

Flange Insulation

Gasket Basics

Why Gaskets Are Used:

Gaskets are used to create a static seal between two stationary members of a mechanical assembly and to maintain that seal under operating conditions which may vary dependent upon changes in pressures and temperatures. If it were possible to have perfectly mated flanges and if it were possible to maintain an intimate contact of those perfectly mated flanges throughout the extremes of operating conditions, a gasket would not be required. This is virtually an impossibility because of:

1. the size of the vessel and/or the flanges
2. the difficulty in maintaining such extremely smooth flange finishes during handling and assembly
3. corrosion and erosion of the flange surfaces during operations.

As a consequence, relatively inexpensive gaskets are used to provide the sealing element in these mechanical assemblies. In most cases, the gasket provides a seal by external forces flowing the gasket material into the imperfections between the mating surfaces. It follows then, that in a properly designed gasket closure, three major considerations must be taken into account in order for a satisfactory seal to be achieved.

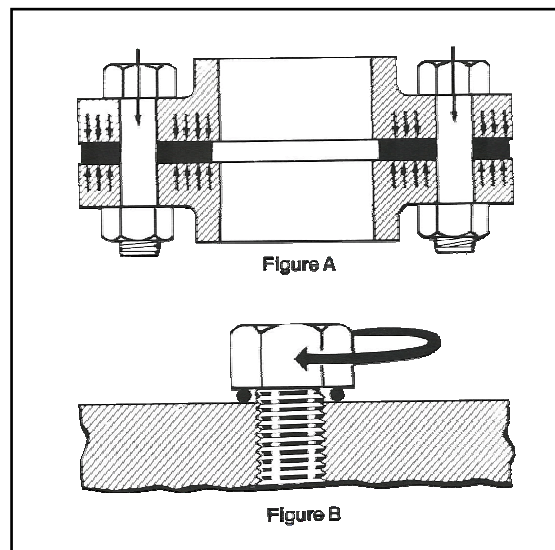
1. Sufficient force must be available to initially seat the gasket. Stating this another way, adequate means must be provided to flow the gasket into the imperfections in the gasket seating surfaces.
2. Sufficient forces must be available to maintain a residual stress on the gasket under operating conditions to ensure that the gasket will be in intimate contact with the gasket seating surfaces to prevent blow-by or leakage.
3. The selection of the gasket material must be such that it will withstand the pressures exerted against the gasket, satisfactorily resist the entire temperature range to which the closure will be exposed and withstand corrosive attack of the confined medium.

Effecting A Seal:

A seal is effected by compressing the gasket material and causing it to flow into the imperfections on the gasket seating surfaces so that intimate contact is mated between the gasket and the gasket seating surfaces preventing the escape of the confined fluid. Basically there are four different methods that may be used either single or in combination to achieve this unbroken barrier.

1. **Compression.** This is by far the most common method of effecting a seal on a flange joint and the compression force is normally applied by bolting. See figure A.
2. **Attrition.** Attrition is a combination of a dragging action combined with compression such as in a spark plug gasket where the spark plug is turned down on a gasket that is both compressed and screwed into the flange. See figure B.
3. **By Heat,** such as in the case of sealing a bell and spigot joint on cast iron pipe by means of molten lead. Note, however, that after the molten lead is poured, it is tamped into place using a tamping tool and a hammer.
4. **Gasket lip expansion.** This is a phenomenon that would occur due to edge swelling when the gasket would be affected by confined fluid, as in the case of electrometric compounds affected by confined fluids, such as solvents, causing the gasket material to swell and increase the interaction of the gasket against the flange faces.

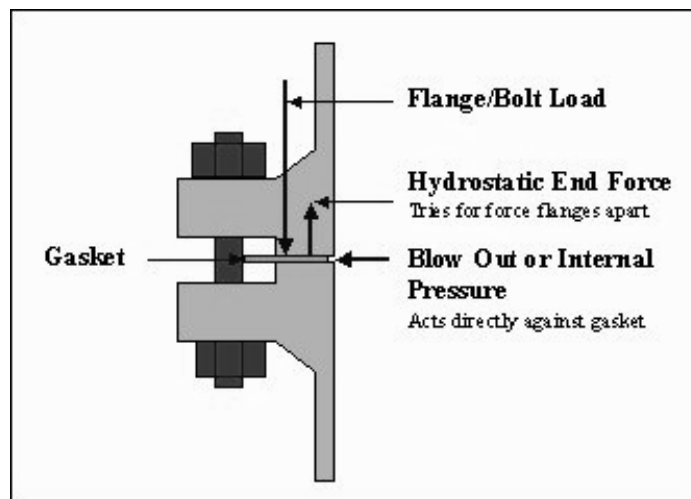
In general, it is considered that only the gasket surface provides the seal in the joint. It is assumed that the gasket material is impervious and will not permit any passage of fluid through the gasket seal.



