Betech
Improving your products

COMPENDIUM

Choosing gaskets

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CONTENTS

What are gaskets?
Gaskets are materials or material combinations specially designed for fitting between two flanges in order to create a level of tightness which can:

- prevent leakage of a medium between the mating surfaces;
- prevent the ingress of dust, dirt, liquid or foreign matter between the mating surfaces;
- retain a pressure or vacuum within the sealed assembly;
- serve a combination of these purposes.

Definition of static and dynamic seals
Gaskets are basically a means of closing (sealing) openings or protecting joints against the ingress or egress of liquids or gases. Seals can be grouped in two main categories: static and dynamic.

- *Static seals*
  Static seals seal two surfaces which do not move in relation to one another (static applications).

- *Dynamic seals*
  Dynamic seals seal two surfaces which move in relation to one another, e.g. the rotary movement of a shaft in a housing or the reciprocating movement of a rod or piston in a cylinder (dynamic applications). Some seals which were initially designed for dynamic applications are, however, also used for static applications.

Tightness
In static applications, tightness is obtained through contact stress, while in dynamic applications medium pressure also contributes to tightness. For further information on applications and fitting, please refer to our O-ring catalogue.

Gaskets can be grouped in three main categories

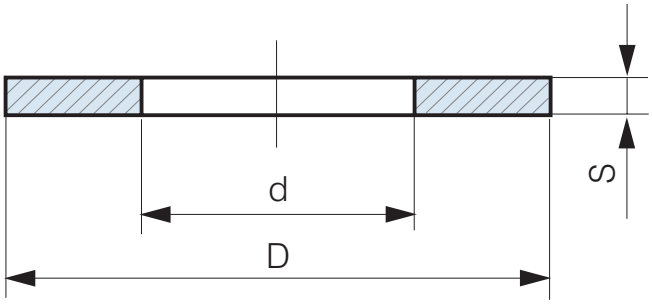
1. Non-metallic gaskets
2. Semi-metallic gaskets
3. Metallic gaskets

1. Non-metallic gaskets

Non-metallic gaskets are made of a variety of polymer materials, rubber cork, various fibre systems, gasket laminates or PTFE materials.

- Rubber gasket sheets are produced in traditional polymer types: NBR, HNBR, EPDM, CR, NR, VMQ and FPM.
- Rubber cork is produced from cork granules of varying size, bonded by means of a polymer of NBR, CR, EPDM or VMQ.
- Fibre systems consist of cellulose fibres, aramid fibres, a combination of fibreglass and aramid, carbon fibres or vermiculite. Fillers are added to the fibres before the material is bonded with rubber.
- Laminated gaskets consist of a stainless steel core coated with gasket material on either side to enhance the tensile strength of the material. Graphite, mica and vermiculite are often used as facing materials.
- PTFE materials include everything from pure PTFE to mono or multi directional types, produced as either sheets or expanded material.

Sheet materials are normally used in applications where pressure is low to intermediate, where aggressive chemicals are present or where temperatures are high.

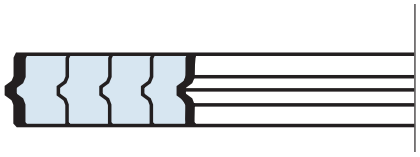


Segmented gaskets

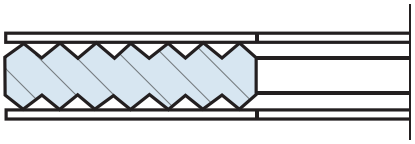
If gaskets are required that are larger than the size of the material used for the application in question, segments are first produced and then joined by means of adhesive bonding, vulcanisation or dovetail joints. Where graphite materials are concerned, dovetail joints can be strengthened using graphite tape. Where the material is FJ2815, a paste is used to enhance the tightness of the joint.

2. Semi-metallic gaskets
Semi-metallic gaskets consist of a metal material joined to either graphite, PTFE or vermiculite. Semi-metallic gaskets can be spiral wound gaskets (SWG), serrated gaskets or metal reinforced gaskets (MRG).

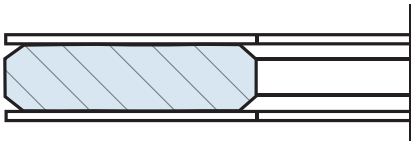
- Spiral wound gaskets consist of a helical profiled metal strip interspersed with graphite, PTFE or the heat-resistant material thermiculite, which acts as the sealing element. Depending on operating conditions, gaskets can be equipped with inner and outer rings.



- Serrated gaskets consist of a milled metal core with a coating of graphite, PTFE or vermiculite as the sealing element.

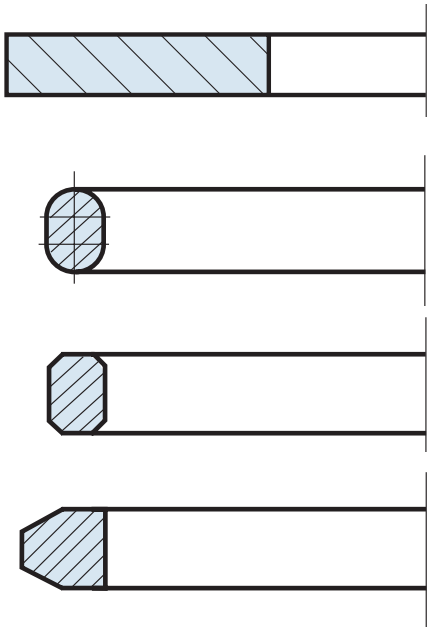


- Metal reinforced gaskets consist of a steel core with a coating of graphite or PTFE as the sealing element.



In semi-metallic gaskets, the metal part gives the gasket strength while the facing material ensures tightness. Such gaskets are used in applications with low, intermediate or high pressure. The temperature they are capable of withstanding depends on the quality of the steel and on the facing material used.

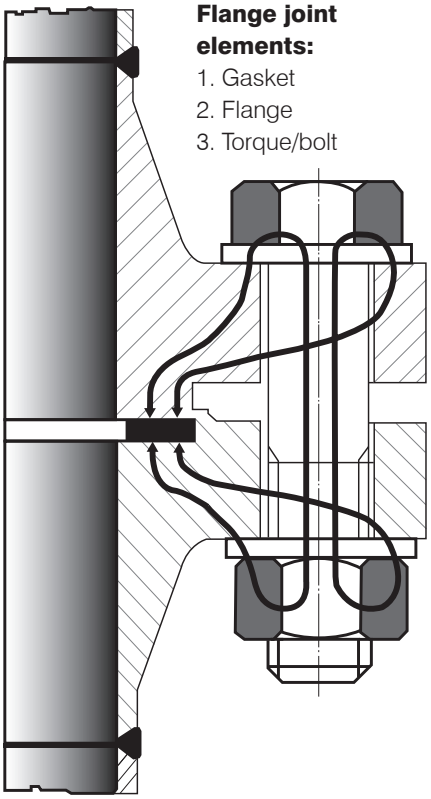
3. Metallic gaskets
Metallic gaskets can be produced in numerous shapes and sizes from various metal alloys. They are primarily used in applications with high pressure or high temperature. Metallic gaskets require high contact stress in order for the gasket to be compressed within the flange joint.



For a gasket to function satisfactorily
it is important that the three elements of a flange joint – the gasket, the flange and the torque – are correctly designed and capable of meeting the requirements of the joint.

