Архангельск (8182)63-90-72
Астана (7172)727-132
Астрахань (8512)99-46-04
Барнаул (3852)73-04-60
Белгород (4722)40-23-64
Брянск (4832)59-03-52
Владивосток (423)249-28-31
Волгоград (844)278-03-48
Вологда (8172)26-41-59
Воронеж (473)204-51-73
Екатеринбург (343)384-55-89
Иваново (4932)77-34-06
Ижевск (3412)26-03-58
Иркутск (395)279-98-46
Казань (843)206-01-48
Калининград (4012)72-03-81
Калуга (4842)92-23-67
Кемерово (3842)65-04-62
Киров (8332)68-02-04
Краснодар (861)203-40-90
Красноярск (391)204-63-61
Курск (4712)77-13-04
Липецк (4742)52-20-81
Магнитогорск (3519)55-03-13
Москва (495)268-04-70
Мурманск (8152)59-64-93
Набережные Челны (8552)20-53-41
Нижний Новгород (831)429-08-12
Новокузнецк (3843)20-46-81
Новосибирск (383)227-86-73
Омск (3812)21-46-40
Орел (4862)44-53-42
Оренбург (3532)37-68-04
Пенза (8412)22-31-16
Пермь (342)205-81-47
Ростов-на-Дону (863)308-18-15
Рязань (4912)46-61-64
Самара (846)206-03-16
Санкт-Петербург (812)309-46-40
Саратов (845)249-38-78
Севастополь (8692)22-31-93
Симферополь (3652)67-13-56
Смоленск (4812)29-41-54
Сочи (862)225-72-31
Ставрополь (8652)20-65-13
Сургут (3462)77-98-35
Тверь (4822)63-31-35
Томск (3822)98-41-53
Тула (4872)74-02-29
Тюмень (3452)66-21-18
Ульяновск (8422)24-23-59
Уфа (347)229-48-12
Хабаровск (4212)92-98-04
Челябинск (351)202-03-61
Череповец (8202)49-02-64
Ярославль (4852)69-52-93

Киргизия (996)312-96-26-47
Россия (495)268-04-70
Казахстан (772)734-952-31

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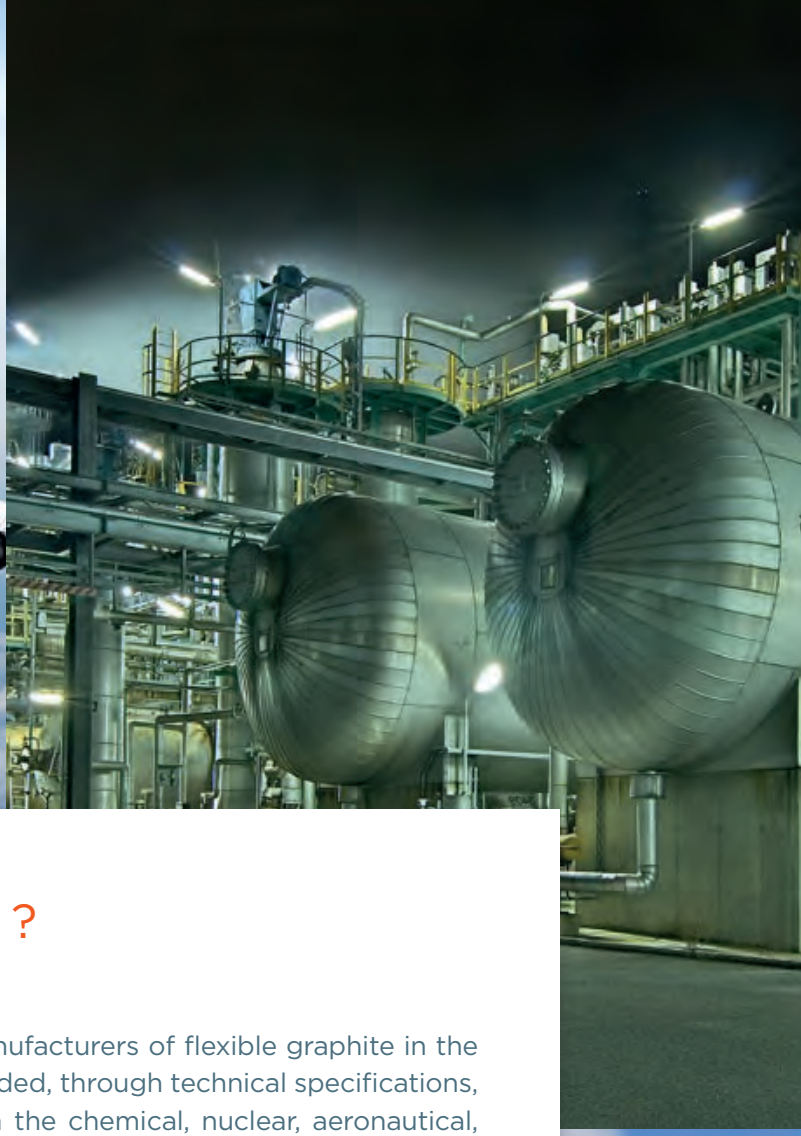
TECHNICAL GUIDE

