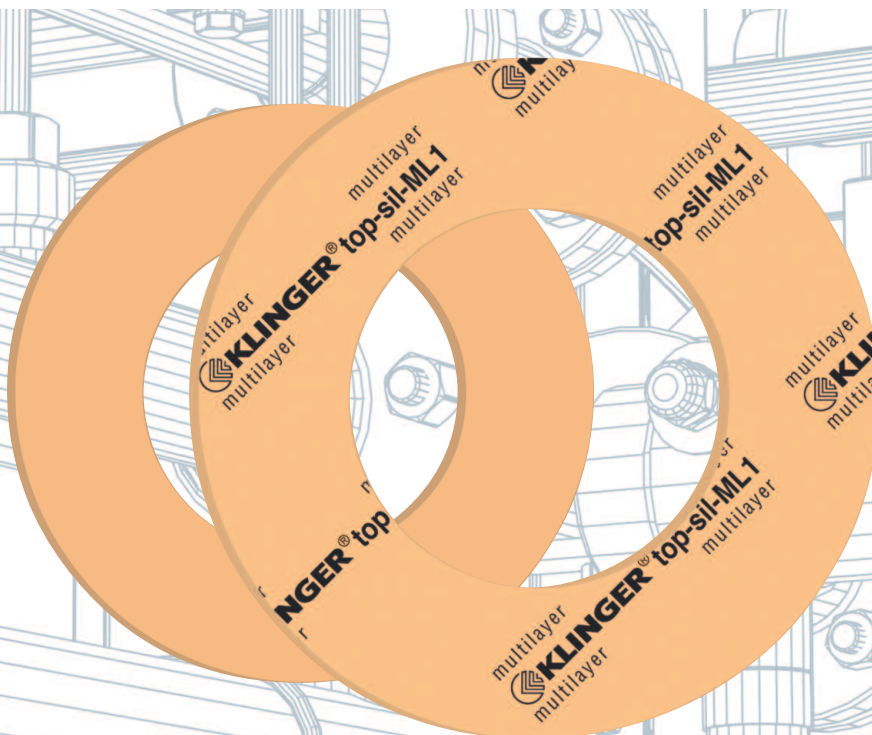




# KLINGER® top-sil ML1

Unique Multi-Layer material  
concept –  
A milestone for  
fibre reinforced gaskets



KLINGER® top-sil ML1  
Revolutionary combination  
of synthetic fibres and different  
elastomers bound in a Multi-  
Layer structure.

# KLINGER® top-sil ML1

Unique Multi-Layer material concept

For quite some years the sealing industry in general has been unable to offer an adequate substitute for the KLINGERit gasket. This gasket, because of its absence of embrittlement at high temperatures was extremely successful.

We are pleased to advise that exactly 110 years after the invention of KLINGERit, KLINGER is able to re-confirm its leading position in the field of fibre reinforced gaskets with the latest development KLINGER® top-sil ML1.

This new concept in material technology\* ties up with the performance benchmark set by KLINGERit gaskets.

The Multi-Layer structure makes it possible to develop materials with new property profiles. The layers containing the special elastomers remain flexible over longer periods than standard materials even at high temperatures and are therefore able to compensate for dynamic load fluctuations induced by the flange. This flexibility suppresses the creation of micro crevices, which are responsible for gasket leakage.

