

SIGRAFLEX® Gaskets

Blow-out Resistance

As a general rule, no gasket blow-outs are likely to occur if the flange/gasket design calculations are accurate, the gaskets are selected to match the application concerned, the equipment is correctly assembled and suitable operating conditions are used.

Defective gaskets are not dealt with in this Technical Information brochure.

Gasket failure can take three main forms:

Case A: A specified leakage limit is exceeded because of unduly high permeability, relaxation, incorrect assembly or chemical attack on the sealing material during operation.

Case B: Service medium escapes between gasket and flange as a result of insufficient gasket pressure.

Case C: A complete gasket, or part of the gasket, is blown or forced out of the flange due to the combined effect of insufficient gasket pressure, excessive tensile stresses or gasket creep and the associated relaxation.

In **Case B**, the service medium may flow at high speed through one or several channels that have formed between the gasket and flange surface.

The reasons may be insufficient gasket pressure due to an incorrect flange/gasket design calculation, failure to tighten bolts or to do so correctly, overloading or breakage of bolts or an unacceptably high service pressure. Further causes may also be an unduly high release of tension in the flanged joint as a result of gasket creep, stresses due to high internal pressures (mainly in large-diameter equipment) and also high external stresses on the pipe work, which may lead to a reduction in gasket pressure.

As a rule, the gasket itself remains in its original place, but may suffer damage by erosion, leading to an increase in the leakage rate.

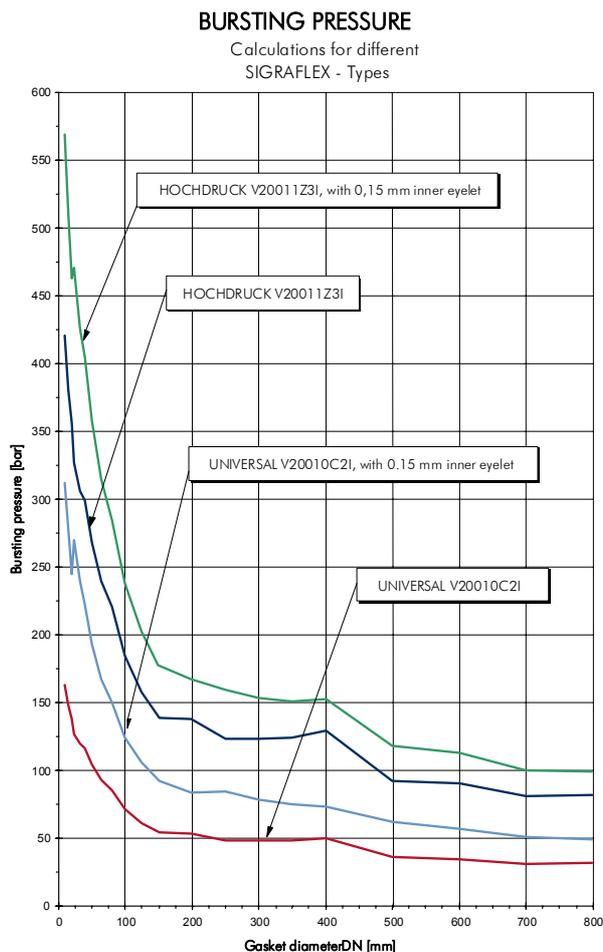
For **Case C**, the same causes can be assumed as for case B. Owing to the destruction and blow-out of the gasket, however, the discharge aperture for the service medium is much wider, resulting in a substantially higher leakage rate than in case B. As a rule, case B is likely where the mechanical strength of the gasket exceeds the radial tensile stress exerted on the gasket by the internal pressure. In certain cases, however, high leakage rates may cause even solid cam-profile gaskets to break as a result of vibratory stresses.

Case C occurs when the gasket breaks either because it is not strong enough or because erosion causes localized wearing away of gasket material (see also bursting pressure diagram). This is frequently due to the extremely rapid closing of shut-off devices, which may result in excessive, unacceptable pressure shocks.

Failure may also be due to certain materials' tendency to creep, e.g. that of PTFE. This may cause the gasket to move slowly out of its seat, though gasket failure is not preceded by any major leakage. The actual failure occurs suddenly when a certain point is exceeded.

It should be borne in mind that no gasket is absolutely resistant to blow-outs, since errors can be made in the selection, design calculation and assembly of gaskets. Even with 100 % metal systems, at least case B is possible under certain conditions.

Blow-out Resistance



SIGRAFLEX® gaskets have been used in widely varying applications for almost 40 years now. Experience has since been gained with several millions of gasketed joints.

To date, instances in which SIGRAFLEX® gaskets have been blown out during operational use are virtually unknown. In the few instances reported to us, failure was shown to be due to gross errors in assembly.

When the blow-out resistance of gaskets is evaluated, the different designs as well as the assembly conditions must be taken into account.