MERSEN
Expertise, our source of energy

PAPYEX® FLEXIBLE GRAPHITE

GRAPHITE FOILS FOR SEALING APPLICATIONS

SUMMARY

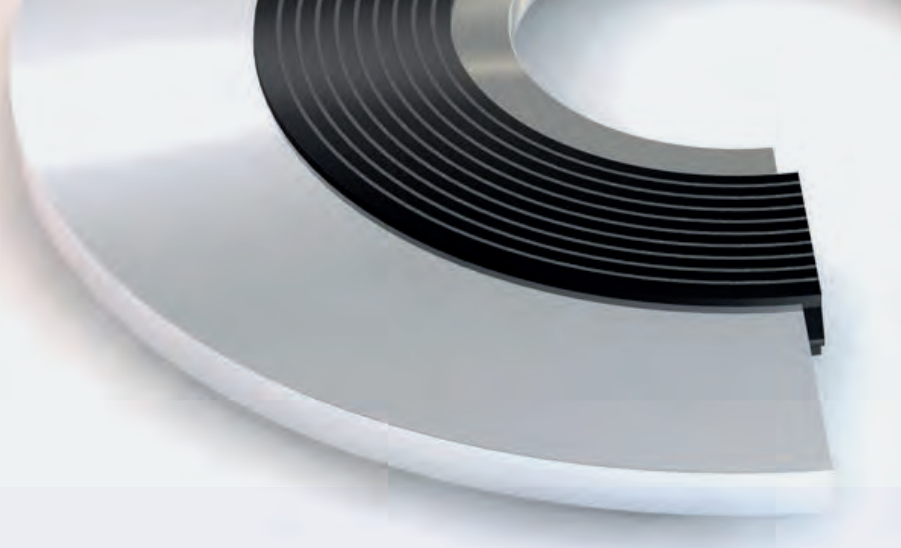


WHY MERSEN?

Mersen is one of the oldest manufacturers of flexible graphite in the world. **Papyex**® quality is demanded, through technical specifications, by many end users engaged in the chemical, nuclear, aeronautical, refining sectors, etc.

Through **Papyex**®, **Mersen** guarantees for its partners, experts in sealing products, reliability, service and performance, in particular in terms of resistance to oxidation.

01 SEALING APPLICATIONS



+ STATIC GASKETS

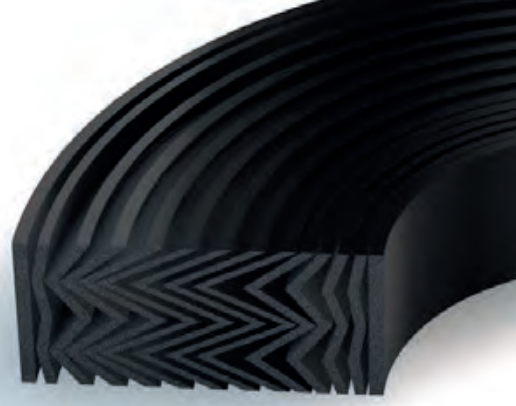
Papyex®, by virtue of its chemical, physical and mechanical characteristics, is an excellent material for flange gaskets.

PAPYEX® FLANGE GASKETS HAVE THE FOLLOWING ADVANTAGES:

- Excellent properties for use under pressure and temperature.
- Insensitivity to thermal shocks.
- No ageing: neither shrinkage, nor hardening, nor hot creep.
- Practically unlimited chemical resistance.
- Non-polluting (asbestos-free).
- Easy to cut and shape.

The main fields of use are: chemical and petrochemical industries, refineries, energy, engineering and automotive sectors.

SPIRAL WOUND GASKET



+ DYNAMIC GASKETS

Seals produced from Papyex® are self-lubricating. They resist high temperatures, high pressures and chemical agents. Regular inspection and periodic replacements are not necessary.

