

SEALING SENSE

Q. How can an expansion joint prevent system leaks?

A. When it comes to system piping, some things make perfect sense once someone shows you. But until you're hit with the proverbial 2 x 4, you just don't think of it.

This article discusses the solution for what is not at all an uncommon problem of failure to fully compensate for piping expansion or contraction.

Leaking, bolted, flanged joints have been a problem for maintenance crews and contractors for years. In addition to traditional problems caused by flange misalignment, the elimination of asbestos gaskets from the market has made proper gasket material selection for the application critical.

So the usual first course is to blame the gasket.

However, aside from proper gasket selection and installation, there are some less apparent causes for bolted flanged joint leaks in a piping system.

One of the most important, but not fully understood, root causes is the load placed on the gasket after the system is energized. Forces, usually either lateral or axial, typically result from thermal expansion or contraction, although torsional forces also are encountered.

For example, the compressive load generated from the expansion of carbon steel pipe can be determined with the equation shown below:

$$\text{FORCE OF EXPANDING PIPE} = EA \Delta L / L$$

E = Young's Modulus (30×10^6 psi)

A = Cross sectional area of pipe (in^2)

ΔL = Change in length of pipe due to thermal expansion

L = Initial length of pipe

The results can be surprising, and depending on the wall thickness of the pipe, can exceed one million pounds. Typically, when selecting a flange gasket a number of variables are considered. These include:

1. Operating temperature
2. Operating pressure
3. Piping media

The flange gasket manufacturer's data should be carefully reviewed. In addition to the standard temperature and pressure ratings, a value for maximum stress is also typical-



Figure 1. Typical elastomeric expansion joint installation.

ly provided. This value indicates the point at which the gasket is crushed and can no longer be a reliable seal.

In addition to the gaskets, proper selection, lubrication, installation of the bolts and washers, and application of the specified bolt torque for the service conditions are all important.

Given that the above conditions for the bolted flange are addressed effectively, the inclusion of an expansion joint is crucial to effective, leak-free operation of any piping system.

Case Study

A piping system was installed without the inclusion of an expansion joint. The pressure test went fine; the system was up and running. A few call backs to re-tighten a few leaking joints weren't out of the ordinary – until it started to become a habit.

Then the owner got involved and everyone started talking back charge. What's going on here?

Steam leaks in this system required faster attention than a water leak because of their ability to rapidly score the face of a flange. The system was put in service in October. By early December, the gaskets on the 10-in flanged steel valve had been replaced twice and the flanged joint was leaking again.

The range of acceptable bolt torque for a 10-in flanged joint is between 160 and 360 ft-lb, which is readily achievable by a mechanic with clear access to all bolts.

A general purpose gasket from a well known and reputable supplier had been installed initially. The maximum permissible stress listed in the manufacture's data sheet for this gasket was 9000-psi.

Typically, if you're having trouble with leaks and you're going through the labor of replacing the gasket, you might as well try something "better." So the next step up was an

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aramid fiber gasket impregnated with fiberglass particles that resist crushing. The Maximum Permissible Compressive Stress listed for this gasket was 15,500-psi.

A week later . . . leaking again.

Using the above formula, an unrestrained 10-ft section of pipe heated from 70-deg F to 350-deg F will expand 0.21-in. Over the 11.9-in² cross section of pipe wall, the thermal stress corresponds to 623,000-lb. Transmitted through the area of the gasket, this results in a compressive load of 17,000-psi. Again, maximum stress for the upgraded gasket was 15,500 psi! The gasket had been crushed!

An almost identical installation, also without expansion joints, was observed nearby. It had the same start up, same valve, same bolts, same general purpose gaskets, same pipe fitters, and has been functioning without a hint of a leak.

The major difference between the two installations was that the 10-ft run of pipe for the problem system was anchored to the wall on both sides of the valve.

This almost identical run of pipe in the leak-free installation made a 90-deg turn before exiting the pit. The flexibility

of this bend provided enough stress relief to prevent the gaskets from crushing. (However, per ASME piping codes the stress on the elbow was not acceptable – but that's another story.)

The solution for the problem installation was the addition of an expansion joint designed to provide compensation for the thermal expansion of the piping system.

In this case, because of the elevated temperatures, a stainless steel expansion joint was installed. However, provided the same situation under lower temperature service, an elastomeric joint designed to adequately compensate for the thermal expansion also would have solved the problem.

Next Month: What are the best pump packing installation techniques?

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.

P&S

Fluid Sealing Association

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The **Piping Systems Non-Metallic Expansion Joint** of the FSA is one of six divisions with a specific product technology focus. As part of their mission they develop publications such as the *Technical Handbook 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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