

Test Methods to Qualify Quarter-Turn Valves for Low Emissions Service

Learn the distinctions between ISO 15848-1 and API 641.

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Currently, two test procedures could be requested to qualify a quarter-turn valve design for fugitive emissions service: International Standards Organization (ISO) 15848-1 (2nd Edition, 2015) and American Petroleum Institute (API) 641 (1st edition, 2016). Both standards are technically viable options that can be used for valve qualification. Both could be considered good engineering practice since they clearly spell out conditions and procedures that help ensure the test is repeatable, and that it can be considered representative of the valve's real life operating conditions. Either protocol can qualify valves for higher temperature service where graphitic seals are typically used and lower temperature service where PTFE-based seals are usually used.

The general process used by both standards is as follows: the valves are set up with blank flanges on both ends; fittings are installed on the blanks to allow the valve to be internally pressurized with test media (methane gas at 97 percent purity minimum as the standard in the U.S.). The static joints on the valve (i.e. bonnets and/or flange gaskets) are tested for leaks before starting the actual test. The valve is pressurized with the test gas, and the valve stem is then actuated a specific number of open and close cycles at ambient temperature.

Leakage measurements are taken at prescribed intervals using a calibrated leak detection unit that meets specific

requirements spelled out in the standard (e.g. sensitivity, response time, etc.). Then, the valve is heated to an elevated temperature, which is determined ahead of time and is based on valve design and materials used and the stem cycling and measurement process is repeated. This cycle of ambient and elevated temperature operation is repeated a number of times. The number of thermal cycles depends on the standard used.

Differences Between ISO 15848-1 & API 641

There are a number of major differences between ISO 15848-1 and API 641 that may steer a manufacturer or end user toward using one test method over the other. The key differences can be grouped into the following: test

conditions, number of stem and thermal cycles, valves qualified under the standard, related valve design standards that may reference either of the above referenced test methods and the end user's specification.

The ISO procedure allows for the use of two different test gasses, helium and methane, each with different leakage measurement methods. In the ISO test, helium is measured by essentially bagging the test valve and measuring the mass leak rate of helium leaking through the packing set. If methane is used, leakage from the packing set is measured as a concentration (in parts per million by volume [ppmv]) using a vapor analyzer and 'sniffing' around the packing set. The ISO standard specifically states "... there is no correlation intended between measurements of total leak rate ... and local sniffed concentration." Also, since helium is generally not accepted as a suitable test medium by enforcement agencies in the U.S., and because current field monitoring techniques are done using 'sniffing' and not 'bagging,' only the methane portion of ISO 15848-1 would generally be considered a viable option for leakage measurement for valves destined for the markets where API valves are used or specified. The API 641 protocol uses methane and 'sniffing' only.

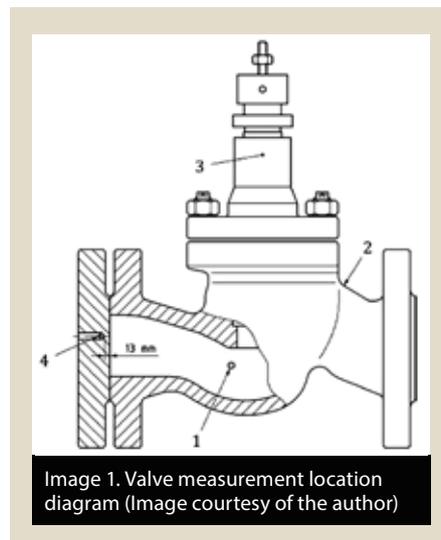


Image 1. Valve measurement location diagram (Image courtesy of the author)

Temperature

Both standards are written so they can be used for qualification of valves using seals intended for high temperature

service as well as for other valve designs and materials intended for lower temperature services that may be sealed with non-graphitic seals (e.g. PTFE packing or v-rings).

API 641 has two temperature groups: valves intended for services above and below 500 degrees Fahrenheit (F) (260 degrees Celsius (C)). For the high temperature group, the maximum test temperature and pressure is 500 F (260 C) and 600 pounds per square inch gauge (psig) or a gauge pressure of 41.4 bar. Valves for lower pressures are tested at their allowable rating and at the 500 F (260 C) test temperature. The lower temperature valves are tested at their maximum temperature rating using the corresponding pressure rating at that temperature. The maximum test pressure is 600 psig (41.4 bar[g]). The maximum temperature and pressure ratings in API 641 correspond to the values used in API 622 and 624 testing. These limits are to ensure safety in the laboratory using methane at high temperatures.

ISO 15848-1 follows a similar methodology using two defined temperature limits—400 C (752 F) for high temperature valves typically sealed with graphitic seals and 200 C (392 F) for the lower temperature valve applications. The test pressure is based on the maximum rated pressure of the valve at the chosen test temperature. As noted earlier, the ISO test can be done with either methane or helium. However, most test facilities will only do the 400 C testing using helium gas given the safety concerns with methane. The ISO standard also defines cryogenic temperatures for testing, -46 C (-50.8 F) and -196 C (-320.8 F), whereas there are no cryogenic parameters spelled out in API 641.

