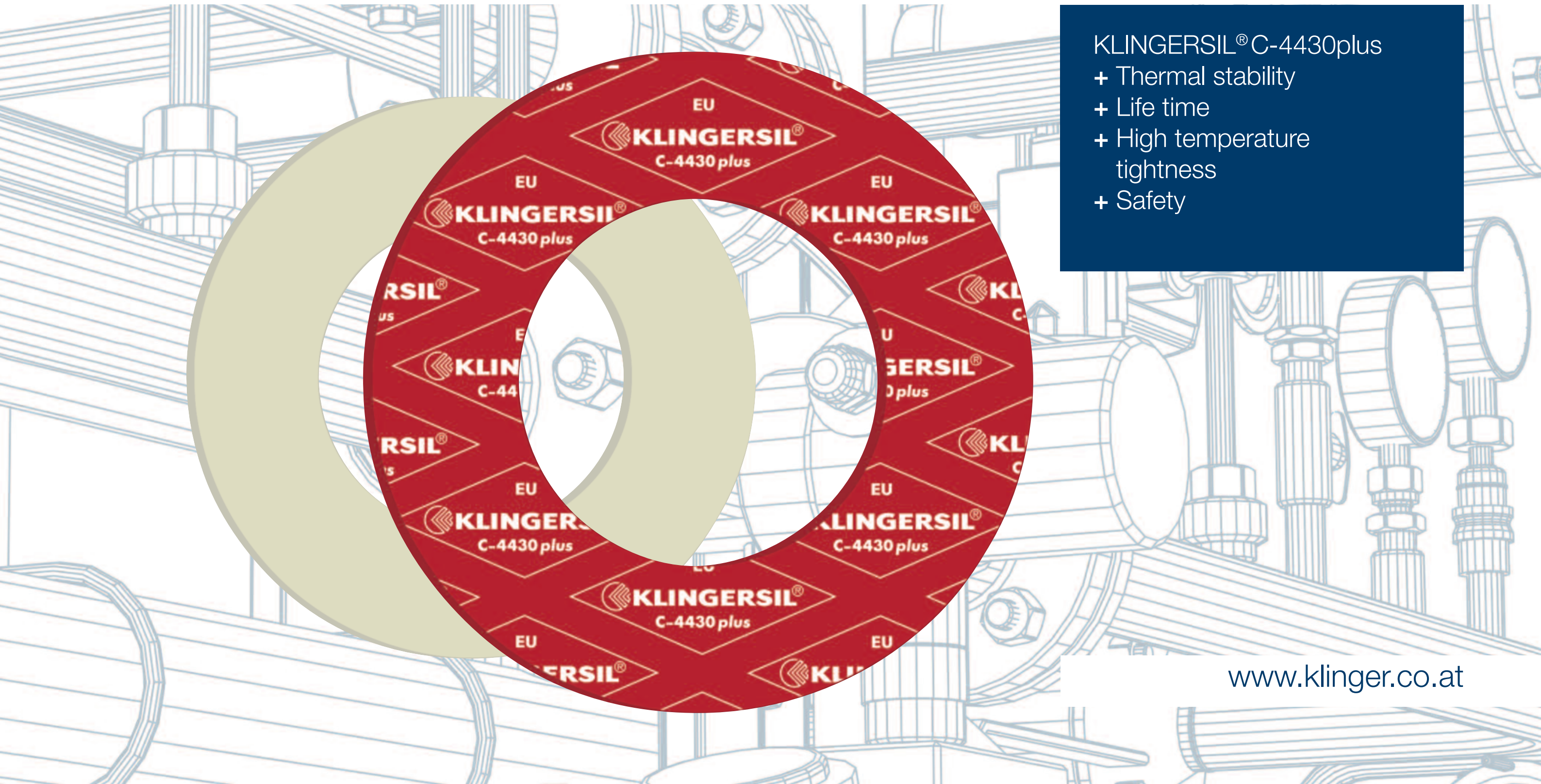
KLINGERSIL® C-4430plus

Superior performance at high temperature applications



KLINGERSIL® C-4430plus
+ Thermal stability
+ Life time
+ High temperature tightness
+ Safety