Papyex® is a flexible, pure, homogeneous material without binder or asbestos. It is characterised by its qualities of thermal conductivity, elastic recovery, capacity for compacting, friction even when dry, and chemical inertness.

Papyex® seals, by virtue of the absence of ageing and relaxation, avoid retightening and eliminate wear on rods and shafts.

Papyex® is used as a stuffing-box material for valves, pumps, mixers and stirrers in the chemical, refrigeration, oil, petrochemical and food industries.

This material guarantees long service life:
a Papyex® seal means 35 000 operations, and several years of use without leakage and without maintenance.

DIE FORMED RINGS

02

THERMAL APPLICATIONS

MERSEN IN FURNACE INDUSTRIES

- Heat-treatment furnaces under vacuum or controlled atmosphere
- Furnaces for passing through controlled atmosphere
- Vacuum brazing furnaces

MERSEN OFFERS A COMPLETE RANGE OF HIGH-PERFORMANCE MATERIALS FOR INDUSTRIAL FURNACES:

- Calcarb®: rigid and soft felt carbon insulation
- Graphite for refractory application
- Carbon/carbon composite
- Papyex®: flexible graphite

Associated with other Mersen's materials Papyex® has become the essential material for overcoming numerous technical difficulties at the best cost for industrial furnace users.

WHY PAPYEX® IN FURNACES?

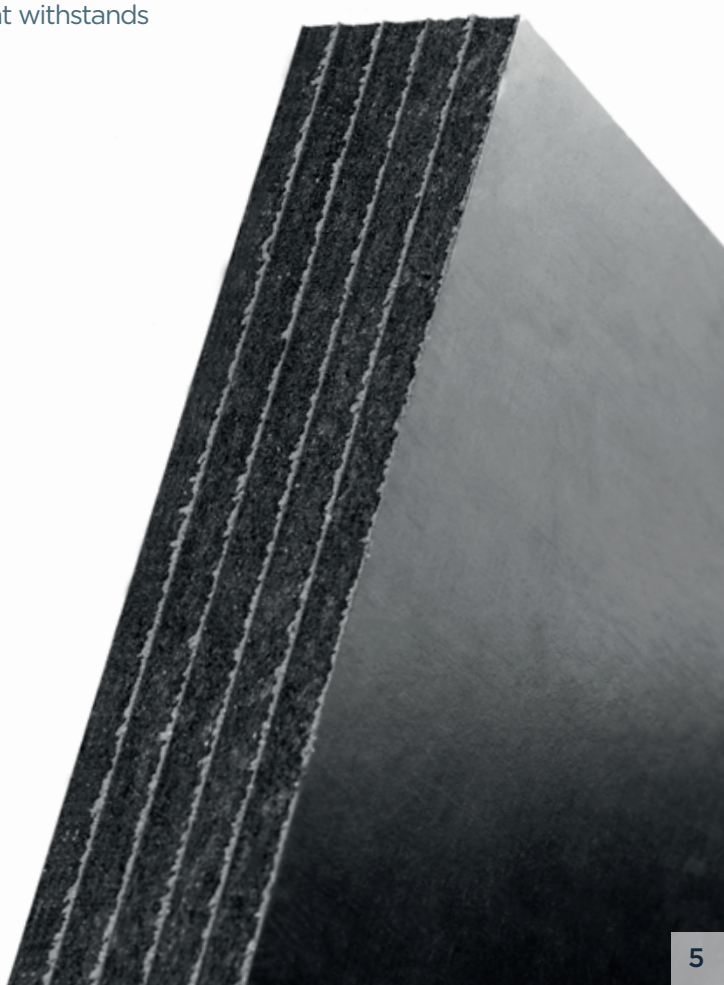
- **As a screen**: thanks to its reflecting capacity, it reduces energy loss. The anisotropy of its thermal conductivity ensures a better homogenisation of the temperature in the chamber.
- **As a thermal insulation element**: it can be used alone, in multiple screens, or in addition to commonplace insulating materials: carbon felt, rigid felt, graphite foam.
- **As a sealing material**: in plants functioning at high temperatures and in a corrosive environment, it is impermeable to hot gas and can be used as a static gasket or impervious packing.

+ ASSEMBLIES WITH INSULATORS

Papyex® is used in combination with insulators for limiting hot spots and for its heat-reflecting capacity.
The assemblies can be produced on rigid insulators such as **Calcarb®** or on flexible felt.
To make these assemblies, **Mersen** uses an adhesive that withstands very high temperatures.

