TECHNICAL INFORMATION

®SIGRAFLEX EMAIL

Multilayer sealing sheet, adhesive-free made from flexible graphite foil reinforced with stainless steel foils especially for use in PTFE-envelope gaskets

10/99

SGL CARBON GROUP

Flexible graphite sealing sheet with high-integrity stainless steel foil reinforcement for use in PTFE-envelope gaskets

®SIGRAFLEX EMAIL has been developed specially for use in PTFE-envelope gaskets. **®SIGRAFLEX EMAIL** is a multilayer sealing sheet made from flexible graphite foil (type Z), which is reinforced with two 0.05 mm thick stainless steel foils.
Manufactured in total sheet thicknesses of 2 mm and 3 mm, **®SIGRAFLEX EMAIL** comprises two outside flexible graphite layers, 0.5 mm thick and one flexible graphite inner layer, 1.0 or 2.0 mm thick, with a density of 1.1 g/cm³. The overall composite is produced by a special process which uses no adhesive. It can thus meet extreme demands for mechanical strength at elevated temperatures.

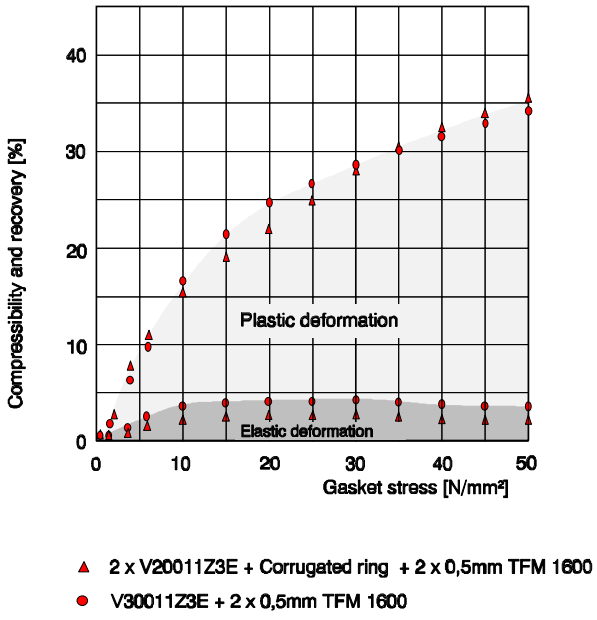
Applications

- Primarily as an asbestos-free soft core material with improved properties for PTFE-envelope gaskets in enamelled pipework, vessels, stub connections and access apertures.
- For PTFE-envelope gaskets in steelpipework with increased demands for operational reliability, impermeability and product purity (aggressive media presenting health hazards; service media listed under the German Clean Air Regulations, Class 1; pharmaceutical industry).

Properties

The graphite's good recovery behaviour, the stainless steel foil reinforcements close to the surface and the adhesive-free joining of the individual layers have together improved the sealing properties of PTFE-envelope gaskets substantially:

- Despite the influence of flow processes in the PTFE the graphite foil layers are prevented from sliding away from the smooth metal reinforcements due to the special bonding technique.
- The good recovery behaviour of flexible graphite even at high temperatures can compensate for cold and warm flow characteristics specific to PTFE.
- Owing to the excellent chemical resistance, high thermal stability and good sealing properties of this optimised core material, good leak-tightness is maintained even if the PTFE enveloping is damaged.



- Excellent bursting safety due to the double metal reinforcement.
- Great adaptability and hence good gasket stress distribution as a result of the flexible graphite's good compressibility without risk of damage to enamelled component even if flanges are destroyed.
- Long-term stability of recovery and compressive behaviour which allows

the manufacture of PTFE-envelope gaskets requiring a minimum of retightening.

- Good handling properties as a result of high rigidity and mechanical strength.
- Excellent punching properties
- Asbestos-free, presents no health hazard
- Minimal ageing of the gasket system (PTFE/graphite/stainless steel)

Material data of ®SIGRAFLEX EMAIL sheet material:

Material type		V20011Z3E	V30011Z3E
Thickness	mm	2	3
Bulk density of graphite	g/cm³	1,1	1,1
Ash content of graphite (DIN 51903)	%	£ 0,15	£ 0,15
Stainless steel foil details			
Material DIN code number		1.4401	1.4401
Thickness	mm	0,05	0,05
Number of foils		2	2
Gas permeability			
DIN 3535 Teil 4	cm³/min	<0,8	<1,0
DIN 28090 T. 1	mg/(s·m)	<0,08	<0,1
Stability under compressive stress DIN 52913 $\sigma_{D\ 16h,300°C,50N/mm²}$	N/mm²	>48	>48
Gasket factors (DIN E 2505) [1)]			
Gasket width b_D = 20 mm			
σ_{VU}	N/mm²	20	20
σ_{VO}	N/mm²	130	120
$\sigma_{BO;\ 300°C}$	N/mm²	110	100
m		1,3	1,3
Deformation factors DIN 28090 T. 2 [1])			
Compressibility ε_{KSW}	%	30 - 40	30 - 40
Recovery ε_{KRW}	%	4 - 5	4 - 5
Creep compression at elevated temperatures ε_{WSW}	%	< 4	< 4
Recovery at elevated temperatures ε_{WRW}	%	3 - 4	3 - 4