Gasket Seating:

There are two major factors to be considered with regard to gasket seating. The first is the gasket material itself. The ASME* Unfired Pressure Vessel Code Section VIII, Division 1 defines minimum design seating stresses for a variety of gasket materials. These design seating stresses range from zero psi for so-called self-sealing gasket types such as durometer elastomers and O-Rings to 26,000 psi to properly seat solid flat metal gaskets. Between these two extremes there are a multitude of materials available to the designer enabling him/her to make a selection based upon the specific operating conditions under investigation.

Forces Acting on a Gasket Joint::



1. **The Internal Pressure:** These are the forces continually trying to unseat a gasketed joint by exerting pressure against the gasket (blowout pressure) and against the flanges holding the gasket in place (hydrostatic end force).
2. **The Flange Load:** The total force compressing the gasket to create a seal, i.e. the effective pressure resulting from bolt loading.
3. **Temperature:** Temperature creates thermo-mechanical effects, expanding or contracting the metals, affecting the gasket material by promoting "creep relaxation" which is a permanent strain or relaxation quality of many soft

* ASME – American Society of Mechanical Engineers

materials under stress. The effect of certain confined fluids may become increasingly degrading as temperature rises and attack upon organic gasket materials is substantially greater than at the ambient temperatures (about 75° F). As a rule, the higher the temperature, the more critical the selection of the proper gasket.

4. **Medium:** The liquid or gas against which the gasket is to seal.
5. **General Conditions:** The type of flange, the flange surfaces, the type of bolt material, the spacing and tightness of the bolts, etc.

Each of these factors require consideration before an effective gasket material is finally chosen. However, the proper gasket may often be rejected because failure occurred due to poorly cleaned flange face or improper bolting-up practice. These details require careful attention, but if complied with, will help eliminate gasket blowout or failure.

There are three principal forces acting on any gasketed joint. They are:

1. **Bolt Load** and/or other means of applying the initial compressive load that flows the gasket material into surface imperfections to form a seal.
2. **The hydrostatic end force**, that tends to separate flanges when the system is pressurized.
3. **Internal pressure** acting on the portion of the gasket exposed to internal pressure, tending to blow the gasket out of the joint and/or to bypass the gasket under operating conditions.

There are other shock forces that may be created due to sudden changes in temperature and pressure. Creep relaxation is another factor that may come into the picture. The initial compression force applied to a joint must serve several purposes.

1. It must be sufficient to initially seat the gasket and flow the gasket into the imperfections on the gasket seating surfaces regardless of operating conditions.
2. Initial compression force must be great enough to compensate for the total hydrostatic end force that would be present during operating conditions.
3. It must be sufficient to maintain a residual load on the gasket/flange interface.

From a practical standpoint, residual gasket load must be “X” times internal pressure if a tight joint is to be maintained. The unknown quantity “X” is what is known as the “m”



factor in the ASME Unfired Pressure Vessel Code and will vary depending upon the type of gasket being used. Actually the “m” value is the ratio of residual unit stress (bolt load minus hydrostatic end force) on gasket (psi) to internal pressure of the system. The larger the number used for “m”, the more assurance the designer has of obtaining a tight joint.

Selecting the Proper Gasket Material:

The optimum gasket material would have the following characteristics. It would have the chemical resistance of PTFE, the heat resistance of graphite, the strength of steel, require zero seating stress such as soft rubber and be inexpensive. Obviously there is no known gasket material that has all these characteristics and each material has certain limitations that restrict its use. It is possible to overcome limitations partially by several methods such as including the use of reinforcing inserts, combining it with other materials, varying the construction or density, or by designing the joint itself to overcome some of the limitations. Obviously, mechanical factors are important in the design of the joint but the primary selection of a gasket material is influenced by three factors.

1. **the temperature of the fluid or gas to be contained**
2. **the pressure of the fluid or gas to be contained**
3. **the corrosive characteristics of the fluid or gas to be contained.**

Some of the factors that can influence the corrosion resistance of a particular material at operating conditions are:

1. **Concentration of the corrosive agent. (Full strength solutions are not necessarily more corrosive than those of dilute proportions and, of course, the reverse is also true.)**
2. **The purity of the corrosive agent. For example, dissolved oxygen in otherwise pure water may cause rapid oxidation of steam generation equipment at high temperatures.**
3. **The temperature of the corrosive agent. In general, higher temperatures of corrosive agents will accelerate corrosive attack.**

As a consequence, it is often necessary to “field-test” materials for resistance to corrosion under normal operating conditions to determine if the material selected will have the required resistance to corrosion.

