API 622: Valve Packing for Fugitive Emissions

Most emissions escape through the valve stem.

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The American Petroleum Institute (API) has developed two commonly used standards designed specifically for the petroleum industry. They include API 622 "Type Testing of Process Valve Packing for Fugitive Emissions," and API 624 "Type Testing of Rising Stem Valves Equipped with Graphite Packing for Fugitive Emissions."

API 622 and API 624 may be specified by an end-user. Valve OEMs must use API 622-approved packing for any valve on test for API 624.

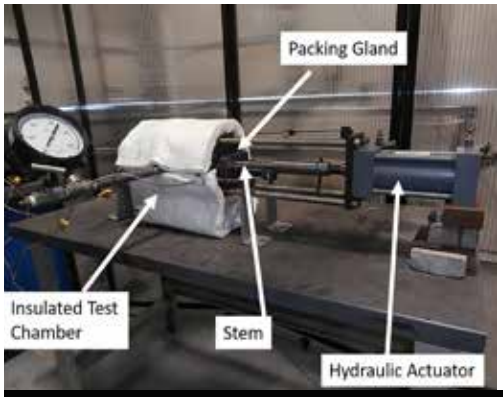

Image 1 (left). Testing fixture
Image 2 (right). Thermo toxic vapor analyzer *(Image courtesy of Yarmouth Research)*

Fugitive Emissions Test Standards

Since the introduction of the U.S. Clean Air Act in 1963, the U.S. Environmental Protection Agency (EPA), as well as individual states, have set increasingly stringent restrictions regulating fugitive emissions from industrial facilities.

Fugitive emissions are any chemical in a physical form that can unknowingly leak from an installation. Valves account for more than 51 percent of all fugitive emissions, including greenhouse gas. Eighty percent of these emissions come from the valve stem—representing more than 300,000 tons annually. It is generally estimated that a high proportion of emissions come from hydrocarbon gasses such as methane.

The consequences of these losses are far-reaching. They include the loss of product in terms of the cost of fugitive emissions, cleanup costs, loss of production time and labor costs to repair leaks.

Plants handling fugitive emissions are expected to implement leak detection and repair (LDAR) protocols monthly.

The EPA monitors leak detection using "sniffing" technology. Although alternate test methods are being used, fines for falling out of compliance can cost some companies millions. So, reducing fugitive emissions not only protects the environment but also saves money for industrial facilities.

Recently, there has been a focus on replacing the "repair" in LDAR with a more proactive, preventative approach that focuses on valve design and low emissions (low E) performance at the manufacturing level.

API 622

The first in a series of embedded low E valve and packing standards is API 622, which was revised for the third time. This is a test standard for the packing itself. It uses a standardized test fixture and eliminates all the variable conditions inherent in each valve. By using a test fixture and a specified set of conditions, a variety of packing sets from multiple manufacturers can be evaluated under the same conditions.

The third edition of API 622 restricts leakage of the packing set to a maximum of 100 parts per million volumetric (ppmv), while eliminating the single previously allowed gland bolt adjustment. This edition also adds the requirement of an 1/8-inch packing sample test, which has been problematic in valve type testing, alongside the 1/4-inch packing, which has been used exclusively in all earlier revisions.

Currently, API 622 is a performance test. It runs a span of 1,510 mechanical cycles (from open to close) at 600 pounds per square inch gauge (psig) operating pressure over five thermal cycles. Measurements of test gas leakage (methane) are taken periodically throughout the test.