[1)] Definitions:

σ_{VU} Minimum gasket assembly stress. (The given minimum assembly stresses apply to a sealing criterion as previously used for compressed asbestos fibre seals. To reduce the rate of leakage, we recommend a higher gasket stress. See brochure „®SIGRAFLEX products manufactured from flexible graphite foil".)

σ_{BU} Minimum gasket stress under service conditions, where σ_{BU} is the product of internal pressure p and gasket factor m for test and service conditions ($\sigma_{BU} = p \cdot m$)

σ_{VO} Maximum permissible gasket stress at RT

$\sigma_{BO;\ 300°C}$ Maximum permissible gasket stress under service conditions (300°C)

m $m = \sigma_{BU}/p_i$

ε_{KSW} Gasket compression and compressibility under a stress of 35 N/mm²

ε_{KRW} Gasket recovery after reduction in stress from 35 N/mm² to 1 N/mm²

ε_{WSW} Gasket creep compression under a stress of 50 N/mm² at 300°C after 16 h

ε_{WRW} Recovery after reduction in stress from 50 N/mm² to 1 N/mm²

The percentage changes in thickness of ε_{KSW}, ε_{KRW}, ε_{WSW} and ε_{WRW} are relative to the initial thickness of the gasket.

Recommended design of PTFE-envelope gaskets

The following design principles are based on a sealing system developed jointly with the leading companies in the chemical industry. For EMAIL gaskets, the following quality criteria have been established:

- optimum impermeability thanks to PTFE enveloping
- good sealing properties even if the PTFE enveloping is damaged
- minimum need for retightening (reloading normally unnecessary, but possible)
- max. service temperature 230°C (depending on service pressure)
- good long-term recovery behaviour
- robust handling properties
- favourable price/performance ratio
- low overall costs (gasket, installation, reloading)
- bursting and blow-out safety

Up to a diameter of 200 mm, PTFE-envelope gaskets are designed without corrugated ring, in a thickness of 4 mm, incorporating a 3 mm thick soft material layer in **®SIGRAFLEX EMAIL**. For larger diameters, the following recommendations are given:

DN	Corrugated ring	Soft material layers
£ 200	-	1 x 3 mm
250 - 450	1	2 x 2 mm
500 - 800	1	2 x 3 mm
> 800	1	4 x 2 mm*

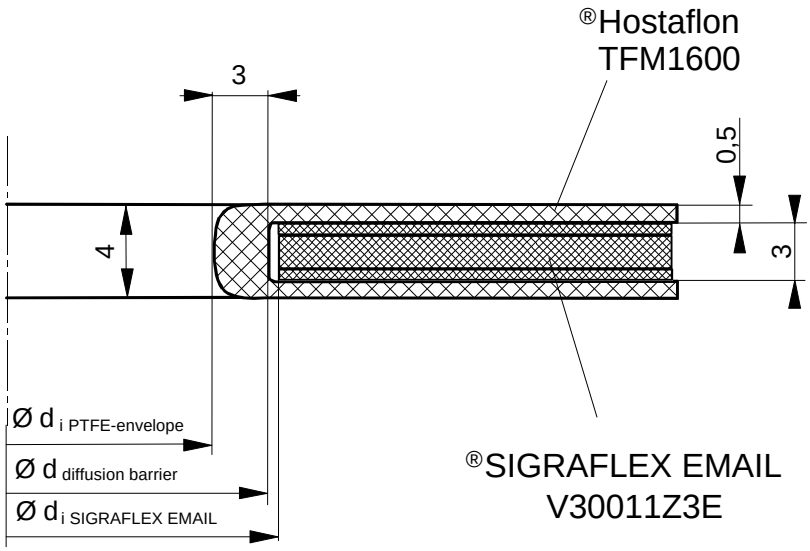
*)overlapped design

Where flange distortions exceed 0.5 mm, the area between corrugated ring and graphite top layer is filled with **®SIGRAFLEX-STANDARD** segments.