Use of unsuitable flange or unsuitable material
Use of unsuitable material may cause the joint to leak, resulting in serious environmental consequences in the form of pollution or fire. Unnecessary down-time may also have major economic consequences.

*Gaskets should therefore never be judged on the basis of price but on their ability to seal the joint during its **entire** service life.*



Flange joint elements:
1. Gasket
2. Flange
3. Torque/bolt

Extensive product range
Betech offers a comprehensive product range, in which we supplement our own products with products from the world's leading manufacturers. As we develop, manufacture and supply products, we are an obvious sparring partner should you require sound advice on which product best meets your particular needs.

We are always pleased to discuss the possibilities as early as the design phase and work closely with our customers' development departments. This approach ensures the best, most reliable and highest quality solutions, which, at the end of the day, lead to significant savings and superior products.

Gasket properties
Gaskets are not only used to create seals. They can also be used to protect a product or its surroundings from wear and scratching, e.g. in a fashion similar to felt pads. Numerous foam materials capable of dampening noise and/or vibration are also available. If the foam material is very porous in structure, it can also be used for air or liquid filtering purposes, e.g. in cooker hoods, etc.

By combining the material with wire gauze or similar, a filter gasket can be produced which is capable of capturing large or small particles depending on the mesh diameter of the gauze. The gasket can also prevent foreign matter from entering the system concerned via air ducts, etc.

Applications which require low contact stress
Foamed or expanded materials of rubber or plastic are used in applications with low contact stress, e.g. cover seals for motors, electrical cabinets, etc. As such covers are often made of plastic with relatively large distances between the bolts, a material with high compressibility at low contact stress is required. The joint should be equipped with compression stops in order to prevent the material from being subjected to excessive stress.

Controlled compression
Combination gaskets can be manufactured from various materials for joints where contact stress is insufficient or where controlled compression of the gasket material is required. With such so-called "sub" gaskets, the available contact stress is used to create the seal while the combination material is used to relieve stress, thus preventing the compressed part of the gasket from being subjected to excessive stress.

Differences in contact stress
In applications with pressed metal flanges or large distances between the bolts, it may be advantageous to use materials with controlled swelling properties, i.e. materials capable of compensating for insufficient contact stress between the bolts by swelling on contact with the medium to be sealed.

Inner ring
Gasket materials which are primarily used for manifolds and exhaust systems are often equipped with an inner ring of steel or copper on the side of the joint facing the medium. Such inner rings serve two purposes: Firstly, as high-temperature materials are often relatively permeable to gases, they improve the gas tightness of the material. Secondly, they allow high contact stress on the side of the joint facing the medium.

An additional advantage of fitting an inner ring to a gasket is that the gasket material is not in physical contact with the medium and is thus protected from wear and chemical and temperature dependent deterioration. It is therefore possible to broaden the range of applications for which specific gasket materials can be used, both from the point of view of temperature and medium, by fitting an inner ring.

Fibreglass and ceramic products
Various types of fibreglass and ceramic products are ideal for packing and insulation at very high temperatures, including cords, tapes, tubes, sheets, paper, blankets and cloths. Such products are used in electrical equipment and machines, for thermal insulation of combustion chambers, and in the steel and smelting industries. The materials are suitable for temperatures of up to 1200°C.

For applications which require high gas tightness, laminated gaskets based on mica and vermiculite are used. Such materials can withstand temperatures of up to 900°C.

Crucial factors when choosing gaskets or gasket materials

The most important requirements on the gasket or material concern:
1. tightness
2. durability
3. loosenability
4. thermal conductivity
5. elasticity

The way in which these factors affect the choice of gasket material is described below.

1. Tightness
Every gasket must provide a certain degree of tightness. However, gaskets are used in an extremely wide variety of operating conditions. Most importantly, gaskets must be capable of withstanding certain pressures and temperatures. They must also be capable of resisting the effects of various media, e.g. superheated steam, engine exhaust, air, oil, chemicals, etc.

Furthermore, it is important to ensure that the chosen gasket can resist the mechanical stress to which it is subjected – in particular the internal pressure it must seal. It must also be capable of withstanding the chemicals to which it is exposed, preventing it from being corroded or dissolved, and the temperatures to which it is subjected, high or low.

As the various gasket materials are capable of resisting different maximum contact stress, it is important to consider the relationship between the part of the gasket subjected to stress and the material thickness.

If the gasket is to be used in screwed connections, it may easily become warped or buckled. This must therefore also be taken into account when choosing a suitable material.

When designing and dimensioning a joint, force lines in the assembly must be considered in order to ensure the best possible connection.

Before choosing a gasket material, it is thus important to know the mechanical, chemical and temperature-related stresses it must be capable of resisting.

2. Durability
It is important that the physical properties of the gasket material do not change during use. If an unsuitable material is chosen the gasket may gradually lose its elasticity, become brittle or disintegrate.

Long service life can only be assured by choosing a material which is suitable for the intended purpose.

Thanks to technological advances, a correctly chosen gasket can now be expected to last for as long as the machine parts it is designed to seal.

3. Loosenability
In many cases, it is important that the gasketed joint must be loosenable, i.e. that the gasket can be removed without damaging the contact surfaces. As standard, most gasket materials are treated with silicone to provide a "non-stick" surface. In special circumstances this may be replaced with a coating of graphite or PTFE on one or both sides.

4. Thermal conductivity
When choosing gasket material, it is sometimes necessary to take into account whether the gasket is to act as a heat conductor or to provide insulation against heat loss. Gasket materials with a wide range of thermal and electrical conductances are thus available.

The consequences of choosing an unsuitable gasket material or type may be catastrophic – both with respect to safety and to the environment (pollution, fire, etc.).

5. Elasticity
The elasticity of the gasket material can also play an important role in its use. If the material is to provide a tight seal throughout its expected service life, it must be capable of compensating for small flange misalignments, surface defects, etc., partly by means of the contact stress applied and partly through its elasticity.

Approvals

The various materials have various approvals or meet the requirements of public or other testing authorities:

DVGW	German approval of materials used in gas applications.
SVGW	Swiss approval of materials used in gas applications.
ÖVGW	Austrian approval of materials used in gas applications.
KTW	German approval of materials used in cold and hot water applications.
W270	German supplement to KTW concerning microbiological applications.
WRAS	British approval of materials used in hot and cold water applications.
FDA	US requirements on materials used with food.
UP401	Gaskets for high thermal loads in fittings and flanges of gas metres and pressure control equipment.
HTB	Gaskets for gas meter connections to DIN 3376 Parts 1 and 2, with reference to DIN 3374.
Fire Safe Test TÜV	Dutch institute at which gasket materials are tested.
BAM	Approval of gasket materials for flange joints in oxygen piping and fittings.
TA Air	Materials which comply with the requirements of VDI 2440.

Examples of Betech's standard gasket materials and approvals

FJ no.	DVGW	SVGW	ÖVGW	KTW	W270	WRAS	FDA	VP401	BAM	HTB	TA Air
2634	x	x	x	x	x	x	x	x	x	x	x
2639	x	x		x		x					
2662	x	x		x		x		x	x	x	x
2663	x	(x)		(x)						x	x
2677	x			(x)				x	x	x	x
2690											
2698											
2912C							x				
2912D							x				
2912C							x				

(X) Presently being tested

Contact stress

A gasket material will shrink considerably if subjected to excessive contact stress. The elasticity of the material is thus affected, preventing it from compensating for fluctuations in contact stress.

