European Sealing Association e.V.

Blow out safety in flange connections

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What does blow out safety (or blow out resistance) mean?

The term "blow out safety" with reference to flange connections is defined by the ESA / FSA Flange Gaskets- Glossary of terms as "The requirement for the joint to ensure that the gasket cannot be blown or forced out of place, or allow excessive leakage, under specific operation conditions".

So "blow out safety" is a double concept already on the definition level. A variety of approaches and testing methods originate from this: some consider the situation when the gasket is not blown out of the connection or defragmented (even if significant leakage occurs) to be alright, but with this approach, seal integrity is expected even if no contact pressure exists! Others methods define it as some leakage level (though integrity of the connection in general, and the gasket in particular, must be maintained), even if the leak is not dramatic and barely perceptible.

When is blow out safety (resistance) of a gasket seen?

In normal operation conditions, flat gaskets are subject to two forces: the pressure exerted on the internal cylindrical surface of the gasket and the friction, between the gasket and the flange surface to counterbalance it. The latter depends on the clamping force exerted on the gasket, the flange surface/gasket friction coefficient, and any possible preservation agents between the surfaces (Figure 1).

The situation when the gasket is blown out of place or the leakage is excessive normally follows a dramatic unexpected scenario, leading to reduced contact pressure between the gasket and flange surfaces. The balance between forces, as in Figure 1a), is then replaced with the situation as in Figure 1b), i.e. the radial pressure exerted on the gasket is counter balanced by a tensile, circumferential stress occurring in the gasket. Therefore at low or zero gasket surface pressure excessive leakage occurs.

Such a situation may also result from deep relaxation of the flange connection, ageing or partial oxidation of the gasket, bolts creeping at high temperatures, or due to major temperature differences between the bolts and flanges i.e. from an external fire situation.

Dropped tension in the flange connection may also come from purely mechanical reasons, such as hydraulic hammering in systems, a shock to connections with a bending moment, a tensile force coming from an outside source, additional load applied on the piping, settling of the device foundations, or corrosion-induced damage, impaired stiffness of piping supports, etc. Therefore undesirable conditions and emergency events still occur, much like car crashes still occur even though the high way code exists!

Similarly, blow out safety is intended to ensure safety to process piping systems and accordingly mitigate risks to people and environment. With this approach, blow out safety is like safety belts in a car; unnecessary most of the time but used for protection just in case.

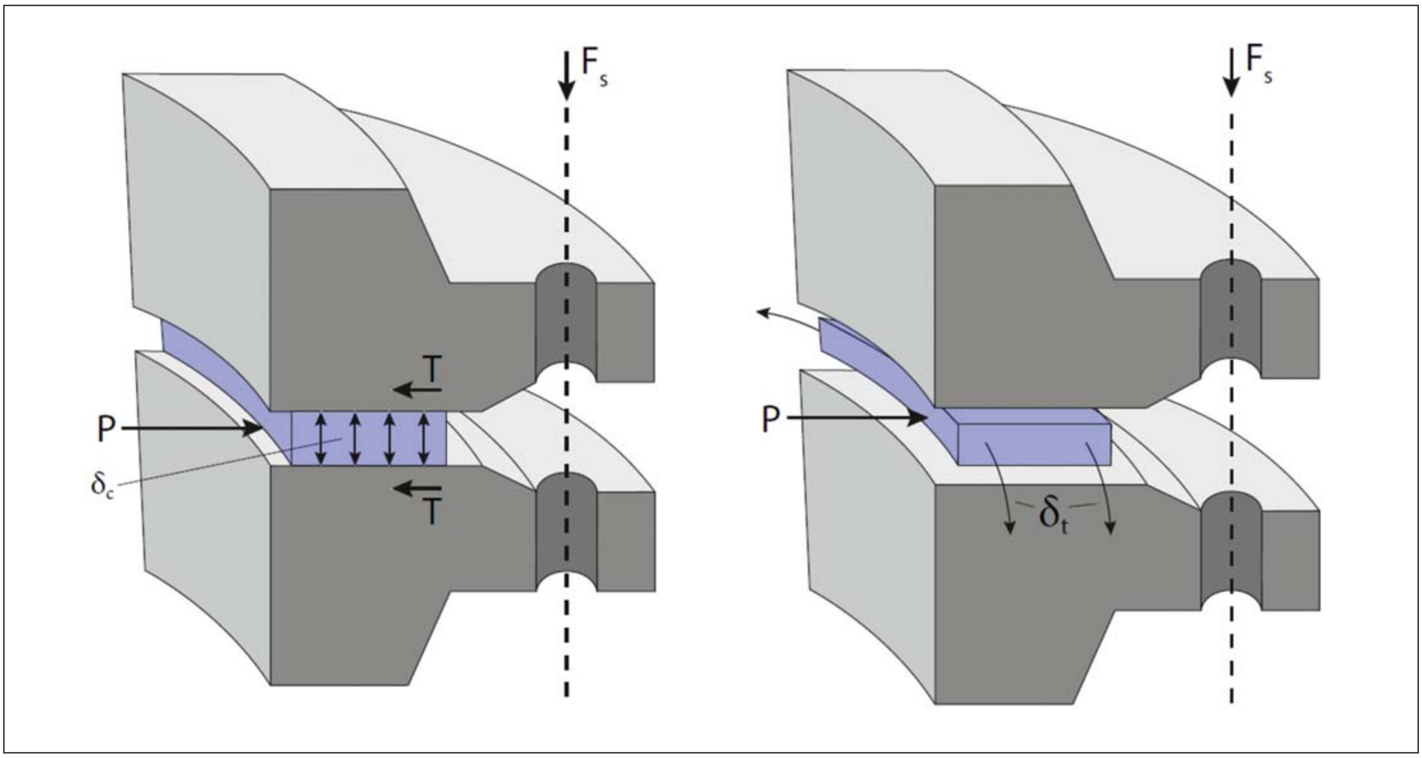

Figure 1. The balance between radial loads of the gasket in a) the connection in service and in b) the situation when contact pressure no longer exists.

