GRAFTech

GrafTech International Ltd.

GrafTech International Ltd. has a proud heritage of more than a century of industry leadership and product innovation. Today, no other company in the world is better positioned to serve the needs of the growing global marketplace for flexible graphite products.

GRAFOIL® flexible graphite was the first fluid-sealing material made exclusively from pure, natural graphite flake. It's resistance to heat, fire and aggressive chemicals make it the most universally applicable sealing material on the market today. GRAFOIL will provide a tight seal after repeated exposure to the harshest environments like no other material.

Natural graphite's flexibility and resilience when expanded, enables GrafTech International Ltd. to commercially fabricate a variety of gasketing and packing materials, cut or rolled flexible graphite sheet, self-adhering tape, RIBBON-PACK® valve packing, gasket laminate materials, heat shield and injectable packing under the GRAFOIL brand name.

All of these product forms come in a variety of grades to create a superior seal tailored to virtually any application. GRAFOIL flexible graphite sealing products have been proven fire-safe in the presence of highly volatile fluids and in extremely high temperature applications. The natural resilience of GRAFOIL flexible graphite ensures leak-tight performance while affording an environmentally safe alternative to asbestos.

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Technology

Discovery, development and implementation of leading edge technologies are key to GrafTech International's success.

From the first demonstration of an electric arc streetlight in Cleveland, Ohio in 1876, through the development of graphite electrodes for the first electric arc furnaces and the discovery of carbon fibers, to innovative work in fuel cells and supercap electrodes, we have led the way in synthetic and natural graphite product and process development.

On this strong technology foundation, we build global systems to ensure consistent execution across our worldwide manufacturing base. These systems include Partners in Quality programs with our key suppliers, Best Practices defining technology on all the steps in our process, and Statistical Process Control on all key process and product variables and indicators. All these systems are standard for all our manufacturing facilities, and are measured and monitored to ensure we always meet our customers' expectations.

Fluid Sealing For Industrial Applications

GRAFOIL® flexible graphite outperforms the competition in high and low temperatures, and provides superior sealing in the most demanding chemical and petrochemical applications. These industrial sealing products are widely recognized as being fire resistant and environmentally safe.

Choose GRAFOIL brand products first as a replacement material for asbestos or other inferior alternatives because its non-fibrous structure withstands the harshest chemicals. Combined with perforated or flat metal sheet, GRAFOIL flexible graphite is used as a high temperature and chemical resistant gasket and valve packing for chemical and petrochemical plants. Fluid sealing customers buy a variety of rolled products to produce spiral wound gaskets as well as a variety of laminates from which many different shapes of gaskets are cut.

Our innovative researchers, scientists, and engineers are exploiting the unique and versatile properties of GRAFOIL flexible graphite, and providing products for established and emerging major markets. We currently offer:

- Single Layer Material as Cut Sheets and Rolls
- All GRAFOIL® laminates
- Metal Reinforced GRAFOIL® laminates
- Non-Metallic Reinforced GRAFOIL® laminates
- GRAFOIL® Ribbon-Pack® for Die-Molded Rings
- GRAFOIL® Adhesive Backed Sheet, Gaskets and Thread Sealant
- GRAFOIL® Thread Sealant Paste
- UCAR-323® Reinforced PTFE Gasketing

Automotive And Internal Combustion Products

Applications include head gaskets, exhaust gaskets, throttle body gaskets, EGR gaskets, anywhere a superior sealing high temperature gasket is needed. Applications also include heat shields, squeak/rattle isolators and thermal hot spot spreaders.

Internal Combustion is the market segment in which the applications are related to internal combustion engines. Such engines are classified as reciprocating or rotary, spark or compression ignition, and two or four stroke. The most familiar combination, used from automobiles to lawn mowers, is the reciprocating, spark-ignited, four-stroke gasoline engine.

Makers of automobiles and small engine manufacturers comprise a large segment of the Internal Combustion Industry. Heavy duty engines for construction equipment, and speciality engines such as those used in marine applications are also part of the industry.

