AWWA C504 BUTTERFLY VALVES

Seat on Disc

Vs.

Seat on Body

Resilient seat location on an AWWA Butterfly Valve has been made a major point of contention by the valve manufacturers during design discussions with consulting engineers. Of the eight (8) major manufacturers of AWWA Butterfly Valves (those who build valves conforming fully to AWWA Standard C504, latest revision), four (4) utilize a design with the rubber seat attached to the disc and four (4) utilize a design with the rubber seat attached to the body.

Each manufacturer obviously believes, and will tell, that their particular seat design is better than the other is. Actually, over the years there have been significant performance upgrades, primarily brought about by replacing less corrosion-resistance alloy cast iron (Ni-resist) metal seats and bonded-to-body rubber seats, penetrated by the valve shaft, in favor of type 18-8 stainless steel seats and adjustable, replaceable offset-mounted seats that provide 360 degree full circle seating. Additionally, non-cored discs, ductile iron discs, low head loss discs (flow-through) and low dynamic torque discs have made real contributions. We recommend using the seat-on-the-disc design for butterfly valves, as we perceive more advantages to this construction. Listed below are what we believe to be the prime elements of seating performance.

1) LEAK-TIGHTNESS OF VALVE SEAL
2) FREEDOM FROM DAMAGE BY CORROSION
3) EASE OF MAINTENANCE
4) PERFORMANCE UNDER ADVERSE CONDITIONS

The following addresses each of these points:

LEAK-TIGHTNESS OF THE SEAL

This is the vital concern. AWWA Standard C504 clearly addresses valve materials of construction, shell thickness, laying length, torque capabilities and testing. However, it requires little more than one-time proof-of-design tests to assist a manufacturer in their effort to design and build effective, long lasting seating systems that conform to ANSI/NSF certification. Unfortunately, much more is involved than this one-time test.

Real world water variation exposes the valve to differing conditions. If solid materials (i.e. sand, silt) are present in the flowing fluid, these solids will impinge on the disc more intensely than on the body. It is, therefore, more advantageous to mount the rubber seat on the disc and the metal seat on the body. It is common knowledge that rubber is better able to withstand this type of abrasive action than is metal. In many applications of this type, rubber is utilized to protect metal components from abrasion.

Seat-on-the-disc design incorporates an offset disc with the shafts located beyond the plane of the valve seat. This also permits the seat to be a full 360 degrees, uninterrupted by the shaft.

A bubble-tight seal also requires that the disc be properly and securely centered in the valve body. This centering can be accomplished either by an adjustable or by a permanently set thrust bearing. Our design utilizes an adjustable thrust bearing, assuring proper alignment between the resilient seat and mating stainless surface in the body (see Figure 1). The advantages of adjustable thrust bearings are obvious.

This seat-on-the disc design enables all sizes to be fully adjustable (seat-bonded-to-valve design on 4" –24" are not adjustable or easily field replaceable.

The seat-on-the-disc design minimizes contact with the mating stainless steel seat in the body until closure, thereby aiding rubber seat life. Early seat-in-the-body designs used a lens shaped non-offset disc and a bonded rubber seat in the body with flats in the trunion area. These old designs require excessive disc-edge to body seat interference and were prone to wear and leaking in the area that the shaft penetrates. Such designs performed poorly when compared to today's butterfly valves. We recommend that your specifications disallow such construction by requiring that the seat be offset from, and not penetrated by, the valve shaft. Seat-on-the-body design have flat areas on the disc, where the disc meets the shaft hub seal, there is no wiping action, therefore when sand and silt are present wear is accelerated.

FREEDOM FROM DAMAGE BY CORROSION

In some systems, AWWA Butterfly Valves were subject to the possibility of tuberculation or corrosion deposit build-up in the unprotected iron valve body and adjacent pipe and fittings. This presented a possibility of damage for any rotating butterfly valve seat, whether of rubber or of metal, but perhaps more so for rubber. Modern epoxy coated valve interiors (to AWWA Standard C550) and the use of cement-lined fittings and pipe as standard have eliminated this problem for all butterfly valves regardless of seat position. Our design incorporates a unique, thick-wall stainless steel body seat that is smooth and corrosion resistant, and that will not support tuberculation. Additionally, the high tensile, abrasion-resistance rubber seat mounted on the disc edge is capable of superior life as compared to alloy cast iron (Ni-resist) and bronze edges as allowed by AWWA Standard C504.

