STATIC SEALS · GASKETS · FLANGES · SEATING STRESS · REFERENCE DOCUMENT · PUBLIC

Gasket selection guide

Choosing a gasket or static face seal — material by media and temperature, the seating stress and bolt load it needs, flange finish, and the failure modes behind most leaks.

REVISION	ISSUED	OWNER	COMPANION
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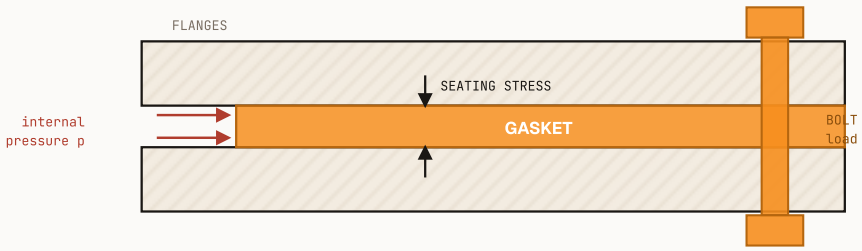
ABSTRACT

A gasket seals a static joint between two faces that can't be machined fine enough to seal on their own. Bolt load crushes the gasket to fill the surface texture (seating), and the remaining clamp must resist the internal pressure trying to unseat or blow it out. Choosing well means matching the material to the media and temperature, then providing enough — and uniform — bolt load.

Section 1 frames static-seal options. Section 2 is gasket types and materials. Section 3 covers seating stress and bolt load (the m and y factors). Section 4 is flange and joint design. Section 5 covers liquid / form-in-place sealants. Section 6 is failure modes and a checklist.

BOLTED FLANGE GASKET — SECTION



A BOLTED FLANGE GASKET. BOLT LOAD CRUSHES THE GASKET INTO THE SURFACE IMPERFECTIONS (THE SEATING STRESS), THEN HAS TO KEEP IT SEATED AGAINST THE INTERNAL PRESSURE TRYING TO BLOW IT OUT — SO IT'S A CLAMP-FORCE PROBLEM AS MUCH AS A MATERIAL ONE.

CONTENTS

1. Static seal options

For a non-moving joint you have several choices; pick by pressure, temperature, media and how the faces are made:

- **Gasket**
  a compressible sheet/ring clamped between flanges; best for larger flat joints and field-serviceable connections.
- **O-ring (in a groove)**
  better for moderate pressure with a machined gland; lower bolt load, reusable (see the
  O-ring selection guide
).
- **Liquid / form-in-place sealant**
  RTV silicone or anaerobic; fills the gap, no cut part, great for covers and irregular faces.
- **Metal seal (RTJ, C-ring)**
  extreme pressure/temperature, precision flanges.

A gasket wins when faces are large, flat and bolted; an O-ring wins when you can machine a groove and want a low-bolt-load, reusable seal.

2. Gasket types and materials

TYPE	MAX TEMP	PRESSURE	MEDIA / STRENGTH	NOTES
Elastomer sheet (NBR/EPDM/FKM/Si)	by elastomer (≤~200 °C)	low–mod	per elastomer compatibility	Soft, low bolt load, cheap; covers/low-pressure
Compressed fibre (CNAF)	~400 °C	high	oils, water, steam	General industrial workhorse
PTFE (virgin / expanded)	~250 °C	mod–high	near-universal chemical	Use **expanded** PTFE to avoid cold-flow creep
Flexible graphite	~450 °C+	high	steam, chemical	High temp; conforms well
Spiral-wound (metal + filler)	high	high	flanged piping	Resilient, recovers after bolt relaxation
Metal ring joint (RTJ)	very high	very high	oil & gas	Needs grooved flanges
Cork / rubber, paper fibre	low	low	oils, fuels (light)	Pans, covers, low-duty
Liquid (RTV / anaerobic)	~200–300 °C	low–mod	per chemistry	Gap-filling (RTV) or rigid metal-to-metal (anaerobic)

Match the gasket *material* to the fluid exactly as you would an O-ring — the elastomer/PTFE/graphite compatibility rules are the same.