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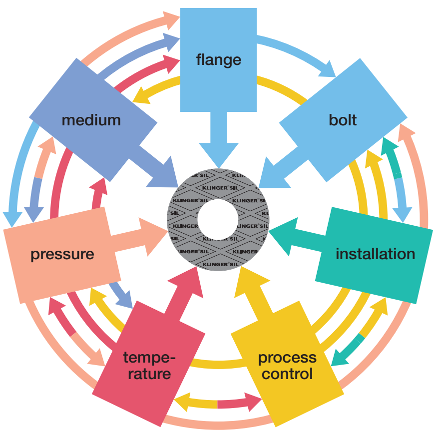
KLINGERSIL® C-4430plus

Flanged joint integrity

The many and varied demands made on gaskets

A common perception is that the suitability and tightness of a gasket for any given application depends upon the maximum temperature and pressure conditions. This is not the case.

Maximum temperature and pressure values alone can not define a material's suitability for an application. These limits are dependent upon a multiplicity of factors as shown in the picture below. It is always advisable to consider these factors when selecting a material for a given application.



A statement about the expected tightness of the flange connection is only possible if a qualified and defined installation of the gasket has been executed.

In facilities, for which limited emission requirements acc. to TA-Luft are specified, the guideline VDI 2290 for the evaluation of the technical tightness of flange connections has to be considered.

Selecting gaskets with pT diagrams

The KLINGER pT diagram provides guidelines for determining the suitability of a particular gasket material for a specific application based on the operating temperature and pressure only.

Additional stresses such as fluctuating load may significantly affect the suitability of a gasket in the application and must be considered separately.

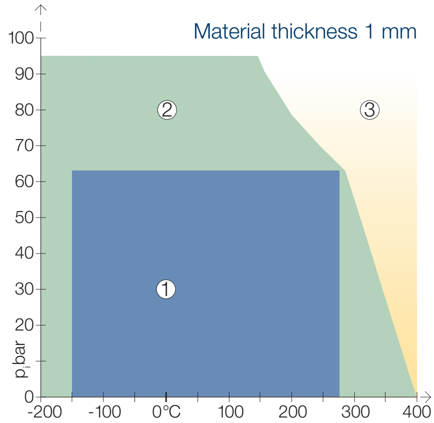
Areas of Application

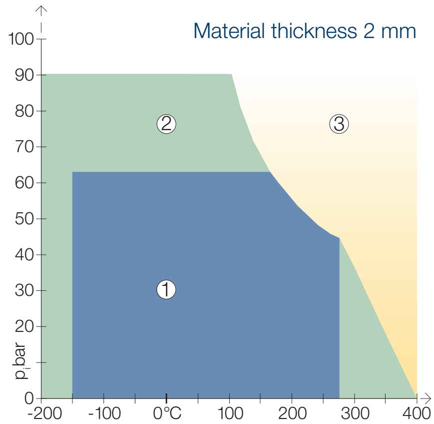
1 In area one, the gasket material is normally suitable subject to chemical compatibility.

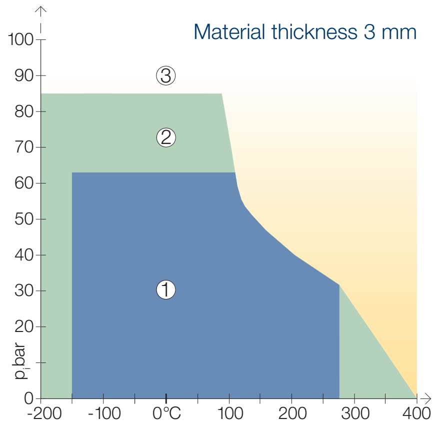
2 In area two, the gasket materials may be suitable but a technical evaluation is recommended.

3 In area three, do not install the gasket without a technical evaluation.

Always refer to the chemical resistance of the gasket to the fluid.







As the maximum operating pressure and load bearing capability are both depending on the gasket thickness, KLINGER provides thickness related pT diagrams.

