

SIGRAFLEX® HOCHDRUCK

Sealing Sheet Made from Natural Graphite
with High-Integrity Stainless Steel Foil Reinforcement
for Extreme Conditions

Expanded Graphite



Broad Base. Best Solutions.

SIGRAFLEX® HOCHDRUCK

Our Contribution to Environmental Protection

SIGRAFLEX® HOCHDRUCK

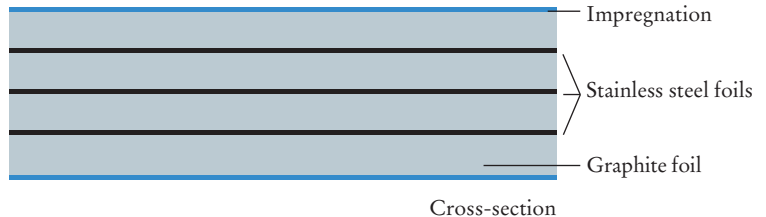
is a multilayer high-strength graphite sealing sheet comprising 0.5 mm thick layers of high-purity graphite foil and 0.05 mm thick stainless steel foils.

Depending on the sheet thickness required, several layers of graphite and stainless steel foil are joined together in a patented adhesive-free process. As a result, the sheets have outstanding mechanical properties. The sealing sheet is impregnated to reduce leakage and improve handling.

SIGRAFLEX HOCHDRUCK allows end users in the process industry to cover almost their entire gasket application range with a reliable and safe product.

Applications

- ▶ For difficult and mechanically highly stressed sealed joints (in tongue-and-groove and special-dimension flanges, process equipment, heat exchangers); also suitable for all common pipework and vessel flange designs
- ▶ Recommended for one-piece gaskets up to 1500 mm outside diameter; for diameters over 1500 mm as two-layer structures with segmented sections and staggered joints, for instance
- ▶ For high internal pressures of up to 250 bar
- ▶ For corrosive media
- ▶ Suitable for a broad range of temperatures from -250°C to approx. 550°C; for applications at more than 450°C, users should request our advice
- ▶ Gaskets for the chemical, petrochemical and refinery industries
- ▶ Steam pipework and boilers in power stations
- ▶ Heat transfer oil and heating facilities
- ▶ Inspection glasses, pumps, fittings
- ▶ Existing plants



Properties

- ▶ Reduction in fugitive emissions due to very high leak-tightness
- ▶ Very high maximum permissible gasket stress
- ▶ High operational reliability and excellent oxidation resistance
- ▶ High blow-out resistance and very high mechanical strength
- ▶ Very high fault tolerance during assembly and operation
- ▶ Good chemical resistance
- ▶ Long-term stability of compressibility and recovery, even under fluctuating temperatures
- ▶ Good scratch resistance; antistick finish due to special impregnation
- ▶ No measurable cold or warm flow characteristics up to the maximum permissible gasket stress
- ▶ No aging or embrittlement, owing to the absence of adhesives or binders
- ▶ Ease of processing
- ▶ Asbestos-free, no associated health risks

Approvals

- ▶ TA Luft (VDI 2440/VDI 2200) with inner eyelets in various designs; for tongue-and-groove flanges without eyelets
- ▶ Fire safety according to BS 6755-2 and API 607
- ▶ Blow-out resistance (TÜV at 2.5 times the nominal pressure)
- ▶ BAM oxygen
- ▶ BAM ethylene oxide/propylene oxide
- ▶ Germanischer Lloyd
- ▶ US Coastguard
- ▶ DVGW (DIN 3535-6)
- ▶ TRD 401



Assembly instructions

For assembly, use dry and undamaged gaskets only. Wet graphite gaskets must not be fitted unless first dried completely. The sealing faces must be clean, dry and free from grease. Do not use release agents! Position the gasket centrally and avoid mechanical stresses during assembly. An assembly aid can be used if necessary. To facilitate assembly in difficult positions, the gasket may be fixed by using a commercially available adhesive. However, the adhesive should be applied sparingly at a few points only.