+ RESISTANCE TO THERMAL SHOCKS

During a rapid rise in temperature, the gases contained in **Papyex®** may cause blisters on the surface of the material. To avoid this inconvenience, **Papyex®** FHT is first treated at high temperature, which eliminates this risk.
Moreover, on request, the surface of **Papyex®** can be perforated to facilitate degassing.

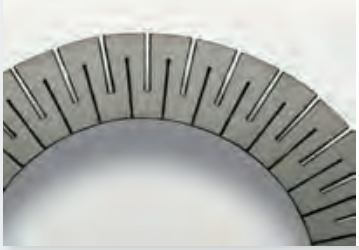


03

OTHER APPLICATIONS

\+ THE RIGHT SOLUTION FOR YOU TO IMPROVE THE PERFORMANCE OF YOUR PROCESS

ELECTRICAL RESISTANCE IN FURNACES



Thanks to its flexibility and fineness, Papyex® can be cut easily, thereby making it possible to manufacture curved resistors that adapt to non-standard laboratory equipment.

PROTECTIVE INTERFACE

IN THE GLASS INDUSTRY

Papyex® is not wet by molten or viscous glass.

IN SPARK PLASMA SINTERING (SPS)

in hot compression operations and in particular in the case of spark plasma sintering (SPS), the thinnest Papyex® makes it possible to produce inserts that facilitate mould stripping and better temperature distribution.

IN SOLDERING OR BRAZING

in particular in the case of work on delicate assemblies, Papyex® is used to protect against splashingof adjacent areas that would risk being damaged.

IN PRODUCING INGOTS

Papyex® is used for protecting the graphite equipment from reactions with the silicon. For this type of application, Papyex® can be purified (less than 5 ppm).

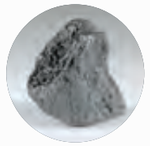
HEAT DISSIPATION PRODUCT

The conductivity of Papyex® in the plane of the sheet increases greatly with an increase in density (see graph page 11). This material can then be used for dissipating heat with equivalent performances than conductive metals such as copper. In electronics, it thus serves as a thermal interface and heat sink. Its lightness and reasonable cost, makes it competitive compared to other solutions.

04

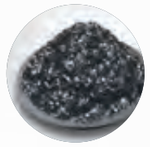
MANUFACTURE

FROM ROUGH MATERIAL TO FINISHED PRODUCTS



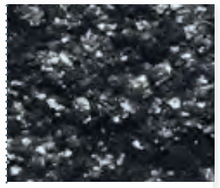
NATURAL GRAPHITE

Flexible graphite is manufactured from purified natural graphite crystallites. The best graphite ores are mainly extracted in China, Canada, India and Madagascar. In order to obtain good-quality flexible graphite, it is necessary to select ores having crystallites with dimensions greater than 180 µm.

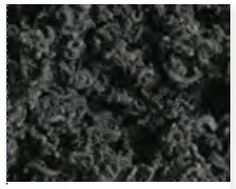


EXPANDABLE GRAPHITE

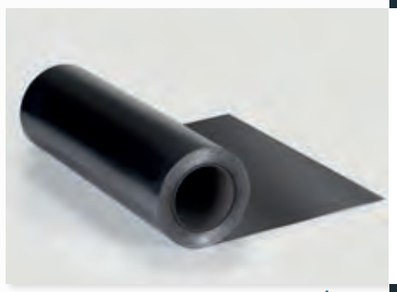
Graphite has the property of forming lamellar compounds by the insertion of atoms or molecules in its structure. This property is used for manufacturing expandable graphite by acid insertion. The inserted compound reacts to a thermal shock at very high temperature: the insertion element vaporises and expands each graphite crystallite.