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Hot Compression Test

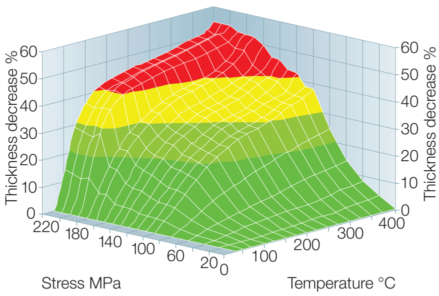
KLINGER Hot and Cold Compression Test Method
The KLINGER Hot Compression Test was developed by KLINGER as a method to test the load bearing capabilities of gasket materials under hot and cold conditions.

In contrast to the BS 7531 and DIN 52913 tests, the KLINGER Compression test maintains a constant gasket stress throughout the entire hot compression test. This subjects the gasket to more severe conditions.

This test method is specified in DIN 28090-2:2014 in short-term test.

The thickness decrease is measured at an ambient temperature of 23°C after applying the gasket load. This simulates assembly.

Temperatures up to 400°C are then applied and the additional thickness decrease is measured. This simulates the first start up phase.



The diagram shows the additional thickness decrease at temperature.

Four plus on safety

Thermal stability

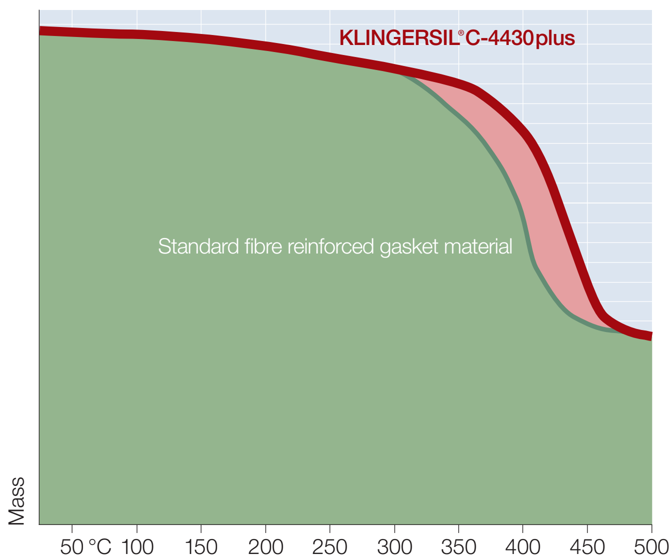
With the market launch of KLINGER®Quantum – the first fibre reinforced gasket material solely bounded with HNBR – KLINGER® has revolutionized the world of gaskets.

The R&D department of KLINGER® has taken the experiences which have been gained during the development of KLINGER®Quantum and applied them on KLINGERSIL®C-4430 – a fibre reinforced gasket material with highest stress relaxation. The result of the usage of the “Quantum technology” is a fibre reinforced gasket material with an extended profile of properties – **KLINGERSIL®C-4430plus**.

With **KLINGERSIL®C-4430plus** the thermal stability of the material has been extended and due to the usage of the “Quantum technology” the maximum operating temperature could be increased. This has been obtained through technical-chemical methods which give the binder NBR a higher temperature resistance. The crosslinking of the elastomer had been modified insofar as it needs more energy to break them which would lead to a change in mechanical properties.

A thermogravimetrical analysis which has been performed for **KLINGERSIL®C-4430plus** shows an onset of decomposition of the gasket material at approx. 400°C which is much higher as for standard fibre reinforced gasket materials.

Thermogravimetrical analysis



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Four plus on safety

+ Life time

The life time or period of application of a gasket material nowadays is a very important economical and safety-relevant factor.

The optimum gasket material causes no unscheduled shutdowns in the plant and therefore also no further costs through maintenance, loss of production or stockkeeping.

Because of the “Quantum technology” which has been chosen for **KLINGERSIL®C-4430plus** the ageing of the gasket material has been prolongated and therefore a longer lifer time of the gasket material in the application has been achieved.

The reduced ageing is indicated over constant material properties at high temperatures and a longer time period. In the below diagram this is illustrated with a constant high tightness of **KLINGERSIL®C-4430plus** at a temperature of 300°C.

Other commercial fibre reinforced gasket materials which are also based on NBR but do not use the “Quantum technology” show an increase in Leakage at the same test conditions because of an ongoing ageing.