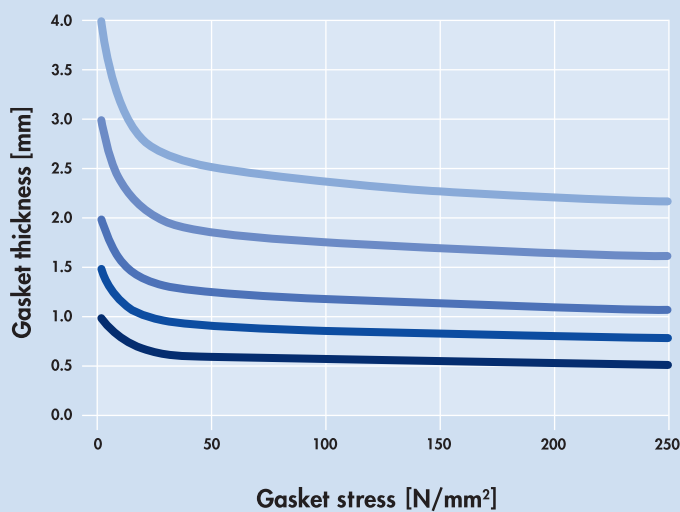
Align the flanges as plane-parallel as possible. First hand-tighten the bolts and then tighten the bolts in a crosswise order to about 50% of the maximum torque value, in the second stage to about 80% and to the full value in the third stage. All bolts must be tightened to the specified bolt load, so the torque must be checked repeatedly. Our detailed assembly instructions are available on request.



Our patented, overlap-free laser welding process allows sheets of up to 1500 mm width without leakage channels



Compressibility of SIGRAFLEX® HOCHDRUCK



Forms supplied

SIGRAFLEX HOCHDRUCK sheets are available in the following dimensions and type designations:

Dimensions in mm

- 1500 x 1500 x 1.0
- 1500 x 1500 x 1.5
- 1500 x 1500 x 2.0
- 1500 x 1500 x 3.0
- 1500 x 1500 x 4.0

Types

- V10011Z3I
- V15011Z3I
- V20011Z3I
- V30011Z3I
- V40011Z3I

The sheets can also be supplied in dimensions of 1000 x 1000 mm.

Material data of SIGRAFLEX® HOCHDRUCK

Material type		V10011Z3I	V15011Z3I	V20011Z3I	V30011Z3I	V40011Z3I	
Thickness	mm	1.0	1.5	2.0	3.0	4.0	
Dimensions	m	1.5 x 1.5 / 1.0 x 1.0					
Bulk density of graphite	g/cm ³	1.1					
Ash content of graphite (DIN 51903)	%	≤ 0.15					
Total chloride content	ppm	≤ 10					
Reinforcing steel foil details		Flat stainless steel foil					
ASTM material number		316 (L)					
Thickness	mm	0.05					
Number of foils		1	2	3	5	7	
Residual stress (DIN 52913) σ_D 16 h, 300°C, 50 N/mm ²	N/mm ²	≥ 48					
Gasket factors (DIN E 2505/DIN 28090-1)							
Gasket width $b_D = 20$ mm							
$\sigma_{VU/0.1}$ at an internal pressure of	10 bar	N/mm ²	10	10	10	12	14
	16 bar	N/mm ²	10	12	14	17	18
	25 bar	N/mm ²	10	14	16	20	22
	40 bar	N/mm ²	13	16	18	25	28
m		1.3	1.3	1.3	1.3	1.3	
σ_{VO}	N/mm ²	305	290	270	240	200	
σ_{BO} at 300°C	N/mm ²	250	230	210	180	160	
Compression factors (DIN 28090-2)							
Compressibility	ϵ_{KSW}	%	30 - 40				
Recovery at 20°C	ϵ_{KRW}	%	4 - 6				
Hot creep	ϵ_{WSW}	%	< 3				
Recovery at 300°C	ϵ_{WRW}	%	3 - 5				
Young's modulus at 20 N/mm ² (DIN 28090-1)	N/mm ²	750					
ASTM	"m" factor		2.5				
	"y" factor	psi	3000				
Compressibility	ASTM F36	%	30 - 40				
Recovery		%	20 - 30				
The gasket factor conversion formulas as per AD Merkblatt B7 are as follows:			$k_0 \cdot K_D = \sigma_{VU} \cdot b_D$ $k_1 = m \cdot b_D$				