As a rule, gaskets **installed in flange grooves** provide higher blow-out resistance than those installed in raised-face flanges (DIN 2690). Blowing-out as described under C is impossible. For applications demanding extremely high safety, e.g. for the primary circuit of nuclear power stations, the gaskets

are installed in flange grooves. Owing to the close material tolerances required, however, such designs are too expensive for a large-scale use.

The most widely employed gaskets are those that take the full forces of the bolt. When selecting from the available design types, a reasonable compromise must be found between maximum safety on the one hand, and economic considerations on the other. The hazard potential of the operating media being sealed and the maximum amount being released in the event of technical failure have to be taken into consideration when selecting the appropriate gasket system (also see TRR 100, TA Luft, UVV-Gases).

Impregnated SIGRAFLEX® gaskets without reinforcement offer operational safety which is comparable to other soft-material gaskets being used.

Besides their well-known advantages in handling, metal-reinforced soft-material gaskets also feature higher blow-out resistance. A distinction must be made between adhesive-free metal reinforcements and graphite gaskets with perforated sheet metal reinforcement, as well as designs with soft-material layers bonded to an even metal carrier.

Despite being a relatively expensive gasket, the gasket offering the highest mechanic stability is a carrier ring made from 1-2 mm strong stainless steel sheet with bonded-on layers of thin graphite foil. As long as an inorganic, thermally and chemically stable adhesive is being used, this type of gasket design features good handling, high admissible gasket pressures and low leakage rates. Owing to the massive metal ring and the relatively thin graphite layer, complete gasket ring blow-outs are very unlikely to occur, but rather the graphite layer is being eroded away under high flow rates.

Besides the relatively high price, another disadvantage of this gasket type is its low adaptability to uneven flange surfaces. In tongue and groove flanges, disassembly can be problematic.

The same is true for **kammprofile gaskets** with soft-material layers. In general, both tightness and blow-out resistance are higher with this design. But as there are high requirements with regard to plane parallelism, surface quality and rigidity of the

flanges, the aspects mentioned in the paragraph above apply to an even greater extent.

When **fiber-based flexible gaskets** are evaluated, it should be borne in mind that the long-term behavior under elevated temperatures has a major influence on the material's bursting limit (release of tension in flanged joints as a result of gasket creep; loss in mechanical strength due to embrittlement or decomposition).

In the case of **PTFE gaskets**, the release of tension in the sealed joint due to gasket flow and the creep elongation under radial tensile stresses should be considered as critical factors.

Gasket designs using thin metal foils with bonded-on graphite foil layers are restricted in their maximum permissible gasket pressure and thus also in the permitted service pressure by the organic adhesives always used in the past. If adhesives are used, the graphite layers tend to slide out sideways when subjected to high gasket pressures under elevated temperatures.

In the event of failure, this gasket type suffers a relatively severe material loss since in the first place, the proportion of graphite in the gasket is very high and in the second place, the graphite layers lie relatively loosely on the metal foils after decomposition of the adhesive.

Graphite gaskets with perforated sheet metal reinforcement have no such disadvantages as no adhesive is used and because the flexible graphite material is protected effectively against blow-out by the mechanically anchored metal teeth. Modifications of the material such as an **impregnated version** not only make for lower leakage rates and easier dismantling, but also for increased mechanical strength, which also improves the gasket's resistance to erosion. The greater compressibility compared to that of gaskets with a solid support ring also allows for the greater distortion and unevenness of the flange. However, the perforation specific to structured sheet metal supports inevitably leads to a loss in their mechanical strength.

The blow-out resistance and sealability can be further enhanced by using **SIGRAFLEX® HOCHDRUCK** gaskets, for example. The multilayer sandwich structure has the advantages of non-perforated stainless steel foils but no such familiar disadvantages as the use of adhesives or inhomogeneities resulting from the sheet metal structure. The graphite/stainless steel bond remains stable even at elevated temperatures. This too has a very favorable effect on the maximum permissible gasket pressure.

Gaskets with eyelets undoubtedly have the greatest mechanical strength, especially if graphite gaskets with several reinforcing layers are fitted with stainless steel eyelets.

Technical testing

In principle, two different methods can be used alone or in combination, as required:

- 1) Testing in properly assembled real flanges under extremely high test pressures (sometimes several times the nominal pressure)
- 2) Testing in real flanges under nominal or test pressures and low bolt tension, with the gasket pressure reduced to σ_{BU} .

Since the mechanical strength of various sealing materials is a function of temperature and time, transfer of the test flanges to the warming cabinet should take place at such temperatures and times as allow sufficiently reliable evaluation or extrapolation of behavior under operating conditions. In the bursting pressure test, the duration of exposure to the test pressure should be suitably matched to the creep behavior of the respective materials.

This Technical Information brochure makes no claim to completeness as other gasket designs such as spiral-wound graphite gaskets or conical cover gaskets may also be considered for special applications.

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