+ Safety

The most common gasket failures at the use of fibre reinforced gasket materials show up at discontinuous applications because of pressure- or temperature changes (ie. steam applications, planned shutdowns, vibrations in the pipeline, etc).

Every fibre reinforced gasket material is getting hard and brittle at higher temperatures over time.

The gasket therefore shows insufficient flexibility which would be necessary to bear possible additional stresses. This can lead to leakages or accidents and therefore higher costs for the plant operator.

Because of the above mentioned retarded ageing of **KLINGERSIL®C-4430plus** this material obtains a higher safety margin to absorb possible impacts of dynamic applications without losing the tightness feature.

+ High temperature tightness

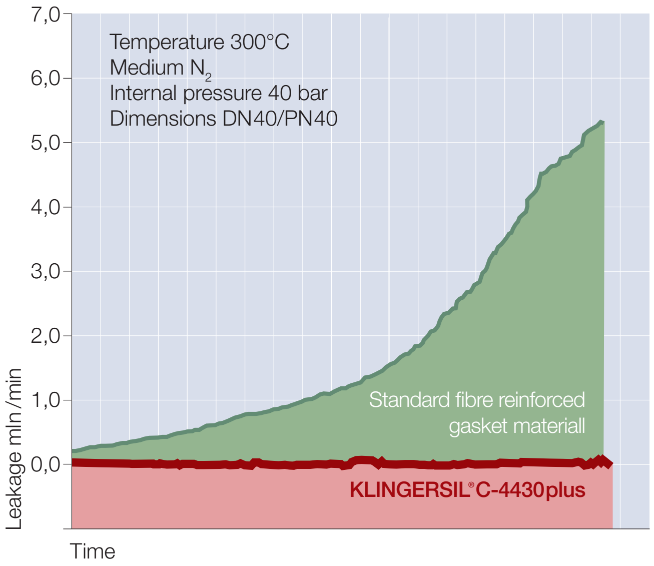
An important criteria for an optimum gasket material is of course a high tightness at installation but moreover a continuous tightness at operating temperature. The growing requirements of many varied guidelines on the tightness of fibre reinforced gasket material demands a consideration of this matter when developing a new gasket material.

The VDI 2440 for example defines as tightness criteria for a high grade gasket a maximum permissible leakage of 1.0 x 10-4 mbar x l/s x m with an internal test pressure of 1 bar helium.

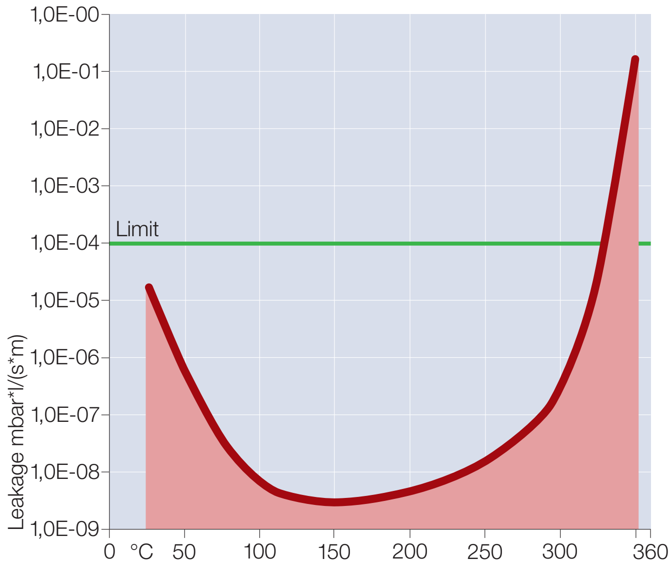
The test is performed on a gasket which is installed in a flange which has to be conditioned at the maximum operating temperature before the test. If this test is performed on several unused gaskets at different temperatures the below shown diagram results for **KLINGERSIL®C-4430plus**.

The determined graph for **KLINGERSIL®C-4430plus** shows a behaviour over the whole recommended temperature range which is by far higher than required.