We Currently Offer:

- Single Layer Material
- Metal Reinforced Laminates
- Exterior Metal Faced Laminates

What is GRAFOIL Flexible Graphite?

GRAFOIL flexible graphite is a distinctive sheet material with the high temperature and chemical resistance characteristics of graphite and the additional characteristics of flexibility, compactability, conformability, and resilience. These characteristics differentiate GRAFOIL flexible graphite from other forms of carbon and graphite and make it a superior high-performance packing and gasketing material. Because of its unique properties, GRAFOIL flexible graphite gaskets and packings are particularly well suited for high and low temperature and corrosive fluid sealing applications. GRAFOIL flexible graphite is widely used as a replacement for asbestos based packing and gasketing materials. GRAFOIL flexible graphite has long been considered one of the safest materials for nearly all fluid sealing applications. GRAFOIL gaskets and packings have been proven fire-safe in the presence of highly volatile fluids and extremely high temperatures.

GrafTech International Ltd. developed GRAFOIL flexible graphite over 35 years ago. GRAFOIL flexible graphite is manufactured in our plant in Cleveland, Ohio employing a process that introduces no organic or inorganic binders, fillers, or other potentially fugitive ingredients. The process starts with a high quality particulate graphite flake that is chemically treated, usually with a mixture of mineral acids, to form a compound with and between the layers of carbon atoms. This intercalation or "between the layer" compound is then rapidly heated to decomposition resulting in an over 200 fold expansion in length compared with the thickness of the starting flake raw material.

The expansion or exfoliation process produces a wormlike or vermiform structure with highly active, dendritic-like, rough surfaces that makes them readily formable into sheet by either a molding or calendering operation. Since the forming involves only the mechanical interlocking of the wormlike expanded flakes, the resulting sheet product is essentially pure graphite, typically well over 98% elemental carbon by weight, with a highly aligned structure.

This proprietary manufacturing process imparts into the GRAFOIL flexible graphite sheet the characteristics essential to a gasketing material...flexibility, conformability, compressibility, resilience, low creep relaxation under load, fire-safe, and excellent sealability. GRAFOIL flexible graphite can be used alone as a gasketing or packing material or reinforced with various materials such as stainless steel or fiberglass to improve handleability.

Shelf-Life GRAFOIL Flexible Graphite

GRAFOIL flexible graphite is made exclusively from a high quality pure natural graphite flake material that has already undergone millions of years of aging in the earth's crust. GRAFOIL is resistant to high temperature, naturally lubricious, chemically inert, and unlike asbestos fiber, it has no water of crystallization to lose. GRAFOIL flexible graphite by itself (GT™A, GT™B, GT™J, GT™K), has an indefinite shelf life (greater than 40 years) and can be stored under normal conditions.

For GRAFOIL cured gasket laminate grades (GH™A, GH™B), and mechanically bonded laminates (GH™E, GH™O), the shelf life is also indefinite (greater than 40 years). Normal indoor storage is acceptable for these products.

For thermally bonded laminates (GH™P, GH™W, GH™N, and GRAFKOTE™) the bond is not affected by time and therefore the shelf life is indefinite (greater than 40 years). Normal indoor storage at temperatures under 100°F is acceptable for these products.

For the adhesively bonded laminates (GH™R, GH™T, GH™L), there is only edge plane exposure of adhesive layers to the environment. Our experience has shown that the laminate material should have a minimum shelf life of five years.

With adhesive backed thread sealant and gasket tape, cosmetic changes may take place after a period of one year. We recommend that adhesive backed tape products (GT™F, GT™H) be examined after a period of one year to make sure that "adhesion characteristics" of the material have not changed. The paper

backing on the tape may begin to "bench up" and separate from the tape due to the hygroscopic properties of the release paper. For optimal storage, we recommend that the adhesive backed tape products be stored in an area where ambient temperature is around 70°F and the relative humidity is reasonable.

