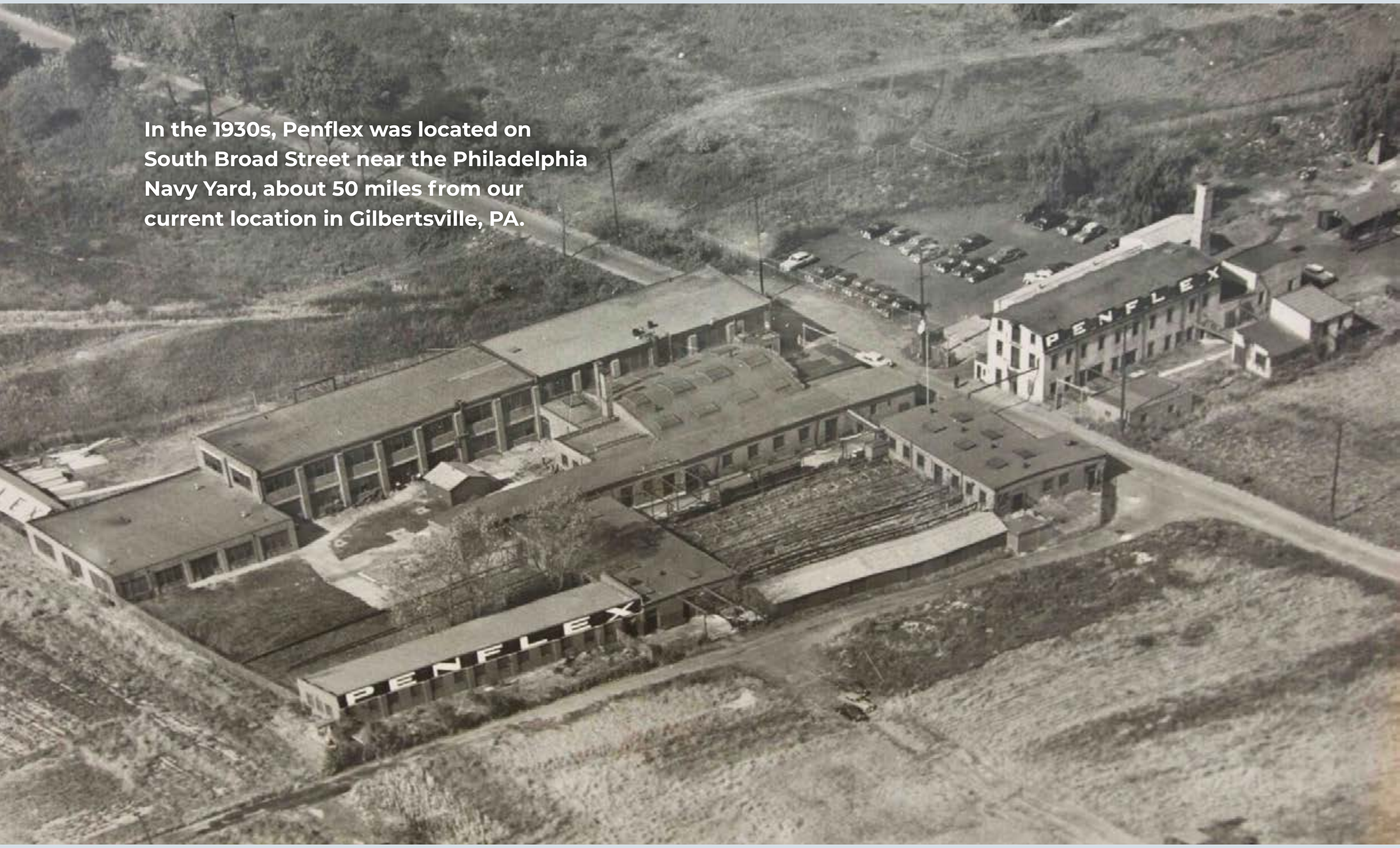
WHY PUMP CONNECTORS FAIL

The guide to prolonging flexible component service life

PENFLEX



In the 1930s, Penflex was located on South Broad Street near the Philadelphia Navy Yard, about 50 miles from our current location in Gilbertsville, PA.

Founded in 1902, Penflex is an ISO 9001-certified manufacturer of flexible metal piping solutions, offering a broad range of metal hose, braid, bellows and expansion joint products. Our complementary services include sales and welder training, engineering support, prototyping, testing and contract braiding. Known for quality and durability, Penflex products are sold into diverse vertical markets all over the world. The company is based in Gilbertsville, PA, and maintains a warehouse in Houston, TX and a second manufacturing facility near Ho Chi Minh City, Vietnam.

