Would a Rubber or Metal Expansion Joint Better Suite my Application?

In the February 2006 issue, we discussed how an expansion joint can relieve stress in piping systems and prevent flange gaskets from being crushed. The case study used in that article was based on an application involving a metal expansion joint.

We did mention that if the same situation occurred under lower temperature service, an elastomeric (rubber) expansion joint designed to compensate for the thermal expansion also would have solved the problem. Let us first describe the two types of expansion joints:

Figure 1. Typical Rubber Expansion Joint

Rubber – a flexible connector fabricated of natural and/or synthetic elastomers and fabric and, if necessary, internal metallic reinforcements designed to provide stress relief in piping systems due to thermal movements and mechanical vibration.

Metal – a flexible element (bellows) constructed of relatively thin gage material (generally stainless steel) designed to absorb mechanical and thermal movements expected in service.

Figure 2. Typical Metallic Expansion Joint

Advantage: Metal

Temperature. Rubber joints with standard construction and materials have an upper range to 230-deg F. Most manufacturers, however, can offer special constructions up to 400-deg F. Metal expansion joints do offer a far greater range, from minus 420-deg F to +1800-deg F. However, working pressures are reduced at elevated temperatures.

Pressure. Rubber joints typically, depending on diameter, can have pressure capabilities up to 250-psi with a full vacuum rating. Metal joints can be designed for pressures up to 1000-psi. The strength of metal is definitely an advantage in high pressure applications; however, the relative stiffness or spring rates coupled with thrust forces should be carefully examined. Piping systems/anchors must be designed to handle the combined load.

Advantage: Rubber

Movements. Rubber and metal expansion joints have similar movement capabilities in the axial plane (compression and extension). However, rubber joints are certainly able to absorb far greater lateral movements when compared to metal joints that have similar face to face dimensions. Constructions (dual or universal) are available for metal joints where large movements in the lateral plane are required but these are considered special design and can be costly.

Spring Rates. Defined as the total force required to move an expansion joint 1-in in any direction. Rubber and metal joints do have similar characteristics in the axial plane for the standard face to face dimensions. Metal joints are much stiffer when subjected to lateral motion and, therefore, typically have a much lower lateral movement capability. Note that all spring rate values are at 0-psig. Both rubber and metal joints produce thrust forces when pressurized that must be considered for proper system design. These forces are defined by the formula shown in Figure 3 below.

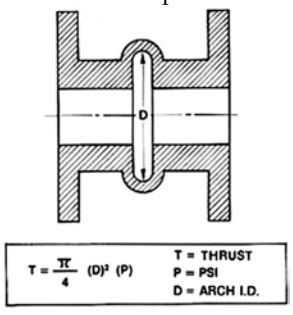

Figure 3. Thrust forces on expansion joint.

Acoustical Impedance. Although well designed (multi-ply) metal joints can lower the transmission of visible vibration, they will continue to transmit distracting and/or damaging noise. Rubber joints significantly reduce this undesirable

transmission in piping systems. The elastomeric composition of the joint acts as a dampener that absorbs the greatest percentage of perceptible noise and vibration.

Abrasion/Erosion Resistance. Metal joints typically have a wall thickness anywhere between .012-in to .080-in. Rubber joints on the other hand are much thicker, 0.5-in to over one inch. The thin gauge construction of metal joints makes them susceptible to erosive chemicals and abrasive liquids and slurries. Rubber joints are highly resistant to abrasion and erosion of all types and do outperform metal joints in the applications where these conditions prevail. Drop-in or fixed liners can be provided to enhance the life of metal joints in many of these applications but at best can only prolong the time to eventual failure.

Fatigue/Cycle Life. The fatigue life of a metal joint is affected by many factors such as temperature, pressure, movement, vibration and, of course, how the joint was initially designed. Typically, metal joints have a defined cycle or fatigue life that can be calculated through various formulas. Metal joints frequently succumb to fatigue failure from excessive cycling/movement. Rubber joints on the other hand are constructed of resilient elastomers and the joint itself acts as a vibration dampener, not susceptible to fatigue/cycle failure.

Installation/Maintenance. As a rule of thumb, rubber joints are 25 percent to 50 percent lighter than metal joints. Rubber joints do not require additional gasketing and, in many cases, are installed easily by one or two men without the use of special handling equipment. Metal joints must be serviced occasionally to insure that the flange gasket is still in tact and not deteriorated. For both rubber and metal expansion joints, control units are recommended to minimize possible damage to the expansion joint caused by excessive motion of the pipeline and in some applications, to absorb thrust forces. When control units are set to eliminate axial extension and compression, the only movement the joint can take is in the lateral plane.

Summary

Metal expansion joints are applied more frequently than rubber primarily because application conditions, e.g. temperatures and pressures, favor their use. Some experts in this industry estimate the metal expansion joint market to be 4X larger than the rubber expansion joint market. The writer of this article has been in the manufacturing business of both rubber and metal joints for over 35 years and would venture to say that is a good estimate.

It may appear that the above comparison is slanted toward the rubber expansion joints. The fact is, rubber can't replace metal in all applications, but it is a better choice for many applications involving high vibration and sound dampening within the guidelines mentioned above. Consultation with a reputable manufacturer for your specific application is always recommended.

Next Month: *How do I evaluate and control my sealing costs?*

We invite your questions on sealing issues and will provide best efforts answers based on FSA publications. Please direct your questions to: sealingquestions@fluidsealing.com.

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Fluid Sealing Association

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The **Piping Systems Non-Metallic Expansion Joint** division of the FSA is one of five with a specific product technology focus. As part of their mission they develop publications such as the *Technical Handbook of Non-Metallic Expansion Joints* and *Flexible Pipe Connectors and the Non-Metallic Piping Expansion Joint Installation Guide*. The former provides construction, installation, and application details, while the latter is a "hands-on" simplified guide for maintenance operators and engineers. Both are primers intended to complement manufacturer's documents produced by the member companies. In addition, standards such as *FSA-NMEJ-701-98 Non-Metallic Expansion Joint Hydrotesting and Vacuum Testing, FSA-NMEJ-702-98 Rubber Flanged Non-Metallic Expansion Joint Installation, Maintenance, and Storage,* and *FSA-NMEJ-703-99 Specifications of Elastomers Used in Piping Systems Non-Metallic Expansion Joints* have been developed in response to important user issues.

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