GRAFOIL® Packing and Gasketing Fire Safety

GRAFOIL flexible graphite is the packing and gasketing material of choice for chemical plants and refineries because of its superior fire resistance. Since the general replacement of asbestos gaskets and packing, GRAFOIL flexible graphite packings and gaskets have been one of the few fire safe packing and gasketing materials available in the market.

Factory Mutual Engineering has evaluated samples of GRAFOIL gaskets and has concluded that "graphite gaskets may be used on any flammable liquid piping or equipment in accordance with the recommendation of the gasket, pipe, or equipment manufacturer and when graphite in void of organic fillers or resins."

Several valve manufacturers have successfully fire-tested valves containing GRAFOIL flexible graphite packings as an integral part of the valve. These tests were conducted to a number of fire test standards such as the API

GRAFOIL Gaskets

607, and British Standard 5146.

In tests completed by the Pressure Vessel Research Council (PVRC) of the Welding Research Council (WRC), a wide range of asbestos, non-asbestos, PTFE, and GRAFOIL flexible graphite gaskets were tested for their resistance to simulated fire test conditions at temperatures of 1200°F (650°C). In these tests, as reported in WRC Bulletin 377, asbestos was able to sustain a simulated fire test soak time of 15 to 30 minutes. Non-asbestos fiber reinforced materials could not sustain these same simulated fire tests. PTFE filled spiral wound gaskets lost all of the filler during the testing. However, GRAFOIL Grade GH™R gaskets "performed very well" in the simulated fire tests. GRAFOIL filled spiral wound gaskets "exhibited excellent performance." The report's conclusion states that "both flexible graphite sheets and graphite filled spiral wound gaskets exhibit excellent behavior" during the simulated fire testing.

GRAFOIL Grade GHV gaskets have been tested and passed the fire safety performance requirements of a modified version of the API Standard 607, Fourth Edition. This test was conducted using 6" ANSI Class 300 raised face flanges with flange thermocouple temperatures reaching temperatures in excess of 1200°F (650°C). The GHV gaskets were first successfully hydro tested at 30 psi (207 kPa) and then at 385 psi (2.6 MPa). The gasketed flanges were then heated with an open flame to over 1200°F (650°C) in 15 minutes and held another 15 minutes at temperature. At the conclusion of the heating of the flanges, they were gradually cooled to 300°F (149°C) by a water mist. Large amounts of water were then applied to the flanges to reduce the temperature below 100°F (38°C). Water at 30 psi (207 kPa) was in the flanges during the high temperature test. The allowable amount of water leakage at the end of the test was 150 ml/min. The GHV gaskets exhibited an average of less than one-fourth the allowed leakage rate.

In addition to excellent fire resistance, GRAFOIL flexible graphite also exhibits excellent high temperature stability. GRAFOIL flexible graphite packings and GRAFOIL gaskets exhibit minimal high temperature creep relaxation and excellent high temperature sealability. The physical properties of GRAFOIL flexible graphite remain constant up to temperatures of 975°F (525°C) for long periods of time making GRAFOIL flexible graphite the number one choice for high temperature fire safe gaskets.

GRAFOIL Flexible Graphite in Oxygen Service

Many inquiries have been received concerning the use of GRAFOIL flexible graphite in oxygen service. GRAFOIL flexible graphite is compatible with both liquid and gaseous oxygen in service conditions of up to 2000 psig and a maximum temperature of 400°C (735°F). These limits are specific to GRAFOIL Grades GT™Z, Ribbon-Pack® and DMBP style performed packing rings, sheet grades, GT™A, GT™I, GT™B, GT™K, and gasket laminate grades, GH™R, GH™E, GH™R, GH™L, and GH™B.

The Union Carbide Corporation, Linde Division laboratory at Tonawanda, New York, conducted three different tests to determine the acceptability of GRAFOIL flexible graphite packing and gasketing materials for oxygen service using 1) an impact test, 2) a calorimeter test, and 3) a bomb test.

