tyco Tyco Valves & Controls, LP

PENBERTHY YARWAY

320 Locust Street
Prophetstown, IL 61277-1147
Voice: 815-537-2311 x160
Fax: 815-537-5764
e-mail: gsanders@tycovalves.com
Thu - 15 Aug 02

PenTech FAQ # 11 by Gary G. Sanders, Director of Engineering

Ball Checks

Definition

Ball checks are a variation of classic gravity operated flapper type check valves. A free ball (of metallic alloy, polymer or glass) is located inside a flowstream bore. If flow occurs in one direction the ball is displaced by flowstream impact forces against a stop and annular flow continues around the ball. If the flow direction is reversed, the ball is displaced onto a seat where it occludes flow. Normally gravity unseats an engaged ball after pressure is removed. A mechanical mechanism is included to hold the ball off its seat during certain process operations or to manually free the ball from its seat.

Background

This discussion of ball checks will be limited to their use in level gauging. Gage glasses, if not properly torqued and maintained, are susceptible to gasket and/or glass blow out. Rather than just using isolation valves with gage glass, a safer alternative, the dual operating gagecock was developed.

Typical valves have one flow control mechanism (e.g., gate, ball, butterfly, etc.) and may be adjusted for proportional control. Typical gagecocks have two flow control mechanisms. The first, usually in the form of a screwed plug manually operated by handwheel, lever or chainwheel for the open / close function. The second is an automatic ball check. Gagecocks have three operating modes: ball hold-off, closed or open flow modes, they are not intended to regulate flow. In contrast with typical valves having straight flow channels, gagecocks normally have 90° flow channels for ease of connecting gage glasses to process vessels.

Mode of Operation

Ball checks are safety devices and ideally would only seat when something goes awry. Assume a pressurized vessel with a gage glass. If the gage glass fails in any manner from a small leak (definition later) to catastrophic gasket or glass blow out, the process fluid attempting to escape will close both upper (vapor phase) and lower (liquid phase) ball checks, preventing further process material loss. For initial gage filling, flow into the gage may activate the ball checks. A ball hold off projection (vernacular = ball knocker) is extended from the stem. For the ball knocker to be effective in holding the ball off its seat, the gagecock should be fully closed, then 'cracked open' no more than a quarter turn. Quick operating, quad thread (usually with lever operators) gagecocks are almost impossible to place into the proper ball hold-off position, other operators should be considered. In this hold-off position, the ball checks can never seat. Always open the gagecock fully to its stop when start-up or maintenance procedures are completed.

Code, Standards, etc.

♦ Chemical

Leaks tend to be critical because the process material may be: toxic, corrosive, flammable, hazardous, expensive, etc., in short, process material escape should be limited. For chemical gage glass (ASME Boiler and Pressure Vessel [B&PV] Code Section VIII and ASME B31.3 "Process Piping"), their associated gagecocks traditionally incorporate automatic ball check devices, both upper and lower horizontally operating for quickest seating.

♦Steam

For ASME B&PV Code Section I and ASME B31.1 'Power Piping' purposes, there are two options: 1) omit ball checks or 2) make special ball checks. After requesting the code writers' rationale without response, I am going to speculate on their reasoning with the understanding that this is my interpretation, not theirs. Steam intrinsically is not considered toxic, corrosive, flammable, polluting or particularly expensive. However, a steam leak will tend to progress to steam cutting, etc. and should be located and repaired expeditiously. Gage glass used with boilers is a primary safety device and should not automatically shut off as erroneous interpretations from a blocked gage glass could be catastrophic. For this reason ASME B&PV Code suggests no automatic ball checks per Section I, PG60.1.6. However, the people who work in and around boiler equipment prefer ball checks rather than being scalded by escaping full pressure steam (personally, I agree with them). A compromise ball check ("if permitted" is the Code language) is allowed using the criteria of Section I, A18 which is paraphrased. Non-corrosive metallic ball, gravity operated, vertically rising lower ball, ball diameter ≥ 1/2", seat ≤ 2/3 ball diameter, bypass annulus radius ≥ 1/8", ball travel ≥ 1/4", leaky upper seat, ball knocker hold off distance ≥ 1/4" and inspection / clean out port for lower ball. I think a primary reason for the vertically rising lower ball is to keep the seat surface above any sediment deposit layer.

Assuming a saturated steam system and a relatively slow leak:

If the leak is in the water portion of the gage, in-flow water will be checked, the gage under steam pressure will continue to leak water until steam reaches the leak then leaky seat steam will escape, the gage will read low with the water level at the leak point.

If the leak is in the steam portion of the gage, steam flow rate will be limited by the leaky seat ball check. Steam will escape the leak until the water level rises then a water / steam mixture will escape. The gage will read high with the water level at the leak point.

In summary, the leak point will be located at the steam / water meniscus and should be easy to locate.

<u>Start Up / Maintenance Procedures</u>

These six suggested operational sequences reduce pressure and thermal stresses on the gage and bring the gage into operation without ball check closure. Note: cracking a gagecock means placing it into the ball hold off mode of operation. Completely close, then crack open the gagecock not to exceed a ¼ turn. Caution: all procedures must end with both gagecocks fully open or the ball checks will not function.