Definitions

$\sigma_{VU/0.1}$	Minimum gasket assembly stress needed to comply with leakage class L 0.1 (according to DIN 28090-1) Recommended gasket assembly stress: ≥ 20 N/mm ² up to σ_{BO}	k_0	In mm, factor for gasket assembly stress
σ_{BU}	Minimum gasket assembly stress in service, where σ_{BU} is the product of internal pressure p and gasket factor m for test and in service ($\sigma_{BU} = p \cdot m$)	k_1	In mm, factor for gasket stress in service
σ_{VO}	Maximum permissible gasket stress at 20°C	K_D	In N/mm ² , max. gasket stress-bearing capacity under assembly conditions
$\sigma_{BO, 300^\circ C}$	Maximum permissible gasket stress in service	ϵ_{KSW}	Compression set under a gasket stress of 35 N/mm ²
m	σ_{BU} / p_i	ϵ_{KRW}	Gasket recovery after reduction in gasket stress from 35 N/mm ² to 1 N/mm ²
"m" factor	Similar to m, but defined according to ASTM, hence different value	ϵ_{WSW}	Gasket creep compression under a gasket stress of 50 N/mm ² at 300°C after 16 h
"y" factor	Minimum gasket stress in psi	ϵ_{WRW}	Recovery after reduction in gasket stress from 50 N/mm ² to 1 N/mm ²

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

Gasket factors of SIGRAFLEX® HOCHDRUCK according to DIN EN 13555

L	PN	e _{G0}	Q _{min} /L	Q _{Smin} /L				e _{G0}	Q _{min} /L	Q _{Smin} /L			
				Q _A =20	Q _A =40	Q _A =60	Q _A =80			Q _A =20	Q _A =40	Q _A =60	Q _A =80
10 ⁻¹	10	2	< 10	< 10	< 10	< 10	< 10	3	< 10	< 10	< 10	< 10	< 10
10 ⁻¹	16	2	< 10	< 10	< 10	< 10	< 10	3	< 10	< 10	< 10	< 10	< 10
10 ⁻¹	25	2	< 10	< 10	< 10	< 10	< 10	3	< 10	< 10	< 10	< 10	< 10
10 ⁻¹	40	2	< 10	< 10	< 10	< 10	< 10	3	< 10	< 10	< 10	< 10	< 10
10 ⁻²	10	2	13	< 10	< 10	< 10	< 10	3	16	< 10	< 10	< 10	< 10
10 ⁻²	16	2	18	13	< 10	< 10	< 10	3	21	< 10	< 10	< 10	< 10
10 ⁻²	25	2	23		< 10	< 10	< 10	3	27	< 10	< 10	< 10	< 10
10 ⁻²	40	2	30		15	< 10	< 10	3	33	22	< 10	< 10	< 10

Relaxation ratio P_{QR}

P _{QR}	e _{G0}	RT		150 °C		300 °C	
		2	3	2	3	2	3
30		0.98	0.98	0.96	0.93	0.93	0.92
50		0.98	0.98	0.98	0.96	0.96	0.95
200/200/200		1.00		1.00		0.99	
200/200/180			1.00		0.99		0.98