Environmental Considerations:

Obviously, material selection depends on the total environmental spectrum in which any given seal will perform. Thorough analysis of seal function should always begin with consideration of the **four major environmental conditions.**



1. **Media** - Always consider all media that may come in contact with the seal and retainer. Example: if the system is to be cleaned or purged periodically, be sure to anticipate what cleaning fluids will be used. These secondary fluids will play as much a role in selecting the most compatible compound as will the principle operating media.
2. **Pressure** - Proper retainer design coupled with a sound choice of materials will provide a molded elastomer seal capable of withstanding extremely high pressures (e.g. some molded elastomer seals have been tested over 100,000 psi). Similarly, reliable molded elastomer seals configurations can be achieved for extremely low pressure levels that is, ultra hard vacuums down in the 10^{-9} range. It is essential that complete pressure data be submitted with all inquires to assure optimum seal design. This includes maximum and minimum presusures, proof pressures, burst pressure, cycling conditions and pulsations.

Note: Extremely high pressure situations demand adequately structured mating assemblies to maintain metal to metal contact and prevent extrusion of the elastomer.

3. **Temperature** - Temperature, though seemingly elementary is often the most misunderstood and exaggerated of the environmental parameters. Hence, it is all too often OVER SPECIFIED. It should always be born in mind that temperature at the seal itself may vary widely from the ambient condition (sometimes by hundreds of degrees).

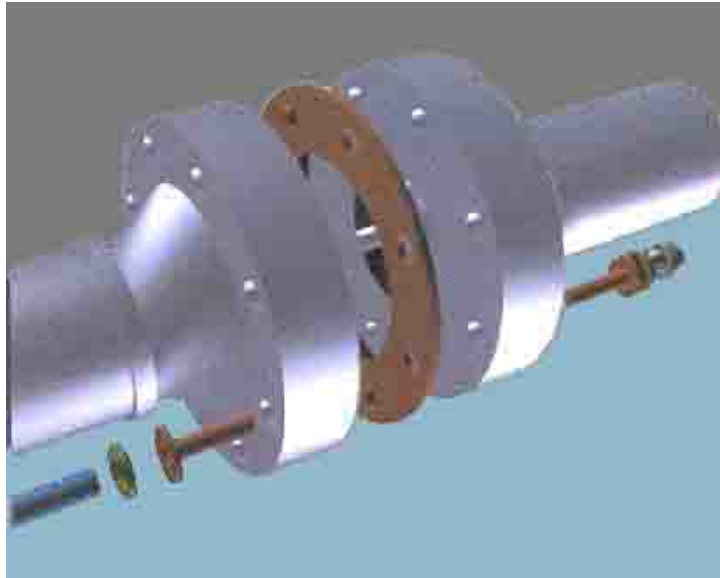
For example: The seal surrounding a water cooling port may never get over 200° F, whereas the temperature in a combustion chamber a mere ¼” away may easily exceed 1,000° F! Low temperature performance, on the other hand, involves a somewhat different consideration...namely the inherent flexibility of the chosen material and its ability to maintain an adequate line of contact.

4. **Time** - The fourth major determinant in material selection is time. Brief temperature excursions up to a temperature level higher than those recommended in the material specifications are often tolerable. Example: The standard Buna-N (Nitrile) is recommended normally for service up to 225° F. However, Nitrile can withstand a much higher temperature for brief periods of time.

Types Of Gaskets:

Type E - Full Face Gaskets

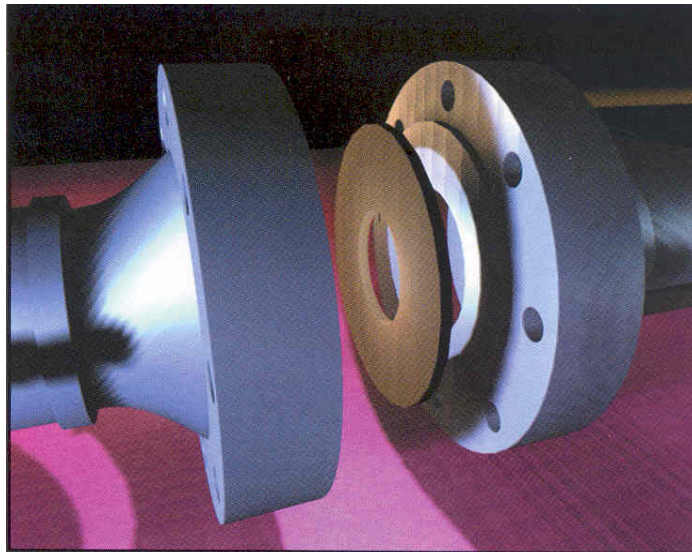
Full face gaskets completely cover the flange face from flange bed to outside diameter. Full face gaskets are used on flat faced flanges, however, can be used with a raised flat face flange to eliminate debris building up in raised area causing a short.



