How to eliminate the 7 most common causes of sanitary clamp gasket failure

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Within the food, beverage and pharmaceutical processing industries sanitary clamp fittings (such as Tri-clamp™ and Tri-clover™) are essential for joining sections of pipework. Sanitary gaskets provide the sealing function in these clamp fittings, but when things go wrong and failure occurs, this can result in leakage, contamination, lost production and costly downtime. This article looks at some of the most common reasons for sanitary gasket failure.

How does a sanitary gasket work?

Let's first look at the components involved. The sanitary gasket (usually made from a polymer) is sandwiched between two ferrules, which are fixed to the ends of the pipes. The whole connection is secured together by a clamp, which when tightened applies compression to the gasket, between the ferrules, creating a seal.

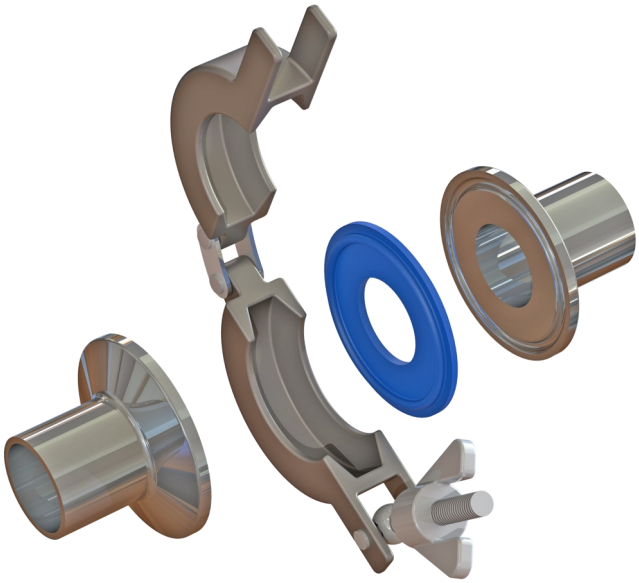

Figure 1 - Components of a sanitary fitting

1) Worn/damaged fittings

When fittings have been in service for a period of time they can become fatigued. It is important to have proper methods in place for inspection, installation and maintenance to ensure trouble-free pipe connections (see Section 7 below).

Common clamp defects include deformations, bent components, loose hinges, damaged threads, and indentations caused by uneven compression. Common ferrule defects include surface imperfections such as scratches, gouges, chips and micro abrasions on the sealing faces caused by poor handling, storage and disassembly techniques.

Any one of these factors can lead to inconsistent or uneven compression. A small scratch on the ferrule face can create a leak-patch and a bug trap for bacteria to grow. Micro abrasions increase the coefficient of friction across the ferrule face which can prevent the gasket from seating correctly.

2) Mismatched fittings

There are several clamp and fastener standards available (BS 4825-3, ISO 2852, DIN 32676 and ASME BPE, to name a few) so it's important to know which standard you are using. Make sure the clamp is the same standard as the ferrules. If you are using inch sized fittings, be aware that these are available in BS, DIN and ASME standards, plus others. There are slight differences between each of the standards, so don't get caught out using a mixture of fittings and expect it to work!

Next check your ferrules for differences between manufacturers, make sure both

ferrules and the clamp are from the same manufacturer. As a rule of thumb, don't mix and match fittings.

With such a wide variety of fittings it's easy to get into a situation where you have mismatched fittings, especially when your plant requires different clamps for certain applications.

Figure 2 - 1" BS 4825-3 ferrule markings for easy identification

3) Ferrule misalignment

When two ends of pipe are not level, the sealing faces of the ferrules will not be completely aligned. Improperly aligned ferrules will not be pulled together evenly by the clamp and result in a compromised seal, causing leakage or bug traps (see Fig 3).

The bead of the gasket must align exactly with the groove in both faces. Ensure pipework is at the same height and not twisted at an angle to maintain even compression on the gasket.

Pipe alignment involves very tight tolerances and the smallest amount of misalignment (2-3 degrees) can cause problems. Clamps must not be used to pull pipes and components into alignment.

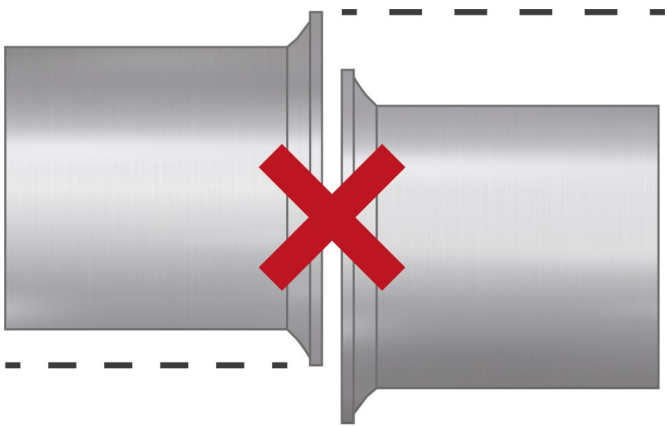

Figure 3 - Ferrules must be completely aligned

4) Incorrect tightening/compression

Correct compression of the gasket is essential to achieve a perfect trouble-free sanitary seal. An improper connection can result in leakage, creation of a bacteria trap or allow contamination of the production batch.