THE GUIDE TO PROLONGING PUMP CONNECTOR SERVICE LIFE

PART 1:

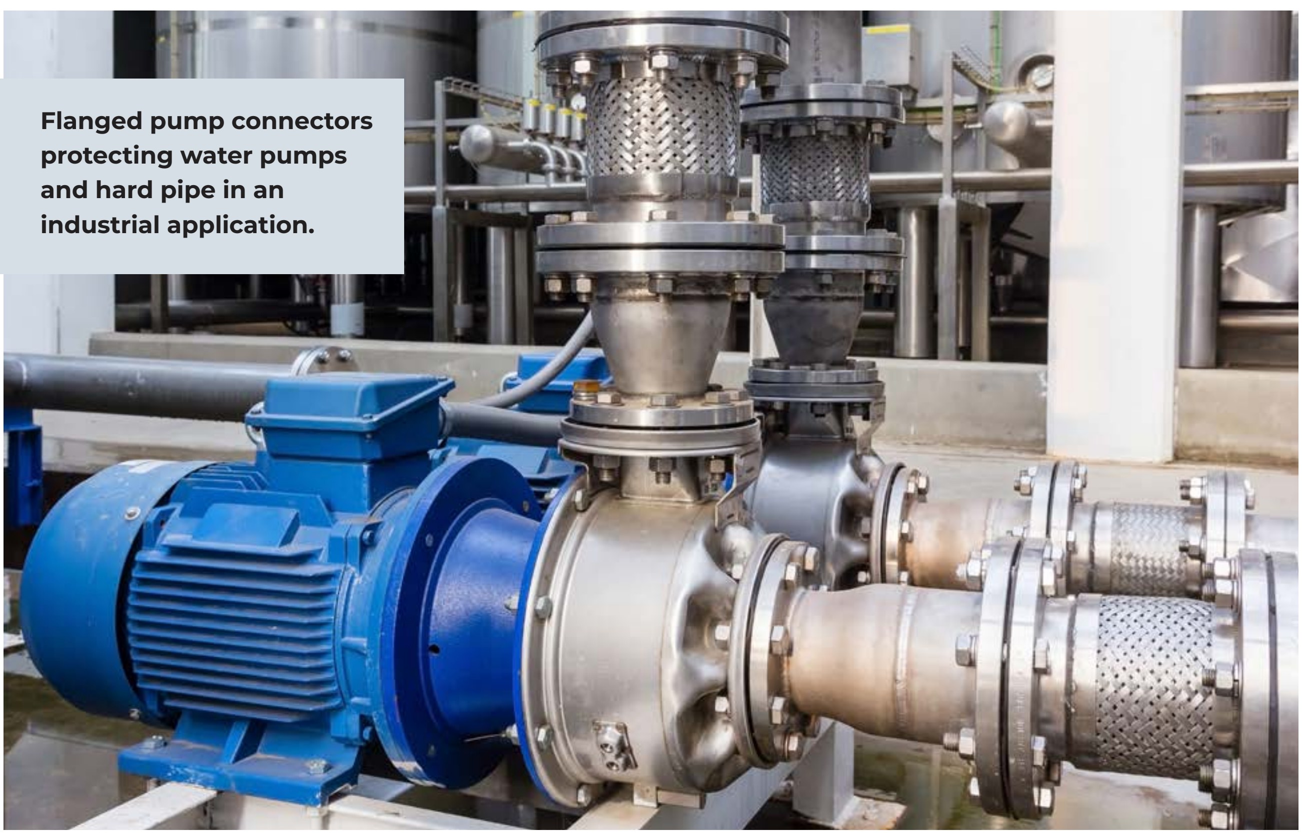
Change your perspective on pump connectors

Let's face it–pump connectors are overworked components, often found in scrappy industrial settings. Most users expect them to fail and accept associated downtime and replacement costs as part of doing business.

They are sacrificial parts that protect expensive equipment–much like the brake pads we expect to replace long before buying a new car. Of course many of us seek to make those brake pads last longer by anticipating stops and braking gradually, removing unnecessary weight from the vehicle, and maintaining fluid levels.

If you could take steps to make pump connectors in your system last longer, wouldn't you?

With a basic understanding of metal hose design and some tips for proper installation and handling, it is possible to optimize the service life of your flexible components. Reducing downtime and saving money can become the new business as usual.



Flanged pump connectors protecting water pumps and hard pipe in an industrial application.