In the Linde impact test, the sample was immersed in liquid oxygen (LOX), then struck with a force of 114 foot-pounds just as the last trace of LOX evaporated. No ignition of the samples was noted. The ABMA (Army Ballistics Missile Association) test by which most materials in the USA are rated is similar except that the ABMA uses only 70 foot-pounds force.

The calorimeter test was a standard determination of the heat of combustion of the sample with pure oxygen. The published value for the graphite is 7840 calories per gram (14,000 BTU/lb). No ignition was attained using ASTM Standard Method D-2382.

In the bomb test, the sample was sealed in a pressure vessel. The vessel was then: 1) filled with pure oxygen, 2) pressurized to 2000 psig, and 3) the temperature increased to either a maximum of 500°C or the ignition point of the sample. The GRAFOIL sample did not ignite at 500°C. The vessel pressure was allowed to rise as the temperature was increased to 900°C. This test was considered to be the most rigorous of the three different evaluations.

As a result of these tests, the Union Carbide Corporation, Linde Division, rated the GRAFOIL materials, listed in the first paragraph as suitable for liquid and gaseous oxygen in service conditions up to 2000 psig and a maximum temperature of 400°C (735°F). In addition, the following GRAFOIL products are suitable only as qualified below:

Maximum Limit	Temperature	Pressure
A/B Crinkle Tape (GT™F and GT™H)	60°C (140°F)	200 psig
A/B Thread Sealant Tape (GT™F and GT™H)	60°C (140°F)	200 psig

For further guidance to the application of GRAFOIL flexible graphite in oxygen service, refer to ASTM Standard Guide G-63.

Three (3) other independent tests have been performed to determine the acceptability of GRAFOIL packings and gaskets in oxygen service:

1. At the request of Union Carbide-Europe, the German Federal Institute for Material Testing (Berlin) conducted tests to determine the acceptability of GRAFOIL packings and gaskets in oxygen service:

   a. *This Institute approved GRAFOIL sheet as a gasketing material for oxygen service up to 100 bar (1450 psig) and 200°C. Due to the limitations of the test apparatus, the institute was not able to determine whether GRAFOIL sheet could be used with higher oxygen pressures and temperatures.*

   b. *This Institute approved GRAFOIL Ribbon-Pack as a packing for stuffing boxes in components of compressed oxygen equipment at pressures up to 250 bars (3625 psig) and temperature up to 200°C. Again, due to limitations of the test apparatus, the Institute was not able to determine whether GRAFOIL Ribbon-Pack could be used with higher oxygen pressure and temperatures.*

   c. *This Institute suggests that GRAFOIL Adhesive-Backed tape can be used to seal flanged joints in components for compressed oxygen equipment up to 100 bars (1450 psig) and temperatures up to 150°C, whether in blind flanges or in those with large and small tongues or with grooves and tongues.*

2. The British Oxygen Company Ltd., (England), Safety Department, Gases Division, approved plain GRAFOIL sheet for use as a packing and gasketing material for gaseous oxygen up to 170 bar (2466 psig) at 50°C, and for liquid oxygen service.

3. Chemetron Corporation is reported to have conducted tests similar to Linde's with results again showing that plain GRAFOIL sheet can be used safely with liquid oxygen.

Note: Organic contaminates e.g. greases/oils must not contact GRAFOIL flexible graphite during fabrication to assure safe operation.

GRAFOIL GT®B Flexible Graphite

GRAFOIL grade GTB flexible graphite sheet is the primary building block material for industrial Fluid Sealing Applications. GRAFOIL GTB flexible graphite sheet is used as the facing material in laminate grades GH™R, GH™E, GH™L, GH™W, GH™V, GH™P, GH™B, GH™C, and GH™T. The GTB flexible graphite sheet used to make each of these laminate grades is produced and inspected to the requirements of Technical Bulletin 103.