3. Seating stress and bolt load

A gasket needs two things from the bolts, and the design must satisfy both:

1. **Seat it** — crush the gasket enough to conform: minimum seating stress **y** (MPa) over the gasket area. `W_seat = y · A_gasket`. 2. **Keep it seated** — resist the pressure end-load plus a margin: the **m** (maintenance) factor sets the residual stress needed under pressure. `W_operate = (pressure end load) + m · p · (contact area)`.

Bolt load must cover the worse of the two. These tie straight into the *Bolted joint* reference — the gasket sets the required preload, and bolt count/size/torque deliver it.

GASKET MATERIAL	M FACTOR	Y SEATING (MPA)
Soft elastomer (<75 Shore A)	0.5–1.0	0 – 1.4
Elastomer with fabric	~1.25	~2.8
Compressed fibre (1.5 mm)	~2.0	~11
PTFE	~2.0	~9
Spiral-wound (SS + graphite)	~3.0	~69
Soft aluminium (flat metal)	~4.0	~60

Values are indicative (ASME VIII Div 1, App. 2 style). Softer gaskets need far less bolt load — but creep more.

4. Flange and joint design

- **Surface finish: soft gaskets actually seal better on a slightly rough, concentric- or spiral-serrated face (Ra ~3.2–6.3 µm) that "bites"; PTFE and metal seals want smoother, flatter faces.**
- **Flatness & rigidity: flanges must stay flat under bolt load**
  thin or widely-spaced-bolt flanges bow between bolts and leak there. Keep bolt spacing tight and flanges stiff.
- **Tighten uniformly in a star/cross pattern in steps to spread the load and avoid cocking the gasket.**
- **Don't over-compress (crush/extrude the gasket) or under-bolt (leak). Use a gasket with the right thickness and width**
  wider needs more total load, thinner creeps less.
- **Blow-out: confine the gasket (raised face, groove, or O-ring style) for high pressure so internal pressure can't push it out.**

5. Liquid and form-in-place sealants

- **RTV silicone (FIPG): flexible, gap-filling, peelable; good for sheet-metal covers and joints that flex or have imperfect faces. Cure needs air/moisture; respect skin-over time.**
- **Anaerobic (flange sealant): cures rigid in the absence of air between close-fitting metal faces; no gap, high strength, excellent on machined housings. Needs clean, close-contact metal.**
- **Both replace a cut gasket where tooling a gasket isn't worth it**
  but require **clean, degreased** surfaces and correct cure before pressurising.

6. Failure modes and checklist

MODE	CAUSE	FIX
Leak at assembly	insufficient seating stress / uneven bolt load	more/uniform preload, correct gasket, star-pattern torque
Leak over time	bolt relaxation, gasket creep (esp. PTFE)	re-torque after seating, use spiral-wound/ePTFE, Belleville washers
Crush / extrusion	over-compression, gasket too soft/wide	harder gasket, confine it, control bolt load
Chemical attack / swell	wrong material	reselect per media compatibility
Thermal relaxation	high-temp creep loses clamp	high-temp gasket, live-loading (springs), re-torque hot
Blow-out	pressure exceeds confinement	confined/raised-face joint, higher bolt load

6.1 Selection checklist

- **Media & temperature**
  choose the material that survives both (Section 2), exactly as for an O-ring.
- **Pressure**
  steady and peak; confine the gasket for high pressure.
- **Seating & operating load**
  from y and m, size the bolt preload (link to the
  Bolted joint
  reference).
- **Flange**
  adequate finish, flatness and tight bolt spacing; star-pattern tightening.
- **Service**
  will it be re-opened? Cut gasket / O-ring for serviceable; sealant for permanent.
- **Relaxation plan**
  re-torque schedule or live-loading for creep-prone or hot joints.