Flowserve - Edward Valves

The PressurCombo Solution for High Pressure Drain Services

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Problem

Valves used intermittently for the removal of accumulated sediment in boilers, equipment and/or piping or to lower boiler water levels in a rapid manner are required by ASME B31.1 to have two valves in tandem that are not T-pattern globe valves. This also applies to continuous blowdown service valves that are elected to be operated intermittently.

Solution

The Flowserve-Edward PressurCombo valve is specifically designed for intermittent boiler blowoff and blowdown applications.

Introduction

While high differential pressure drain and vent applications in fossil fuel plants are not new, lifetime limitations in such valves have become an increasing concern because of the ways that many plants are now operated. These valves are typically operated only during startup and shutdown, but many power plants are now used for "peaking" to satisfy variable load demands. Some new combined cycle plants undergo daily shutdown/startup cycles at times. With more frequent plant cycling, life expectancy improvements are desirable.

Flowserve has two Univalve design options that can be implemented individually or in combinations to enhance service life of valves in high differential drain service. All basic Univalve features are retained, so they provide good traditional globe shutoff features (no sliding of seating surfaces and good sealing at both low and high differentials). The options are designed to minimize erosive wear of seating surfaces and to maintain "live loading" of seats to overcome possible effects of stem relaxation or inadequate seating force.

Introduction

Figure 1 illustrates the most recent version of the standard Edward Univalve globe stop valve. Univalves are also made as piston lift check valves and as stopcheck valves. Some Univalves are also furnished with motor actuators, but the standard "handwheel" valve shown in Figure 1 is the most common and best illustrates the basic features.

- Stub Acme bonnet threads for improved inline maintainability.
- Bonnet locking device for unwelded valves.
- Positive engagement feature to insure foolproof alignment of gland bolts with glands.

Drain valve problem studies were first undertaken as part of standard Edward research to evaluate customer feedback. An evaluation of standard Univalves in drain applications revealed that there were no "immediate breakdowns" like the jamming experienced before body guided disks were introduced. Most problems were due to moderate or severe seat leakage after a service period that was considered short by the customer. Service times before valve removal from service ranged from about 6 months to 2 years.

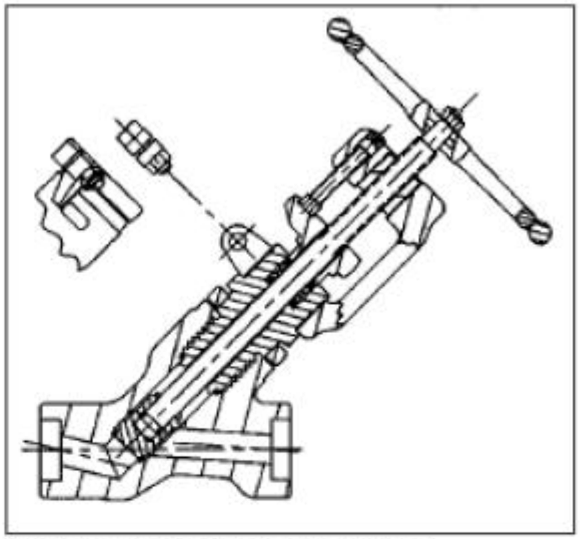

Figure 1: Standard Edward Univalve

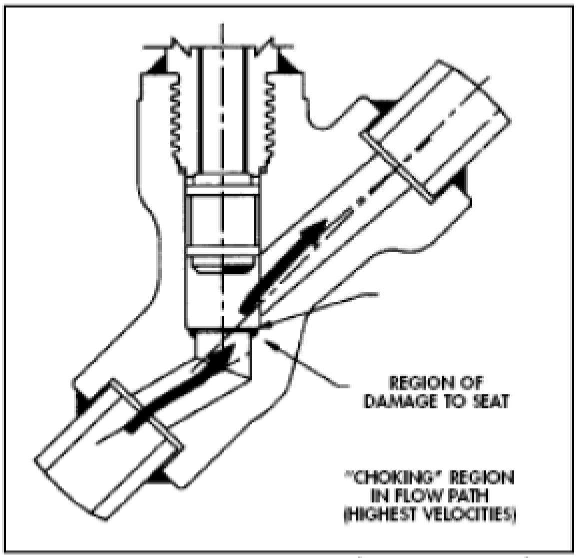

Figure 2: Seat Damage in Turbine Drain Valve

Most valves inspected after removal from service had extensive foreign material (e.g. magnetite deposits) in the flow passages. None of the valves inspected had been subjected to seat maintenance. In two cases, seat tightness was restored in our plant within a few minutes of service with standard seat repair tools. Thus, the study showed that the service life of standard valves could be improved by use of available repair tools.