In 2000, GrafTech International Ltd. began enhancing grade GTB flexible graphite sheet. The enhancement was the addition of our oxidation and corrosion inhibitor for no additional cost. Addition of the oxidation/corrosion inhibitor allowed us to increase the maximum recommended continuous use temperature for GTB sheet from 850°F to 975°F (450°C to 525°C) in oxidizing conditions. The addition also greatly reduces the potential for galvanic corrosion when GRAFOIL GTB sheet is in contact with steel or stainless steel and an electrolyte solution. These same enhanced properties also apply to each of the laminate grades noted above since GRAFOIL GTB is used as the facing material in all of them.

The specification for GRAFOIL GTB sheet (TB103) includes a performance-based requirement to insure that the oxidation/corrosion inhibitor is present. This performance-based requirement is the oxidation rate at 670°C for 1 hour. Uninhibited flexible graphite sheet will oxidize much faster than enhanced GTB sheet. The oxidation rate specification for GTB sheet is less than 10% weight loss after 1 hr at 670°C. Typically when tested, the oxidation rate for enhanced GTB is normally 2%.

The oxidation/corrosion inhibitor is added during the processing of GTB sheet at a point where it is thoroughly mixed with the raw materials. The inhibitor is therefore an integral part of the entire thickness of the enhanced GTB sheet, not just a surface coating.

GRAFOIL GTB flexible graphite is the highest performing flexible graphite in the market today. Be confident in your material choice by specifying GRAFOIL grade GTB flexible graphite, and allow no substitutes!

PROPERTIES

GRAFOIL is Anisotropic.

Due to its crystalline structure, GRAFOIL flexible graphite exhibits anisotropic characteristics with physical properties such as electrical and thermal conductivity and tensile strength.

GRAFOIL is Resilient and Compressible.

GRAFOIL flexible graphite recovers after compression, protecting systems from load loss caused by bolt stretch.

GRAFOIL is Naturally Lubricious.

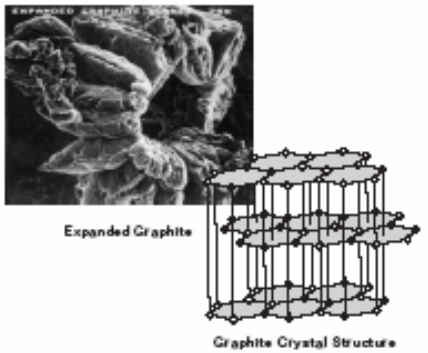
Natural lubricity makes GRAFOIL flexible graphite the ideal choice for gasket and seal applications where surface movement exists. Even in sliding movements, GRAFOIL flexible graphite maintains the utmost in performance and sealability.

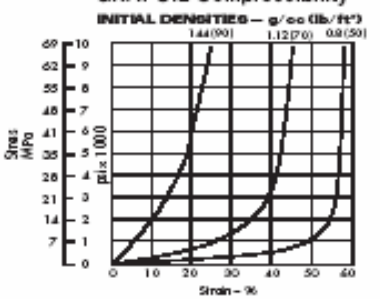
GRAFOIL is Thermally Stable.

Dependable performance is assured from -240°C (-400°F) to 3000°C (5400°F) in non-oxidizing atmospheres, and up to 450°C (850°F) or 525°C (975°F) for GTB in oxidizing environments when GRAFOIL is shielded. GRAFOIL flexible graphite will not cold flow or creep under normal gasket loads and there is no embrittlement.

GRAFOIL is Easily Cut.

Using conventional tools, GRAFOIL flexible graphite can be cut or molded into most required configurations. GRAFOIL flexible graphite is manufactured in both sheets and laminate forms (with or without metal and non-metallic cores) and is offered in any thickness from 75 microns (0.003") to 1650 microns (0.065") in a variety of densities from 0.6 g/cm³ (40 lbs/ft³) to 1.5 g/cm³ (90 lbs/ft³).





