Ask the Expert

The *Ask The Expert* column will give readers the opportunity to have their valve concerns addressed, find out the answers to their pressing valve challenges and ask for feedback on application issues. If you have a question that you need answered, please feel free to contact s.bradley@kci-world.com with the email subject: Ask The Expert. If you are an individual with extensive valve expertise that you believe the Valve World readership could benefit from, please contact our Editor to become a future featured Expert.

This month our Experts are Luke Chou – Staff Engineer for Neway Valve International, Inc. and Rodney Roth & Scott Boyson – Business Development Managers for A.W. Chesterton Company.

Q Why is the API 624 low emission valve standard changing bolting practices on packing gland flanges?

A The API 624 standard for low emission valves was published earlier this year to identify the requirements for low emission valves. The standard is applicable to API 600, API 602, API 623 and API 603 valves.

The API 624 standard requires a production valve to pass a 310 mechanical cycle test that uses methane at 600 psig and three thermal cycle that varies from ambient to a temperature of 500 °F. The API 624 standard requires the use of API 622 tested/certified packing.

The performance results of both the API 622 tests and API 624 tests are required as part of the API 624 documentation package. This documentation package can be reviewed by end user corporate engineering for approval and suitability for use. While a pass/fail result in API 624 requires no more than 100PPM leakage without packing gland bolting adjustment, some companies are already looking at performance well below the 100 ppm for their approval process. Multi-year performance is critical as the US EPA has defined low emission valves as valves that meet the following definition -

Certified Low-Leaking Valves" shall mean valves for which a manufacturer has issued either: (i) a written guarantee that the valve will not leak above 100 parts per million (ppm) for five years; or (ii) a written guarantee, certification or equivalent documentation that the valve has been tested pursuant to generally-accepted good engineering practices and has been found to be leaking at no greater than 100 ppm.

One area requiring much more scrutiny is proper loading of the API 622 packing installed in the valve for the API 624 test. Achieving the required loading to properly seat the "Certified Low E" packing set is crucial to obtaining the sealing performance at the low leak rates that are required to successfully pass API 624 testing. The gland pressure exerted on the packing is a function of packing type, sealing requirement and the pressure being sealed. Therefore, valve pressure class and stuffing box geometries need to be analyzed for the application of proper bolt torque. Also, gland flange stud size and the thread and nut lubricant also impact the force applied to the gland and are variables that also need to be included in the analysis to create proper gland stress for API 624 low emission sealing.

The gland stress acting on the packing that produces ring compression along with radial sealing forces is much more significant in low emission applications. Gland plates and gland studs need to be analyzed for the additional stress required by low emission packing. Also, the gland nose and gland flanges need to be reviewed as it is important that they remain perpendicular to the stem. Non-perpendicular gland flange plates can result in improper sealing (see Figure 1).

A Gland Flange that is not perpendicular to the stem centerline can result in uneven loading of packing, leading to increased leakage and additional stem friction.

To apply the proper gland stress, a torque wrench must be used to apply an accurate and repeatable load. A "Crows Foot" type wrench is often needed to access the nuts especially on small forged valves. The increased moment arm should be added to the calculation as a result of the increased distance as a result of its use.

Figure 1. Uneven loading of gland flange

The industry practice prior to the release of API 624 is for a valve to be only capable of meeting low fugitive emission when prepared for testing, such as in the ISO 15848-1 test. In ISO 15848-1 type testing, there are few limitations of special preparation to the valve before the test beyond mechanical modifications. However, in API 624, it is specified that only a verification of torque is allowed prior to testing of the valve. API 624 further elaborates for the testing center to document all pre-test activities.

ISO 15848-2 Valve production testing clearly stipulates that the stem/shaft seal adjustment shall be "adjusted according to the manufacturer's instruction." Combining this clause with the fact that ISO 15848-2 only requires only 5 cycles ensures the valve is capable of meeting low emission requirements AFTER adjustments. It does not necessarily qualify a valve for adjustment free low emission performance.