Maximum permissible contact stress

Individual gasket materials have their own specific maximum permissible contact stress depending on temperature and material thickness. Thin gasket materials can always withstand higher contact stress than thick materials. The thinner the material, the higher are the requirements on flange joint parallelism and surface roughness.

Blow out

If the gasket material is soft, the pressure between the gasket and flange must provide sufficient friction to prevent the gasket from being extruded from the joint, a phenomenon known as "blow out".

Hydrostatic end force

When a joint is subjected to internal pressure, the pressure will attempt to force the joint apart, thus reducing the contact stress on the gasket. Such internal pressure, also known as "hydrostatic end force", must be taken into consideration when calculating the minimum contact stress during operation and the testing stress, which in the majority of cases will be much higher than the operating contact stress.

Bolt tightening and lubrication

To ensure the correct contact stress, bolts should be tightened using a torque wrench. In addition, bolts, nuts and washers should be lubricated in order to reduce friction and enhance bolt preloading.

The estimated friction coefficient of lubricated joints is 0.14 while that of non-lubricated joints is 0.3.

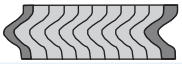
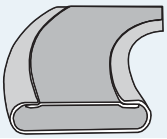
Gasket thickness

Gaskets should always be as thin as possible in order to achieve maximum strength and minimum leakage through the gasket material.

The necessary material thickness is determined by the following parameters:

- Surface roughness: the lower the Ra value, the thinner the gasket.
- Compressibility: the lower the compressibility, the thicker the gasket.
- Contact stress: the higher the contact stress, the thinner the gasket.

Requirements on flange roughness

Gasket type	Gasket cross section	Flange surface finish, microinch Ra	Flange surface finish, micrometre Ra
Spiral wound gaskets		**125 – 250**	**3.2 – 6.3**
Flexpro gaskets		**125 – 250**	**3.2 – 6.3**
Metallic serrated gaskets		**Max. 63**	**Max. 1.6**
MRG		**125 – 250**	**3.2 – 6.3**
Solid metal gaskets		**Max. 63**	**Max. 1.6**
Metal jacketed gaskets		**100 – 125**	**Max. 2.5**
Soft cut sheet gaskets		**Material thickness** < 1.5 mm 125 – 250 **Material thickness** ≥ 1.5 mm 125 – 500	**Material thickness** < 1.5 mm 3.2 – 6.3 **Material thickness** ≥ 1.5 mm 3.2 – 12.5

Important - Under no circumstances should flange sealing surfaces be machined in a manner which leaves tool marks extending radially across the sealing surface. Such tool marks are practically impossible to seal regardless of the type of gasket used.

Gasket materials and contact stress

The usual contact stress ranges of various gasket materials are listed below. Note, however, that medium pressure, temperature and gasket thickness must also be taken into account.

Material type	Min. MPa	Max. MPa
Rubber cork	2	7
Rubber materials	2	10
Cellulose materials	5	70
Fibre-based gasket materials	20-30	80-180
Graphite laminates/vermiculite	20	110-160
High-pressure graphite	30	500
SIGMA	13	195
SWG graphite/PTFE/vermiculite	50	150
SWG IR	50	300
Serrated gaskets, graphite/PTFE	20	500
MRG gaskets, graphite	20	110
Metal gaskets RTJ, soft iron	235	525
RTJ F 5	400	900
RTJ AISI	335	750

Gasket parameters to DIN 2505 E 4/90

Material	Thickness	N/mm2 σ_{VU}	N/mm2 σ_{VO}	N/mm2 σ_{BO} 100°C	N/mm2 σ_{BO} 200°C	N/mm2 σ_{BO} 300°C
FJ 2639	1.5	18	95	60	15	
	2.0	23	80	55	10	
	3.0	25	70	50	10	
FJ 2662	1.5	23	135	60	24	
	2.0	26	115	55	22	
	3.0	28	70	43	18	
FJ 2663	1.5	20	255	113	67	
	2.0	22	240	102	63	
	3.0	28	150	84	52	
FJ 2677	1.5	25	260	126	74	
	2.0	27	240	110	68	
	3.0	29	200	88	56	
FJ 2634	0.5	35	250	140	90	
	1.0	35	220	120	80	
	2.0	30	180	100	60	
	3.0	20	160	90	40	
FJ 2690	2.0	20	140	140	140	140
FJ 2698	2.0	20	160	150	150	150
FJ 2815	1.6	20	180	140	115	90
FJ 2912C	2.0	13	195	130	70	
FJ 2912 D	2.0	16	228	164	100	
FJ 2912 D	2.0	16	190	135	80	

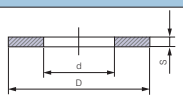
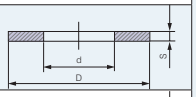
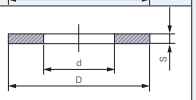
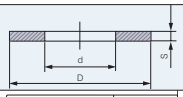
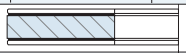
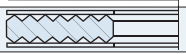
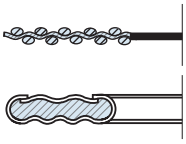
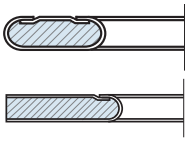
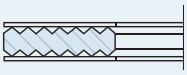
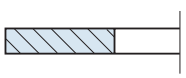
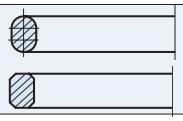
Definitions:

σ_{vu} Minimum required gasket stress during assembly
σ_{vo} Maximum permissible gasket stress during assembly
σ_{BO} Maximum permissible gasket stress during operation

Calculations for ASME boilers and pressure vessels

Gasket materials and sealing surfaces

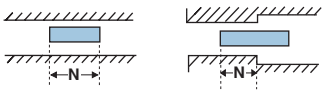
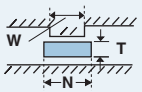
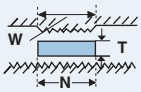
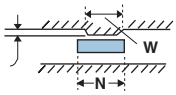
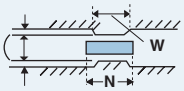
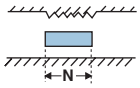
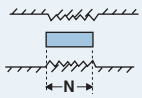
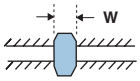
Gasket factor (m), operating conditions and minimum seating stress (y)