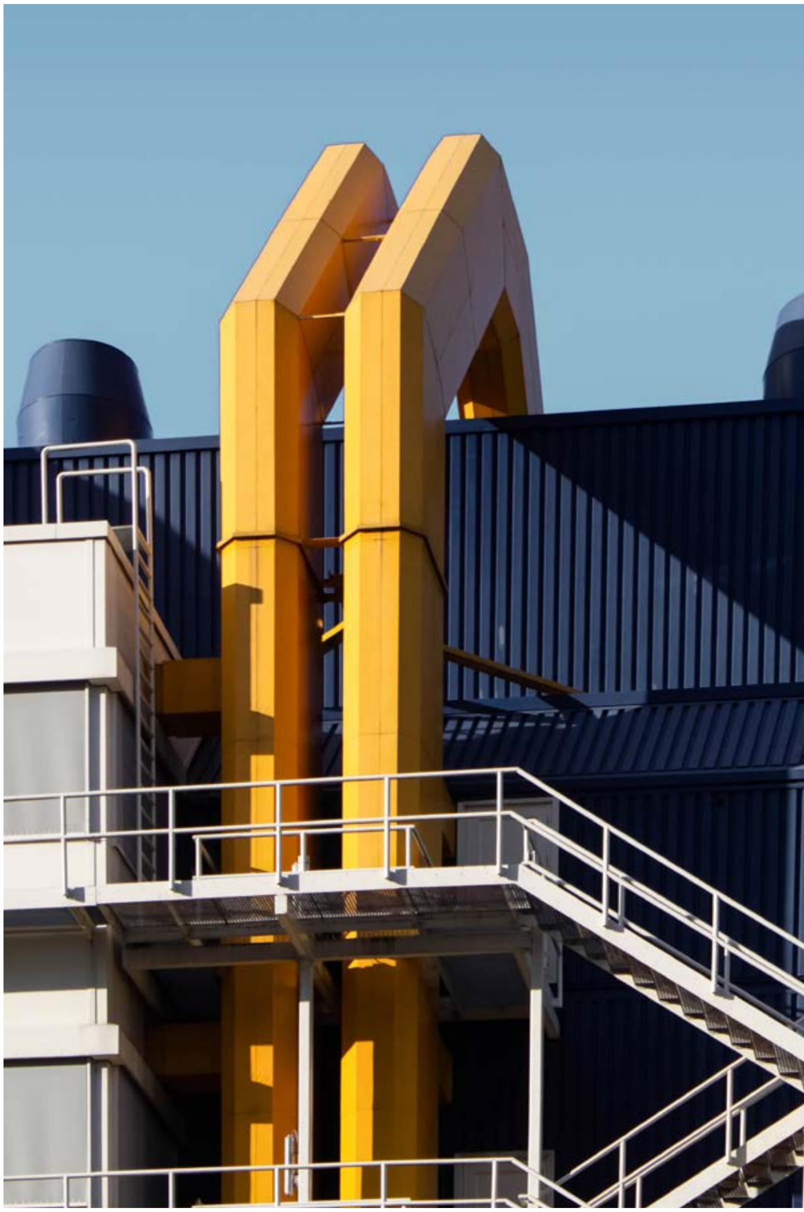
PART 2:

Think of them as short metal hose assemblies

We use a specific term to describe this subset of products because, unlike most metal hose assemblies which are built to order and come in countless configurations, there are a standard set of pump connector designs.

Standardization is driven by the HVAC industry where these flexible components are most often used. To ensure safe and efficient operation, industry groups and regulatory bodies publish detailed standards and guidelines for HVAC piping systems. Among the most prominent is ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Given similarities across HVAC systems, pump connectors are built to inventory. Off-the-shelf options generally fall into two categories: those with **flanged ends** and those with **male NPT ends**.



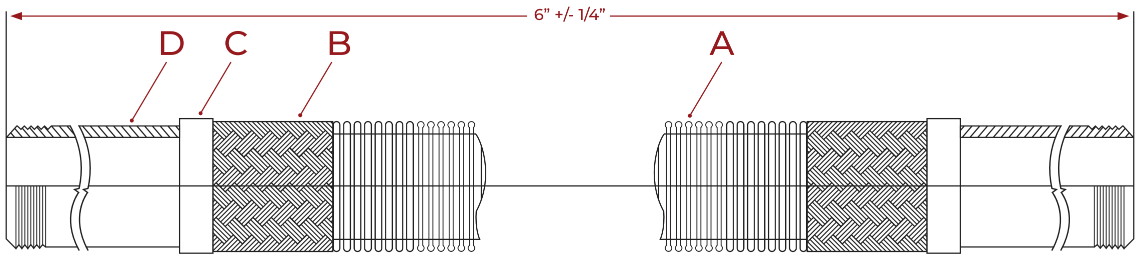
PART 3:

Common pump connector designs

Penflex TC1-004 is a common threaded pump connector design.

- ¼" pump connector
- 321 stainless steel hose
- 304L stainless steel braid
- Overall length: 6"

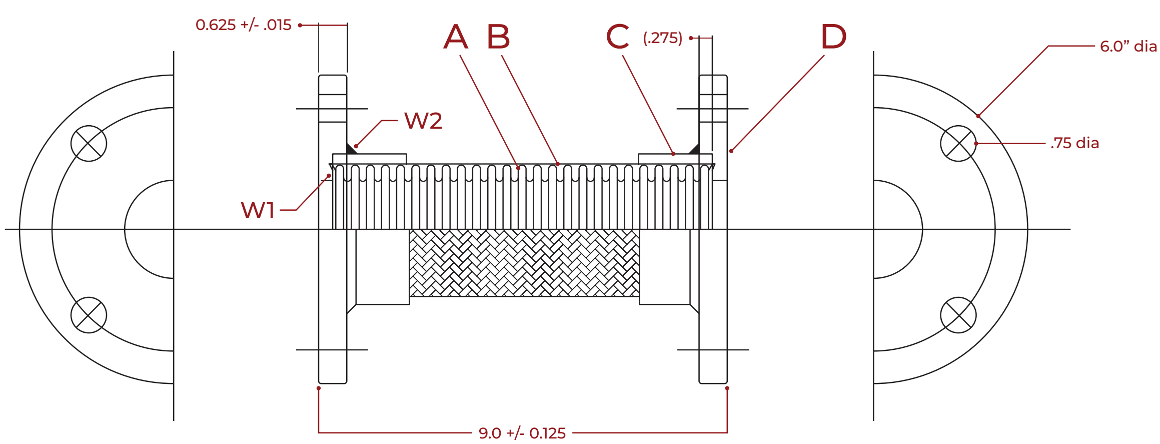
Component	Description
A: Corrugated Hose	Penflex 3021-004: ¼" 321 Stainless Steel Corrugated Hose
B: SS Braid	Penflex P3-B3004-004: 1 Layer ¼" 304L SS Braid (24 x 6 x .010)
C: SS Braid Ferrule	304 Band-Type Retainer Ring EE
D: CS End Fitting	¼" x 1-½" ASTM A53 S40 CS NPT WN EE



Penflex PFPC-032 is a common flanged pump connector design.