API 641 calls for three full thermal cycles; during each cycle, the valve stem is actuated 100 stem cycles at ambient temperature and 100 stem cycles at elevated temperature. The valve is allowed to cool overnight and the process is repeated until completion, with a final 10-stem cycles at ambient temperature conducted before the final emissions reading.

The test is considered passed if there are no emissions readings above 100 ppmv through the test and no stem adjustments to the packing gland are applied. Also, note that the API standard does not specify the type of service for which the valve is intended, i.e. control valve service or on/off (isolating) service.

ISO does a similar process of ambient and elevated temperature cycling, but it details two specific endurance classes, each with three stages. For valves intended for on/off service, the class 'CO' is used. CO1 is two full thermal cycles, each with 50 stem cycles (fully open to fully closed) at ambient and 50 at elevated temperature; 10 ambient cycles are done at the end of the two full thermal cycles/stages. CO2 is a continuation of CO1 with 790 stem cycles at ambient and 500 stem cycles at elevated temperature (for a total of 1,500 stem cycles). CO3 extends from CO2 with 500 stem strokes



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at ambient and then 500 at elevated temperature for a total of 2,500 cycles.

For control valves, the three levels are CC1, CC2 and CC3. CC1 is 10,000 cycles at ambient followed by an equal amount at elevated temperature, CC2 continues with 20,000 more cycles at ambient and 20,000 at elevated temperature and CC3 repeats CC2 once more. In CC testing, all stem cycles are plus-10 percent of their stroke or angle from the midpoint of the valve stroke or angle. Speed of the stem is also dictated to be 1 to 5 degrees per second. One packing gland adjustment is allowed in each endurance class level (i.e. one in CO or CC1, an additional adjustment in CO2 or CC2, etc.). The ISO standard contains multiple leakage classes as well. If we consider only methane for the purposes of comparison to API 641, ISO specifies leakage classes-AM (≤ 50 ppm), BM (≤ 100 ppm) and CM (≤ 500 ppm).

Measurement Point

While on the subject of thermal cycles, another key consideration between the two standards is the measurement point on the valve from which the temperature for the test is monitored. (See Image 1, page 62 and note: valve shown is not a rotary valve and is used for illustration purposes only as found in ISO 15848-1, 2nd edition).

API 641 specifies the temperature is measured in two places: within $\frac{1}{2}$ inch (12.7 mm) of the stem seal (3) and externally on the valve body adjacent to the flow path (2). The test temperature must be controlled within plus-5 percent at both points. API 641 specifies the temperature is measured in two places: within $\frac{1}{2}$ " (12.7mm) of the stem seal (3) and externally on the valve body adjacent to the flow path (2). Both measurements have to be controlled within plus-5 percent of the specified test temperature. ISO specifies three measurement points: the flow path inside the test valve (1), an external point adjacent to the flow path (2) and an external point adjacent

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to the stem/shaft seal (3). The flow path temperature defines the test temperature (and is controlled within plus-5 percent of the target temperature); the other two locations (2 and 3) are taken for informational purposes.

This is a significant point as valve testing has shown that the fluid process temperature can be significantly higher than the temperature at the stuffing box where the seal is located. This, of course, will vary depending on the valve design. Where API 641 specifies that the stuffing box temperature defines the test, the actual temperature of the fluid (i.e. test gas) can be significantly higher than the test temperature. Conversely, with ISO using the test fluid as the controlling factor, the stuffing box temperature can be much lower than the test temperature. To be able to practically compare ISO 15848-1 and API 641 test data, you would have to compare the API 641 test temperature with T3 temperature measurement in the ISO test.

So, looking closely at the two standards, there are significant differences between the two. Number of temperature and stem cycles differs, one allows adjustments and one does not, and it is difficult to compare data given that the test temperature is defined differently in each standard. Both procedures, however, are considered examples of good engineering practice.

Which Standard Should I Use?

The answer will depend on the valve design standard that end-users are requesting. API 641 first edition was released in October 2016, whereas ISO 15848-1 is in its second edition, released in 2015. Either could be deemed acceptable assuming methane is used as

the test gas. However, one has to consider what valve standards currently call out for required type tests, as well as what will be added to valve standards in the future. API has done this for multi-turn valves by adding a requirement to various standards such as API 600, 602, etc. specifying that the valves shall be API 624 compliant (which requires API 622 compliant packing) in order to be tagged as API 600 or API 602 valves.

The current editions of API quarter turn valve standards (API 608, API 609) do not have API 641 certification as a requirement. However, the next edition of API 608 will have this requirement added and API 609 and API 599 are expected to require API 641 testing as well. ISO is not referenced in any of the API standards, nor is there any expectation that it will be in the future. However, given the global environmental concerns, there is a good chance that ISO 15848-1 could be added as a requirement to international valve standards as they are re-published. ■

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