High temperature tightness



Tightness acc. to VDI 2440



KLINGERSIL® C-4430plus

Tightness of flange connections / Application and Installation instructions

Specific requirements on the tightness of flange connections
With heightened awareness of safety and environmental issues, reducing leaks from flanged assemblies has become a major priority for industry. It is therefore important for companies who use gaskets to choose the correct material for the job and install and maintain it correctly to ensure optimum performance.

In facilities, for which limited emission requirements acc. to TA-Luft or the compliance with tightness classes are required, often with increasing internal pressures high surface pressures have to be applied.

For such operating conditions the plant operator has to verify, that the required flange connections are also suitable to bear these demands without mechanical overloading.

Only gasket materials with a TA-Luft-certificate may be used. The required tightness and stress analysises acc. to EN 1591-1 (or comparable) have to be carried out with specific gasket factors acc. to EN 13555. The assembly of the gasket has to be executed solely by qualified assembly personnel (EN 1591-4:2013).

Only the controlled tightening of the bolts assures that the assembly bolt load is within the required narrow tolerances.

Tightness of flange connections in operating condition
The flange connection will remain tight as long as the surface pressure on the gasket in service is higher than the required minimum surface pressure for a certain tightness class L.

The higher the initial surface pressure of the gasket, the safer the required tightness in operating condition can be achieved.

The maximum permissible surface pressure of the gasket in operating condition may not be exceeded.

The sealing calculation program KLINGER®expert contains important information regarding the performance of KLINGER sealing materials.

Discontinuous operation
If the gasket is to be subjected to non-static loading and stress fluctuations due to temperature and pressure cycling, it is advisable to select a gasket material which is less prone to embrittlement with increasing temperatures (e.g. KLINGER® graphite laminate, KLINGER® top-chem, KLINGER® Quantum).

In cyclic loading conditions we recommend a minimum surface stress of 30 MPa. In such cases the gasket thickness should be as thin as technically possible.
For safety and functional reasons never re-use gaskets.

The following guidelines are designed to ensure the optimum performance of a reliable flange connection.

1. Choosing the gasket
There are many factors which must be taken into account when choosing a gasket material for a given application including temperature, pressure and chemical compatibility.

Please refer to the information given in our brochure or, for advice to our software program KLINGER®expert.

If you have any questions regarding the suitability of a material for a given application please contact KLINGER Technical Department.

2. Media Resistance
Attention has to be paid on the fact that the media resistance of the gasket material is also given under operating conditions. In general, higher compressed gaskets show a better resistance to media influences than less compressed gaskets.

3. Gasket thickness – Gasket width
A generally binding rule to determine the required gasket thickness doesn't exist. The gasket chosen should be as thin as technically possible. In most cases, at small and medium nominal diameters, a thickness of 2 mm is sufficient. To ensure optimum performance a minimum thickness/width ratio of 1/5 is required (ideally 1/10).

4. Flange connection
Ensure all remains of old gasket materials are removed and the flanges are clean, in good condition and parallel.

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Application and Installation instructions

5. Gasket compounds
Ensure all gaskets are installed in a dry state, the use of gasket compounds is not recommended as this has a detrimental effect on the stability and load bearing characteristics of the material. In its uncompressed form the gasket can absorb liquid, and this may lead to failure of the gasket in service.
To aid gasket removal KLINGER materials are furnished with a non sticking finish.
In difficult installation conditions, separating agents such as dry sprays based on molybdenum sulphide or PTFE e.g. KLINGERflon® spray, may be used, but only in minimal quantities. Make sure that the solvents and propellants are completely evaporated.

6. Gasket dimension
Ensure gasket dimensions are correct. The gasket should not intrude into the bore of the pipework and should be installed centrally.

7. Bolting
Wire brush stud/bolts and nuts (if necessary) to remove any dirt on the threads. Ensure that the nuts can run freely down the thread before use.
Apply lubricant to the bolt and to the nut threads as well as to the face of the nut to reduce friction when tightening. We recommend the use of a bolt lubricant which ensures a friction coefficient of about 0.10 to 0.14.

8. Joint assembly
It is recommended that the bolts are tightened using a controlled method such as torque or tension, this will lead to greater accuracy and consistency than using conventional methods of tightening. If using a torque wrench, ensure that it is accurately calibrated.