- 2" pump connector
- 321 stainless steel hose
- 304L stainless steel braid
- ASTM A36 carbon steel 150# plate flanges
- Overall length: 9"

Component	Description
A: Corrugated Hose	Penflex 3021-032: 2" 321 Stainless Steel Corrugated Hose
B: SS Braid	Penflex P3-B3004-032: 1 Layer 2" 304L SS Braid (48 x 9 x .020)
C: SS Braid Ferrule	304 Band-Type Retainer Ring EE
D: CS End Fitting	PLF-150-A36-032: 2" 150# Plate Flange A36 w/150 Bolt Patterns EE



PART 4:

Understand how hoses are—and are not—designed to move

Pump connectors are designed to move in certain ways

Pump connectors play a critical–if often overlooked role–in piping systems. By absorbing stresses, these flex connectors protect surrounding hard pipe and equipment from damage.

Movements caused by vibrating equipment, thermal expansion and contraction and changes in flow velocity can be compounded by the settling of support foundations over time. To accommodate these movements, metal hoses flex angularly, laterally and–to some degree-randomly.

The amount of deflection or offset a component can handle depends on its length. The longer the hose, the greater the distance it can travel.

They are not designed to move in other ways

Pump connectors are not designed to accommodate axial compression or exension–that's a job for an expansion joint. While metal hoses can absorb axial movement if installed in a traveling loop configuration, space constraints in pump systems typically make this an unrealistic option.

Often unavoidable, vibration poses unique challenges

Vibration is a defining characteristic of pump systems. Start-up, shutdown and ongoing operation create irregular stresses of varying frequency and amplitude which are difficult to measure and, as a consequence, design for. It's often these stresses that fatigue pump connectors over time, leading to cracks and eventual failure.

While the benefits of vibration damping to the piping system outweigh the stresses on flexible components, designing to minimize the effects of vibration can support longer life in service.

Engineers should account for factors such as minimum hose length, operating pressure, and vibration derating factors early in the design phase.

Pump connectors can be used for noise reduction

The noises associated with vibrating equipment–those shudders and rumbles–can prove frustrating to people living and working nearby. Not surprisingly, noise reduction is a common topic of conversation with pumps and compressors.

While metal pump connectors, as flexible components, do provide vibration damping, if noise reduction is the primary objective, a rubber connector may be the better choice. That said, there are temperature and pressure scenarios where only metal pump connectors will work, and application requirements should always guide material selection.

What do pump connectors do?

- Absorb movement
- Correct misalignment
- Damp vibration
- Reduce noise

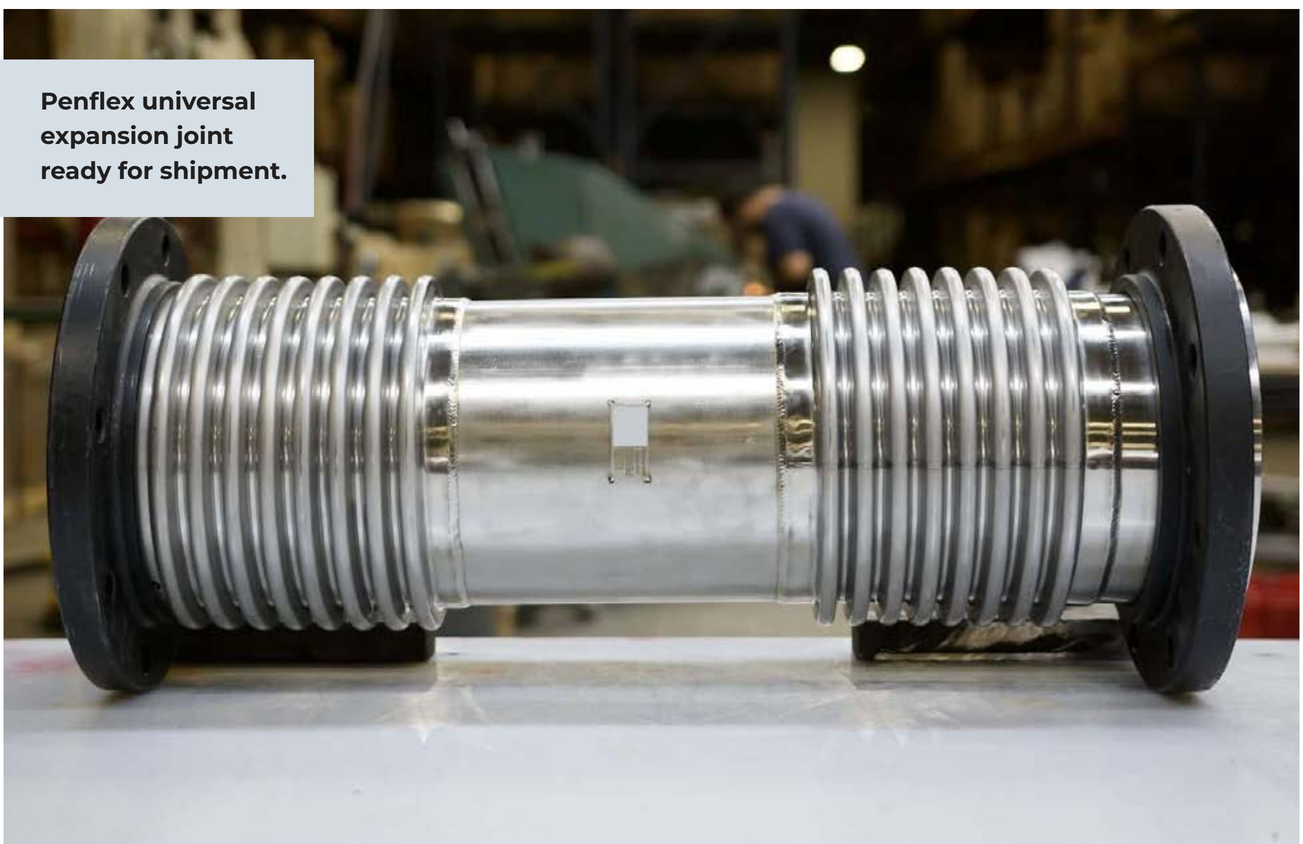
PART 5:

The difference between pump connectors and expansion joints

Are pump connectors and expansion joints the same thing?

No, a pump connector is not an expansion joint. It is a short metal hose assembly. This is an important distinction. Expansion joints and metal hoses are not designed to accommodate the same kinds of movement. For instance, an expansion joint can accommodate axial movement, while a metal hose cannot. Metal pump connectors primarily absorb lateral movements.

Confusion sometimes arises because pump connectors are short like expansion joints. They can also both be used in pump systems. And because there is some overlapping industry jargon! There are manufacturers that label certain expansion joints as “bellows pump connectors” or “bellows-style pump connectors” but without braid, typically featuring tie rods and capable of accommodating axial movement, we would consider these products to be expansion joints.



Penflex universal expansion joint ready for shipment.

PART 6:

Choose the right material for your application

Should you use a metal or rubber pump connector for your application?

When it comes to choosing between a metal or rubber pump connector, the decision depends on the specific needs of your application. Below, we compare the two side-by-side so you can determine which option makes the most sense for your system. Then, we dive deeper into each topic.

How long will a pump connector last in service?

Regardless of material, pump connectors absorb movement. This is what they are designed to do. By absorbing stresses so hard pipe and equipment don't have to, these flex connectors are susceptible to wear.

Pump Connector Options		
	Metal	**Rubber**
Shelf Life	Unlimited	Limited
Routine Inspection	Yes	Yes
Required Maintenance	No	Yes
Material Identification	PMI in Operation	Lab Analysis
Working Pressure	Higher	Lower
Operating Temperature	Up to 1000°F	Max 400°F
Corrosion Resistance	Better	Variable
Movement	Lateral	Axial, Lateral, Torsion
Noise Reduction	Less	Better
Cost	Higher	Lower

Will the strain reduce service life?

With a metal pump connector, the answer is no. We're talking about some pretty robust materials here. Let's look at what is used to fabricate a standard flanged pump connector.

- 304/321/316L hose
- 304L/316L braid
- Carbon steel plate flanges

If installed properly and operating within design limits, a metal pump connector can, theoretically, last indefinitely.

With a rubber pump connector–or rubber expansion joint as they are more often called–the answer is yes. Rubber does not have the same fatigue strength that metal does. On average, a rubber expansion joint might last 5 years, but scheduled replacements may be more frequent in critical applications.

In either scenario, improper installation or operation outside design limits will reduce service life.

At some point, it may be necessary to confirm the material of construction. For metal components, this can be done in service using Positive Material Identification (PMI) equipment to verify the alloy. Rubber components, however, must be removed from service and sent to a lab for analysis.

Do pump connectors have a shelf life?

Due to material degradation over time, rubber expansion joints come with a shelf life, making this an important consideration for stocking programs.

Shelf life is based on the date of manufacture. The longer a part sits on the shelf—especially if it isn't stored properly—the shorter service life will be. Heat, humidity, sunlight, and even airborne contaminants accelerate degradation.

This is not a concern with metal pump connectors which can be stored indefinitely without impacting performance.

What kind of maintenance is required?

Routine inspections are a good preventative maintenance practice for any piping system. Watch out for the warning signs in the box to the right.

If users see any of the items listed above, further investigation and possible replacement may be required. Of course, action should be taken immediately if any leaks or visible signs of corrosion are noted regardless of whether a metal or rubber pump connector is installed.

Regular maintenance is, however, only a requirement for rubber expansion joints. These components need routine cleaning to remove buildup of dirt, oil, and chemical residue that can degrade elastomeric materials. Conditioning may also be required to prevent the rubber from drying out and cracking. On the other hand, metal pump connectors do not require this kind of ongoing maintenance.

What role do pressure and temperature play in material selection?

Are you working with a high pressure pump? Or saturated steam? In a high pressure or high temperature application, a flexible piping component's strength is critical. Generally, metal pump connectors have higher pressure ratings than comparable rubber pump connectors.

And as a rule, metal components can operate within a wider temperature range. Just reference the chart below to see how stainless steel accommodates a greater range of temperatures than common elastomer materials NBR and EPDM.