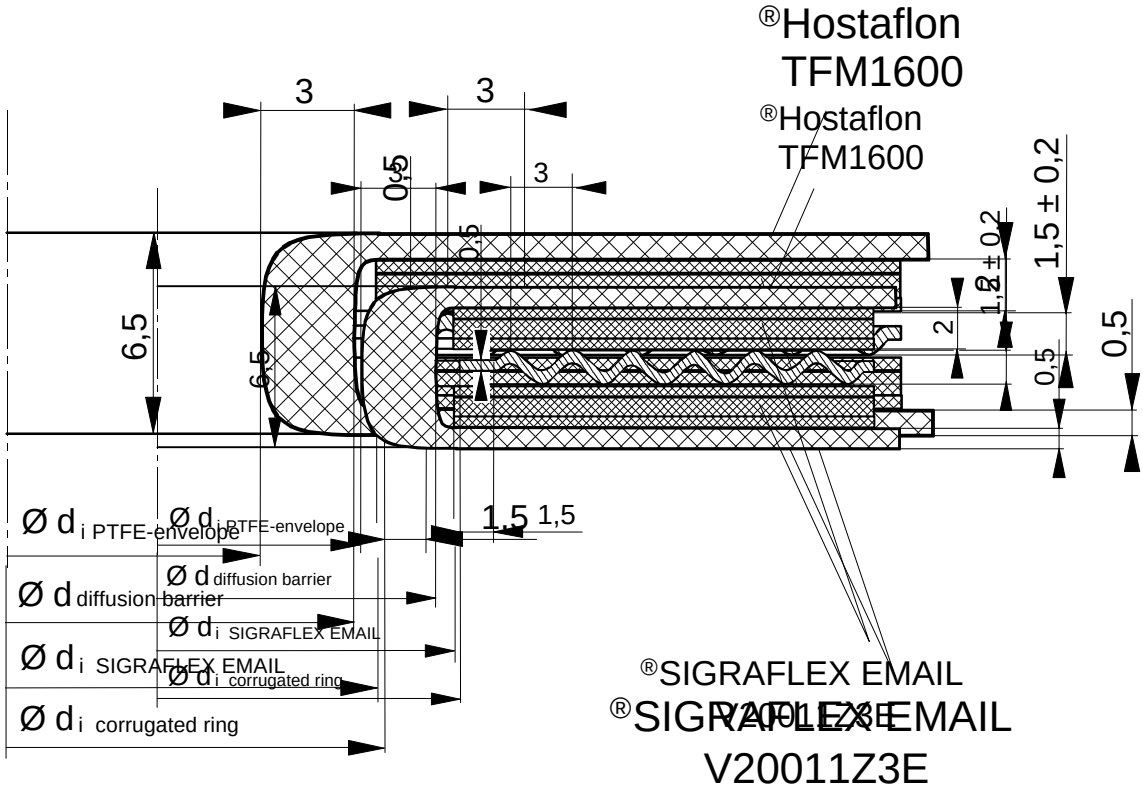
The corrugated ring should be manufactured from 0.5 mm thick stainless steel sheet 1.4571 with a corrugation width of 3 mm and a height of 1.5 mm. It should be free from burrs. Where it reaches the inside edge of the ring, the corrugation should be at the mid-point between the two outer layers.

The PTFE-enveloping should be rounded off at the inside edge and a diffusion barrier of at least 3 mm should be incorporated. The recommended thickness of the enveloping is 0.5 mm.

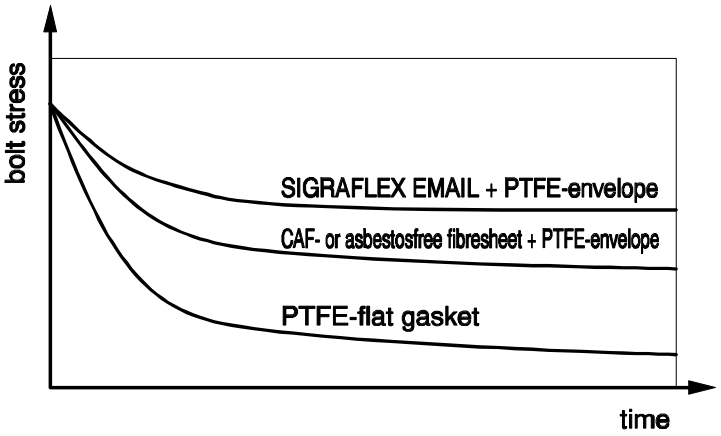
Recommended design for diameters up to 200 mm:



Recommended design of PTFE-envelope gaskets with a diameter of 250 to 450 mm:



The soft material layer based on flexible graphite increase the life-time properties of the complete PTFE-envelope gasket (figure).