As already discussed in Section 3, perfect alignment is critical. Any misalignment will result in inconsistent or incomplete compression. It must be even on all sides. If ferrules meet at an angle, then one side of the gasket will be over-compressed and the opposite side under-compressed (see Fig 4). Typically, compression of the gasket is very minimal – just 0.3mm in some cases – so there's very little margin for error.

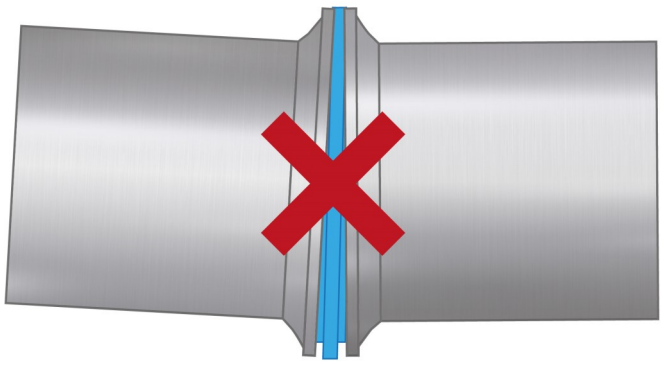

Figure 4 - One side of the gasket is over-compressed and the other side has a gap where contamination or leakage can occur

Make sure you know what torque settings your fittings should be tightened to in order to achieve the correct compression of the gasket. Under-tightening the clamp will under-compress the gasket, leaving gaps between it and the ferrule. This will create a trap for process material, where clean-in-place processes cannot reach, and bacteria could collect (see Fig 5).

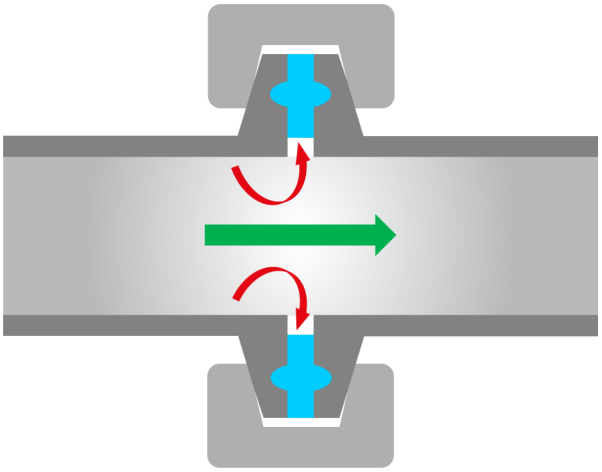

Figure 5 - Under compressed gasket resulting in a void and gap between ferrule

Conversely, over-tightening the clamp will over-compress the gasket and cause it to protrude into the pipeline (see Fig 6). The intrusion could also result in a build-up of bacteria and make cleaning difficult. In order to achieve the correct amount of tightness, either hand-tighten or use an approved torque tool and always tighten to the appropriate torque specification.

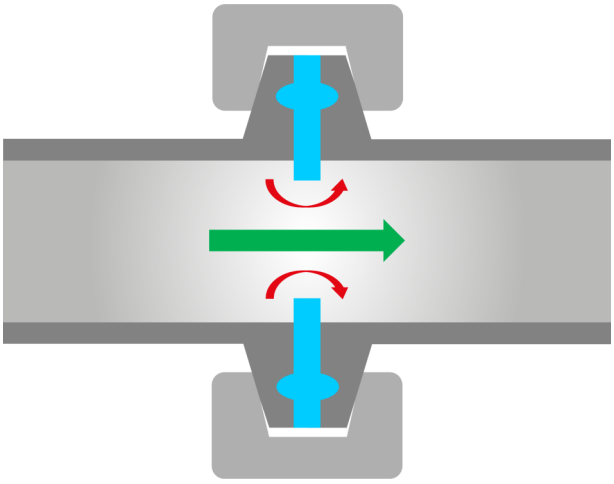

Figure 6 - Over compressed gasket protruding into pipework

5) Incorrect size gasket

With multiple sanitary fitting standards in use around the world, it's important to understand that there are subtle differences in the size of gaskets between the standards. For example, a 1" gasket from ASME BPE is a slightly different size to a 1" gasket from the BS 4825-3 standard (see Table 1). These small dimensional differences may not sound like a lot, but in some cases they could mean the difference between a working seal and failure.

If you have checked for mismatched fittings (see section 2 above), you should know which standard you are using. Make sure you ask your gasket supplier for the correct standard gasket for your specific fittings and not just a generic 1" gasket. The old adage "one size fits all" is not always true!