Over time, heat accelerates the aging process of rubber. Materials harden and become stiff. Components are then susceptible to cracking and less capable of absorbing the movements they were designed to absorb.

With metal pump connectors, look for:

- Broken, bulged, loose or worn braid
- Dents or flat spots
- Loose or cracked end fittings
- Twisting of the braid

With rubber expansion joints, look for:

- Blistering or further indication of ply separation
- Change in material texture
- Cracking
- Flattening of the arch

Even in the short term, as temperatures climb above 70°F there is an impact on material strength. This is true of metal as well, though not to the same degree. As a result, working pressures must be reduced in elevated temperature applications. Users can consult derating factors published by manufacturers of both metal and rubber pump connectors for specifics.

Given metal retains its material properties better than other materials at elevated temperatures, it is often the material of choice in high temperature applications.

Is flow media corrosive?

Chemical resistance charts indicate that stainless steels generally provide broader compatibility across a wider range of chemicals than most rubber materials. However, advances in polymer technology continue to expand the range of applications where elastomeric expansion joints may be suitable options.

Material selection should always consider flow media. In systems that circulate corrosive fluids—for instance, many refrigerants used in cooling applications are corrosive–metal pump connectors often offer superior long-term performance. In contrast, water-based systems typically pose less of a corrosion risk, allowing for greater flexibility in material choice.

What kind of movement do you need to accommodate?

Pump connectors are designed to absorb movement in a piping system, but not all connectors handle movement the same way.

Metal pump connectors are designed to accommodate lateral movement and some piping misalignment. The amount of movement will be determined, in large part, by the length of the component. Like any other metal hose assemblies, pump connectors are not designed to accommodate axial or torsional movements.

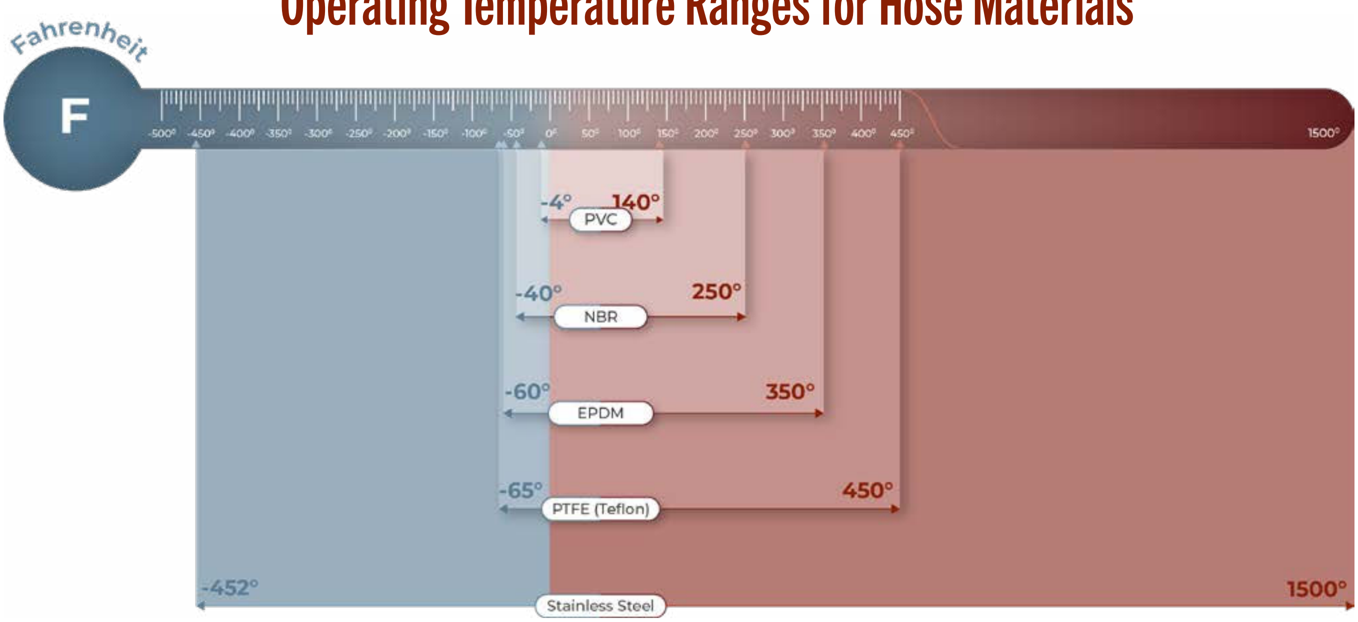
Rubber pump connectors, on the other hand, can accommodate axial, lateral, and even some torsional movement, often to a greater degree than metal given their elastic properties. They can also be used to correct some piping misalignment. Another advantage of rubber expansion joints is their ability to absorb multiple kinds of movement simultaneously. For these reasons, rubber connectors are often preferred when the pump base is mounted on a spring.

Is your primary objective to reduce noise?

If a quieter system is the goal, rubber pump connectors have a clear advantage. Their flexibility allows them to absorb vibration and dampen sound more effectively than metal pump connectors, making them a popular choice for mechanical rooms located near offices, apartments, and other occupied spaces.

Metal pump connectors, while excellent at handling certain operating conditions, are not designed with noise reduction in mind. In noise-sensitive environments, that difference can be important—not just for comfort, but for compliance with sound-level regulations in certain facilities as well.