Installation instructions

The sealing faces must be clean, dry and free from grease. Gaskets must be undamaged. No release agents should be used.
During installation, the flanges should be aligned centrically, as otherwise leakage may occur as a result of misalignment, especially at enamelled, convex sealing faces. The flanges should be aligned parallel. Flange bolts should be tightened in an alternate order, first to approx. 50 % of the maximum torque value, in the second stage to approx. 80 % and to the full value in the third stage but not before. All bolts must be tightened to the specified value. Where flange distortions exceed 0.5 mm, ®**SIGRAFLEX STANDARD** should be used for filling. This is described in our technical information sheet "Installation instructions for segmented gaskets", which can be supplied on request.
As a result of the cold and warm flow characteristics of the PTFE enveloping, bolt loading declines after installation and changes in temperature. Under certain service conditions it is therefore recommended that the bolts be retightened to the specified values. It is recommended as a general rule that the bolts be retightened at temperatures above 100°C (Retightening at room temperatures!). This is not necessary where internal pressure is low and thermal stresses are minor.
The application range of PTFE-envelope gaskets is governed by the mechanical properties of enamelled flanges, because the load-bearing capacity of enamelled flanges is not very high, the manufacturers of enamelled vessels and pipework recommend relatively low gasket stresses.
The manufacturers of enamelled vessels give specific recommendations for tightening and retightening. The max. admissible torque values for enamelled flanges specified by these manufacturers must always be adhered to. Exceeding these values may result in damage to the enamel layer and consequent loss of claims under the guarantee.

Material data of PTFE-envelope gaskets in accordance with our design recommendations:

Material type soft material core PTFE envelope corrugated ring		V30011Z3E ®Hostaflon TFM 1600 -	2 x V20011Z3E ®Hostaflon TFM 1600 1.4571
Total thickness	mm	4,0	6,5
Gas permeability DIN 3535 DIN 28090 T 1 [1)]	 cm³/min mg/(s·m)	 <0,01 <0,001	 <0,01 <0,001
Stability under compressive stress DIN 52913 $\sigma_{D\ 16h;\ 150°C;\ 30\ N/mm^2}$	N/mm²	≥16	≥14
Gasket factors (DIN E 2505) [1)] Gasket width b_D = 20mm			
σ_{VU}	N/mm²	8	8
σ_{VO}	N/mm²	60	80
$\sigma_{BO;\ 200°C}$	N/mm²	50	50
m		1,1	1,1
Deformation factors DIN 28090 T 2			
Compressibility at RT ε_{KSW}	%	30 - 40	30 - 40
Recovery at RT ε_{KRW}	%	3 - 4	2 - 3
Creep compression at elevated temperatures ε_{WSW}	%	5 - 6	4 - 5
Recovery at elevated temp. ε_{WRW}	%	2 - 3	2 - 3

[1)] Definitions:

σ_{VU} Minimum gasket assembly stress. (The given minimum assembly stresses apply to a sealing criterion as previously used for compressed asbestos fibre seals. To reduce the rate of leakage, we recommend a higher gasket stress. See brochure "®SIGRAFLEX products manufactured from flexible graphite foil".)

σ_{BU} test Minimum gasket stress under service conditions, where σ_{BU} is the product of internal pressure p and gasket factor m for and service conditions ($\sigma_{BU} = p \cdot m$)

σ_{VO} Maximum permissible gasket stress at RT

$\sigma_{BO;\ 200°C}$ Maximum permissible gasket stress under service conditions (200°C)

m $m = \sigma_{BU}/p_i$

ε_{KSW} Gasket compression and compressibility under a stress of 35 N/mm²

ε_{KRW} Gasket recovery after reduction in stress from 35 N/mm² to 1 N/mm²

ε_{WSW} Gasket creep compression under a stress of 20 N/mm² at 150°C after 16 h

ε_{WRW} Recovery after reduction in stress from 20 N/mm² to 1/3 of this value(6.7 N/mm²)

The percentage changes in thickness of ε_{KSW}, ε_{KRW}, ε_{WSW} and ε_{WRW} are relative to the initial thickness of the gasket.

Forms supplied

Sheets in ®**SIGRAFLEX EMAIL** are available in the following dimensions:

Dimension:	Type:
1500 x 1500 x 2.0 mm	V20011Z3E
1500 x 1500 x 3.0 mm	V30011Z3E

SGL CARBON GROUP

Expanded Graphite

SGL TECHNOLOGIES GmbH

Werner-von-Siemens-Str. 18
D-86405 Meitingen / Germany
Phone +49 (0) 82 71/83-2276
Fax +49 (0) 82 71/83-2419
expandedgraphite@sglcarbon.de