Gasket material		Gasket factor (m)	Minimum design seating stress (y) (psi)	Sketches and slot groups	Seating width (see table)	
					group	column
Elastomers without liner below 75 Shore A 75 Shore A and above		0.50 1.00	0 200		(1a), (1b) (1c), (1d) (4), (5)	II
Elastomers with liner		1.25	400			
Fibre-based gasket materials		1.75	1100			
Graphite sheets	FJ2695 foil FJ2690 FJ2698	2.00 2.00 2.00	900 900 2500		(1a), (1b)	
MRG gaskets		2.0	2500		(1a), (1b)	
Serrated gaskets		2.0	2500		(1a), (1b)	
Spiral wound gaskets, standard type		3.0	10000		(1a), (1b)	
Spiral wound gaskets, LS type		3.0	5000		(1a), (1b)	
Corrugated metal gaskets with gasket material or corrugated metal beaded with liner	Soft aluminium Soft copper or brass Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	2.50 2.75 3.00 3.25 3.50	2900 3700 4500 5500 6500		(1a), (1b)	
Corrugated metal	Soft aluminium Soft copper or brass Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	2.75 3.00 3.25 3.50 3.75	3700 4500 5500 6500 7800		(1a), (1b) (1c), (1d)	
Smooth metal beaded with liner	Soft aluminium Soft copper or brass Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	3.25 3.50 3.75 3.50 3.75 3.75	5500 6500 7600 8000 9000 9000		$(1a)_2$, $(1b)_2$ (1c), (1d) (2)	
Machined metal	Soft aluminium Soft copper or brass Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	3.25 3.50 3.75 3.75 4.25	5500 6500 7600 9000 10100		(1a), (1b) (1c), (1d) (2), (3)	
Pure metal gaskets	Soft aluminium Soft copper or brass Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	4.00 4.75 5.50 6.00 6.50	8800 13000 18000 21800 26000		(1a), (1b) (1c), (1d) (2), (3) (4), (5)	I
Ring type joint (RTJ) gaskets	Iron and soft steel Monel with 4-6% chromium Stainless steel and nickel-based alloys	5.50 6.00 6.50	18000 21800 26000		(6)	

Note:
This table lists the most commonly used gasket materials and sealing surfaces. The suggested design values for m and y have proved to be satisfactory during operation with the effective sealing surfaces (b) shown in the table on the following page. The design values and other information given in the table are for guidance only and are not obligatory.

Calculations for ASME boilers and pressure vessels

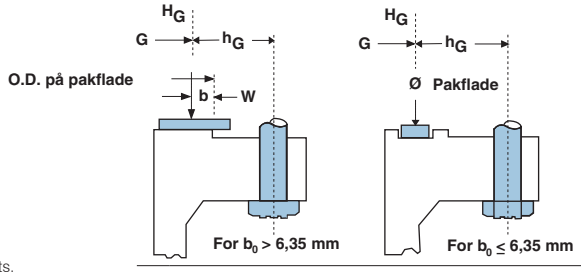
Effective width of sealing surface – see note (1)

Sketch of sealing surface, enlarged	Effective width of sealing surface, b_0	
	Column I	**Column II**
(1a) 	$\frac{N}{2}$	$\frac{N}{2}$
(1b) See note (2) 		
(1c)  W ≤ N	$\frac{W+T}{2}$; $\left(\frac{W+N}{4}\text{ max.}\right)$	$\frac{W+T}{2}$; $\left(\frac{W+N}{4}\text{ max.}\right)$
(1d) See note (2)  W ≤ N		
(2) 0.4 mm elevation  W ≤ N/2	$\frac{W+N}{4}$	$\frac{W+3N}{8}$
(3) 0.4 mm elevation  W ≤ N/2	$\frac{N}{4}$	$\frac{3N}{8}$
(4) See note (2) 	$\frac{3N}{8}$	$\frac{7N}{16}$
(5) See note (2) 	$\frac{N}{4}$	$\frac{3N}{8}$
(6) 	$\frac{W}{8}$	

Effective width of sealing surface, b

$b = b_0$ if $b_0 \leq 1/4"$; $b = 0.5\sqrt{b_0}$ if $b_0 > 1/4"$

Positioning gasket force



Notes:

(1) Gasket factors only apply to gaskets within the bolts.

(2) Where roughness does not exceed 0.4 mm in depth with 0.8 mm distance in width, sketches (1b) and (1d) should be used.

Designations

Designations of several characteristics relevant to the choice of gasket are listed below. All designations are from DIN 28090 September 1995.

Symbol	Designation	Unit
A	Gasket area	mm^2
b_D	Gasket width	mm
d_D	Gasket diameter in centre of gasket area	mm
d_1	Inside diameter of gasket	mm
d_2	Outside diameter of gasket	mm
F_1	Internal pressure	N
F_{DBU}	Minimum required tightening force during operation	N
F_{DVU}	Minimum required tightening force during assembly	N
F_{SBU}	Minimum bolt force during operation	N
F_{DBO}	Maximum permissible tightening force during operation	N
F_{DVO}	Maximum permissible tightening force during assembly	N
S	Safety factor	
p	Internal pressure	N/mm^2
F_{SBO}	Maximum bolt force during operation	N
σ_{vu}	Minimum required gasket stress during assembly	N/mm^2
σ_{vo}	Maximum permissible gasket stress during assembly	N/mm^2
σ_{BU}	Minimum required gasket stress during operation	N/mm^2
σ_{BO}	Maximum permissible gasket stress during operation	N/mm^2
m	Gasket factor	
F_{SO}	Bolt force during assembly	N

DIN 2505 calculation

F_{DBU} is the minimum required tightening force during operation if joint tightness is to be assured. The safety factor (S = 1.2) allows for unforeseen conditions during operation. A safety factor of 1.3 can be used for gasket sheets.

$F_{DBU} = d_D \times \pi \times b_D \times \sigma_{BU} \times S$, where $\sigma_{BU} = m \times p$

$F_{DBO} = d_D \times \pi\, b_D \times \sigma_{BO}$

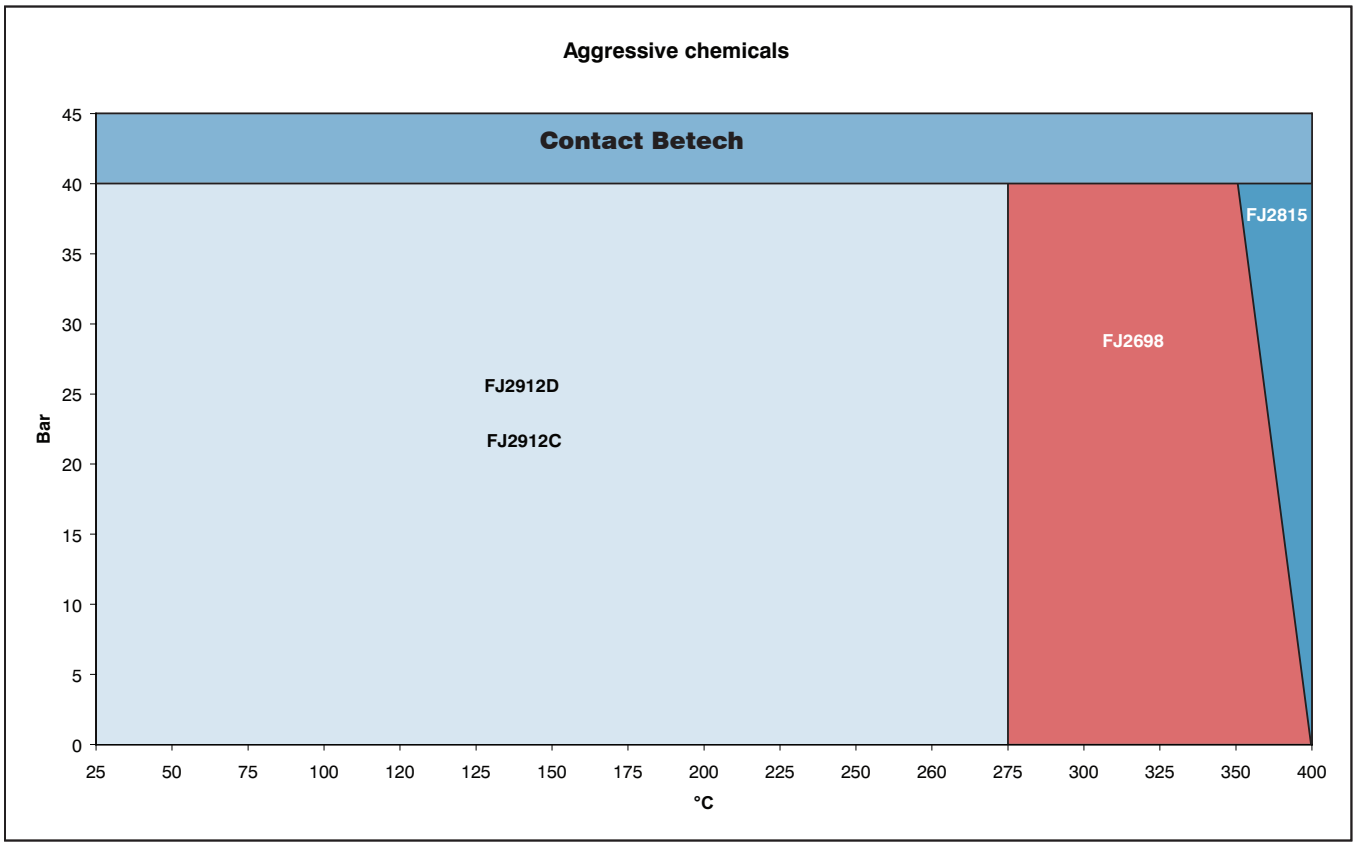
F_1 is the force generated by the internal pressure.

