WHY A BUTTERFLY

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The basic concept of the butterfly valve was perhaps best illustrated by a comparison with a damper in a pipe. A round disc, of essentially the same diameter as the pipe, is rotating on an axis at a right angle to the pipe centerline.

When closed, the disc is positioned at a right angle to the fluid flow; when open, the disc is parallel to the fluid flow. The butterfly valve is thus a rotary, quarter-turn valve.

The name "butterfly" derives from the appearance of the valve assembly, which bears a resemblance to the body and stretched wings of a butterfly.

**Equipment History**

Butterfly valves, in the form of spigot valves, have been used as fluid control devices for centuries. In early devices, the disc had no surface to measure. The edge of the disc was used to indicate the position of the valve.

In the advent of rubber liners, the closed gap between the edge and the pipe or valve seat became a tighter seal. While natural rubber was not successful in this application, the development of synthetic rubbers in the 1950s offered non-sticking, non-swellable characteristics required for acceptable stem sealing.

Rubber liners seal the pipe end with a soft, non-stick edge. They are used to replace the pipe's exposed edge with a flexible, non-stick surface that prevents leakage. Typically, tight-seal soft rubber liners are limited to maximum pressures of 150 psi.

**Against higher pressures, the disc of the valve would have to be compressed by the rubber liner, creating an operating torque destructive to the liner.**

**Economic Factors**

The single most important reason for selecting a butterfly valve is its low cost compared to other types of valves. A related advantage is the compact size and light weight of a butterfly valve, which results from its smaller end-to-end dimensions.

Installation costs, like initial costs, are equally attractive. A small maintenance crew, for example, can easily install or replace a 16-inch butterfly valve without using mechanical lifting equipment. Economies are also possible with pipe hanger supports and other installation and preparation expenses.

Seal replacement, particularly in high-performance butterfly valves, is relatively simple. Stem packing can be replaced without disassembling the stem and disc, and in many installations, without even removing the valve actuator.

Butterfly valves are often specified for throttling and flow regulating service because of their inherent ability to maintain a constant pressure drop, making them an ideal choice for many applications.

**Water Works (AWWA) Butterfly Valves**

Applicable Standards:
- MSS-SP67, API 609 (October, 1983 Edition)

This type makes up the largest segment of the total butterfly valve market and is generally offered at the lowest price. While limited in its applications, as noted below, butterfly valves are still widely used due to their low cost, simplicity, and ease of maintenance.

**Industrial Rubber-Lined Butterfly Valves**

Applicable Standards:
- MSS-SP67, API 609 (October, 1983 Edition)

This type makes up the largest segment of the total butterfly valve market and is generally offered at the lowest price. While limited in its applications, as noted below, butterfly valves are still widely used due to their low cost, simplicity, and ease of maintenance.

**High-Performance Butterfly Valves**

Applicable Standards:
- MSS-SP67, API 609 (October, 1983 Edition)

As mentioned earlier, this is the latest type of butterfly valve on the market today. It was not until October of 1983, in fact, that an industry standard was produced indicating its acceptance in the valve market. Other industry standards are expected to follow shortly.

High-performance butterfly valves (HBBVs) are often specified for high pressures and temperatures due to their ability to handle a wide range of fluids and gases. These valves are designed for use in applications requiring high durability and reliability, such as chemical processing, petrochemical plants, and power generation facilities.

In addition to their high performance, HBBVs offer a number of advantages over traditional butterfly valves, including greater leak tightness, improved control characteristics, and enhanced durability.

HBBVs are manufactured with a variety of materials, including stainless steel, cast iron, and nickel alloys, to withstand the harsh conditions encountered in manufacturing, processing, and transporting petrochemicals, fluids, and gases. These valves are available in a range of sizes to accommodate various process requirements, and are typically designed for use in systems requiring high pressure ratings and temperature capabilities.
Temperature capability ranges up to 450°, 500°F, although pressure ratings are significantly reduced at the higher temperatures.

The inherent cost advantages of a flangeless or socket-type butterfly valve (designed to be bolted between pipe flanges), when combined with higher pressure/temperature capability, has created an enormous market for HBPV's where gate and globe valves were previously used. Further developments with the HBPV have resulted in versions which are fire-tested for flammable liquid service, versions for cryogenic services at -320°F and, most recently, versions with metal seats which push the capability of the valves into applications which had been exclusively held by gate, globe and plug valves.

**HBPV Design**

The performance of a HBPV is dependent on the seat design, along with several other design considerations. All HBPV's currently on the market are designed with an offset seat; the seat is set off to one side of the stem to provide an uninterrupted circular seat ring against which the disc seats when closed. The TFE seats can be designed so that fluid line pressure acts upon the seat to increase the contact pressure between seat and disc very similar to an O-ring seating concept. This results in a leak-tight valve at all rated pressures. A properly designed seat should provide bi-directional, tight shut off, sealing drop-tight at high as well as low pressure differentials. It should also produce a low operating torque, should be self-cleaning (not become packed with suspended solids in the fluid media), and should perform all of its required functions within the normal pressure/temperature ratings of the valve.

All these requirements for good seat design can be achieved only with an extremely flexible and resilient seat. An HBPV seat which meets these design requirements is illustrated below (Figure 1).

Most high-performance butterfly valves on the market today employ a second, almost imperceptible offset of the disc. These valves are sometimes referred to as "double offset" high-performance butterfly valves.

When the stem of such a valve is rotated (see Figure 2), the second offset provides a camming action which, in the fully open position, completely removes the disc from any contact with the seat. Without this offset, the disc would stay in constant compressive contact with the seat in the two areas where the plane of the disc intersects the plane of the seat. In this situation, if the valve has remained open for a long-time—and especially after a few temperature cycles—the compressive contact of the disc with the TFE seat should result in a permanent indentation of the seat in these two areas. When the valve is then closed, these two indentations in the TFE seat would not resume their former shape and leakage would eventually be experienced in the area. The "double-offset" design eliminates this problem.

Recent improvements in HBPV's have also been made in bearings and stem seats—all of which have made it possible to achieve reliable valve operation through 100,000 or more cycles. And the use of exotic body and trim materials—such as Stainless Steel 316, 17-4PH, Alloy 20, Monel and aluminum bronze—has extended use of these valves into a great many corrosive applications.

**Conclusion**

All butterfly valves in today's market are not alike. There are several distinct types, each having its own performance characteristics and preferred applications. It is anticipated that continuing advances in technology will further enhance butterfly valve performance and broaden applications. Even so, no single type can fully satisfy every application. There will always be a need for all types of butterfly valves mentioned in this article.

As industries strive to reduce construction and operating costs, however, butterfly valves seem certain to appear more frequently in the notebooks of application engineers. And continuing favorable user experience will no doubt open many new applications for the performance butterfly valves.

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