For torque settings please refer to the KLINGER®expert or contact our Technical Department which will be happy to assist you.

Carefully fit the gasket into position taking care not to damage the gasket surface.

When torquing, tighten bolts in three stages to the required torque as follows:
Finger tighten nuts. Carry out tightening, making at least three complete diagonal tightening sequences i.e. 30%, 60% and 100% of final torque value. Continue with one final pass – torquing the bolts/studs in a clockwise sequence.

If certain tightness classes should be achieved in critical plants, the installation of the gasket has to be executed by qualified and competent assembly personnel (acc. to EN 1591-4), without exception.

9. Tightness of the flange connection
Basically the tightness depends on the applied surface pressure during installation, as well as on the remaining surface pressure in the operating condition.

Gaskets installed with high seating stresses exhibit a longer service life than gaskets installed with lower compressive stresses.

10. Retightening
Provided that the above guidelines are followed retightening of the gasket after joint assembly should not be necessary.

If retightening is considered necessary, then this should only be performed at ambient temperature before or during the first start-up phase of the pipeline or plant. Retightening of compressed fibre gaskets at higher operating temperatures and longer operating times may lead to a failure of the gasket connection and possible blow out.

11. Low temperature area
KLINGER gaskets are also applicable at low temperatures without any problems. The assurance of the required surface pressure in the complete temperature range, is the precondition for the tightness of the flange connection.

12. Re-use
For safety and functional reasons never re-use gaskets.

KLINGER®expert
the powerful sealing calculation.
The powerful calculation program for the skilled personnel.
KLINGER®expert's data base contains standard flanges, bolt details and a comprehensive catalogue of media to help the user design joints, select materials and calculate installation values.
Free download.
App for Android and Apple also available.

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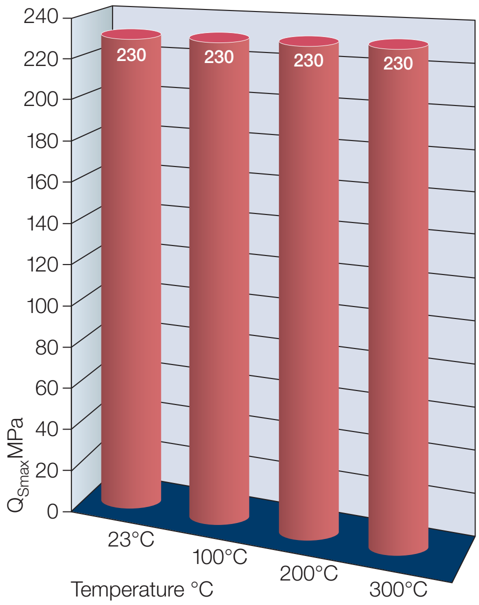
Gasket factors acc. to EN 13555

Maximum permissible surface pressure under operating condition Q_{Smax} acc. to EN 13555
The maximum surface pressure in operating condition is the maximum permissible surface pressure the gasket can be loaded at the specified temperatures.

To validate the test result of Q_{Smax}, P_{QR} values are provided. An evaluation of the tested gasket regarding unacceptable extrusion
in the bore or damage of the gasket is also required.

The diagram shows these values for the various temperature ratings.



Creep relaxation factor P_{QR} acc. to EN 13555
This factor considers the relaxation influence on the gasket load between the tightening of the bolts and the long-term effect of the service temperature.

P_{QR} values for stiffness 500 kN/mm, gasket thickness 2 mm				
Temperature	Gasket stress		P_{QR} bei Q_{Smax}	Q_{Smax} (MPa)
	30 MPa	50 MPa		
23°C	0.93	0.95	0.98	230
100°C	0.76	0.86	0.93	230
200°C	0.72	0.86	0.87	230
300°C	0.59	0.72	0.82	230

Secant unloading modulus of the gasket E_G and gasket thickness e_G acc. to EN 13555