In addition to valves examined in our plant, several turbine drain valves inspected by Edward personnel in customer facilities revealed a pattern that was considered very useful in defining one type of problem:

• Valve body seats showed large areas of very minor "frosted" erosion in the 4 o'clock to 8 o'clock position as viewed through the valve inlet. See Figure 2.

– Since the valves were normally fully open during power plant startup, passing wet and possibly dirty steam, it appeared that the "frosting" was the result of erosion in the main high velocity flow path while the valves were fully open.

– Edward engineers concluded that this minor erosion could have caused some seat leakage after valve closure, but it did not appear that it should have caused leakage so severe that the valves would have required replacement.

• Within the frosted erosion bands (above), localized areas in the seats showed minor but significant localized "steam cutting" – the type of erosion that can cause severe leakage if not repaired on a timely basis.

• The damaged valves suggested strongly that the ultimate leakage problems were the result of a 2-stage process:

1. Minor seat erosion in high velocity regions due to wet and dirty steam flow during startup periods.

2. Minor leakage developed after valves were closed after startup as a result of the minor erosion (above), and leakage increased progressively due to long-term superheated steam cutting during normal power operation.

Results of the market survey interviews provided a good basis for improvement opportunities for Univalves in difficult drain services. Among the responses were:

1. In plants of all types, drain valves must handle choked flow of water (sometimes cavitating), and both wet and steam during startup. There is often dirt and pipe scale in these lines, because there is no flow during normal operating periods between shutdowns.

2. Duration of drain blows is quite variable. Four to eight hour blows were mentioned by several interviewees, but some are shorter (as little as 30 to 45 seconds) and some are much longer.

3. Frequency of operation is highly variable.

• Large base load stations undergo shutdown/startup cycles only at, major outages, which may be only annual or 2 to 3 per year at the most. However, these may involve very long drain valve blows if startups are "aborted" due to other problems.

• Peaking stations undergo cycles as, frequently as daily. Some of these are older units that operate only when peak power is needed. Others are small, modem units specifically designed for peaking service. Some COGEN stations report weekend shutdowns.

4. Responses to questions on need for "throttling" (extensive operation in partial open positions) with vent and drain valves did not show any consistent pattern. Responses indicated recognition that this can be very damaging to valves that are not "control valves," but all responses showed that some valves are throttled (whether authorized or not).

5. Many superheater and turbine drain applications use a tandem assembly of two valves in series – an inboard "root valve" and an outboard "guard valve." Recommended procedures are to open the root valve first and to close it last, so that it operates only under no-flow conditions; the guard valve takes the "punishment" of opening and closing under choked flow conditions. In theory, this procedure prolongs the seat tightness of the tandem assembly by delaying damage to root valve seats.

Other Valve Types in Drain Valve Applications

The new entries in the power plant drain valve marketplace are floating ball valves and parallel-slide gate valves. A number of manufacturers of these valve types claim "advantages" based on the sliding contact between the moving valve closure member and the fixed seat(s). Manufacturers claim that these designs protect the seats from erosion damage and provide a "wiping" action to clean the seats. Also, since these valves are "position-seated", it is claimed that they do not require high "seating torques" like globe valves to effect a seal.

While some merits were recognized for ball and gate valves by Edward engineers, it was concluded that three major disadvantages made these design approaches undesirable for power plant drain and vent valves:

1. The seat sliding action that provides the "wiping advantage" also assures that the seating surfaces must slide under very high contact stresses when a valve is opened or closed under very high differential pressures. Even without considering dirt and scale, this sliding may cause scratching or galling that will later erode into serious leakage paths.

2. Position-seated floating balls or parallel slide gates depend upon differential pressure loading to provide effective seat sealing. Serious leakage may develop under low differential conditions that are sometimes encountered in power plant service.