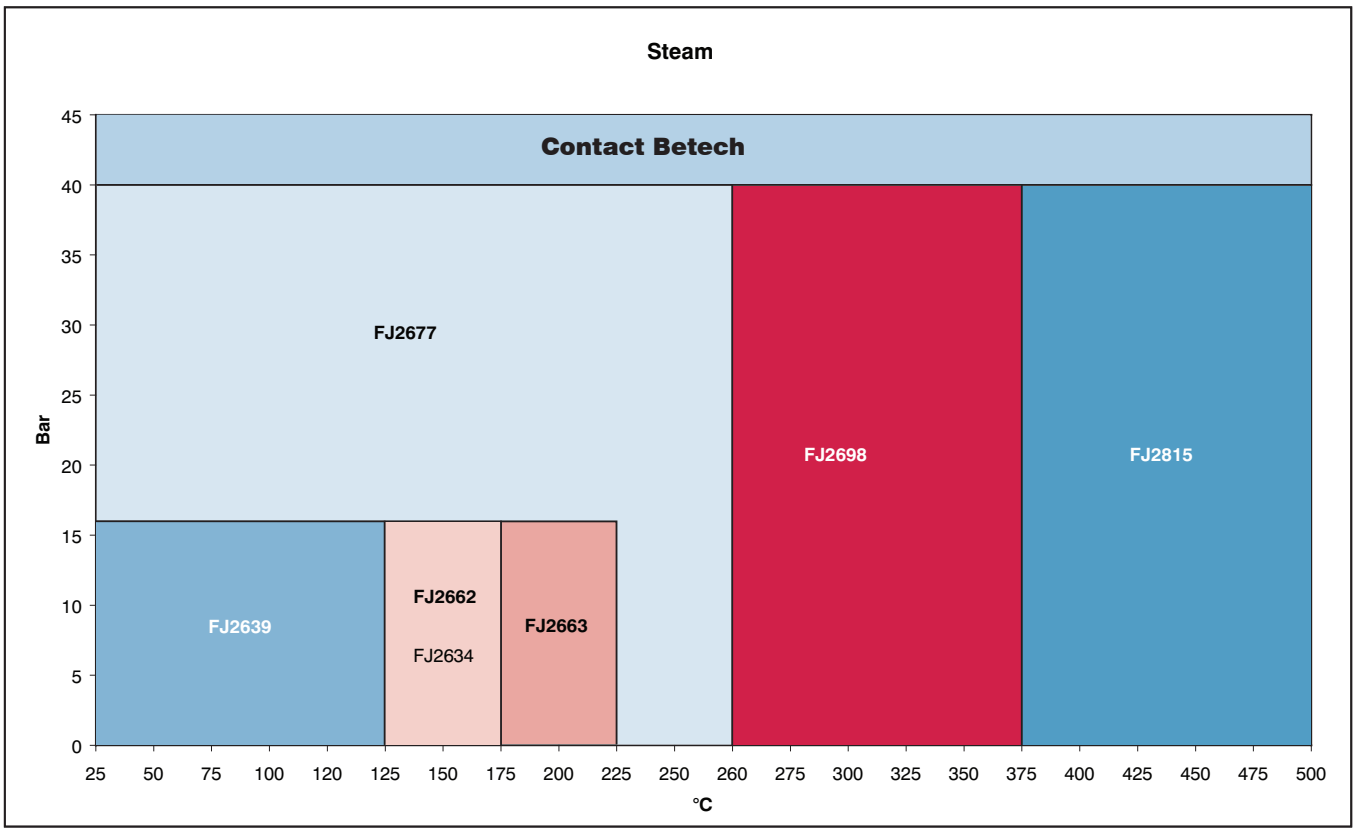
$F_1 = d_D^2 \times \pi \times p / 4$

$F_{SBU} >= F_{DBU} + F_1$

Applications

The specified gaskets can be used under the conditions shown without further testing if due regard is given to bolt tightening. See page 12.