1. Cold Start (filled gage - hot process)
   Since pressure and temperature tend to equalize and ramp up together in both the vessel and the gage, both gagecocks should be fully open and no further action is required.
2. Cold Start (empty gage - head pressure, ambient temperature; e.g., storage tank)
   Crack lower gagecock then crack the upper gagecock. Allow gage level to stabilize then fully open both gagecocks.
3. Hot start (empty gage at ambient pressure and temperature - hot, pressurized vessel)
   ♦Chemical use: crack the upper gagecock, then crack the lower gagecock. Allow gage level to stabilize, then open both gagecocks fully.
   ♦Steam use: start with all valves and gagecocks closed. Open drain valve, then crack steam leg gagecock. Bleed steam until the gage is near its thermal operating point. Close drain valve, crack water leg gagecock, allow gage to fill with water to the operating level. Fully open both gagecocks.

4. Blowdown
   Although other procedures may be used, this is the one I suggest. Assuming some liquid is in the gage, close lower gagecock, crack upper gagecock and slowly open drain valve. Allow vapor to blow gage contents along with sediment / debris into the drain. After blowdown is complete, close drain valve, crack lower gagecock until gage level stabilizes. Fully open upper, then lower gagecocks.
5. Washdown
   Close upper gagecock, crack lower gagecock, open drain valve slowly. Allow liquid to wash gage contents along with sediment / debris into the drain. Close drain valve and allow gage to refill with liquid. Close lower gagecock, crack vapor gagecock, open drain slowly, allow vapor to push liquid in the gage along with sediment / debris into the drain. After washdown is complete, close drain valve, crack lower gagecock until gage level stabilizes. Fully open upper, then lower gagecock.
6. In Situ Gage Rodding or Brushing
   Close both upper and lower isolation valves, open both gagecocks fully, open vent and drain until gage empties. Rod or brush, assumes offset pattern gagecocks. Close vent and drain, close both gagecocks, open isolation valves. Restart using procedure 2 or 3 above as appropriate.

Is the gage not tracking level now?

If a gage does not seem to track liquid level, the most probable cause is a pressure locked ball check. Completely close both gagecocks to unseat the balls, crack both, allow the system to stabilize, then fully open both gagecocks.

What Can Go Wrong with Ball Checks?

1. Gagecock operator not fully opened during normal operation.
2. Pressure locked seated balls which effectively isolates the gage. Manually free both balls with the ball knockers.
3. Sediment, rust, scale, goo, particulates, etc. either trapping the ball or interfering with the ball seating. Proper maintenance including periodic blowdown / washdown will correct this problem.
4. Corrosion of the ball, the seat or the flow channel. The proper choice of process compatible materials will eliminate this problem.
5. Fluid flow below operating minimums.

Ball Check Maintenance

If the ball check environs are clean (see washdown and blowdown) and not corroded, no other maintenance is required.

Refer to the individual gagecock IOM (Installation, Operation and Maintenance Manual) for a ball check testing method. For ASME lower ball checks, the inspection port allows direct observation.

Flow and Pressure Requirements for Ball Check Activation

The following chart contains the minimum ball check activation flow rates and differential pressures across the ball (with a safety margin). These values are based on the flow channel diameters of Penberthy 100 and 300 series gagecocks and the standalone ballchecks. Flow channels in the other Penberthy armored (century) series gagecocks and Yarway model 4000 gagecocks are larger diameter yielding somewhat lower values.

Ball Material	Fluid and Orientation of Ballcheck					
	Air - Horizontal Ball		Water - Horizontal Ball		Water - Vertical Ball	
	Flow Rate	Pressure	Flow Rate	Pressure	Flow Rate	Pressure
Metal	13.3 SCFM [22.6 m^3/ hr]	4.0 psid [27.6 kPad]	3.7 GPM [14.0 /min]	4.0 psid [27.6 kPad]	4.4 GPM [16.7 /min]	6.0 psid [41.4 kPad]
Glass / PTFE	8.2 SCFM [13.9 m^3/ hr]	1.5 psid [10.3 kPad]	2.2 GPM [8.3 /min]	1.5 psid [10.3 kPad]	2.5 GPM [9.5 /min]	2.0 psid [13.8 kPad]

To calculate for a gas other than air:

$$\text{Gas Flow} = \sqrt{\frac{29}{mw}} \times \text{Air Flow Rate (from chart)}$$

where mw = molecular weight of the gas.

To calculate for a liquid other than water:

$$\text{Liquid Flow} = \sqrt{\frac{1}{sg}} \times \text{Water Flow Rate (from chart)}$$

where sg = specific gravity of the liquid.

The differential pressure requirement remains the same. Note the pressure requirement for water (horizontal metal ball) equates to a 9.2 foot [2.8 m] head.

Example flow rate calculation for steam (mw = 18) with a metal ball check:

$(29/18)^{1/2}$ x 13.3 SCFM = 21.4 SCFM [36.4 m^3 / hr]

Miscellaneous

Vacuum fluid service:

Normal ball checks have their seats on the gage side of the ball. For vacuum service, the location of the seat is changed to the vessel side, the gagecocks must be specified for 'vacuum service'. Differential pressure and flow rate requirements for ball check activation are the same as in the preceding chart.

Viscous fluid operation:

There is no single definitive answer for high viscosity liquids. The higher the differential pressure across the ball check, the higher the viscosity of the liquid which will seat the ball. Unseating time may be problematic, however manually cycling the ball knocker will eliminate this problem.

Standalone Ball Checks:

For operations where standard valves (not traditional gagecocks) are used with gauging, standalone ball checks are available for chemical or steam service. They should be installed in series on the gage side of any isolation valving. These are unidirectional, straight through flow devices. Ensure they are oriented properly.

Important Final Note

When in service, the gagecock operator must be fully open for proper ball check operation.

Acknowledgements to Dan Supan, Minneapolis,MN and Gary Saluti, Broomall, PA for suggesting the subject addressed by this FAQ.