Typical Properties	Standard	Units	Nominal Density 1.36 g/cm³ (85 lb/ft³)	Nominal Density 1.12 g/cm³ (70 lb/ft³)
Compressibility	F-36	%	20	43
Recovery	F-36	%	25	15
Creep Relaxation	F-38 Method B	%	<5	<5

TYPICAL GRAFOIL SHEET PROPERTIES

TYPICAL MATERIAL PROPERTIES

Properties	English	Metric
Density (ASTM F-1315)	70 lb/ft³	1.12 g/cc
Leachable Chloride Content-		
Industrial Grades	<20 ppm	
Premium (Nuclear) Grades	<10 ppm	
Sulfur Content —		
Industrial Grades	550 ppm	
Premium (Nuclear) Grades	450 ppm	
Carbon Content —		
Industrial Grades	98%	
Premium (Nuclear) Grades	99.9%	
Compressibility (ASTM F-36)	43%	
Recovery (ASTM F-36)	15%	
Creep Relaxation (ASTM F-38)	<5%	
Sealability (ASTM F-37)	0.017 fluid ounces/hr.	0.5 ml/hr

TYPICAL PHYSICAL PROPERTIES

Properties	English	Metric
Tensile Strength — (ASTM F-152)		
Along Length & Width		
Industrial Grades	650 psi	4.4 MPa
Premium (Nuclear) Grades	1000 psi	6.9 MPa
Coefficient of Friction against Steel		
@ 4 psi (0.03 MPa)	0.018	
@ 8 psi (0.06 MPa)	0.052	
@ 12 psi (0.08 MPa)	0.157	
Compressive Strength		
Through Thickness		
(ASTM C-695)	35000 psi	240 MPa
Modulus of Elasticity	0.2 x 10⁶ psi	1380 MPa
Young's Compressive Modulus		
Through Thickness	27000 psi	186 MPa

NUCLEAR RADIATION RESISTANCE

Exposure Levels	Results
5.5 X 10¹⁰ N/T @ 1000°C 1.5 x 10⁸ rads Gamma Radiation (1.5 x 10⁶ erg/g)	No Apparent Effect
	No Apparent Effect

+ Source: Oak Ridge National Laboratory (1978)

Integrated Neutron Flux

N = Neutrons/cc
V = cm/sec
T = Seconds
(1 rad = 100 erg/g)

TYPICAL THERMAL PROPERTIES

Properties	English	Metric
Functional Temperature Range		
Neutral or Reducing Atmosphere	-400 to 5400°F	-240 to 3000°C
Oxidizing Atmosphere GT™A Grade	-400 to 850°F**	-240 to 450°C**
GT™B, GT™K, GT™J Grades	-400 to 975°F**	-240 to 525°C**
Thermal Conductivity		
Along Length & Width	980 BTU·in/ft²·hr·°F	140 W/m·K
Through Thickness	36 BTU·in/ft²·hr·°F	5 W/m·K
Thermal Expansion		
"a" Direction Parallel to Layers		
70°F-2000°F (21°C-1094°C)	0.2 x 10⁻⁶ in/in·°F	0.4 x 10⁻⁶ m/m·°C
2000°F-4000°F (1094°C-2206°C)	0.5 x 10⁻⁶ in/in·°F	0.9 x 10⁻⁶ m/m·°C
"c" Direction, Through Thickness		
70°F-4000° (21°C-2206°C)	15 x 10⁻⁶ in/in·°F	27 x 10⁻⁶ m/m·°C
Specific Heat at 75°F (24°C)	0.17 Btu/lb·°F	711 J/kg·K
Heat Storage in a 0.015" layer at 1000°F (538°C)	0.035 Btu/ft²·°F	0.02 cal/cm²·°C
Surface Emissivity	0.5	0.5
Sublimation Point (Does not melt)	6000°F	3300°C
Thermal Shock Resistance	Excellent	Excellent

** The fluid temperature in an oxidizing atmosphere may considerably exceed the indicated temperature without oxidation of the GRAFOIL flexible graphite providing that the fluid temperature of the GRAFOIL gasket is below these temperatures or that the fluid being handled does not come into direct contact with the graphite. Examples: a metal spiral-wound gasket with a GRAFOIL GT™ filler material. GRAFOIL gaskets may be used at higher temperatures with non-oxidizing fluids such as steam.