However, API 624 requires a manufacturer to design a valve capable of passing a 310 mechanical and 3 thermal cycle emission test with only one gland torque verification prior to starting the test. The packing set must be installed correctly and properly consolidated prior to the API 624 test as no additional adjustments can be made throughout the test. Therefore, accurate and repeatable bolting practices as part of API 598 testing are critical to apply adequate load on the packing to achieve long-term, adjustment free low emission sealing.

Q Should a thread lubricant or anti-seize be used on low emission valves?

A The application of thread lubricant/anti-seize to the gland flange studs is important to ensure the correct gland stress is used for "Certified Low E" sealing performance. Testing have shown that majority of the intended load to a fastener is lost due to friction as seen in Figure 2. To ensure that consistent gland stress is being applied, it is necessary to have consistent friction factor.

Unlubricated gland flange bolts and nuts can have large variations in the friction due to inconsistencies in surface finishes and bolt thread profiles. Variations of 40% of bolting have been seen with unlubricated bolting. This is largely thought to be from uneven contact surfaces of metal to metal being engaged in both the thread of the nut and the packing gland flange stud. It is also caused by variations in the gland flange surface and contact area of the packing gland flange nut. This has a direct relationship to the variation in packing gland stress and sealing performance. Lower sealing stress can result in lower sealing performance. Gland stress that is higher than predicted can result in excessive valve stem friction and valve operating torque. Cases have been observed where gland flanges and bolts have plastically deformed due to excessive stress. To reduce these wide variations in stresses, it is important to lubricate not only on the threads but also the nut and flange face for accurate and repeatable sealing performance.

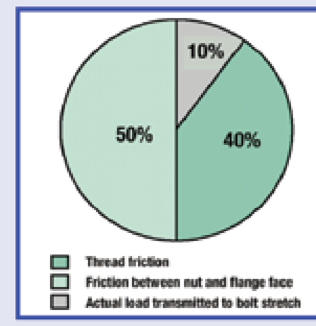

Figure 2. Distribution of Torque to Fastener Load Conversion

Accurate and repeatable thread and nut lubrication is important because the disparity in load and its potential to impact sealing cannot be identified during the required API 598 testing. API 598 testing uses water and visual leakage as its pass/fail criteria. API 624 production valve sealing performance is much more stringent and requires a change in practices for new valves, repaired valves, field repacks and field packing bolting re-torques. In fact, hardened washers are being evaluated for use on both new and repaired valves to reduce variations in friction due to nut embedment into gland flange plates.

Q What should I look for in a thread lubricant/anti-seize product?

A An ideal thread lubricant will provide consistent friction properties for both initial assembly and future adjustments. The friction coefficient of a thread lubricant is identified as a Knut factor. For it be repeatable, the particle size of the thread lubricant should have small variations in size. Thread lubricant Knut factor scatter can be 20% which will directly correlate to 20% variation on packing stress.

As packing gland flange studs are tightened in the field, a number of addition thread lubricant factors need to be considered. Thread lubricant should not easily be washed off as it needs to lubricate the threads in the future. Water washout test performance is important to review when selecting the correct thread lubricant. Also, thread lubricant should protect the threads from corrosion so performance in salt fog tests can be analyzed and benchmarked. Corroded bolts will typically have a high friction factor and not load the packing correctly. Another critical element for evaluating thread lubricants is the wet vs. dry Knut factor. Over time, especially at elevated temperatures, thread lubricant will lose its moisture content. A thread lubricant that has variations in wet vs. dry Knut factor will result in varied gland stresses being applied in the field. A thread lubricant that has low variation in wet vs. dry Knut factor is ideal for safe field reapplication of gland flange bolting adjustments.

Figure 2. Thread lubricant tested for Knut factor friction variation

Valve engineers, valve repair shops, and end-users need to evaluate the impact of tighter sealing requirements not only on their valves designs but also their gland flange bolting. With the introduction of new valve production standards and plant-wide sealing expectations, a sealing approach that creates safe, accurate and reliable sealing performance should be adopted.