Secant unloading modulus of the gasket E_G (MPa) and gasket thickness e_G (mm)								
Gasket stress	Ambient temperature		Temperature 100°C		Temperature 200°C		Temperature 300°C	
MPa	E_G MPa	e_G mm	E_G MPa	e_G mm	E_G MPa	e_G mm	E_G MPa	e_G mm
1		2.067		2.087		2.083		2.058
20	1377	1.916	1231	1.868	2399	1.846	2906	1.807
30	1923	1.876	1937	1.838	2513	1.828	4198	1.793
40	2815	1.847	2204	1.810	2715	1.811	3416	1.775
50	2938	1.820	2801	1.788	3279	1.799	4323	1.762
60	3543	1.796	3315	1.772	4706	1.789	6029	1.751
80	7062	1.772	4905	1.752	4935	1.773	7536	1.734
100	6642	1.748	6206	1.731	5351	1.756	6756	1.717
120	6572	1.728	8047	1.712	5866	1.739	8790	1.704
140	8927	1.716	7681	1.690	6526	1.722	9942	1.692
160	11166	1.706	7558	1.666	7915	1.704	9569	1.680
180	10560	1.695	7994	1.641	7348	1.679	8859	1.669
200	9652	1.683	8144	1.617	7523	1.650	9444	1.661
220	8664	1.672	8454	1.593	7320	1.619	9971	1.653
230	8467	1.665	8489	1.578	7398	1.600	10157	1.647

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Gasket factors acc. to EN 13555

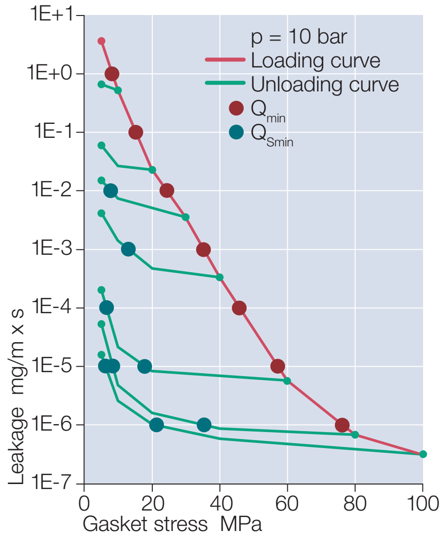
Minimum surface pressure $Q_{min(L)}$ acc. to EN13555 (Installation)
The minimum surface pressure during installation is the minimum required surface pressure, which has to be applied on the gasket surface during assembly at room temperature.
This is to assure that the gasket can adjust to the roughness of the flange surfaces, that internal leakage paths can be tightened and that the required tightness class L for the specified internal pressure will be achieved.

Minimum surface pressure $Q_{Smin(L)}$ acc. to EN13555 (Operating condition)
The minimum surface pressure in service is the minimum required surface pressure, which has to be applied on the gasket surface under operating conditions, i.e. after unloading during service, in order to keep the required tightness class L for the specified internal pressure.

Minimum stress to seal for tightness class L
$Q_{min(L)}$ at assembly/ $Q_{Smin(L)}$ after off-loading 10 bar

L	$Q_{min(L)}$	$Q_{Smin(L)}$ MPa						
mg/ s x m	MPa	Q_A= 10 MPa	Q_A= 20 MPa	Q_A= 30 MPa	Q_A= 40 MPa	Q_A= 60 MPa	Q_A= 80 MPa	Q_A= 100 MPa
10^{-0}	8	5	5	5	5	5	5	5
10^{-1}	15		5	5	5	5	5	5
10^{-2}	24			8	5	5	5	5
10^{-3}	35				13	5	5	5
10^{-4}	46					7	5	5
10^{-5}	57					18	9	6
10^{-6}	76						35	21

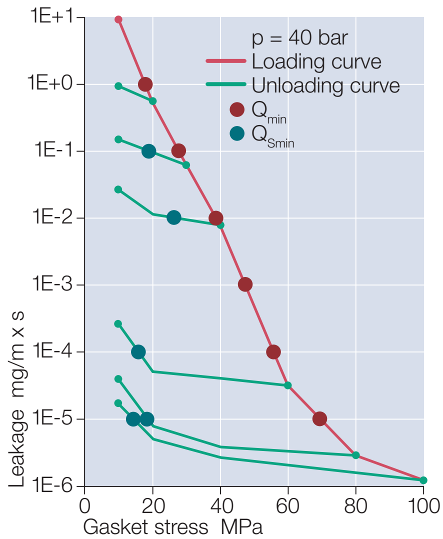
Q_A = Stress on the gasket during installation before unloading



