Flowserve - Edward Valves

Development of the Flowserve Edward Equiwedge Gate Valve

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Problem

Gate valves in severe service applications that experience premature trim wear from seat guided discs or leakage due to inflexible wedge-type disc designs.

Solution

The Flowserve-Edward Equiwedge combines a 2-piece disc design into a clever, body guided wedge that is second to none for isolating high pressure and high temperature applications.

Why A Gate Valve?

Probably the single most important characteristic of a gate valve is the efficiency with which fluid flows through the valve. All valves must control fluid flow, meaning they must stop, regulate or allow fluid to pass through. Because the gate valve provides a straight-through, unobstructed flow passage, it is a very efficient fluid control device.

Gate valves also require only relatively moderate force to open or close and thereby require less manual operating effort or smaller actuators. The force the stem must deliver to the closure element is essentially $F_s = mW$, where W is the pressure load on the gate and m is the coefficient of friction of the gate against the body seat. This compares to globes where Fs = W, so that the gate is only m (commonly 0.3) times the globe. Gates also are bidirectional and normally have similar flow characteristics in both directions.

Wedge vs Parallel Slide

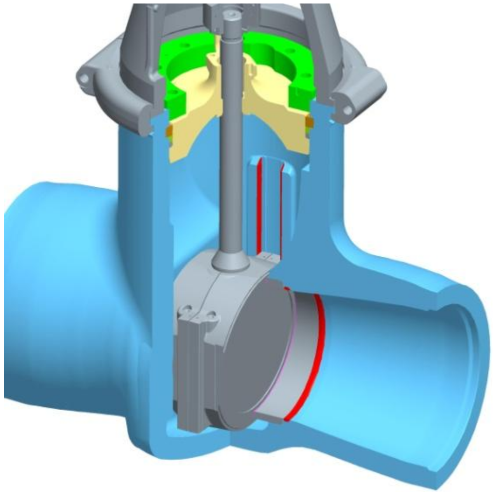
There are two basic types of gate valves in common use today for high pressure & temperature water and steam service—the wedge and parallel slide. The wedge gate concept has been selected by Flowserve for its Equiwedge Gate Valve because of several functional advantages.

The closure of the gate interrupts the flow and at the same time effects a seal at the gate to body interface via the high wedging forces generated between the seats. Herein lies the major difference with the parallel slide - the presence of the wedging force. It should be understood that this wedging force is added to the primary fluid pressure force acting on the gate. Extensive laboratory tests at Flowserve have demonstrated the advantage of this extra loading in achieving superior seat tightness.

Extremely high forces generated by the wedge must be accompanied by a rigid body that will sustain these forces without harmful stresses. Also, inadequate wedge flexibility can cause sticking, particularly when thermal effects or external pipe loads are present. The Equiwedge two piece wedge has a high degree of flexibility to accommodate such conditions within safe operating limits.

Another advantage of the wedge gate valve as compared to the parallel slide is minimized seat rubbing and scuffing during opening and closing. While closing a wedge gate, any pressure load on the gate is carried by the gate guide system until the final increment of seating travel. This is only some 5% of the total gate travel.

By comparison, the seats of most parallel slide valves carry the gate load through essentially all of the travel. Should high differential pressure be present, very high stresses develop especially on the body seats, accelerating wear and possibly causing galling damage to the seal surfaces. For this reason, parallel slide valves commonly require bypass valves to equalize the pressure across the gate before opening.



Cutaway of Equiwedge Gate Valve

Development of the Flowserve Edward Equiwedge Gate Valve

The Wedge

A large part of the development effort has been directed toward the wedge. It was recognized that wedge flexibility—that is, a high deflection index—was essential for good sealability and freedom from wedge sticking, a problem all too common to wedge gates.

Why is flexibility important? All valves in high pressure-temperature service, whether gate or any other type, are subjected to forces caused by external loads imposed by the connecting piping and thermal effects caused by temperature changes. A rigid body shape will minimize the seat deformation produced by these forces but the cost effectiveness of material added to increase rigidity is not attractive.

