Copeland Valve Testing

All Copeland valves are pressure tested by the factory for internal and external leakage before they are shipped. The type and method of the tests are selected by our customers and conforms to one or more of many different standards. The purpose of this article is to help guide the end user and those who choose testing specifications for them so that better informed decisions can be made.

THE STANDARDS FOR CHECKING FOR EXTERNAL AND INTERNAL LEAKAGE

Typically, the valve is subject to two different types of pressure tests: external and internal. An external test checks for leakage from pressure inside the valve to the atmosphere. The leakage may occur through imperfections in the valve body, through a bonnet, top plate or body gasket or through the stem packing area. This is typically called a shell test and no leakage is allowed at defined pressures greater than the valve rating. Internal leakage past the valve seat when the valve is closed is normally checked with a seat leakage or a closure test.

Some of the common standards are as follows:

ASME B16.34, Valves – Flanged, Threaded and Welding End: The most widely used valve design standard contains charts that identify the working pressures used in conjunction with other test standards, such as API 598. ASME B16.34 contains test methods, but does not define allowable seat leakage.

API 598, Valve Inspection and Test: The most widely used test specification in the world was developed primarily for consideration of isolation valves. The standard includes leakage rates and testing criteria for both metal-seated and resilient-seated valves.

MSS - SP61, Hydrostatic Testing of Steel Valves: One of the first valve test standards but no longer widely used. It was the basis for the more recent standards and similar to API 598.

ISO 5208, Industrial Valves, Pressure Testing of Valves: This is ISO's primary valve test standard, and covers many types of valves. It has 10 levels of allowable - internal leakage, and the acceptance criteria is to be negotiated between the purchaser and manufacturer.

ANSI FCI 70-2, Control Valve Seat Leakage: This contains detailed test procedures and leakage rate classes for control valves but is practically used as an acceptance criteria for on-off valves as well. It has six different leakage levels from Class I up to Class VI. ANSI FCI 70-2 is for internal testing only and refers users to API-598 for testing isolation valves.

SHELL TESTING

A hydrostatic shell test is usually performed first after the valve is fully assembled and in the partially open position. For safety, this test is normally done with water, not gas. API-598 refers to ASME B16.34 for body pressure rating, which varies by body material. For example, a Class 150 valve in carbon steel (e.g., WCB) is tested at 31 bars. The same valve in stainless steel (e.g., CF8M) is tested at 29 bars.

Note: The EN (European Committee for Standardization) and DIN (German Institute for Standardization) standards consider the body pressure rating only and not the body material. For all body materials, a PN10 valve is tested at 15 bars and a PN40 is tested at 60 bars. It is not uncommon for customers conducting business internationally and used to working with EN and DIN standards to claim the wrong test pressure was applied when a valve is shell tested per API or ASME.

In addition, even a test as simple as the shell test has issues including:

Casting porosity: In some cases, valve body castings have porosity too small for water to leak through, which is commonly called micro-porosity. To detect this type of casting defect, the valve must be tested with a gas first, and the valve is then immersed in water or the exterior covered with soap solution.

Special clean valves: Valves for use in services such as oxygen, chlorine and hydrogen peroxide require an extra level of cleaning and inspection to ensure their safe use. Water inside the fully assembled valve can introduce undesirable and unsafe contaminates. Any residual water remaining after the test can be hazardous when installed into service. For example, residual water remaining in valves for cryogenic service can freeze and prevent valve operation. In such cases, it is best to test the valve body prior to valve assembly.

Water left inside valve after testing: Residual water inside carbon steel valves can lead to crevice corrosion, a particularly aggressive type of corrosion that can damage critical sealing surfaces and result in both internal and external leakage. Attempts to remove the water through baking or heating the valve at elevated temperatures are generally ineffective.

Chloride content: Concerns regarding stress-corrosion cracking of stainless steel has resulted in restrictions in the chloride content of test water limits around 50 parts per million (ppm), to 30 ppm or lower. Low chloride levels are normally not available using a public or city water supply.

INTERNAL TESTING

API 598 is the most common standard for measuring internal leakage. Terms like “Zero Leakage”, “Bubble tight” and “Zero Leak” should always be further vetted and is best tied to an established standard so that all of the conditions of the test are easily understandable.

Most valve internal leak testing is done with air for a relatively short duration, from a few seconds to a few minutes. This is sufficient time to allow quick visual observation of a significant leak without being overly burdensome and impairing the factory’s capacity to build and ship valves.

It is reasonable to expect body joints and other static seals in the valve to be leak free when testing. However, it is not reasonable to expect closure elements, which are dynamic seals, to achieve this level of tightness over an extended time period, especially with gas.

WHAT DOES TESTING PROVE?

The real purpose of the factory internal leak test is to verify the quality of the product, not to validate the strength of the design or how it will perform in service. A thorough evaluation of the product and a technical review of the manufacturer’s claims should always be part of the purchasing process.

COPELAND’S STANDARD TESTING

Copeland tests valves to international standards like FCI 70-2, API 598 and MSS-SP61 and will accommodate reasonable additions to these tests requested by our customers. By testing to a recognized standard, the customer can relay on not only the test results but on the test being conducted in a well recognized and acceptable way. It is important that the valve past a standard test to Copeland as well as the end user so this step is never omitted and the customer may have a copy of the test results or view the valve being tested.

Zero Leakage is another criteria often requested especially by small bore block valves that vent to the atmosphere. Like all tests, **Zero Leakage** has a definition and Copeland meets the following criteria which exceeds most other standards:

Tests are performed at the following standard pressures:
Hydrostatic shell test performed at or above 1.5 times the cold working pressure.
Hydrostatic seat test performed at 1.1 times the cold working pressure.
A low pressure air test is performed between 50 and 80 psig for a period of 3 minutes after the valve has been cycled multiple times.

High pressure valve gas test:
Seat Leakage: The maximum allowable leakage of each seat closure shall be 10m/hr of liquid or 0.1 standard cu. ft/hr of gas per unit of NPS (0.4 ml/hr of liquid or 120 standard ml/hr of gas per unit of DN) under specified test conditions.
Seat Leakage Test Times:
2” and smaller = 15 seconds
2-1/2” – 8” = 30 seconds
10” – 18” = 60 seconds
20” and larger = 120 seconds
Class V: 1.1 times cold working pressure allowable leakage: .005ml/min of water per inch of port diameter per psi differential.
Class VI: 50 psi air or nitrogen, allowable leakage: 2” – 3 bpm*, 6”-27 bpm*, 8” – 45 bpm (bubbles per min.)
Allow sufficient time for leakage flow to stabilize and use a suitable measuring device.

ONE FINAL NOTE

Zero leakage never means that a valve will not leak. They are all made of materials that can be damaged or will eventually wear. It is a testing criteria that was probably developed to give the customer a sense of security and became a popular and accepted method of testing valves.

In order to keep the leakage rate low during usage, the seat and ball should be made of the same material when there are temperature fluctuations. Metals expand and contract at different rates. If a seat is integral with a valve body then it probably will not expand and contract at the same rate as the ball, resulting in a leak that may show itself after room temperature testing and during actual operation.