3. Compact floating ball valves and parallel slide gate valves typically do not offer practical in-line repairability for the cases where inevitable maintenance is required. Many lower pressure ball valves are flanged into the line and can be removed for maintenance, but this is not practical for many higher pressure valves.

Based on careful evaluations of competitive product types, including testing in Edward facilities, it was concluded that the best approach to drain valve improvements was to offer special enhanced features for the Univalves already widely used in this service.

Univalve Enhancements for Drain Services

After considerable engineering study and prototype testing, it was concluded that a combination of optional features should be offered instead of a single "improved drain valve." This decision came about because the evaluations showed a variety of problems – not necessarily the need for a radical combination of special features in all drain valves. Desirable features (not necessarily required in all valves) that were identified in the study are:

- Reduce velocity in body seating regions during choked flow in full-open drain operation to minimize erosion of critical seating areas. This should eliminate the problems observed in turbine drain valves and discussed above.

- Improve resilience in "seat loading system" to assure maintenance of adequate seating loads during and after thermal transients (e.g. following "cooldown" of a valve closed at maximum temperature).

- "Pressure-energized" seating forces to supplement the resilience noted above and to assure tightness if pressure increases after closure or if stem loading should be reduced due to stress relaxation.

- Essentially, it is desired to simulate the pressure-energized seating forces of a ball or gate valve while retaining the globe valve advantages for sealing at low pressure differentials.

- Seating materials with improved erosion resistance to promote better valve life in drain valves that require occasional or moderately frequent throttling.

The PressurCombo Solution for High Pressure Drain Services

The Univalve special feature options and some combinations are described below:

1. The PressurSeat option shown in Figure 3-A is proposed for use primarily as an upstream root valve in tandem drain assemblies.

- In lieu of the integral stellite 21 seat used in standard Univalves, the PressurSeat option utilizes a separate "seat insert" that is sealed into the body with a flexible graphite seal. Flexible graphite seal tightness has been demonstrated by long experience with unwelded bonnet seals that were introduced in Univalves in 1980.

  The flexible graphite installed below the seat insert also provides resilience in the seating system, which is desirable to guard against load loss from stem contraction. The relationship of the flexible graphite seal and seat diameters insures that the seat is pressure-energized into the disk after an initial preload is overcome by stem thrust during closure.

- The PressurSeat option retains the cone-in-cone seating that has been successful in Univalves for many years, so good globe valve seating features at low pressures are maintained.

- The non-integral seat insert in the PressurSeat option allows use of materials that cannot be welded practically, so very hard (HRC 51-54) stellite 3 disks and seats are used for enhanced erosion resistance.

In addition to offering improved seat life in fullopen drain valve applications, the stellite 3 seating material offers improved life in applications where throttling is necessary. In testing on Edward steam testing facilities, no visible erosion damage has been detected on stellite 3 seating assemblies.

- A handwheel is used in lieu of the "impactor" handwheels or handles used on larger standard Univalves. For typical power plant pressures at which drain valves are used, the standard handwheel permits adequate torque to activate the self-energized PressurSeat.

2. The PressurEater option shown in Figure 3-B is proposed primarily for use as a downstream guard valve in tandem drain assemblies, although it may also be a cost-effective improvement for single-valve drains that are not throttled excessively in service.

- This option is a standard Univalve as in Figure 1, except that an integral "choke nozzle" is provided in the outlet (overseat) port to restrict the choked flow through the valve under high differential pressure "blowdown" conditions. With this feature velocities are reduced in the valve seat port regions during full-open drain operation.

- The diameter of the choke nozzle reduces choked flow of the valve by about 50%, and reduces the seat area velocities even more because of its downstream location. An integral high-recovery truncated diffuser minimizes pressure drop under low differential flow conditions.

- 13% chromium stainless steel nozzle material minimizes erosion damage, but note that nozzle erosion will not affect valve tightness. The main function of the nozzle is to minimize damage to seating materials.

3. For many and perhaps most tandem drain valve assemblies, the standard PressurCombo (Figure 3-C) will provide a cost effective combination of options if operated as recommended for most standard root/guard valve assemblies. With a Univalve with the PressurSeat option upstream, opened first and closed last, the user should benefit from excellent long-term tightness of the assembly.