Applications

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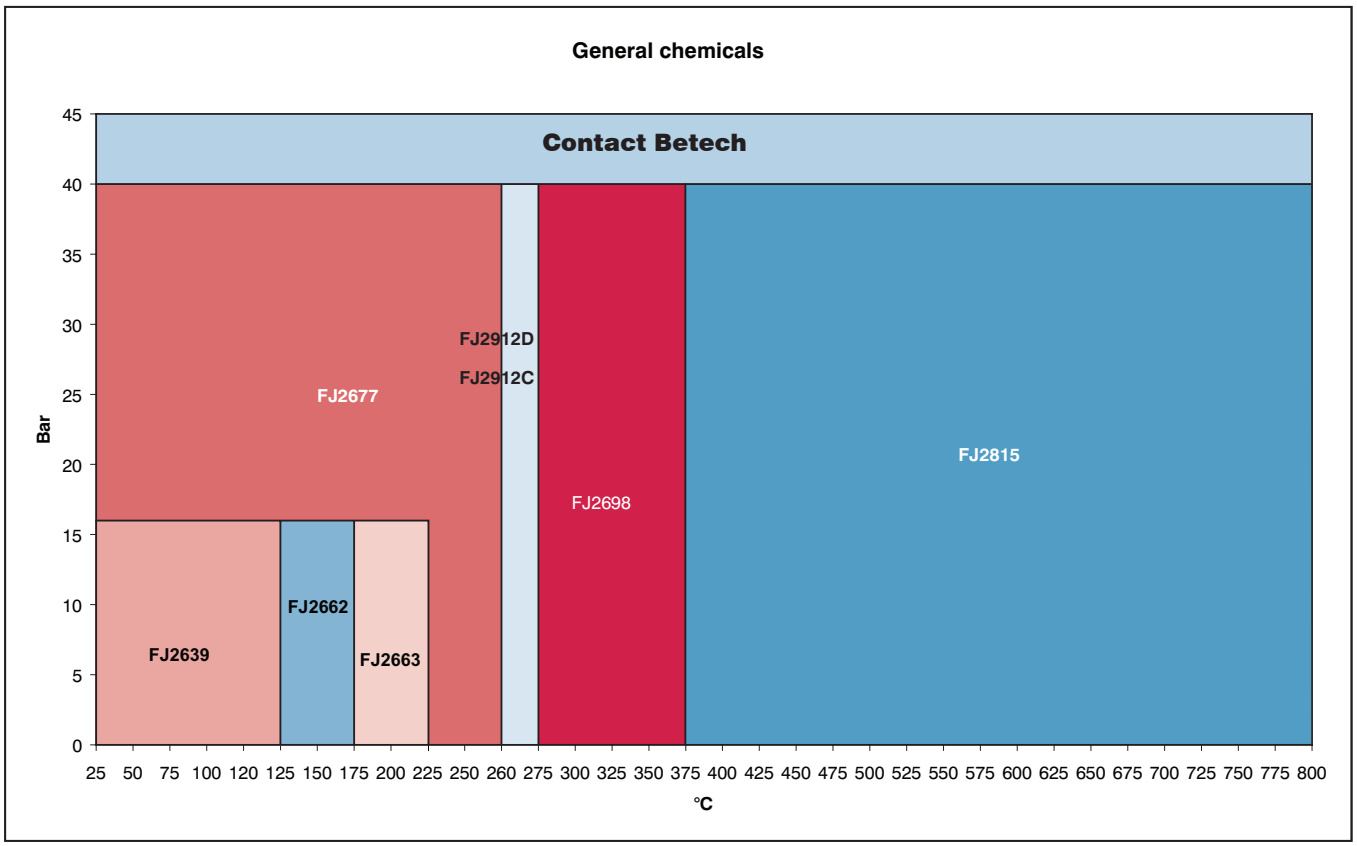
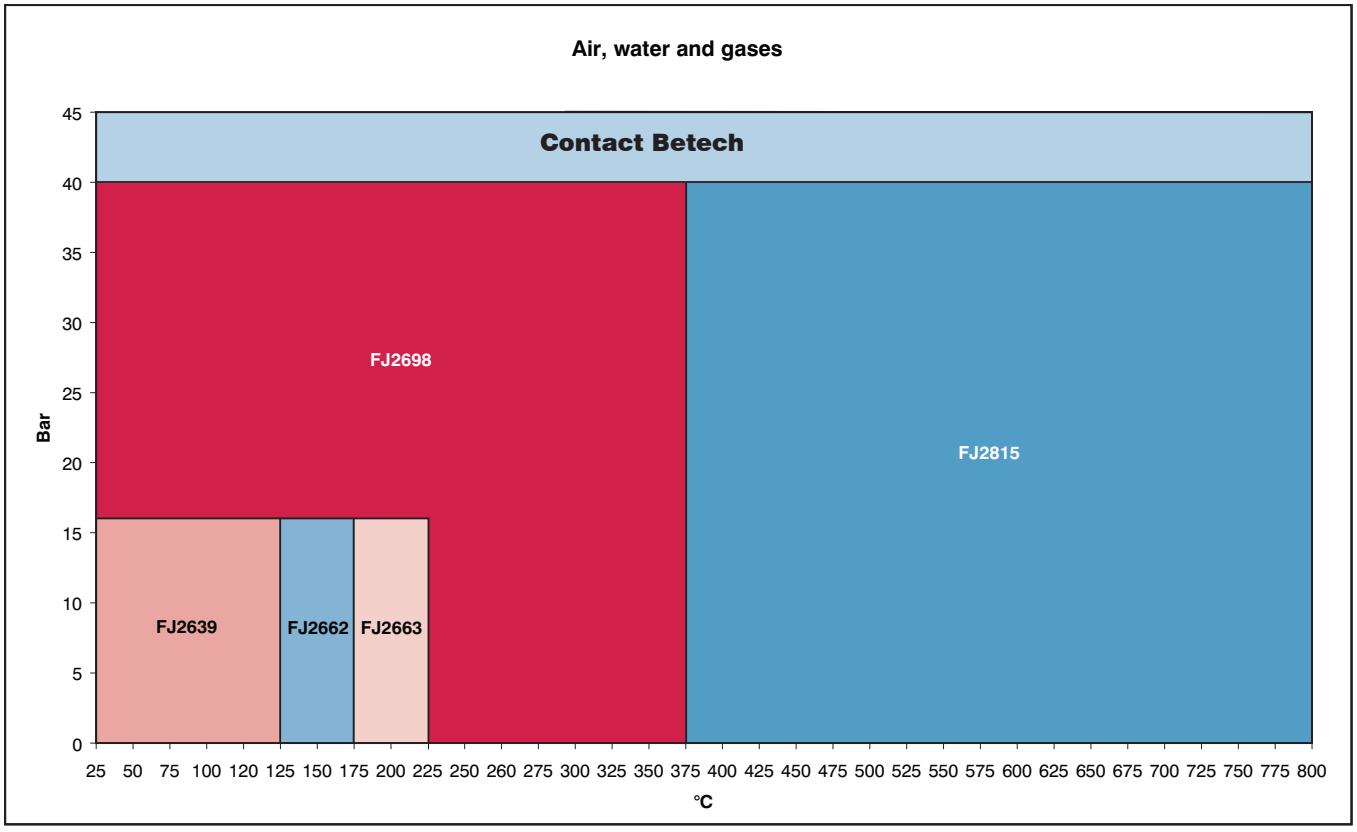




Fitting gaskets
To obtain a reliable flange joint, it is imperative that the gasket be fitted correctly.

It is also important that the bolts and surfaces to be sealed are selected in accordance with the contact stress required by the chosen sealing material or gasket.

Clean the sealing surfaces thoroughly without scratching them and ensure that they are completely dry. Check the bolts, nuts and washers for defects and rust. Clean or replace if necessary.

Bolts, nuts and washers should be lubricated on all load-transmitting surfaces.

Check that the gasket has the correct shape, is made of suitable material and is free of imperfections and scratches. Always use dry gaskets.

Position the gasket carefully between the flanges. Never use joint paste, release agents, grease, etc. on the gasket or flanges.

Bring the flanges together and tighten the bolts with your fingers. Where large flanges are concerned, a wrench should be used.

Always use suitable tools, i.e. a calibrated torque wrench or other approved tensioner.

To ensure uniform distribution of contact pressure, the bolts must be tightened in a cross-pattern sequence to the recommended torque in five steps:

1) Tighten the bolts by hand.

2) Tighten to approx. 30% of the recommended torque.

3) Tighten to approx. 60% of the recommended torque.

4) Tighten to 100% of the recommended torque.

5) Re-tighten to 100% torque in a clockwise sequence to ensure uniform contact stress.

For safety reasons, never reuse a gasket.

Storing gaskets
Fibre-based gasket materials consist of various fibre systems, fillers and polymers, all of which are subject to ageing. As a result, the mechanical properties of the gasket change over time.

Gaskets should never be stored for more than two or three years and must:

- always be stored in a cool, dark place – protected from sources of heat and direct sunlight;
- always be stored in a dry environment;
- always be stored away from any sources of electrical discharge (ozone production);
- always be stored horizontally;
- never be hung from a nail or folded.