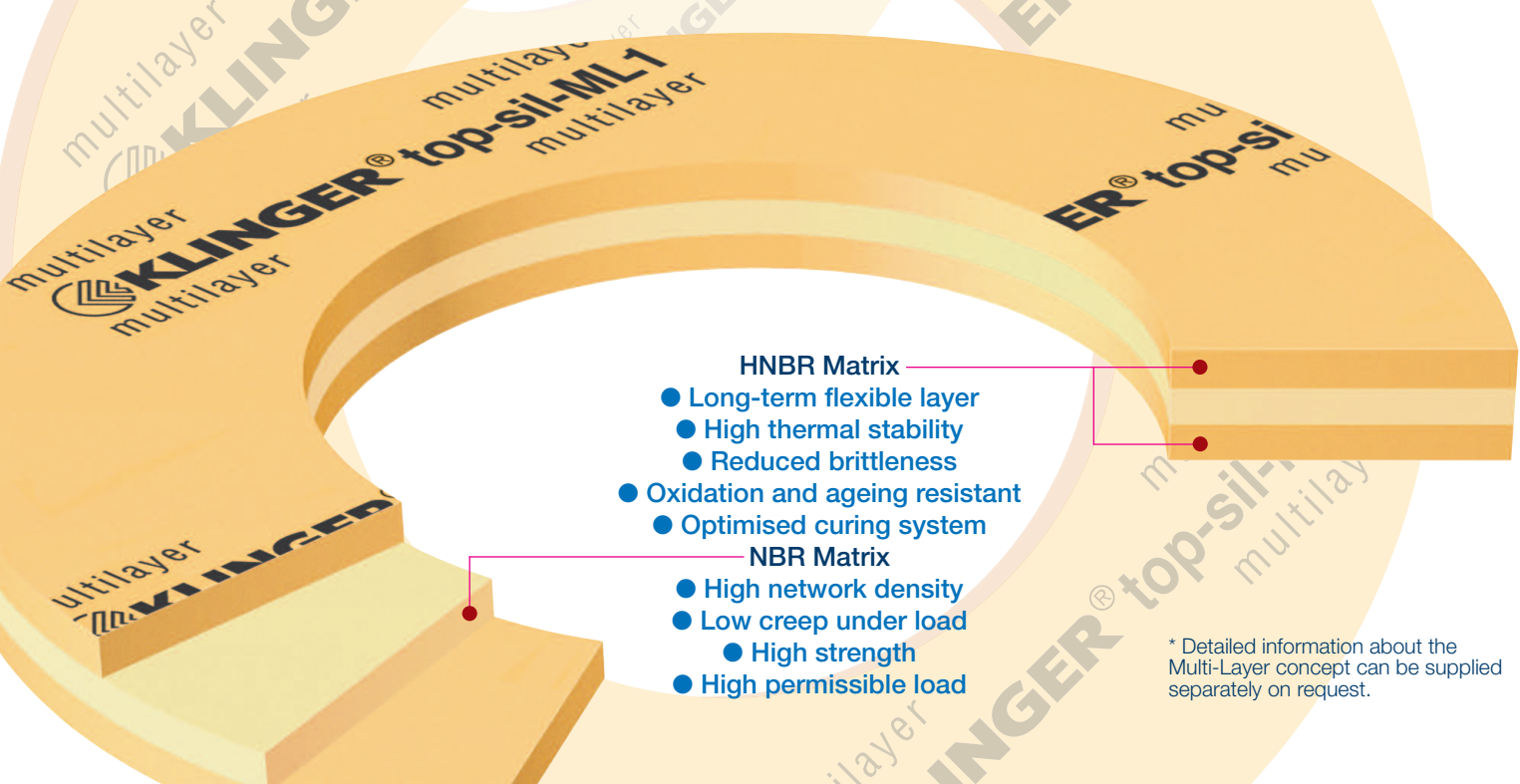
The layers containing standard elastomers are better able to resist deformation under load due to the formation of a denser network.

The gasket therefore remains flexible but still retains its strength.

The layers of the structure are characterised by the selection of elastomers. Since at least one of the layers contains a different elastomer (compared with the standard elastomers like NBR, SBR, etc.) the decomposition and ageing processes associated with conventional fibre materials i.e. post curing, thermo oxidative decomposition, degradation of the polymer chains etc. depending on application, can be suppressed.

## Multi-Layer property profile

- Extended service life and less leakage in spite of high temperatures
- Higher residual flexibility
- Delayed ageing
- Less creep
- High permissible load



### HNBR Matrix

- Long-term flexible layer
- High thermal stability
- Reduced brittleness
- Oxidation and ageing resistant
- Optimised curing system

### NBR Matrix

- High network density
- Low creep under load
- High strength
- High permissible load

\* Detailed information about the Multi-Layer concept can be supplied separately on request.

# KLINGER® top-sil ML1

## A milestone for fibre reinforced gaskets

### Tightness behaviour in saturated steam

This test is an excellent method to test the decomposition of elastomer bounded sealing materials within a reasonable time. The applied temperature of 320°C coupled with an environment of saturated steam at around 120 bar provides a stringent test for the elastomers.

The arduous nature of the test conditions is designed to promote decomposition of the samples, allowing an assessment of ageing resistance of the Multi-Layer materials. By these extreme testing conditions a differentiation of different gasket types becomes possible.

A sudden pressure loss within the test rig chamber indicates either steam escape through crevices within the material or destruction of the test specimen. Both effects result from embrittlement of the gasket due to degradation of the elastomers.

