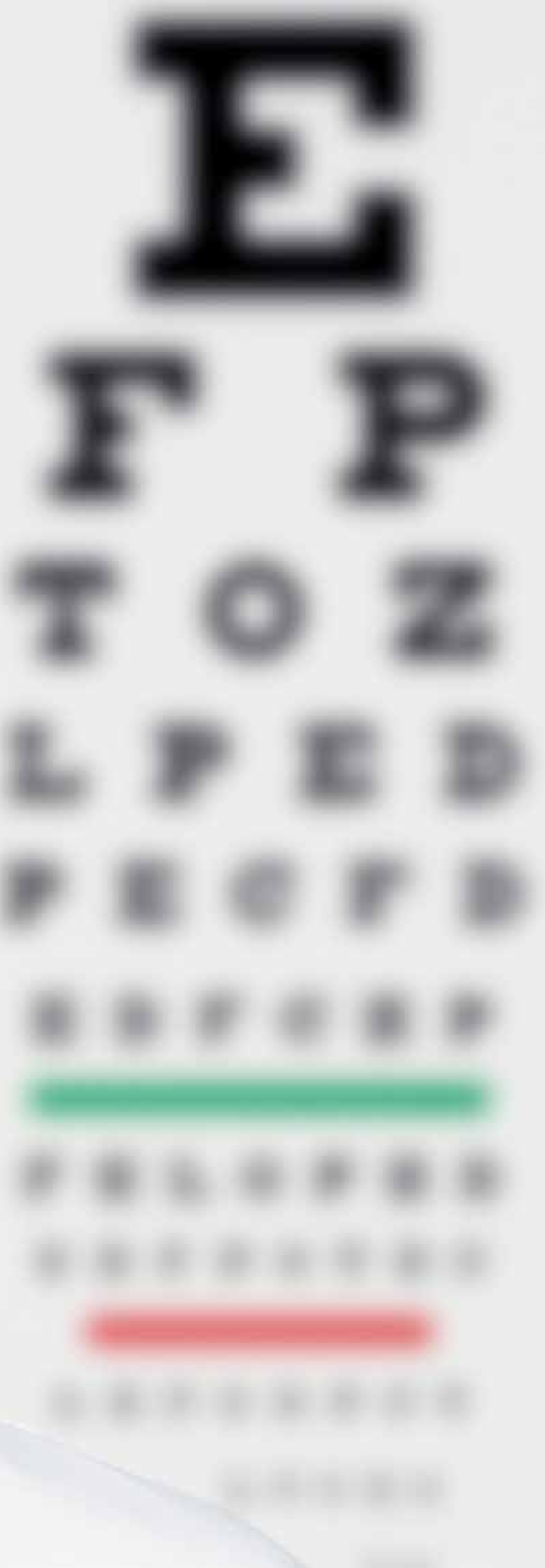

BUCKLE VISION

MATT TONES AND CHAD YODER, GARLOCK SEALING TECHNOLOGIES, USA, DESCRIBE HOW RADIAL BUCKLING IN SPIRAL WOUND GASKETS CAN BE PREVENTED OR AVOIDED ALTOGETHER.

Spiral wound gaskets combine metallic windings and filler materials, allowing them to seal piping system connections with less force than solid gaskets. The metal and filler materials are wound in a circular spiral to produce alternate layers of metal and filler, with the filler serving as the sealing element, and the metal providing structural support.

Unfortunately, spiral wound gaskets are subject to radial buckling caused by the excessive flow of the metal windings and fillers toward the inner diameter. This results in the windings and fillers protruding into the process stream when the gaskets are compressed (Figure 1). If severe enough, this buckling can act as a catch point in the pipe. Worse yet it can cause the welds at the inner diameter of the gasket to rupture, allowing the wound wire and filler to come apart spring like and enter the pipe.

This buckling action results in immediate loss of bolt load on the gasket, which can result in a leak. If the welds have been broken the sealing element of the joint will not only leak, but equipment such as pumps and valves may also be damaged by the entry of the winding wire from the gasket. This problem was first recognised in spiral wound gaskets with lubricious PTFE fillers, prompting the American Society of Mechanical Engineers (ASME) to mandate that all PTFE filled gaskets for standard ASME B16.5 and B16.47 pipe flanges have inner rings. These solid metal rings on the inside of the winding provide additional hoop strength to prevent the gaskets from buckling.

However, radial buckling is not limited to PTFE filled gaskets; it also occurs with graphite and other fillers. In this case simply adding inner rings to the gaskets may not be the ideal solution.

Flanges

It is important to note that ASME B16.20 spiral wound gasket dimensions are based on raised face and flat face weld neck flanges. Attention must therefore be paid to larger bore and lighter weight slip on and threaded, stub end, lap joint and Vanstone flanges.

ASME B16.20-2007 Table 15 (Minimum pipe wall thickness suitable for use of spiral wound gaskets with inner rings for ASME B16.5 flanges) sets out the inner diameters of flanges for which these gaskets are suitable. It is also important to reference Table 16 (Maximum bore of ASME B16.5 flanges for use with spiral wound gaskets) for the type of flanges that are compatible with specific nominal pipe size (NPS) and pressure class gaskets. In many cases, non-weld neck flanges have larger inner diameters in the lower pressure range, so the inner ring is no longer held between two solid flange faces (Figure 2).