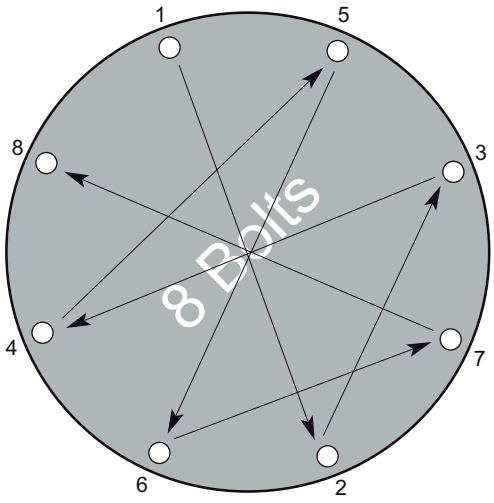
Gaskets of PTFE or graphite are not subject to ageing in the same way as fibre-based gaskets, but should also be stored horizontally.

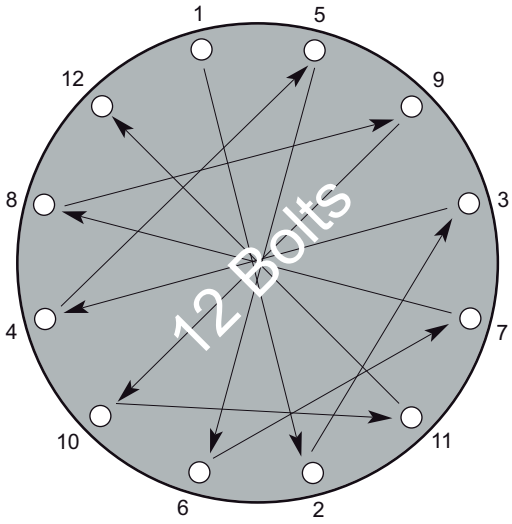
Trouble Shooting

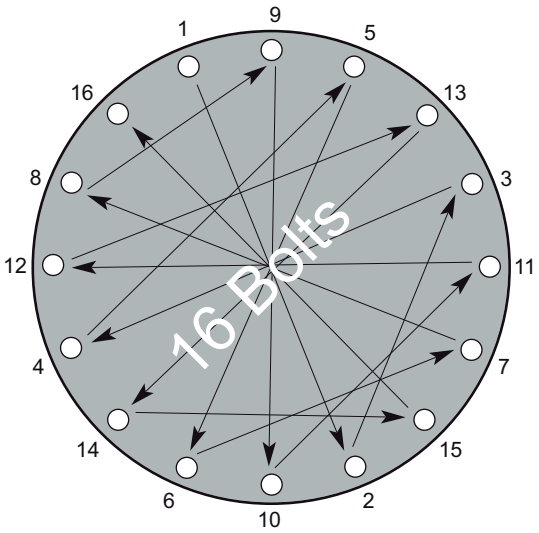
Good preparation ensures good performance

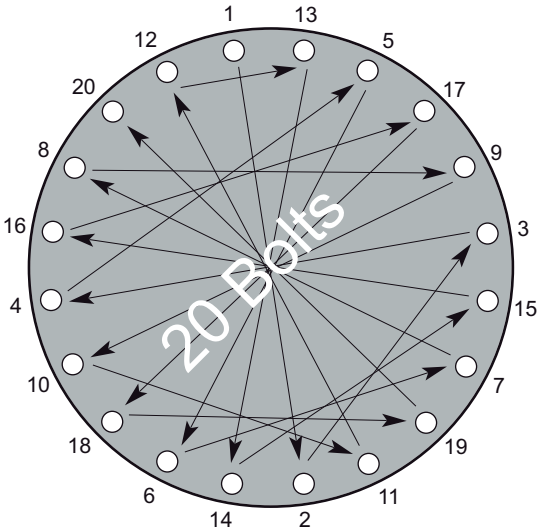
- Handle with care
- Keep in package
- Protect from damage and the weather
- Stack; don't hang
- Check flange surfaces for correct finish, blemishes, flatness etc.
- Verify that proper stud material is being used
- Check condition of studs and nut
- If washers are used they must be hardened
- Lubricate threads and bearing surface of nuts
- Don't apply any compounds or pastes on the gasket
- Use the correct, *new* gasket
- Don't secure the gasket to the flange with duct tape
- Use a cross bolting pattern in incremental steps; then go bolt-to-bolt
- Apply sufficient load