The time before the pressure drop occurs can be seen as a measurement of the ageing resistance of the gasket. In order to quantify the effects caused by the formation of micro crevices, the test rig was pressurised with 40 bar nitrogen to measure the leakage rate at room temperature following the steam test. By this method a direct correlation can be defined between the ageing of the gasket and its leakage rate.

**The Multi-Layer material guarantees the user significantly lower emissions over a longer service life at elevated temperatures.**

### Elastic properties

To evaluate flexibility potentials of sealing materials the three point bending test is often used to assess the flexibility of compressed fibre materials. Trials with conditioned test specimens provide an indication of the level of embrittlement and therefore the ageing behaviour of the elastomers employed.

Prior to the bending tests samples were conditioned as follows.

- Hot air for 168 h at 160°C and
- Saturated steam for 168 h at 185°C

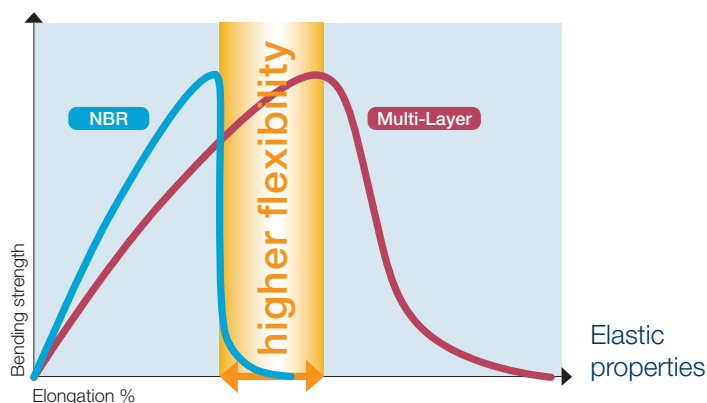
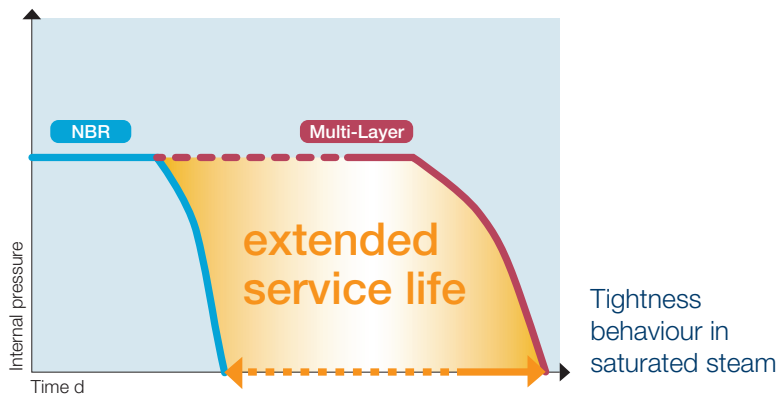
Steam hammer often occurs in steam applications and leads to damage of the sealing materials. A more flexible gasket will therefore contribute to a safer and more reliable flange connection.

The novel Multi-Layer material concept significantly increases ageing resistance at elevated temperature when compared with conventional materials.

With this concept, it is possible to minimise all the undesirable property changes associated with traditional compressed fibre materials such as embrittlement, formation of crevices and increased leakage.

Incorporation of special elastomers into separate layers within the Multi-Layer structure ensures that a longer service life and increased temperature resistance can be expected.

Tests have shown that such a combination of properties cannot be achieved through homogenous mixing of two elastomers.