Type "E" Flange and Gasket

Type F - Ring Gasket

Ring Gaskets are designed to set inside the bolt circle and are most commonly used with raised face flanges.



Type "F" Flange and Gasket

Type D - Ring Type Joint (RTJ)

The RTJ is an oval phenolic gasket designed to work specifically with RTJ grooved Flanges. RTJ gaskets are sized by R-number.

A neoprene filler gasket is sometimes used to set on the I.D. of the RTJ gasket to the I.D. of the flange bore. This is to eliminate debris bridging across and causing a short. The RTJ's are made from plates of phenolic, therefore, the gas pressure would be paralleled to the grain allowing the RTJ to work with pressures up to 2,500 PSI.



RTJ Gasket

Type D - BX

BX gaskets are an octagonal shape phenolic gasket designed to work specifically with a BX grooved flange. BX gaskets are machined from phenolic tubing; therefore, the gas pressure would be perpendicular to the grain, allowing the gasket to withstand pressures up to 15,000 PSI.

BX gaskets are supplied with an asbestos-fill gasket which is placed from the O.D. of the BX to inside the bolt circle.

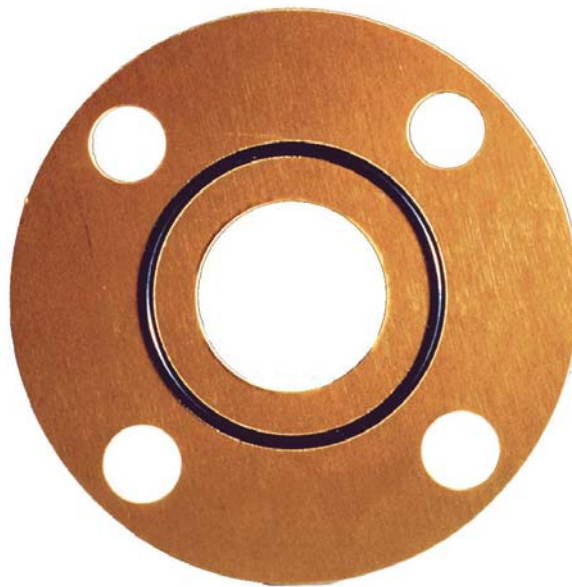


BX Gasket

“Jock” O-Ring Type

The “Jock” O-Ring gasket can be a full face (Type E) or ring gasket (Type F) configuration. The “Jock” has a high-energy O-Ring elastomer seal that compresses and expands to fill any voids as the flange is tightened. The totally encapsulated sealing element prevents gasket blow-out. The O-Ring provides a positive, constant seal with zero environmental leakage. Complete contact of flange and retainer prevents fire failure and reduces exposure of the seal to service fluids and environment. The confined O-Ring seal allows zero “m” and “y” factors to be achieved.

On special request, the “Jock” gasket can replace most sizes of RTJ and BX gaskets. With the versatility of changing the sealing element or the retainer material, the “Jock” can be utilized in most any application.



“Jock” Gasket

Insulating Washers

Central’s standard insulating washers are manufactured from CE Phenolic. The maximum operating temperature is approximately 225° F with a compression strength of 36,400 PSI and a dielectric strength of 300 VPM. Our high temperature insulating washer has a maximum operating temperature of 450° F.

Insulating Sleeves



Central offers insulating sleeves in a variety of materials. Our most standard include Mylar, High Density Polyethylene, Phenolic and Nomex. They are designed to easily be inserted in the bolt hole leaving ample room for the bolt, even when the bolt holes are misaligned. The wall thickness is 1/32" and can be provided for bolt sizes from 1/2" to 3-1/2".

Molded One-Piece Sleeve & Washer

The one-piece sleeve and washer reduces handling (many loose parts) and make-up problems in the field. One glance and an inspector can easily tell if the flange has been properly insulated. A Minlon material should be used because of its high compression strength and superior toughness. A one-piece sleeve and washer is most generally used for one-side flange insulation in that we mold it in a sleeve length, that is on an average, significantly longer than the thickness of a single flange. They can be cut to size for two-side insulation. The maximum operating temperature is 250° F, dielectric strength 420 VPM and compression strength 19,000 PSI.