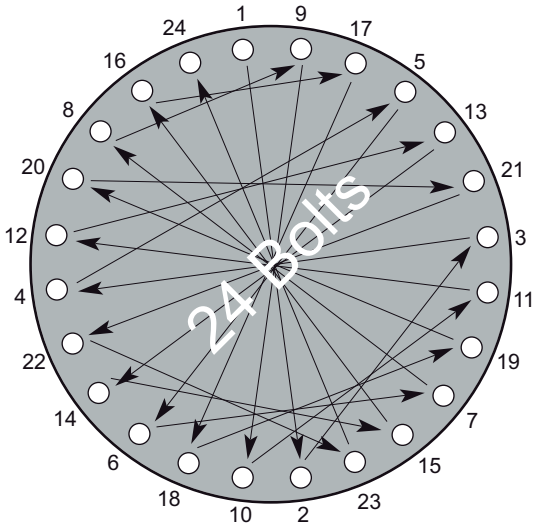
Bolt tightening sequences



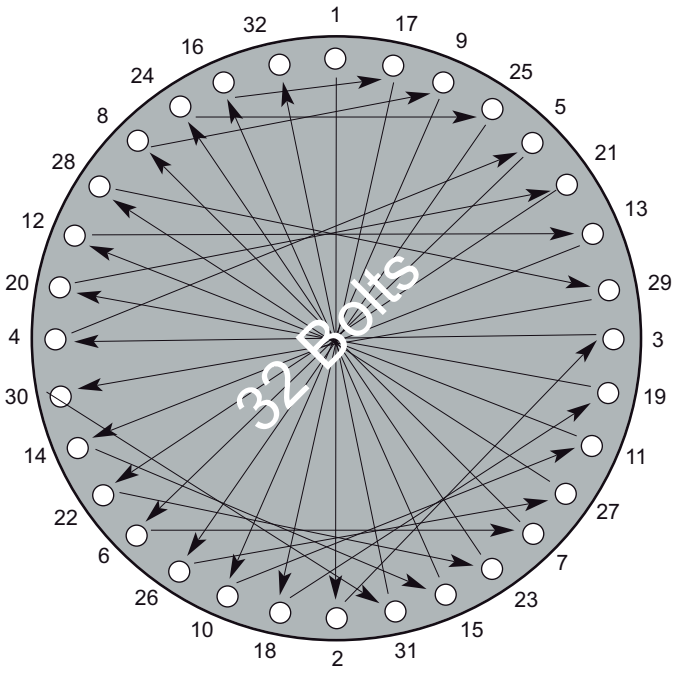


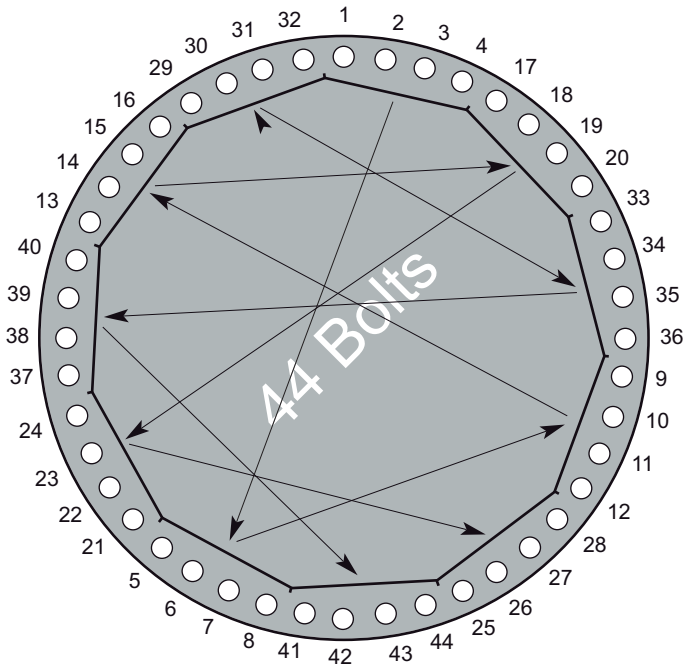


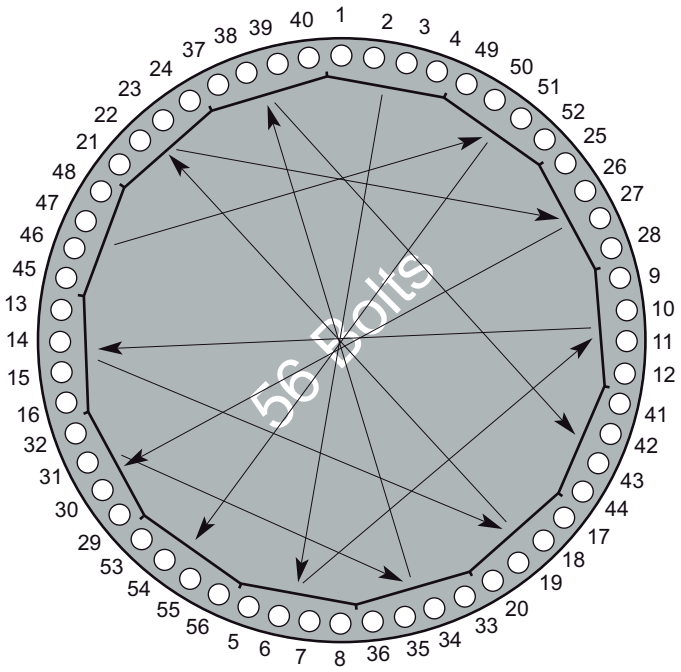


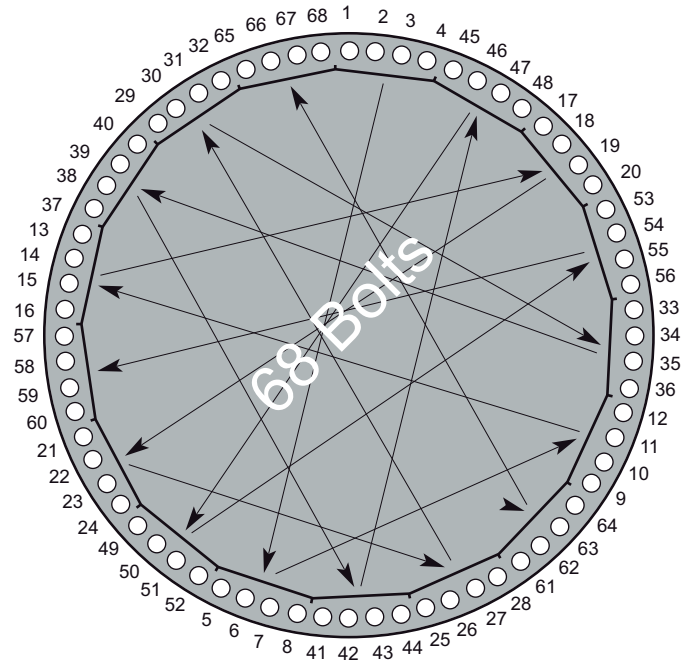


Bolt tightening sequences









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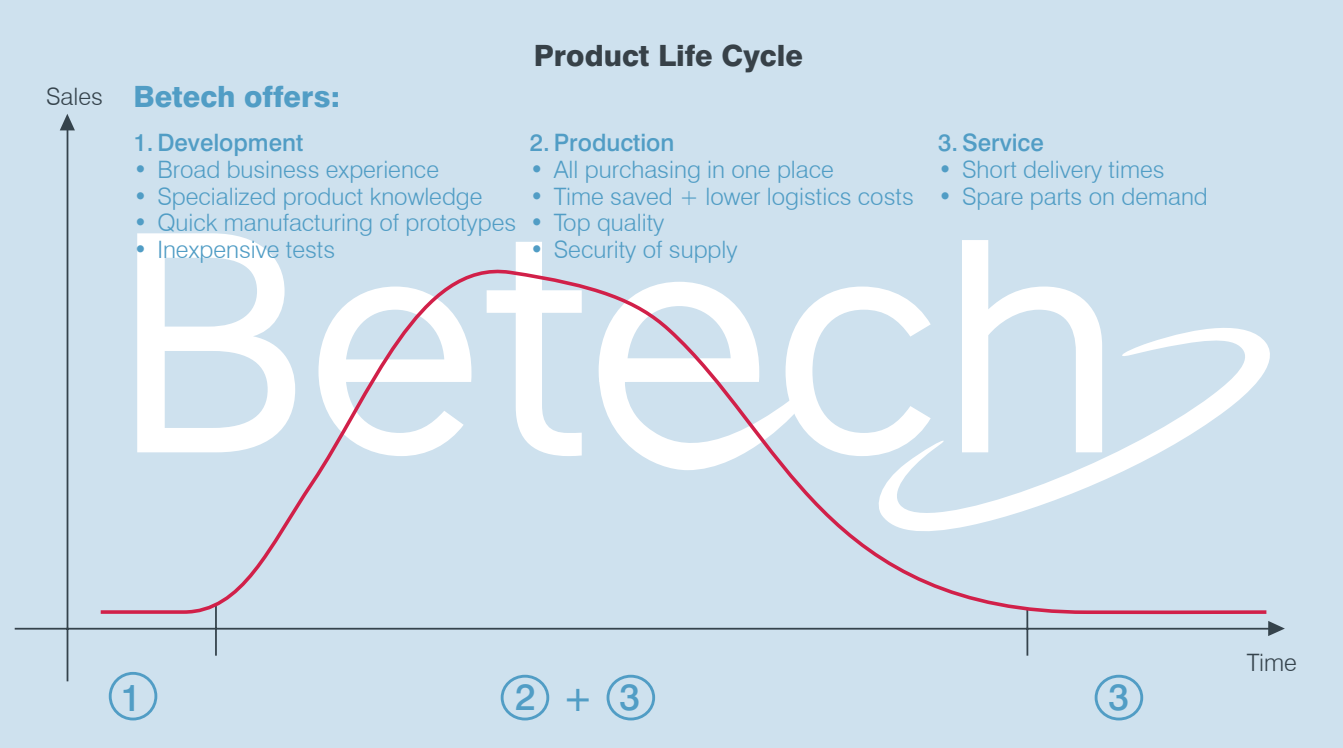

When you enter into a collaboration with Betech, you get:

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- An innovative and solution-oriented sparring partner all the way from design to manufacturing and maintenance
- A total supplier with an extensive product portfolio and fast and flexible delivery

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