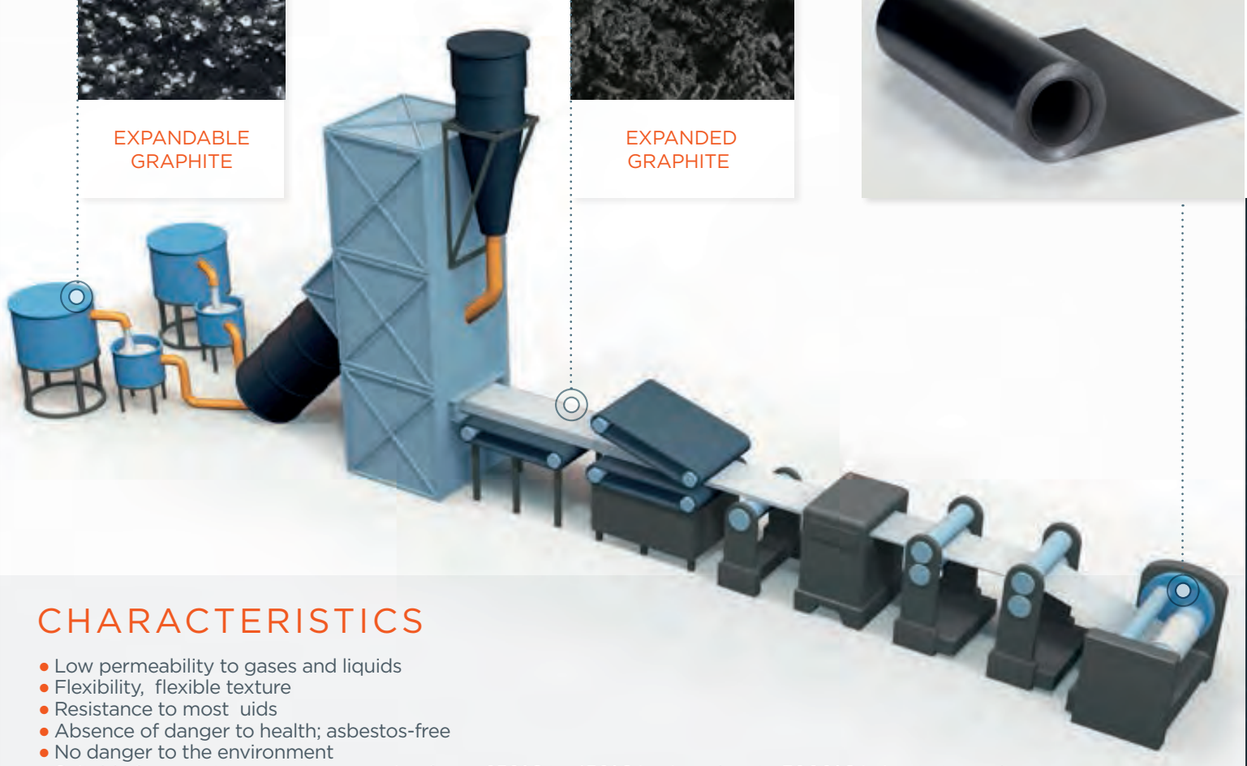


EXPANDABLE GRAPHITE



EXPANDED GRAPHITE

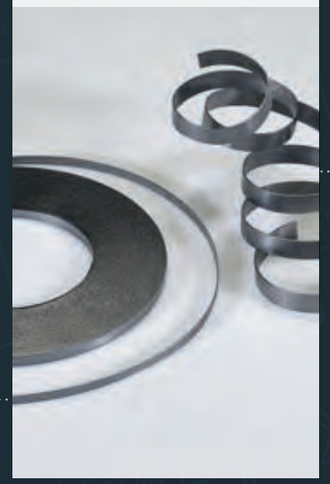




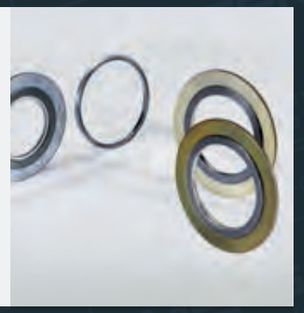
CHARACTERISTICS

- Low permeability to gases and liquids
- Flexibility, flexible texture
- Resistance to most uids
- Absence of danger to health; asbestos-free
- No danger to the environment
- Suitable for use at temperatures varying from -250°C to 450°C in air and up to 3000°C in inert atmosphere
- Absence of binders causing neither ageing nor crumbling
- Long-term compressibility stability over a wide range of temperatures
- High elastic recovery
- Anisotropic electrical and thermal conductivity
- Resistance to radiation
- Very good resistance to thermal shock
- Facilitates cutting by punch

PAPYEX® TAPE SLIT FROM A ROLL
Minimum width: 4,5 mm



SPIRAL WOUND GASKET
Co-winding of Papyex® and steel



GRAPHITE RINGS
with or without metal insert obtained by compressing Papyex® tapes

PAPYEX® ROLL

Standard width:
500, 1 000, 1 500 mm

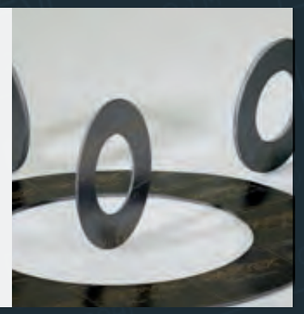
Standard density:
0,7g / cm³ to 1,1g / cm³