Max. permissible gasket stress Q_{Smax}

Q _{Smax}	e _{G0}	RT	150 °C	300 °C
		2	3	3
2		> 200	> 200	> 200
3		> 200	200	180

Secant unloading modulus E_G

E _G	e _{G0}	RT		150 °C		300 °C	
		2	3	2	3	2	3
20		370	409	399	432	454	466
30		548	631	644	660	722	670
40		881	936	907	1003	997	995
50		1005	1089	1085	1038	1262	1423
60		1359	1275	1401	1400	1447	1323
80		1996	1979	1805	1838	2119	2025
100		1970	2578	2231	2582	2057	2427
120		2455	2840	2578	2868	2416	3163
140		2927	3146	2828	3155	2788	3322
160		3031	3960	2734	3294	3135	3190
180		2958	4279	3301	3892	3340	3245
200		3161	3695	3480	4154	3273	



Definitions

E _G	[MPa]	Secant unloading modulus of the gasket
e _{G0}	[mm]	Gasket thickness
L	[mg/(s·m)]	Leakage class
PN	[bar]	Nominal pressure
Q _A	[MPa]	Gasket assembly stress
P _{QR}		Relaxation ratio for stiffness C = 500 kN/mm
Q _{min} /L	[MPa]	Minimum gasket assembly stress
Q _S	[MPa]	Gasket stress
Q _{Smin} /L	[MPa]	Minimum gasket stress in service
Q _{Smax}	[MPa]	Maximum permissible gasket stress before damage occurs
RT		Room temperature
Further values on request.		

Product overview

Product		Characteristics	Recommended applications
SIGRAFLEX® FOIL F....C/Z/APX	▲	Flexible, continuous	-250°C to approx. 550°C; for compressed packings, spiral-wound and kammprofile gaskets
SIGRAFLEX® STANDARD L....CI	■	Unreinforced, impregnated	Raised-face flanges; enamel or glass flanges; highly corrosive media
SIGRAFLEX® ECONOMY V....C4	■ ▲	Reinforced with bonded s/s** foil	Pumps; fittings; gas supply; waste gas pipelines
SIGRAFLEX® UNIVERSAL V....C2I	■	Reinforced with tanged s/s** foil, impregnated	Pipework and vessels in the petro-/chemical industries and in power stations
SIGRAFLEX® UNIVERSAL PRO V....C2I-P	■	Reinforced with tanged s/s** foil, impregnated	For TA Luft* applications; for pipework and vessels in the petro-/chemical industries and in power stations
SIGRAFLEX® SELECT V16010C3I	●	High-integrity s/s** foil reinforcement, impregnated	For TA Luft* applications; raised-face flanges; pipework in the chemical and petrochemical industries
SIGRAFLEX® HOCHDRUCK V....Z3I	■	High-integrity multilayer laminate, impregnated	Universal sealing sheet, also for solving sealing problems in pipework, process equipment, tongue-and-groove flanges and non-standard joints in the petro-/chemical industries and in power stations
SIGRAFLEX® HOCHDRUCK PRO V....Z3I-P	■	High-integrity multilayer laminate, impregnated	Universal sealing sheet for TA Luft* applications, also for solving sealing problems in pipework, process equipment, tongue-and-groove flanges and non-standard joints in the petro-/chemical industries and in power stations
SIGRAFLEX® MF V....Z2MF	●	High-integrity laminate made of graphite, s/s** and PTFE	Maximum requirements for sealability (TA Luft*), safety, chemical resistance and process hygiene; sealed joints in the chemical and petrochemical, pharmaceutical and food industries
SIGRAFLEX® EMAIL V....Z3E	■	High-integrity s/s** foil reinforcement	PTFE-envelope gaskets in enameled pipework, vessels, stub connections, etc.

Forms supplied: ▲ roll or tape ■ sheet material ● gasket with inner eyelet, for applications requiring TA Luft approval

* TA Luft: German Clean Air Act ** s/s: stainless steel

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This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should therefore not be construed as guaranteeing specific properties of the products described or their suitability for a particular application. Any existing industrial property rights must be observed. The quality of our products is guaranteed under our "General Conditions of Sale".

Expanded Graphite

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