SIZES AVAILABLE

Sheet Thickness: 0.005" to 0.060" in 0.005" increments
Widths: 24", 39.4", 60", or custom slit to your requirements
Length: 50', 100', 108', 250', 300', 500', 1000', 2000', 3000', 4000'

Laminate Thickness:	1/32", 1/16", 1/8"	
Length x Width	24" x 24"	610 mm x 610 mm
	39.4" x 39.4"	1000 mm x 1000 mm
	60" x 60"	1524 mm x 1524 mm
	39.4" x 78.8"	1000 mm x 2000 mm

GH™R, GH™E, GH™L, GH™D - 1/32", 1/16" is available in coils
39.4" x 100 ft
39.4" x 250 ft
39.4" x 500 ft

GRAFOIL Gasketing Techniques

GRAFOIL flexible graphite is a resilient form of graphite that has excellent properties as a gasketing material. It seals about as readily as rubber, it is chemically compatible with a very wide range of chemicals, it is recommended for temperatures up to 975°F in oxidizing conditions, and it does not creep or harden with age or temperature. GRAFOIL flexible graphite can be fabricated into metal core laminates or into spiral wound gaskets for an even wider recommended range of applications. GRAFOIL gaskets will seal the maximum pressure specified on properly designed, correctly manufactured and suitably maintained equipment when loaded to the recommended gasket stress.

While being flexible and resilient, GRAFOIL flexible graphite is still all graphite. It has no resins, binders, filler materials, or other additives that might detract from the chemical inertness and temperature resistance of pure graphite. GRAFOIL gaskets will not cold flow, become brittle, or vulcanize to gasketing surfaces in service. The unique chemical and physical properties of GRAFOIL flexible graphite combine to make it a nearly universal gasketing material especially suitable to high temperature and cryogenic service and/or corrosive environments.

General Points To Remember When Gasketing With GRAFOIL Flexible Graphite

1. The flange surfaces must be clean, and free of nicks, scratches, burrs, metal filings, scale or other foreign matter.

2. Use proper bolt tightening sequence to insure a uniform load is applied to the joint (see ASME PCC-1 Bolted Joint Assembly Procedure). The use of a torque wrench or other measurable tightening procedure is advantageous to ensure that a uniform tensile stress is applied to each bolt.

3. GRAFOIL GH™E 316 stainless steel tang metal inserted gaskets should not be used between any metal surfaces that are softer than the stainless steel (i.e. aluminum, brass, bronze), or between glass or ceramic surfaces. When GRAFOIL GHE gaskets are used, the metal tangs must be compressed such that the GRAFOIL facing begins to seal. Due to the minimum seating stress recommended for these gaskets (2500 psi), the metal tangs can make small indentations in the softer metal of the flange face. The tangs can also create stress concentration points on glass or ceramic surfaces.

4. GRAFOIL flexible graphite gaskets must be loaded with a net compressive unit load greater than shown in the Unit Load versus Leak Pressure Curve, Figure 1.

5. The initial thickness of the GRAFOIL gasket must be such that when it is compressed between two mating surfaces, the GRAFOIL gasket is strained sufficiently at all points in the joint to seal the maximum service pressure. If the flange surfaces are scratched, serrated, or warped, the initial gasket thickness must be large enough to completely fill and compensate for the effect of surface defects when the joint is made and the gasket compressed.

6. The flatness of the flange surfaces is as essential to good gasketing practice as the proper gasket unit load. If for any reason the gasketed surfaces are not flat while in service, the gasket unit load can be less at some point or points than the amount required to seal the operating or test pressures. In general, if when the flange faces are brought together (i.e. just touching and under no bolt load), a 0.001" feeler gage can not be inserted anywhere around the circumference of the joint, then a 1/64" thick GRAFOIL gasket can be used. If this criterion can not be met, then a thicker GRAFOIL gasket will be required.