We recommend that your specifications require rubber-to-type 304 stainless steel seating, and epoxy coating in conformance to AWWA Standard C550 on internal wetted ferrous surfaces where corrosion is a concern. In this way you will obtain top quality and will disallow less suitable alloy cast iron (Ni-resist) and bronze seats. REFER TO SECTION 44 OF AWWA STANDARD C504-00 FOR THE OFFICIAL POSITION OF THE STANDARD REGARDING LESSER SEAT MATERIALS. The primary reason not to use the lesser mating seats is related to accelerated corrosion which damages the rubber seats at each closing and opening.

EASE OF MAINTENANCE

Seat-on-the-disc design seat is readily removed, adjusted or replaced with standard wrenches. This is true in all sizes, which is the minimum requirement of the AWWA Standard (REFER TO SECTION 4.5.5.2 OF AWWA STANDARD C504-00 – RUBBER VALVE SEATS SHALL BE OF A DESIGN THAT PERMITS REMOVAL AND REPLACEMENT AT THE SITE OF INSTALLATION FOR VALVES 30" AND LARGER). The resilient seat is mechanically secured to the valve disc by means of a stainless steel retaining ring and standard self-locking stainless steel screws. Should field adjustments be required, the seats can be adjusted in either direction without special tools or cumbersome epoxy systems. Replacement is clean and simple. Remove the retaining bolts, remove the existing seating, install the new seat ring and replace the retaining bolts. Some seat-in-the-body designs have the rubber recessed in the cast iron and held in place by toxic epoxy (liquid state) injection. None of these design approaches provides the simplified adjustment and replacement benefits of seat-on-the-disc Butterfly Valves. Of course, no one wants or anticipates seating problems, but sound engineering practice demands that the manufacturer provide for future reparability.

We recommend that your specifications require that valve seats shall be of a design that permits removal and replacement at the site of the installation for all size valves, not just 30" and larger. In this way, you will disallow the obsolete and expensive-to-repair bonded seat design that we referred to earlier. A butterfly valve that must be returned to the factory for seat repair represents an unnecessary and unacceptable burden to its owner.

PERFORMANCE UNDER ADVERSE CONDITIONS

When a Butterfly Valve is operated continuously in a throttled position, additional stress is placed upon its seating surfaces by the increased velocity of fluid through the valve. A typical fluid velocity profile surrounding a butterfly valve disc in a throttling position shows that the velocity increases at the disc edge and only slightly near the shaft trunions. The higher velocity is ably resisted by both the rubber seat and the mating stainless steel seat regardless of where each is mounted. Of slight concern is that the seat-in-the-body designs that incorporate mechanically adjustable parts, the slower velocity along the shaft trunion areas can allow build-up of deposits or debris in the body recesses.

If the upstream pressure is high enough and, if the valve is throttled far enough, potentially damaging cavitation can occur. With a seat-on-the-disc butterfly valve, the rubber seat is not subject to this cavitation zone.

The nearly closed valve creates a flow restriction, which causes a necking down or contraction of the flow stream. The minimum cross-sectional area of the flow stream occurs just downstream of the nearly closed valve disc. This point is called the "vena contracta". The velocity of the fluid is greatest at the vena contracta where the cross-sectional area is the least.

This increase in velocity (which is an increase in kinetic energy) results in a substantial decrease in fluid pressure (which is a decrease in potential energy). If the conditions are severe enough, the fluid pressure will drop below the vapour pressure of the fluid and cause bubbles in the fluid stream (see Figures 2 and 3).

As the fluid moves past the point of greatest constriction, the cross-sectional area of its flow stream increases, its velocity decreases, and its pressure increases causing the bubbles to collapse or implode. This releases potentially damaging energy and produces a noise that sounds like there is gravel flowing through the valve.

If the bubbles collapse in close proximity to surfaces in the valve, the energy released will gradually tear away certain types of materials. Stainless steel is one of the materials which is most resistant to these cavitation effects. Rubber, on the other hand, tends to experience a failure of its molecular bond, which allows it to break away in large chunks.

Regardless of which direction the flow passes through the valves, the edge of the disc will always be slightly upstream from the cavitation zone (see Figures 2 and 3). A rubber seat mounted on the disc will never be subjected to the potentially damaging cavitation zone, which can only occur downstream from the disc.