During the thermal cycling test, the fixture operates at ambient temperature for 150 cycles. At that

Table 1. stuffing box dimensions and tolerances *(Image courtesy of EGC Enterprises)*

Item	1/8-inch Packing Fixture	1/4-inch Packing Fixture
Stem diameter	11.05 mm to 11.1 mm (0.4355 in. to 0.4375 in.)	25.2 to 25.4 mm (0.992 in. to1.0 in.)
Stem straightness	Max. 0.04 mm per 305 mm (0.0016 in. per 12 in.)	Max. 0.04 mm per 305 mm (0.0016 in. per 12 in.)
Stem cylindricity	0.04 mm max. (0.0016 in. max.)	0.04 mm max. (0.0016 in. max.)
Stem surface finish	0.40 µm Ra to 0.80 µm Ra (16 µ-in. Ra to 32 µ-in. Ra)	0.40 µm Ra to 0.80 µm Ra (16 µ-in. Ra to 32 µ-in. Ra)
Stuffing box diameter	17.46 mm + 0.06 mm or – 0.0 mm (0.6875 in. to 0.6900 in.)	38.1 mm + 0.25 mm or – 0.0 mm (1.5 in. to 1.510 in.)
Stuffing box depth	19.05 mm ± 1.5748 mm (0.75 in. ± 0.062 in.)	44.5 mm ± 1.5748 mm (1.75 in. ± 0.062 in.)
Stuffing box surface finish	3.20 µm Ra + 1.25 µm Ra or – 0.625 µm (125 µ-in. Ra + 50 µ-in. Ra or –25 µ- in.)	3.20 µm Ra + 1.25 µm Ra or – 0.625 µm (125 µ-in. Ra + 50 µ-in. Ra or –25 µ- in.)
Gland bottom machined flat	0.15 mm (0.006 in.) max.	0.15 mm (0.006 in.) max.
Gland to stuffing box diametrical clearance	0. 63 mm to 0.190 mm (0.0025 in. to 0.0075 in.)	0.13 mm to 0.38 mm (0.005 in. to 0.015 in.)
Stem to gland (flange) diametrical clearance	0.254 mm to 0.381 mm (0.010 in. to 0.015 in.)	0.5 mm to 0.8 mm (0.020 in. to 0.030 in.)
Gland stud diameter	3/8 in. - 16 UNC (2 pieces)	5/8 in. - 11 UNC (2 pieces)

point, the temperature is increased to 500 F, running another 150 cycles. This sequence repeats four additional times, and the final stage of the test runs for 10 cycles at ambient temperature.

The test fixture is designed to resemble a 4-inch, 300-pound gate valve, using a 1/4-inch cross-section packing sample and a 4-inch stem stroke (or the distance traveled from fully open to fully closed, see Image 1). Stem diameter is 1 inch and box diameter is 1.5 inches for a 1/4-inch packing cross-section size.

This test fixture is detailed within the test standard so that every test, independent of location, can be compared and evaluated. Leakage of up to 100 ppmv is permitted. Leakage measurements are taken using an organic vapor analyzer (Image 2) to measure hydrocarbons and volatile organic compounds (VOCs). The test no longer allows one adjustment of the gland bolts if the packing set began to leak.

API 624

This is a test for the valve itself, including the stem packing. The intention of this test is to measure the low E capability of a valve over an accelerated lifecycle. API 624 is a valve-type test meant to evaluate the total performance of the valve itself and not the packing alone.

The packing used in an API 624 tested valve should be previously tested to measure up to API 622 requirements. All the variables within a given valve design are being tested in API 624, while the packing has been proven to be, at least theoretically, suitable for use in a low E valve.

The test runs a span of 310 mechanical cycles at 600 psig operating pressure over three thermal cycles. All the while, periodic leakage measurements are taken of the test gas, which is specified as methane.

During the thermal cycles, the valve will run at ambient temperature for 50 cycles. The temperature is increased to 500 F, and the valve is cycled another 50 times.

Finally, the valve is returned to ambient temperature for a run of 10 cycles. Allowable leakage during this test is 100 ppmv at the stem and bonnet seal. No stem seal adjustments are allowed. If at any point the leakage exceeds 100 ppmv, the test is considered a failure.

The API taskforce is working on a new revision of API 624 and has expanded its line of valve standards by adding API 641 for emission-type testing of quarter-turn valves. ■

Next Month: Sealing High-Speed Shafts in Turbo-Machines

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