Operating Temperature Ranges for Hose Materials



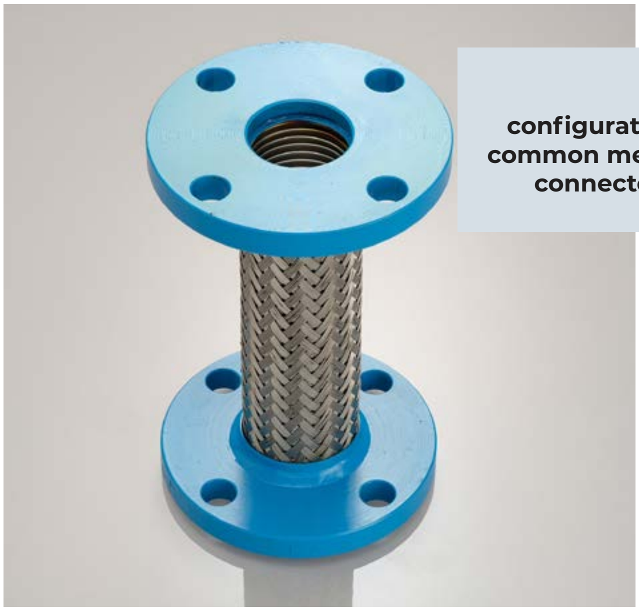
How much are you looking to spend on a pump connector?

Budget is always part of the conversation, and the choice between a metal or rubber pump connector will affect the bottom line. Metal pump connectors generally come with a higher price tag, reflecting the higher cost of materials and labor. This initial investment can pay off over time through reduced maintenance and replacement costs.

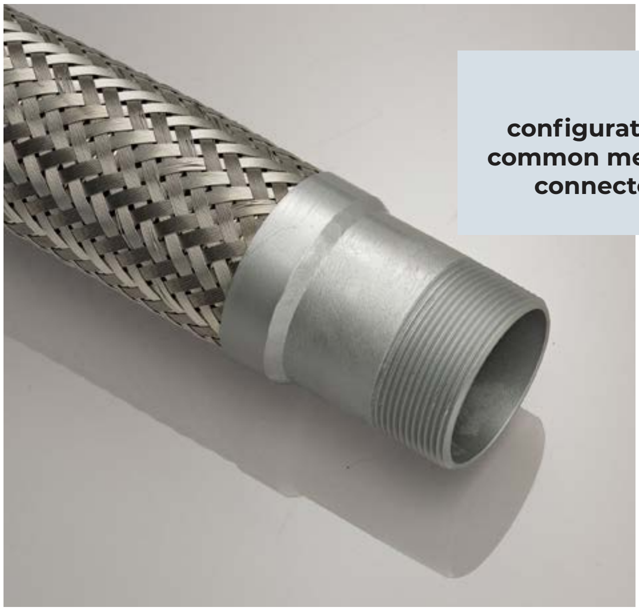
Rubber pump connectors, on the other hand, are typically less expensive up front, which can make them appealing for projects with tight budgets or in applications where durability is less of a priority.

What's the best fit for your system?

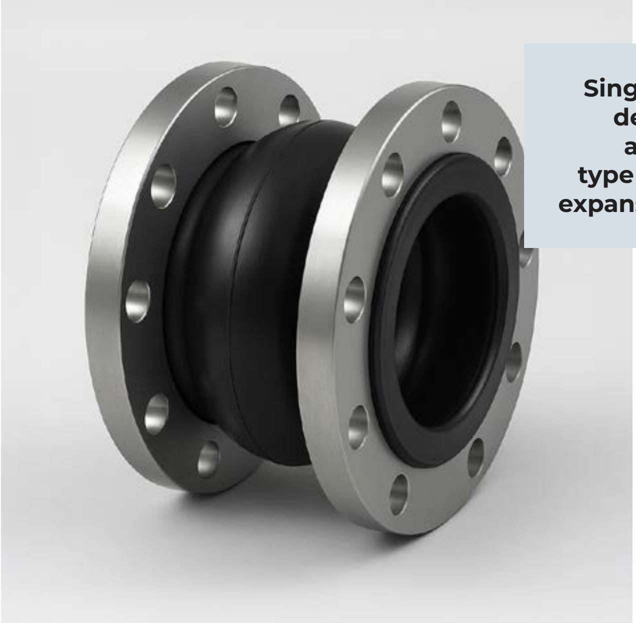
Selecting between a metal or rubber pump connector starts with understanding the demands of your application. High temperatures, corrosive media, or a need for long-term, maintenance-free performance often point to metal. Noise-sensitive environments, greater movement flexibility, or budget constraints may lead you toward rubber. In many cases, it may not be about which is "better" in a general sense, but which is better for your system.



Flanged configurations are a common metal pump connector design.



Threaded configurations are a common metal pump connector design.



Single-sphere designs are a common type of rubber expansion joint.

PART 7:

Follow proper installation and handling guidelines

Good design is only part of the equation when it comes to service life. Proper installation and careful handling are just as critical. When hoses are not installed correctly or mishandled, we see a reduction in service life and premature failure, especially in systems where vibration is present.

To ensure optimal performance, follow these installation and handling precautions.