- The Univalve with the PressurEater option downstream enhances the combination, because the choke nozzle limits velocities in the seating regions of both the root valve and the guard valve during startup flow conditions. If throttling is required, the user must choose which valve is to be used to throttle.

- If throttling is done with the downstream PressurEater valve, its standard integral seat may suffer damage, because the choke nozzle does not protect the seats completely when the disk is throttled. Still, with the upstream PressurSeat valve protected, the combination should provide excellent tightness. Of course, the tightness of the downstream valve can be restored with standard Univalve seat repair tools if necessary.

- If throttling is done with the upstream PressurSeat valve, its harder stellite 3 seat and disk will provide inherently better resistance to damage. Some users may consider throttling with a root valve unadvisable to be sure this valve remains tight, but this may be satisfactory in some applications. Again, the seat insert may be repaired with standard Univalve seat repair tools if necessary.

4. Grouping of the enhanced Univalve features as options permits individual valves to be furnished with both the PressurSeat and PressurEater features. While perhaps not necessary or costeffective for all drain valve applications, a valve with both the hard, live-loaded PressurSeat insert and the downstream PressurEater choke nozzle may provide valuable life enhancement in some applications, specifically:

- Single-valve drain applications involving significant throttling – when an existing system does not have both a root valve and a guard valve, a Univalve with both the PressurSeat and PressurEater options may be cost effective on the basis of overall life enhancement for valves used frequently.

- For use as guard valves in tandem assemblies that require extensive throttling – The compromises described above may be avoided by using the PressurSeat feature in both the upstream Root Valve and the downstream Guard Valve. By using the guard valve for all throttling, the root valve seating surfaces receive maximum protection from erosive action.

Conclusions

The PressurSeat and PressurEater options offered for Edward Univalves are enhancements intended for the most severe service conditions. These features are the among a series of improvements offered since the Univalve product line was first introduced.

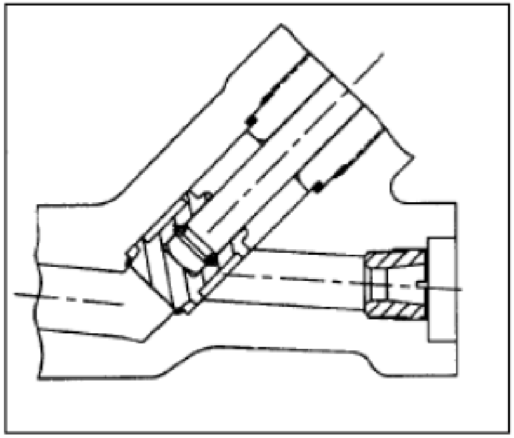

Figure 3B: PressurEater Features

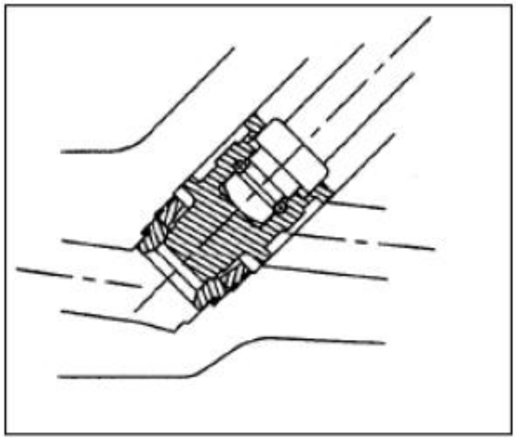

Figure 3A: PressurSeat Features

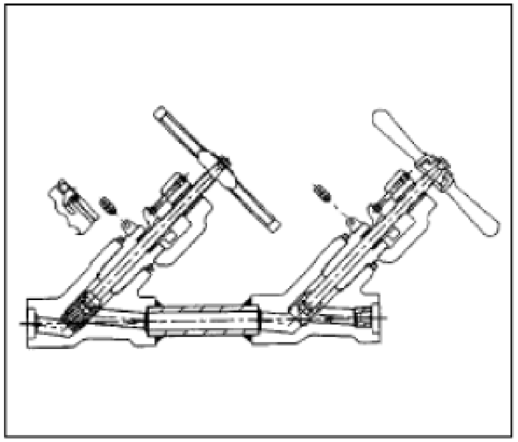

Figure 3C: PressurCombo Tandem Assembly

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