Temperature & Pressure Considerations for Nonmetallic Piping Expansion Joints

Size will have a major impact on all essential parameters.

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Gathering all the information available regarding a system using an expansion joint is of utmost importance. It is the only way to reach the design life expectancy of any expansion joint. There is no such thing as too much information when it comes to the selection process.

The acronym "STAMP" can be beneficial in remembering all the essential parameters. STAMP stands for:

1. Size
2. Temperature
3. Application (movements—axial, lateral and angular)
4. Media
5. Pressure

These parameters should be considered of equal importance. However, size has a major impact on the ability to handle the other parameters. Then, knowing the pressure is essential—not only the operating pressure, but any excursion, if there are pulsations, or even shock.

Media and temperature will determine the expansion joint tube material, as it must be chemically compatible and able to handle the process temperature. Finally, the movement needed will determine the expansion joint design. Larger displacements may require more than one convolution. Angle and lateral offsets can also be built into the expansion joint, thus minimizing stress on the joint and piping.

Expansion joint failure is rare when conditions are known and verified. Failures typically occur when known conditions are given incorrectly, or the system exceeds one or more factors of the information known. In both cases, failure would be the result of misapplication.

The nonmetallic expansion joint industry, following the Fluid Sealing Association (FSA) best practices, provides conservative designs and expansion joints with capabilities that can handle adverse conditions that may not have been considered during the initial selection process. One factor that leads to this is that the construction involves several materials—unlike metallic expansion joints—and performance is almost entirely determined by the bellows single composition material. With nonmetallic expansion joints, specifically elastomeric expansion joints, there are several factors:

1. The elastomer itself
2. The reinforcement material
3. The design and interaction of the different material
4. The interaction with the flange attachment

It is the manufacturer's responsibility to provide options of product design for use in a specific application. The following should help the specifying engineer or end user make an intelligent selection based on design conditions.

Image 1. Temperature pressure deration factors

Maximum System Temperature	Pressure Reduction Factor
225 F	1.00
250 F	.85
275 F	.65
300 F	.50

Image 2. Elastomer temperature limits

ASTM Designation	NR	CR	CHR	CSM	EPDM	FKM
Maximum Temperature F	180	230	300	250	300	400
Minimum Temperature F	-65	-60	-60	-60	-65	-20

Material Considerations

All elastomers have temperature limits. There is a range of temperatures in which elastomers will remain pliable and elastic. If the temperature is below the glass temperature, the elastomer will lose elasticity and will not be able to respond to the required motion. When temperatures get near or exceed the higher limit, the elastomer can get hard and brittle, leading to cracking, and expansion joint failure is bound to occur. The most sophisticated and strongest reinforcement material could be used, but it will be ineffective if the elastomer is not maintained within its temperature range.

Temperature & Pressure
Maximum pressure and temperature limits cannot be considered separately. As temperatures increase, the pressure capabilities of an expansion joint are reduced. Image 1 shows a general guideline of derating the pressure capability based on temperature level for ethylene propylene diene monomer (EPDM) or butyl elastomer. Thus, at 300 F the catalog-rated pressure limit must be reduced in half to ensure reliability and operating life. If the temperature exceeds the capability of an elastomer, a different compound with a higher temperature limit can be selected. Image 2 lists temperature limits for common elastomers.

Reinforcements
There are four basic fabrics used as reinforcements in elastomeric piping expansion joints: polyester tire cord, aramid fiber (Kevlar), fiberglass and nylon. Nylon is rated at a max temp of 230 F, polyester tire cord 300 F and Kevlar/fiberglass up to 400 F, which is higher than any other elastomer except fluoroelastomer. It is important to match the max elastomer capability with the maximum fabric reinforcement capability to achieve the highest expansion joint capability. Due to differences in the coefficient of thermal expansion for the various material, conservative evaluation should prevail.

PTFE Molded Expansion Joints
Polytetrafluoroethylene (PTFE) is generally rated for over 400 F, but this limit is not for expansion joints when used for pressure retention. It is not recommended to use molded PTFE joints at over 300 F.

As the temperature rises, PTFE gets softer and begins to creep. This creep reduces the hoop strength of the PTFE bellows and, therefore, lowers the

Image 3. Pressure ratings according to temperature and the number of convolutions

		PTFE Expansion Joint Working Pressure PSIG			
Size	Number of Convolutions	70°F.	200°F.	250°F.	300°F.
1”	3	150	110	90	75
	2	175	140	110	100
1-1/2”	3	145	105	85	70
	2	170	135	105	95
2”	3	140	100	80	75
	2	165	130	100	90
2-1/2”	3	135	95	75	70
	2	160	125	95	85
3”	3	130	90	70	65
	2	155	120	90	80
4”	3	130	90	70	65
	2	155	120	90	80
5”	3	125	85	65	60
	2	150	115	85	75
6”	3	125	85	65	60
	2	150	115	85	75
8”	3	120	80	60	55
	2	145	110	80	70
10”	3	115	75	55	50
	2	140	105	75	65
12”	3	110	70	50	45
	2	135	100	70	60

WIDE ARCH SPOOL TYPE EXPANSION JOINTS
BUTYL/EPDM

		MAXIMUM SYSTEM PRESSURE (PSI) VS. MEDIA TEMPERTURE			
SIZE RANGE	FACE TO FACE	180°F	212°F	250°F	300°F
10" THRU 14"	8"	225	200	180	120
	12"	200	180	160	110
	16" (2 ARCH)	185	150	130	75
36" THRU 48"	10"	90	80	70	50
	14"	80	70	60	45
	18" (2 ARCH)	70	60	50	35
74" THRU 96"	12"	80	70	60	35
	16"	70	60	50	25
	20"	65	50	40	20

Image 4. Pressure limits depending on temperature and size

Maximum pressure and temperature limits cannot be considered separately. As temperatures increase, the pressure capabilities of an expansion joint are reduced.

pressure rating. Image 3 lists pressure ratings according to temperature and the number of convolutions.

Expansion Joint Size

Another factor is expansion joint size. The larger the size, the lower the ability to handle pressure, including negative pressure or vacuum conditions. This must be added to the limitations from the reduction in pressure capability at elevated temperature conditions. Image 4 shows the pressure limits to be used considering process temperature and the size for an elastomer expansion joint.

In addition, there are several factors that need to be considered when selecting an expansion joint. For example, the design of the joint, such as the number of convolutions, will impact its ability to handle pressure. A multi-arch design will not handle as much pressure as a single-arch design.

Finally, the process characteristics, location and environment in which the joint will be installed could have an impact on its performance.

The more information available, the better the selection process. Lacking or incorrect information will invariably lead to reduced operating life or possible premature failure in the piping system. ■

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