Standard thickness:
0,2 to 1,5 mm in roll form
up to 10 mm in plate form

REINFORCED SHEETS ASSEMBLED by gluing or clinched with tanged inserts

FLAT GASKET
cut by punch, water jet, oscillating blade

PAPYEX® HP
multi-reinforcement gasket easy to cut by conventional means



05 PAPYEX® GRADES

FOR MORE THAN 30 YEARS, MERSEN HAS BEEN RIGOROUSLY SELECTING AND PROCESSING THE BEST NATURAL GRAPHITE ORES IN ORDER TO GUARANTEE ITS CLIENTS COMPLIANCE WITH THE STRICTEST STANDARDS FOR INDUSTRIAL, NUCLEAR AND AUTOMOTIVE SEALING.

FLEXIBLE GRAPHITE MEETING SEALING REQUIRE-MENTS

	CHEMICAL, PETROCHEMICAL INDUSTRIES				AUTOMOTIVE	
	I600		I980		A960	
	Low oxidation rate		Standard purity		Low purity	
	specification	typical value	specification	typical value	specification	typical value
Carbon rate	> 99%	99,40%	> 98%	99,25%	> 96%	98,45%
Ash content	< 1%	0,60%	< 2%	0,75%	< 4%	2%
Sulfur content	< 700 ppm	500 ppm	< 1400 ppm	< 700 ppm	1400 ppm	1000 ppm
Total chlorine content	< 50 ppm	25 ppm	< 50 ppm	25 ppm	80 ppm	50 ppm
Mass loss (500°C / 24h)	< 0,5%	0,10%	< 4%	1,50%	< 10%	5%
Mass loss (670°C / 4h)	< 4%/h	3%	-	-	-	-
Maximum operating temperature to air	550 °C		450 °C		450 °C	
Maximum operating temperature under an inert atmosphere	2700 °C		2700 °C		2700 °C	

GENERAL PROPERTIES

	specification	typical value
Tensile strength (D=1g / cm³)	> 4 Mpa	4,5 Mpa
Compressibility	45% to 52%	45% to 52%
Elastic recovery	10% to 15%	10% to 15%
Area weight distribution (g / m²)	+/-5%	3,50%

PHYSICAL PROPERTIES

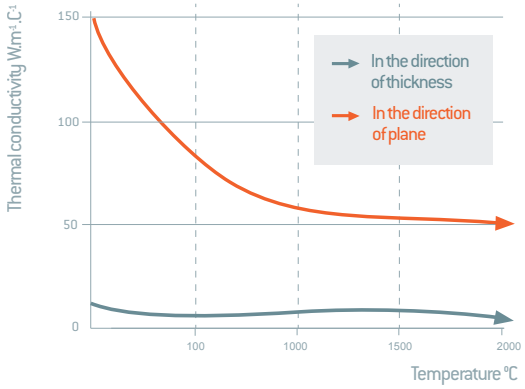
	unit	in plane	through thickness
Permeability	$cm^2.s^{-1}.atm^{-1}$	-	10^{-5}
Shore hardness	C²	25	25
Coefficient of thermal expansion	$10^{-6}.°C^{-1}$	zero	25 to 28
	$10^{-6}.°F^{-1}$	zero	14 to 15
Electrical resistivity	Ω.cm	0,001	0,05
	Ω.inch	0.0004	0.02
Emissivity coefficient at 400°C	-	0,4	0,4
Emissivity coefficient at 1 000°C	-	0,6	0,6

The wide range of Papyex® grades can meet the most advanced requirements for chemical purity in order to minimise risks of corrosion and extend its use beyond 450°C.
Specific anti-corrosion and anti-oxidation treatments further extend its use under extreme conditions.