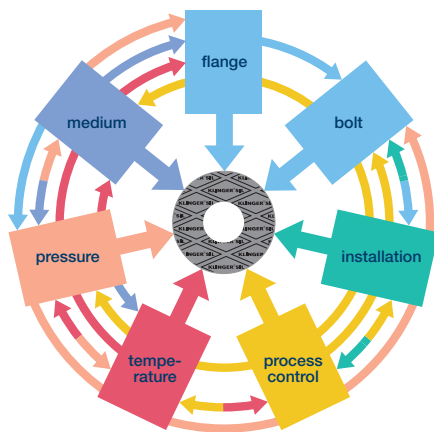
# KLINGER® top-sil ML1

## 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

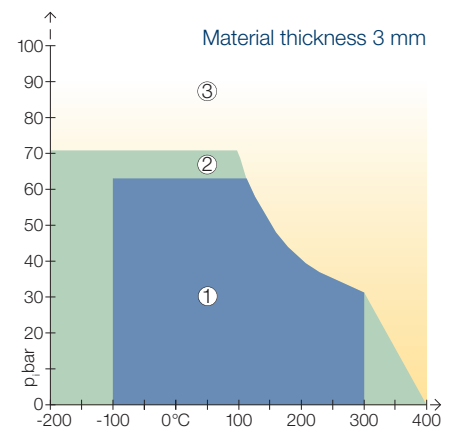
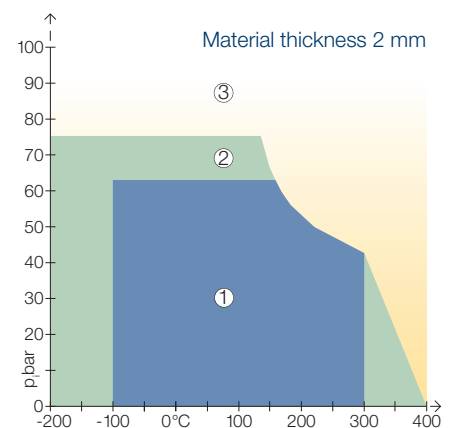
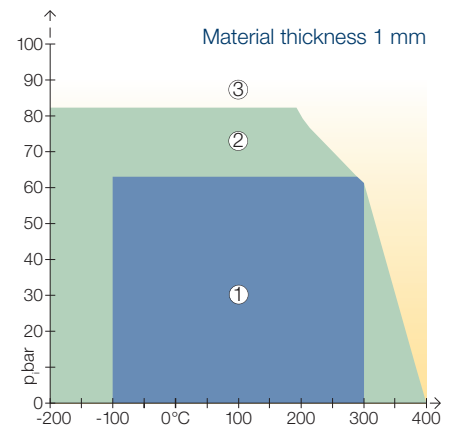
The KLINGER pT diagram provides guidelines for determining the suitability of a particular gasket material for a specific application based on the operating temperature and pressure only.

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.**



# KLINGER® top-sil ML1

Flanged joint integrity / Tightness of flange connections

## KLINGER Hot and Cold Compression Test Method

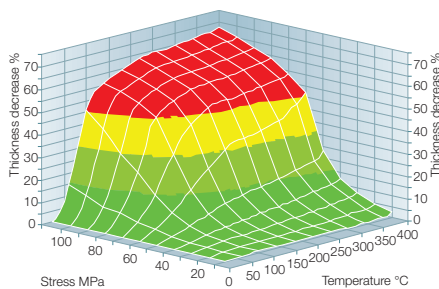
The KLINGER Hot Compression Test was developed by KLINGER as a method to test the load bearing capabilities of gasket materials under hot and cold conditions.

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 300°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.

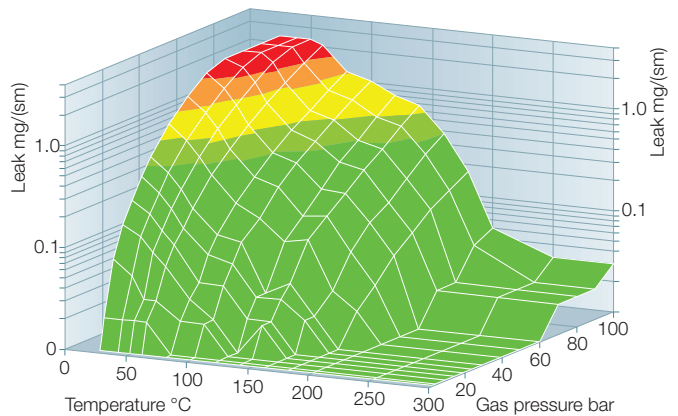
## High temperature tightness

High temperature tightness is measured by means of the KLINGER Hot Compression test under defined constant gasket load and temperature with increasing internal pressures using nitrogen as test fluid.