Therefore, flexibility must be designed into the wedge to accommodate these distortions in the body seat area.

Gate Designs

The simplest wedge gate is the solid wedge shown in Figure 1. It is used in some designs of high pressure-temperature steel gate valves, but its useful flexibility is very limited. For this reason, an "H" design is more common. The "H" shape is achieved generally by casting a groove around the outside periphery and leaving a connecting hub in the center. This provides for relative bending between the wedge halves, which is needed to adjust for body seat angle changes. The degree of bending varies significantly with individual designs. In all cases, however, the center hub acts as a connecting link between the wedge "halves" and severely limits the freedom of the wedge to make the necessary adjustment. If the hub is made small enough to permit adjustments of any magnitude, stresses in the hub can exceed the yield strength of the material. A large hub on the other hand diminishes the desired flexibility of the wedge "halves" (See Figure 2).

It is because of these serious deficiencies that Flowserve looked for a "better way". The result is the Equiwedge two-piece wedge shown in Figure 3. The important features of this design are:

- Independent wedge halves for maximum freedom of the wedge to adjust for angular distortions in the body seats.
- An optimized "tapered plate" design with a high degree of flexibility at the edge or seat joint, to accommodate distortions in the body seat faces (out of flatness), within code allowable working stresses.
- Adaptability to a captured stem design resulting in a more compact stem-wedge connection and reducing the overall valve height several inches.
- Minimum wedge thickness for a reduced gate cavity width and improved flow characteristics.
- Superior wedge casting quality due to the absence of a center hub.