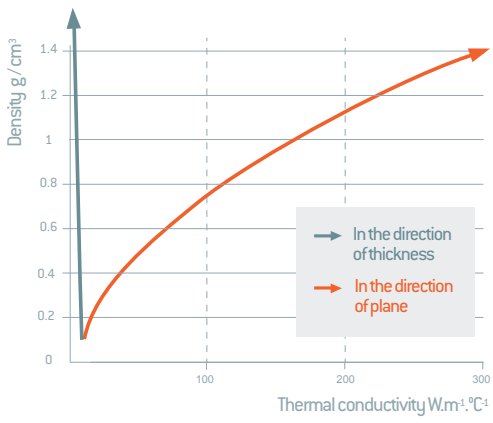
FLEXIBLE GRAPHITE MEETING SEALING REQUIRE-MENTS

	NUCLEAR							
	N9985		NS200		N998		NP998	
	The highest purity without additive		Very low sulfur		High purity without additive		High purity with oxidation inhibitor	
	specification	typical value	specification	typical value	specification	typical value	specification	typical value
Carbon rate	> 99,85%	99,90%	> 99,5%	99,55%	> 99,8%	99,85%	> 95%	98,50%
Ash content	< 0,15%	0,10%	< 0,5%	0,45%	< 0,2%	0,15%	< 0,2%	0,15%
Inhibitor rate	-	-	-	-	-	-	1% to 3%	1,35%
Sulfur content	< 600 ppm	500 ppm	< 200 ppm	120 ppm	< 600 ppm	450 ppm	< 600 ppm	450 ppm
Total chlorine content	< 30 ppm	20 ppm	< 30 ppm	20 ppm	< 30 ppm	20 ppm	< 30 ppm	20 ppm
Leachable chlorine content	< 20 ppm	10 ppm	-	-	< 30 ppm	20 ppm	-	-
Halogen content (F, Br, I)	-	-	< 50 ppm	30 ppm	-	-	-	-
Mass loss (500°C / 24h)	< 1%	0,50%	1%	1%	< 1%	0,60%	< 0,50%	0,10%

THERMAL CONDUCTIVITY ACCORDING TO TEMPERATURE



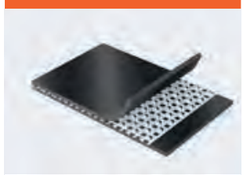
THERMAL CONDUCTIVITY ACCORDING TO DENSITY



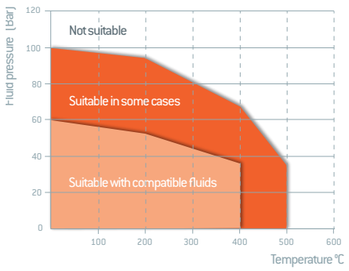
dous Substances in electrical and electronic equipment). Besides Mersen guarantees the application of the European Community REACH-Regulation (Registration, Evaluation, Authorization and Restriction of Chemical substances) to all its plants located in Europe. We are constantly involved in engineering and development. Accordingly, Mersen reserves the rignt to modify, at any time, the technology and product specifications contained herein.