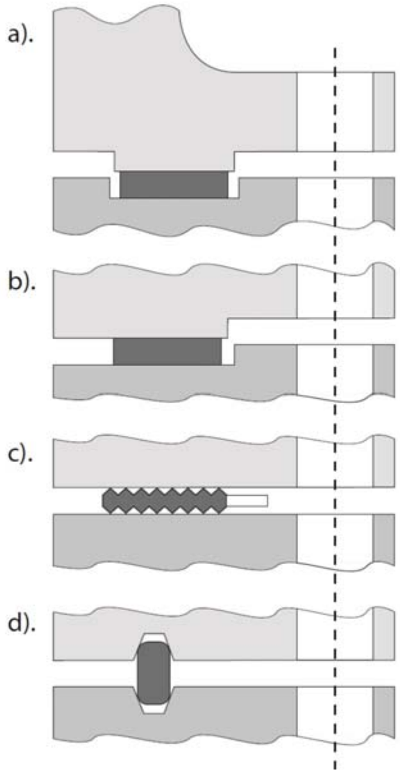

Figure 2. Different solutions of flange connections for safety against mechanical blow-out.

Obviously, the higher the risk is (higher pressure or temperature, hazardous medium, larger flange diameter), the better blow out safety is expected.

What does the mechanical blow out depend on?

The resistance of the gasket to be forced out of its place is affected by the gasket bursting strength and design, as well as by the design of the flange.

Let us start with the latter. It is quite straightforward that with such designs that fit to each other, as is the case with RTJs (Figure 2 d)) or lens gaskets (an RTJ gasket is inherently resistant to be forced out of its place, while lens gaskets are seated in special sockets), blowing the gasket out of its place is almost impossible and has never been heard of by the authors.

Another solution that involves gasket/flange shape fitting are flanges with TG (tongue and groove) - Figure 2 a) or SR (spigot-recess or male-female) – Figure 2 b) flange surfaces.

In such circumstances, the gasket deprived of contact pressure leans with its external surface against the cylindrical wall of the tongue or the groove. The gasket then, even if made of a low rate tensile strength material, normally holds in place and may restore the seal when the contact pressure is brought back.

As far as gaskets for RF (raised face) flanges are concerned, they have no support, so they withstand the blow out due to insufficient contact pressure by generating internal tension. The susceptibility to blow out is affected by flange to gasket surface friction (when contact pressure partially drops) and the exact bursting strength of the gasket.

Therefore preservation agents for the gasket and/or the flange surface that may decrease the friction coefficient, i.e. anti stick pastes or lubricants, should never be used!

It is possible to increase blow out safety with the use of metal supporting components that increase the gaskets' overall mechanical strength, as demonstrated in serrated gaskets (Figure 2 c)), spiral wound gaskets with outer and centring rings, metal eyelet or metal jacketed gaskets, corrugated gaskets etc. However the additional safety gained is in no way a substitute for utilising modern connection design calculations and accredited installation procedures such as described in EN 1591-4. Incorrect installations and poorly calculated connections remain the greatest causes of blow outs.

It needs to be considered that low gasket pressure which results in excessive leakage can still cause a mechanical blow out of most gasket types as shown in Figures 2 a), b) and c), especially if those are equipped with a soft material on their surface, as the leaking media can "wash away" the soft material, which in the end is similar to a mechanical blow out.

How can excessive leakage be evaluated?

As explained above, not only is the "blown or forced out of place" definition important, but also the definition of "excessive leakage" is important, especially in the case of hazardous media connections.

The predominant understanding of an accepted leakage is a leakage level which does not cause a radical environmental or workplace hazard. The decisive criterion which determines the existence of a blow out situation is therefore the leakage level alone.

Using the modern calculation procedures, provided by e.g. EN1591-1, the design features of a flange connection may be determined in a way that leakage does not exceed a certain level, which **is called tightness class "L_w"**, which has its numerical value w (in mg/m/s) for specified service states. According to a definition of the MPA Stuttgart for example, it is recommended to consider the connection to be a blow out if this level is exceeded a hundredfold.

A certain level of contact pressure corresponds to the leakage level. The pressures may be determined for a given seal and they may become an additional parameter of the seal (minimal pressures ensuring the blow out safety), which is useful for ensuring the operational safety of flange connections.

There is, however, a certain relationship between the blow out resistance and the flange design, which requires, as far as tightness is concerned, a holistic approach rather than focusing on the seal itself.

According to regulation VDI 2200 the blow out resistance is determined arbitrarily by measurement using a specified leakage method and the sealing is qualified or disqualified as resistant to blow out in a binary scale.

Blow out safety is greatly affected by assembly, as this affects the correct contact pressure applied. Therefore any installation of a gasket should be undertaken by certified personnel. Certification to EN 1591-4, ASME PCC-1 or similar guidelines is recommended. Some best practice information can be found in the FSA/ESA gasket installation procedure.

Regulations requiring the use of elevated blow out safety gaskets are found in AD-Merkblatt 2000, TA-Luft and other in-company regulations. Adequate test methods involve among the others: VDI 2200, ASME 434, PVRC-HOBT.

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