaft retention	Redundant shaft retention provides added protection.
Actuator & positioner	The Fisher 2052 actuator, along with a Fisher FIELDVUE instrument with linkage-less position feedback, provides fast response, long life, and high reliability. • Actuators like the Fisher 2052 are engineered for precise control. • Digital positioners such as the Fisher FIELDVUE digital valve controller provide advanced control capabilities. • Tight integration between the valve, actuator, and positioner is essential.

Table 1 – Elements and features of Fisher rotary control valve packages

By optimizing each component in the control valve assembly, the desired performance can be achieved with minimal deadband and lost motion. This integrated, precision-engineered approach ensures the control valve system delivers the best possible performance.

What Makes a Butterfly Valve Fit for Control Applications?

When selecting a valve, the decision should not be solely based on cost or the latest technology; rather, it should be tailored to the specific application requirements. For instance, in an on/off application with minimal pressure drop or in a control application where precision is not critical, a conventional butterfly valve may be adequate.

However, for applications requiring precise control, a high performance butterfly valve combined with a precision control system, such as the Fisher 2052 actuator and Fisher FIELDVUE digital valve controller, is necessary.

In safety-critical applications or those where minimizing seal wear is essential, a triple offset valve, like the Vanessa 30,000 series, may be the most appropriate choice. It's important to note the distinction between resilient-seated and torque-seated designs when making this selection.

In summary, the ideal valve should align with the specific needs of the application rather than simply focusing on cost or technology.

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