- Design the system to allow for ground movement after installation.
- Select a connector of proper length. Remember hoses typically extend 1–2% under pressure.
- Follow all instructions provided with the flex connector.
- Handle and store connectors carefully. Avoid areas with spillage, corrosive fumes, sprays, or weld splatter.
- Do not compress a connector to fit the space. Metal hoses are not designed for axial movement.
- Install connectors so flexing occurs in only one plane. Guard against out-of-plane bending.
- Use a wrench only on the fitting hex flats—never on the braid or ferrule.
- Prevent torque. Do not twist the hose when aligning bolt holes or pipe threads. Use wrenches on both mating hexes.
- Check for leaks before covering the installation.
- Ensure the connector does not rub against other equipment while in operation.
- Verify pressure ratings are not exceeded once in operation.

PART 8:

Perform routine visual checks

Routinely inspect pump connectors

As a safety precaution and to protect a company's machinery, Penflex recommends regular inspection of hose assemblies. Beyond a more formal inspection, all those working anywhere around hose assemblies should be educated to look for the most common indicators of hose failure.

- If any of the following indicators are observed, replacement hoses should be considered before failure occurs.
- Loose, broken, bulged, frayed or worn braid.
- Deformation of the hose, which may include twisting, kinking, denting or flat spots.
- Slipped, cracked or dented couplings. If couplings show excessive corrosion, this is also a red flag.
- Traces of the media that's inside the hose coming out or being on or around the assembly. This is an obvious indication of a leak.
- Loose or damaged hose guards or covers.
- Indications of hose or braid corrosion.
- Loose fitting attachments.
- Hose assemblies that are rubbing against one another or making contact with adjacent machinery or piping.
- Unreadable or missing identification or tag if this information is required.

Some of these indicators can be fixed before replacement hoses are needed. In the case of loose or damaged hose guards or covers, look to replace the guards or covers first. However, a careful inspection of the hose and braid beneath the damaged protective layer should be carried out before replacements are installed.

PART 9:

Pick a value-added supplier

If a metal pump connector is the right component for your application, here's what Penflex offers. We stock flanged and threaded pump connectors in a range of standard configurations at our Pennsylvania factory and Houston warehouse for quick shipping or pick-up.

All pump connectors are made using 321 stainless steel hose with 304L stainless steel braid. Flanged pump connectors feature carbon steel #150 plate flanges and come in sizes 2" - 12." Threaded pump connectors feature schedule 40 carbon steel, 304 or 316 male NPT ends and come in sizes ¼" - 4".

Threaded Pump Connectors

TC1: 321SS Hose with 304SS Braid and Carbon Steel Male NPT Ends			
Nom.I.D. (in.)	Part Number	Overall Length (in.)	Working Pressure @70°F (PSIG)
1/4"	TC1-004	6	1647
3/8"	TC1-006	6	1639
1/2"	TC1-008	6.5	1200
3/4"	TC1-012	7	1034
1"	TC1-016	8	796
1-1/4"	TC1-020	8.5	600
1-1/2"	TC1-024	9	551
2"	TC1-032	10.5	557
2-1/2"	TC1-040	12	387
3"	TC1-048	14	316
4"	TC1-064	16	232

TC2: 321SS Hose with 304SS Braid and 304SS Male NPT Ends			
Nom.I.D. (in.)	Part Number	Overall Length (in.)	Working Pressure @70°F (PSIG)
1/4"	TC2-004	6	1647
3/8"	TC2-006	6	1639
1/2"	TC2-008	6.5	1200
3/4"	TC2-012	7	1034
1"	TC2-016	8	796
1-1/4"	TC2-020	8.5	600
1-1/2"	TC2-024	9	551
2"	TC2-032	10.5	557
2-1/2"	TC2-040	12	387
3"	TC2-048	14	316
4"	TC2-064	16	232

TC3: 316SS Hose with 304SS Braid and 316SS Male NPT Ends			
Nom.I.D. (in.)	Part Number	Overall Length (in.)	Working Pressure @70°F (PSIG)
1/4"	TC3-004	6	1647
3/8"	TC3-006	6	1639
1/2"	TC3-008	6.5	1200
3/4"	TC3-012	7	1034
1"	TC3-016	8	796
1-1/4"	TC3-020	8.5	600
1-1/2"	TC3-024	9	551
2"	TC3-032	10.5	557
2-1/2"	TC3-040	12	387
3"	TC3-048	14	316
4"	TC3-064	16	232

Flanged Pump Connectors

Nom.I.D. (in.)	Part Number	Hose Series	Overall Length (in.)	Working Pressure @70°F (PSIG)	Flange Thickness (in.)	Approx Weight (lbs.)
2"	PFPC-032	P3	9	475	5/8"	11
2-1/2"	PFPC-040	P4/700	9	350	5/8"	14
3"	PFPC-048	700	9	300	5/8"	15
3"	PFPC-048-168	700	14	300	5/8"	16
4"	PFPC-064	P4/700	9	250	5/8"	20
5"	PFPC-080	700	11	175	3/4"	28
6"	PFPC-096	700	11	165	3/4"	33
8"	PFPC-128	700	12	234	1"	52
10"	PFPC-160	700	13	230	1"	74
12"	PFPC-192	700	14	161	1"	100

If your application requires a configuration not listed among our stock pump connectors, reach out to one of our engineers for a custom assembly quote. Don't let the expectation of failure lead you away from seeking to optimize the service life of your flexible components!

PENFLEX

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