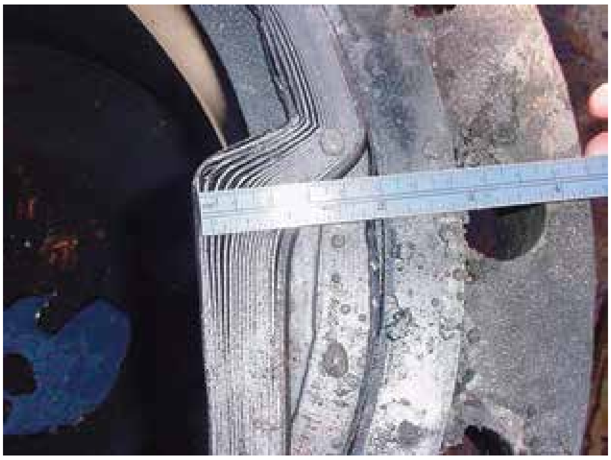

Figure 1. Buckled spiral wound gasket protrudes into the pipe bore.

Figure 2. Buckled inner spring spiral wound gasket.

Figure 3. Buckled standard spiral wound gasket from small bore, slip on flange.

It should be noted that the inner ring is nominally 0.125 in. thick, making the gasket strong in its lateral plane. However, if it is forced out of this plane, the inner ring can become distorted due to inward stress from flange compression. The rotation prevalent in larger bore and light weight flanges should also be considered, as this causes their inside edges to open. This leaves the inner ring free to bend out of the lateral plane under compressive stress, further forcing the windings toward the inner diameter of the flange (Figure 3).

Metal expansion joints

The use of metal expansion joints, the inner diameters of which may be larger for weld neck flanges, is another common cause of inner ring buckling. In many pumping applications metal expansion joints and spiral wound gaskets are used together. This is an area where performance can be improved by using different types of gaskets that will not introduce contaminants into the system.

In one such instance, a standard spiral wound gasket with outer and inner rings was used for an application involving a raised face, weld neck flange mating to a metal expansion joint. Made of thinner metal and with an inner diameter much larger than that of the flange, the expansion joint did not fully compress the inner ring and a portion of the windings, even though the gasket was properly centred in the flanged joint. During installation and tightening of the bolts, the backer flange on the expansion joint rotated under the force, creating a fulcrum effect that caused the flanges to separate at the inner diameter of the connection.

The compressive force together with the flange rotation caused the windings to move inward, leading the inner ring to buckle, not in a radial direction toward the process stream, but perpendicular to the flange face. After the inner ring buckled there was nothing retaining the windings on the sealing surface. The compressive force also caused the windings to buckle, resulting in leakage from the loss of bolt force in the assembly. In this case the solution was a metal kammprofile gasket with graphite facing, designed to seat at lower stress and without winding material subject to radial buckling.

Valves

In terms of equipment performance, caution should be used when installing spiral wound gaskets with inner rings against wafer and butterfly valves. If not sized correctly the inner ring can prevent the disc or wafer from opening and closing properly. In addition, many of these types of valves are designed to fit within the bolt pattern of a raised face flange, leaving a portion of the outer windings in an uncompressed state and subject to outward buckling. Figure 4 shows a wafer valve that was installed using a spiral wound gasket designed for a typical weld neck, raised face flange.

There is no foolproof way to avoid radial buckling, but there are measures that can be taken to prevent it. The pipe should be measured to make sure the inner diameters of both flanges are less than or equal to the inner diameter of the gasket inner ring; otherwise, gaskets that will perform as well or better in the particular application should be considered. There are many variables in a flanged connection, including temperature, pressure, media, flange finish, and system temperature and pressure cycling. The best way to ensure that the correct gasket is selected is to individually evaluate each application.

Combating buckling

Two of the most common gaskets used to combat radial buckling are kammprofile and corrugated metal. Kammprofile gaskets come closest to offering the pressure and temperature capabilities of spiral wound gaskets, but both kammprofile and corrugated metal gaskets with graphite provide additional advantages. Due to their one piece construction, both resist radial buckling. In addition, both require less assembly stress: typically 2000 – 3000 psi, compared to 10 000 psi for spiral wound gaskets. This makes them better suited for applications where available bolt load is limited. Faced with flexible graphite or other soft materials, they also conform better to minor flange surface irregularities, such as steam cuts, pitting or scratches. In the case of moderate to severe damage, the flanges must be repaired or replaced.

There are also potential disadvantages to using these gaskets, among them facing damage. Since the compressible facing material is fully exposed, it is vulnerable to damage during transport, handling and installation in a flanged connection. If this occurs, the gasket must either be replaced or refaced to ensure that it seals properly. Nor is their load retention, or resistance to creep relaxation, equal to that of spiral wound gaskets, which have better recovery characteristics.

Figure 4. Uncompressed external windings in a wafer valve application.

Conclusion

These observations should serve to debunk the notion that the use of inner rings is a panacea for radial buckling of gaskets. Inner rings are effective in preventing buckling of spiral wound gaskets installed on weld neck flanges, but kammprofile and corrugated metal gaskets may be better options for larger bore and light weight, non-weld neck flanges. Besides preventing buckling, these gaskets seal at significantly lower bolt loads and are more conformable to flange irregularities for improved sealing.