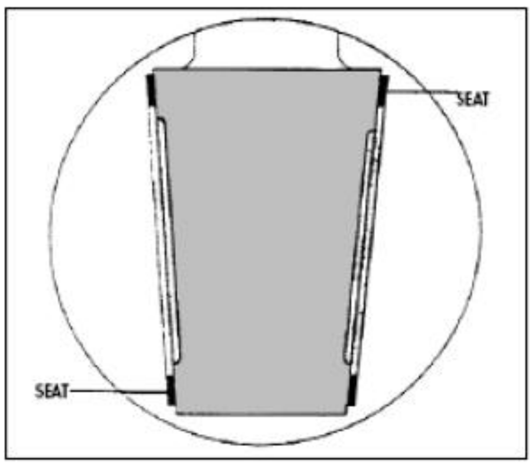


Figure 1 – Solid Wedge Design

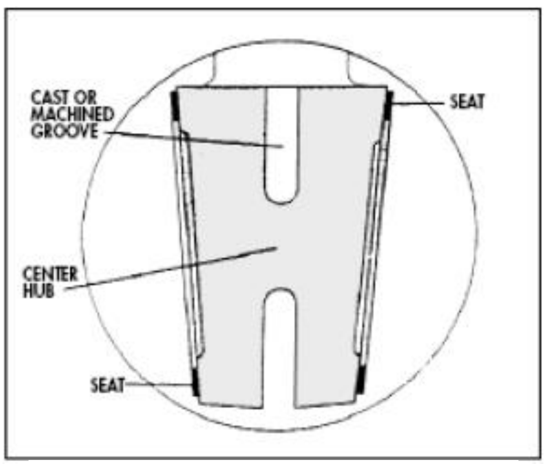


Figure 2 – "H" Shape Wedge Design

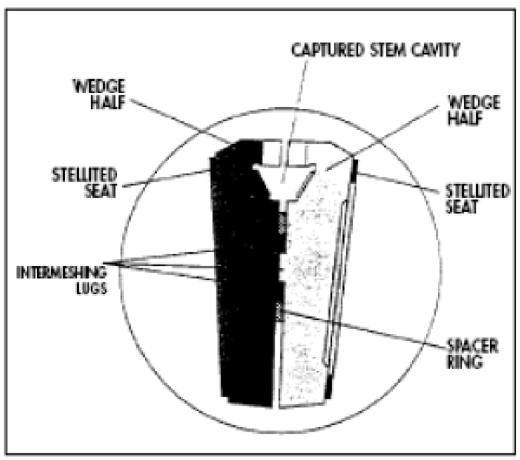


Figure 3 – Cutaway of Equiwedge Two-Piece Wedge

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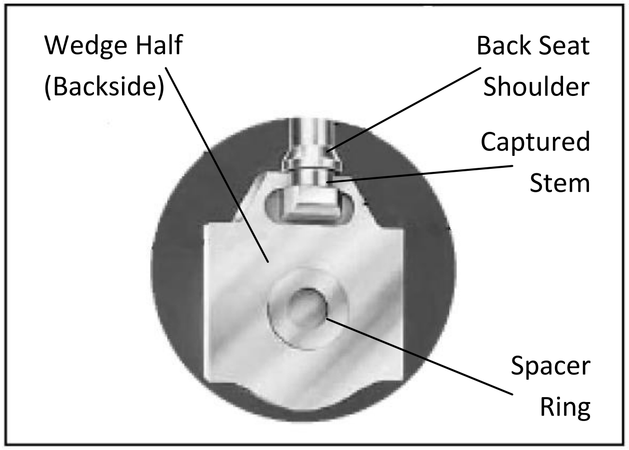
- Better quality control during manufacture because of the accessibility of all wedge surfaces to visual and NDT inspection.
- Adaptability to a center spacer ring, facilitating wedge fitting and permitting certain field repairs without wedge replacement.

Wedge Spacer Ring

Matching a one piece wedge to the body seats with the proper wear allowance requires a precision fitting operation during manufacture. Further, should damage to the seats in the field necessitate seat refinishing, the wedge thickness must necessarily be reduced. This destroys the factory fit if the defect is so deep that excessive seat facing must be removed. Since one thousandth of an inch removed from each seat of a 10° wedge causes a movement of eleven thousandths into the gate cavity, a 0.060 defect in one wedge seat drops the wedge more than three-tenths of an inch. The spacer ring provides a novel and inexpensive means of varying the wedge thickness either during manufacture or for field repair. A spacer ring of appropriate thickness can be installed for optimum wedge fitting, within the limits of the clearance in the wedge guiding system.



Guiding Systems

The Equiwedge two-piece wedge is fully guided throughout its stroke by a body groove guide system. In the fully open position, therefore, the wedges are both trapped and guided because the body guide groove extends high into the body neck region. By using this construction, rather than a conventional wedge groove-body tongue, the stem wedge assembly is held securely together without the need for pins, fasteners, disk clips, etc. This simplifies the design and eliminates completely the chance of assembly components failing and causing leaks, or becoming entrained in the flow stream.

Other Design Features

- The welded in seat rings have cobalt base hardfaced seats for long life. This hardfacing has excellent high temperature hardness, corrosion-erosion resistance and eliminates galling and rapid wear of the seats. Seat ring material chemistry is equivalent to the body to eliminate dissimilar growth/contraction rates which might cause seat ring distortion.
- The Equiwedge Gate Valve features the Flowserve Edward Pressure Seal Design, proven successful in hundreds of thousands of service hours.
- The segmental retaining ring design is used for the higher pressure ANSI Class 900 thru 2500 series. In the Class 600 series, where the pressure loading is more suitable to nominal sized bolting studs are substituted for the segmental retaining ring.
- The extended bonnet region between the hardfaced backseat and the packing is a cooling chamber. When the stem is lifted to the open position the hotter portion rises into the cooling chamber rather than the packing.
- The yoke is designed for adequate stiffness to support the heaviest motor operator in the “stem horizontal” position.
- A soft bronze bushing in the gland bore protects the stem from damage should the gland bolts be tightened nonuniformly and the gland cocked.

The Equiwedge Cast Steel Gate Valve has been tailored especially for the high pressure, high temperature water and steam services common to many electric utility, industrial and petrochemical applications. It offers all the advantages inherent in the wedge gate concept plus several novel design features. Further, certain disadvantages common to gate valves have been minimized in the Equiwedge Gate Valve design.

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