Standard	ID (inch)	ID (mm)	OD (inch)	OD (mm)
ASME BPE	0.85	21.70	1.34	34.00
ASME BPE	0.85	21.70	1.98	50.40
DIN 32676	0.88	22.30	1.99	50.50
BS 4825-3	0.90	22.80	1.99	50.50
BS Sch 5	1.20	30.50	1.99	50.50

Table 1 - Comparison of 1" gasket dimensions from various standards

Our whitepaper "*How to measure and specify the correct Tri-Clamp sanitary gasket*" explains how to ensure you select the correct size gasket.

6) Incorrect gasket material

Sanitary gaskets are available in different materials, and the correct selection will vary depending on the needs of the application. Commonly used gasket materials include EPDM, Silicone, FKM (Viton®) and PTFE. Each material provides unique benefits, such as chemical resistance and temperature capability, to suit a variety of process requirements.

Some aggressive cleaning regimes such as SIP and CIP can damage gaskets, so bear in mind what your process media and cleaning requirements are when selecting a suitable gasket material. EPDM and silicone gaskets are low cost and ideal in relatively inert conditions, however when applications become more demanding, fluoroelastomers (FKM and FFKM) or PTFE materials may be required (see Table 2). However, there can also be disadvantages with certain materials, such as PTFE.

PTFE provides outstanding chemical resistance, but it is harder and less compliant than elastomers. Over time PTFE gaskets become less effective and they don't provide the sealing force that elastomers do. If you need the universal chemical resistance of PTFE with the sealing benefit of an elastomer, then consider FFKM (perfluoroelastomer) gaskets.

Another potential problem that can arise if you are using different materials for specific connections in your plant (say a black EPDM and a black FKM) is they both look the same. How do you know which is which when they are removed from the packet? Is there the potential for them to be installed in the wrong location? This could easily result in failure when the material is not suitable for the process conditions. Insist on adequate part marking from your gasket supplier to eliminate this problem.

Media	FFKM	FKM	EPDM	VMQ	PTFE
Caustic soda	1	2	2	3	1
Hot water	1	1	1	1	1
Nitric acid (conc.)	1	2	4	4	1
Phosphoric acid	1	1	2	4	1
Sodium hypochlorite (20%)	1	1	2	2	1
Steam (to 175°C)	1	1	2	4	1
3% Ethanol	1	1	1	1	1

1 = Excellent, 2 = Good, 3 = Doubtful, 4 = Do not use
Based on volume swell at room temperature: 1 = <10%, 2 = 10-20%, 3 = 20-40%, 4 = >40%

Table 2 — Chemical compatibility of elastomer gasket materials

You can compare elastomer gasket materials against over 1000 chemicals using PPE's material chemical compatibility guide.

7) Insufficient cleaning/maintenance

Inspection, cleaning and maintenance are important when it comes to process equipment to avoid problems caused by ineffective clamp connections. Plant reliability and safety can be compromised when these procedures are not robust and adhered to.

When cleaning ferrules, residue should be carefully removed to leave a smooth, flat surface. Screwdrivers and other sharp tools should never be used to scrape off residue or separate components, as they will scratch the sealing face leading to problems highlighted in Section 1 above.

Clamps must be regularly inspected to ensure that they remain at their installed torque setting. Vibration in pipework can cause clamps to loosen. Thermal cycling that occurs in high pressure steam lines can result in the gasket compression fluctuating, which over time can also loosen clamps. Regular monitoring is essential as gaskets can lose sealing force or experience cold flow with age. These factors can degrade the quality of the connection and cause leaks. You can avoid this by performing scheduled inspections and carrying out regular preventative maintenance.

When visually inspecting gaskets you should be on the lookout for cracks, tears, gouges, discoloration and any imperfections. Used gaskets can accumulate a build-up of process media on the surface, or become brittle and crack when flexed – a clear sign they need replacing. Never re-use expired gaskets as they are far more likely to leak or harbour bacteria.

Conclusion

We've addressed some of the most common reasons for sanitary gasket failure. Some reasons are quite obvious, but others can be much less apparent. If you are experiencing challenges with your sanitary connections it could be one, or a combination of these factors that are causing failure. Talk to your supplier, but remember that most metal fittings providers buy in their gaskets, and as such may not be experts in sealing and elastomer behaviour. For specialist advice speak to a gasket manufacturer, such as PPE, who can work with you to identify and solve the problem, saving you costly downtime and lost production.

Precision Polymer Engineering (PPE) manufactures HyClamp™ sanitary gaskets to BS, ISO and DIN standard sizes, in a range of elastomer materials including EPDM, Silicone, white FKM and white FFKM, plus X-ray/metal detectable grades. Materials are compliant with industry requirements such as FDA, 3A 18-03, USP Class VI and EC1935/ EC2023.

More information on the range of HyClamp™ sanitary gaskets can be found on the PPE website: www.prepol.com

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