Minimum stress to seal for tightness class L
$Q_{min(L)}$ at assembly/ $Q_{Smin(L)}$ after off-loading 40 bar

L	$Q_{min(L)}$	$Q_{Smin(L)}$ MPa					
mg/ s x m	MPa	Q_A= 20 MPa	Q_A= 30 MPa	Q_A= 40 MPa	Q_A= 60 MPa	Q_A= 80 MPa	Q_A= 100 MPa
10^{-0}	18	10	10	10	10	10	10
10^{-1}	28		19	10	10	10	10
10^{-2}	39			26	10	10	10
10^{-3}	47				10	10	10
10^{-4}	56				16	10	10
10^{-5}	69					19	14

Q_A = Stress on the gasket during installation before unloading



KLINGERSIL® C-4430plus

Technical values

High pressure gasket for universal applications.
Suitable for use with water and steam at higher temperatures as well as to oils, gases, salt solutions, fuels, alcohols, moderate organic and inorganic acids, hydrocarbons, lubricants and refrigerants.
Premium material grade with outstanding stress retention.

Basis

Optimum combination of synthetic fibres bonded with NBR.

Dimensions of the standard sheets

Sizes:
1,000 x 1,500 mm,
2,000 x 1,500 mm.
Thicknesses:
0.5 mm, 1.0 mm, 1.5 mm,
2.0 mm, 3.0 mm
Tolerances:
Thickness acc. DIN 28091-1,
length ± 50 mm, width ± 50 mm.

Other thicknesses, sizes and tolerances on request.

Surfaces

KLINGERSIL® gasket materials are generally furnished with surfaces of low adhesion.

Function and durability

The performance and service life of KLINGER gaskets depend in large measure on proper storage and fitting, factors beyond the manufactor's control. We can, however, vouch for the excellent quality of our products.

With this in mind, please also observe our installation instructions.

Typical values for thickness 2.0 mm			
Compressibility ASTM F 36 J		%	9
Recovery ASTM F 36 J		%	55
Stress relaxation DIN 52913	50 MPa, 16 h/175°C	MPa	39
	50 MPa, 16 h/300°C	MPa	35
Stress relaxation BS 7531	40 MPa, 16 h/300°C	MPa	31
KLINGER cold/hot compression	thickness decrease at 23°C	%	8
50 MPa	thickness decrease at 300°C	%	11
	thickness decrease at 400°C	%	14
Tightness	DIN 28090-2	mg/s x m	0.05
Specific leakrate λ	VDI 2440	mbar x l/s x	2.9E-06
Thickness increase after fluid	oil IRM 903: 5 h/150°C	%	3
immersion ASTM F 146	fuel B: 5 h/23°C	%	5
Density		g/cm³	1.8
Average surface resistance	ρ_O	Ω	4.1x10E13
Average specific volume resistance	ρ_D	Ω cm	4.5x10E12
Average dielectric strength	E_d	kV/mm	21.3
Average power factor	50 Hz	tanδ	0.03
Average dielectric coefficient	50 Hz	εr	6.7
Thermal conductivity	λ	W/mK	0.38
ASME-Code sealing factors			
for gasket thickness 1.0 mm	tightness class 0.1 mg/s x m	y	20
	MPa	m	1.1
for gasket thickness 2.0 mm	tightness class 0.1 mg/s x m	y	20
	MPa	m	1.6
for gasket thickness 3.0 mm	tightness class 0.1 mg/s x m	y	20
	MPa	m	2.2
Classification acc. to BS 7531:2006	Grade AX		

Tests and approvals

BAM-tested
DIN-DVGW
DIN-DVGW W 270
Elastomer-Guideline
WRAS approval
TA-Luft (Clean air)
Fire-Safe acc. to DIN EN ISO 10497

Certified according to DIN EN ISO 9001:2008

Subject to technical alterations.
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