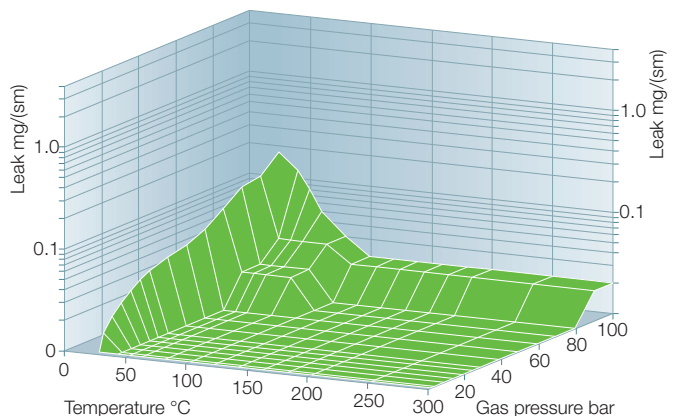
Stabilisation time for each reading is two hours and a new test specimen is used for every gasket load and temperature.

The tightness is analysed with a massflow meter. The pressure is controlled by pressure controller.

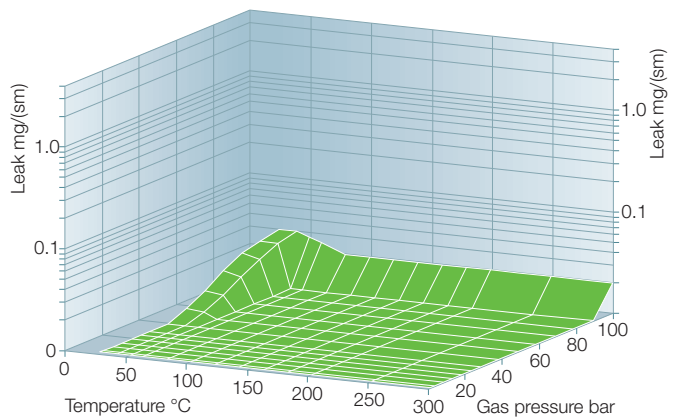
### Gasket load 10 MPa



### Gasket load 20 MPa



### Gasket load 30 MPa



# KLINGER® top-sil ML1

## 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 analyses 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.

# KLINGER® top-sil ML1

## 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.





# KLINGER® top-sil ML1

## 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 $Q_{S\min(L)}$ acc. to EN13555 (Operating condition)

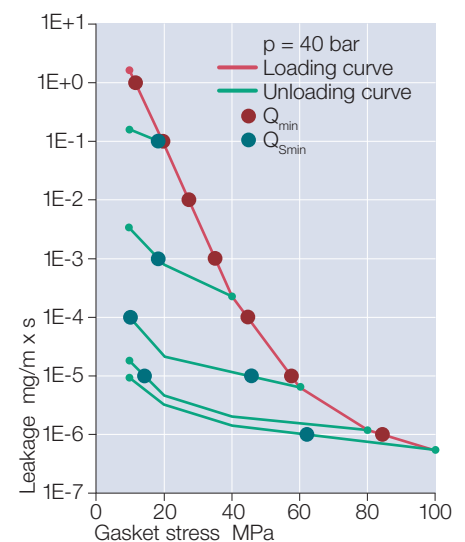
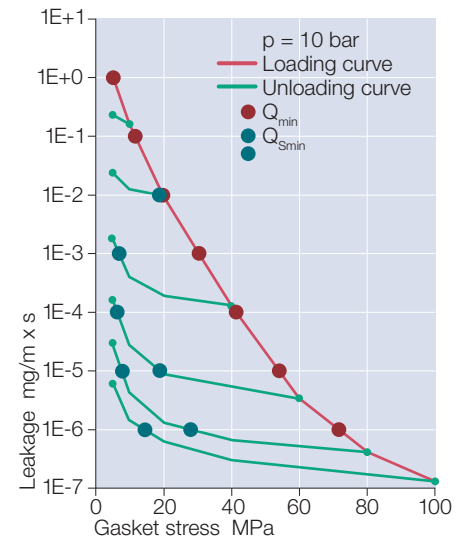
The minimum surface pressure in service is the minimum required surface pressure, which has to be applied on the gasket surface under operating conditions, i.e. after unloading during service, in order to keep the required tightness class L for the specified internal pressure.