06

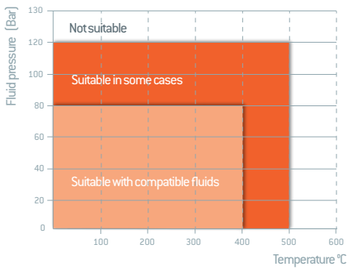
TECHNICAL DATA OF PAPYEX® SHEETS

		PAPYEX® SR	PAPYEX® RI	PAPYEX® RN	PAPYEX® PI	HIGH PERFORMANCE PAPYEX® HP
						
		Flexible graphite sheet without reinforcement.	Flexible graphite sheet reinforced with a 50 µm glued flat stainless steel insert. It is used in flange connections for chemical, petrochemical industries.	Flexible graphite sheet reinforced with a 13 µm glued flat nickel insert. Easy cutting and resistant to very corrosive fluids, in particular chlorine.	Flexible graphite sheet reinforced with a tanged 100 µm stainless steel insert, without adhesive. Suitable for manufacturing pipe gaskets & reactors seals in chemical and petrochemical industries.	Multi-reinforced flexible graphite sheet designed to resist very high pressures and mechanical stresses even the highest temperatures. Suitable for high pressure steam in generator, pump seals and high pressure vessels.
	Unit / standard	technical data	technical data		technical data	technical data
Sheet size	m	1 x 1 / 1,5 x 1,5	1 x 1 / 1,5 x 1,5	0,5 x 1 / 1 x 1 / 1,5 x 1,5	1 x 1 / 1,5 x 1,5	1 x 1 / 1,5 x 1,5
Insert material	DIN / ASTM	without insert	1.4401 / SS316 (flat)	Nickel	1.4401 / SS316 (perforated)	1.4401 / SS316 (L) (tanged)
Insert thickness	µm	-	50	13	100	50
Nomenclature	DIN 28 091-4	GR-10	GR-10-0-1 K-Cr	GR-10-I K-Ni	GR-10-0-1 M-Cr	GR-11-I-3-Cr
Flexible graphite density	g / cm³ +/-10%	0,7 to 1,3	0,7 or 1	1	1	1,1
Standard thicknesses	mm +/-10%	1,0 / 1,5 / 2,0 / 3,0	0,75 / 1,0 / 1,5 / 2,0 / 3,0	0,4 / 0,8 / 1,0 / 1,5 / 2,0 / 3,0	1,0 / 1,5 / 2,0 / 3,0	1,1 / 1,5 / 2,0 / 3,0 / 4,0
Amount of inserts	nb	0	1 / 1 or 2	1 / 1 or 2	1 / 1 or 2	1 / 2 / 3 / 5 / 7
Gas permeability (helium)	cm³ / min	< 0,30 / < 0,60 / < 0,80 / < 0,85	< 0,60	< 0,85	< 0,60 / < 0,60 / < 0,80 / < 1,0	
Specific leakage rate L	mg / s / m	< 0,05 / < 0,08 / < 0,1 / < 0,15	< 0,06	< 0,1	< 0,06 / < 0,06 / < 0,08 / < 0,1	
σ_{vo}	N / mm²	160 / 140 / 120 / 100	100	110	180 / 160 / 140 / 120	
σ_{Bo} at 300°C Standard thicknesses	N / mm²	140 / 120 / 100 / 80	70	90	160 / 140 / 120 / 100	
"Anti-sticking" treatment		Option available	No	No	Option available	yes
Tightness						Ta-Luft certification, optional
Gasket coefficient (bD = 20 mm) :						
σ_{vu} DIN E 2505	N / mm²	20	10	10	20	20
m DIN E 2505	DIN coef cient	1,3	1,3	1,3	1,3	1,3
m coefficient ASTM		2	2	2,5	3 / 2,5	2,5
y coefficient ASTM	psi	1500	900	1000	9000 / 4000	3000
Mechanical tests:						
EN 13555 - Gasket width 20 mm	T°C					20°C / 300°C / 400°C
Q_{smax}	N / mm²					> 220 / > 220 / 200
PQr (50 Mpa)						0,99 / 0,94 / 0,92
Compressibility ASTM F36A-66	%	40-50	40-50	40-50	30-35 / 30-40	30-40
Elastic recovery ASTM F36A-66	%	10-15	10-15	10-15	15-20	4-5
Residual stress DIN 52913, 16h/300°C	N / mm²	> 47	> 45	> 45	> 48 / > 48 / > 48 / > 45	> 48

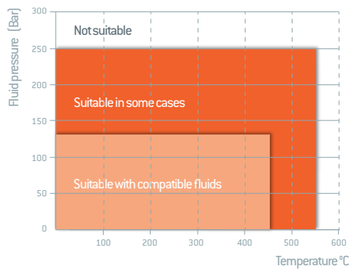
PAPYEX® RI / PAPYEX® RN
PRESSURE / TEMPERATURE



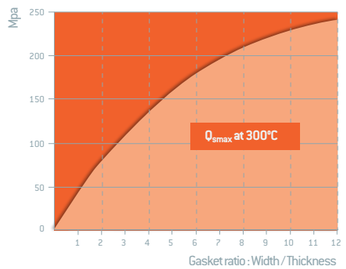
PAPYEX® PI
PRESSURE / TEMPERATURE



PAPYEX® HP
PRESSURE / TEMPERATURE



PAPYEX® HP
MAXIMAL SEAT PRESSURE ON THE GASKET



IN PARTNERSHIP WITH SPECIALISTS IN STATIC SEALING, MERSEN HAS DEVELOPED A COMPLETE RANGE OF FLEXIBLE GRAPHITE SHEETS ALLOWING CUSTOMERS TO CUT FLAT GASKETS FOR THEIR SPECIFIC APPLICATIONS.

They are available in all grades suited to purity specifications for the chemical, petrochemical, refining, and nuclear or aeronautics industries. **Mersen** checks the purity of its materials in its analysis and measuring laboratories on a daily basis in order to guarantee its customers compliance with chemical specifications for materials.

ANTI-STICKING COATING FOR FACILITATING GASKET REMOVAL

Mersen has developed a surface impregnation that forms an anti-adhesion coating effective up to 350°C in application. This AS "Anti-Stick" coating meets the technical specifications of leading chemical firms in Germany. It is an option that is particularly recommended for tanged reinforced products.

A UNIQUE SERVICE FOR PROMOTING YOUR BRAND

Mersen - sealing specialists - offers its customers the option of promoting or customizing their own brand, by means of a service marking the sheets by screen printing. We can print your sheets in the colour and model of your choice.
The largest format is up to 1500 x 2000 mm.

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