Minimum stress to seal for tightness class L							
$Q_{\min(L)}$ at assembly/ $Q_{S\min(L)}$ after off-loading 10 bar							
L	$Q_{\min(L)}$ MPa	$Q_{S\min(L)}$ MPa					
		$Q_A=$ 10 MPa	$Q_A=$ 20 MPa	$Q_A=$ 40 MPa	$Q_A=$ 60 MPa	$Q_A=$ 80 MPa	$Q_A=$ 100 MPa
10 <sup>-0</sup>	5	5	5	5	5	5	5
10 <sup>-1</sup>	12		5	5	5	5	5
10 <sup>-2</sup>	20		19	5	5	5	5
10 <sup>-3</sup>	30			7	5	5	5
10 <sup>-4</sup>	41				6	5	5
10 <sup>-5</sup>	54				19	8	5
10 <sup>-6</sup>	71					28	15

$Q_A$  = Stress on the gasket during installation before unloading

Minimum stress to seal for tightness class L						
$Q_{\min(L)}$ at assembly/ $Q_{S\min(L)}$ after off-loading 40 bar						
L	$Q_{\min(L)}$ MPa	$Q_{S\min(L)}$ MPa				
		$Q_A=$ 20 MPa	$Q_A=$ 40 MPa	$Q_A=$ 60 MPa	$Q_A=$ 80 MPa	$Q_A=$ 100 MPa
10 <sup>-0</sup>	12	10	10	10	10	10
10 <sup>-1</sup>	20	18	10	10	10	10
10 <sup>-2</sup>	27		10	10	10	10
10 <sup>-3</sup>	35		18	10	10	10
10 <sup>-4</sup>	45			10	10	10
10 <sup>-5</sup>	57			46	14	10
10 <sup>-6</sup>	84					62

$Q_A$  = Stress on the gasket during installation before unloading



# KLINGER® top-sil ML1

## Technical values

Multi-Layer sealing material with extended service life and improved flexibility at higher temperatures.

Suitable for use with oils, water, steam, gases, salt solutions, fuels, alcohols, moderate organic and inorganic acids, hydrocarbons, lubricants and refrigerants, food industry.

Outstanding performance in many applications.

### ■ Basis

Revolutionary combination of synthetic fibres and different elastomers bound in a Multi-Layer structure.

### ■ Dimensions of the standard sheets

Sizes:

2,000 x 1,500 mm

Thicknesses:

0.8 mm, 1.0 mm, 1.5 mm, 2.0 mm, 3.0 mm

Tolerances:

Thickness acc. DIN 28091-1, length  $\pm$  50 mm, width  $\pm$  50 mm.

Other thicknesses, sizes and tolerances on request.

### ■ Surfaces

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

### Typical values for thickness 2.0 mm

Compressibility ASTM F 36 J		%	9
Recovery ASTM F 36 J		%	50
Stress relaxation DIN 52913	50 MPa, 16 h/175°C	MPa	34
	50 MPa, 16 h/300°C	MPa	28
Stress relaxation BS 7531	40 MPa, 16 h/300°C	MPa	29
KLINGER cold/hot compression 50 MPa	thickness decrease at 23°C	%	8
	thickness decrease at 300°C	%	15
Tightness	DIN 28090-2	mg/s x m	0.05
Specific leakrate $\lambda$	VDI 2440	mbar x l/s x m	3.51E-06
Thickness increase after fluid immersion ASTM F 146	oil IRM 903: 5 h/150°C	%	4
	fuel B: 5 h/23°C	%	8
Density		g/cm <sup>3</sup>	1.7
Average surface resistance	$\rho_O$	$\Omega$	9.3x10E12
Average specific volume resistance	$\rho_D$	$\Omega$ cm	3.8x10E12
Average dielectric strength	$E_d$	kV/mm	18.8
Average power factor	50 Hz	$\tan \delta$	0.048
Average dielectric coefficient	50 Hz	$\epsilon_r$	7.3
Thermal conductivity	$\lambda$	W/mK	0.36
<b>ASME-Code sealing factors</b>			
for gasket thickness 1.0 mm	tightness class 0.1 mg/s x m MPa	y	15
		m	1.5
for gasket thickness 2.0 mm	tightness class 0.1 mg/s x m MPa	y	15
		m	2.2
for gasket thickness 3.0 mm	tightness class 0.1 mg/s x m MPa	y	15
		m	4
Classification acc. to BS 7531:2006 Grade AX			

### ■ Function and durability

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

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

### ■ Tests and approvals

BAM-tested  
 DIN-DVGW  
 WRAS approval  
 German Lloyd  
 TA-Luft (Clean air)  
 Fire-Safe acc. DIN EN ISO 10497

Certified according to  
 DIN EN ISO 9001:2008

Subject to technical alterations.  
 Status: September 2015

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