Important Points Concerning Flange Surface Finish And 'Standard' Serrations

Under equivalent compressive unit loads, GRAFOIL gaskets will seal where flange surface finishes range from 5 RMS (root mean squared) to 500 RMS. Within that range any RMS finish will seal well. As a matter of practice, we recommend a 125 to 250 RMS surface finish that complies with ASME B16.5 requirements.

Flanges ordered with "standard serrations" or a "standard finish" usually have finished surfaces machined in accordance with MSS Standard Practice SP-6 that allows for considerable latitude in surface finish. The SP-6 Standard refers to AARH finishes or arithmetic average roughness. AARH values are different from RMS values for any given surface. RMS measurements are made with a stylus tracer instrument, whereas, AARH finishes are evaluated by "sight and touch" comparisons with standard specimens.

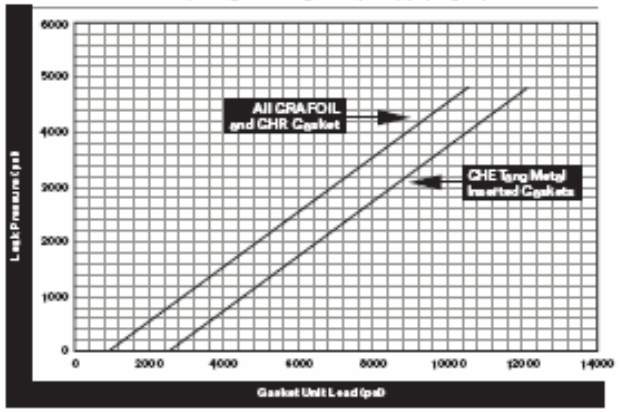
The standard serration may be concentric or spiral. If concentric, there may be up to 32 serrations per inch, and the depth of the serration may range from 0.005" to 0.015". The serration cross section can range from a radiused "u" cut to a "v" cut.

Spiral serrations can range from 20 to 50 per inch in number and from 0.001" to 0.006" in depth. Spiral serrations in contrast to concentric serrations, can form a continuous leak path if the gasket material does not deform and seal all the way to the bottom of the groove. Consequently, the greater the depth of the spiral serration, the greater the required thickness of the GRAFOIL gasket in order to seal.

Concentric serrations have shown a very slight improvement in helping GRAFOIL gaskets to seal. Because of the highly conformable nature of GRAFOIL gaskets, they will seal serrations more dependably than most other gasket materials.

Figure 1

Leak Pressure Vs. GRAFOIL Gasket Unit Load
For All GRAFOIL, CHR and GHE Gaskets 1/32", 1/16" and 1/8" Thick



GRAFOIL® Grades for Fluid Sealing Applications

GT™A :

GTA premium, high purity flexible graphite sheet, typically used for Nuclear, Semiconductor, or other applications where impurities are not allowed. GTA is typically 99.8% graphite. Its leachable chloride is typically less than 15ppm and meets D50YP12 Rev2. GTA is available in sheets or rolls from 0.005" to 0.040" thick.

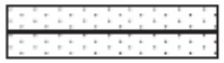
GT™J:

GTJ premium sheet flexible graphite, based on GTA with corrosion /oxidation inhibitor added. GTJ is available from 0.005" to 0.040" thick. It can be laminated to stainless steel, to plastic, or to itself to form a thick gasket assembly.

GT™B

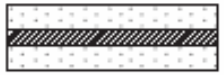
GTB is inhibited flexible graphite sheet used as a stand alone product or as the base material to produce the other laminate materials for fluid sealing applications. GTB is homogeneous, all flexible graphite formed to thickness on our rolling line. It is available in sheets and rolls from .005" to .060" thick and 24" wide, meter wide, or 60" wide.

GH™L



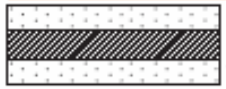
GHL is a laminate made by adhesively bonding two or more layers of GTB sheet together to the required thickness.

GH™R



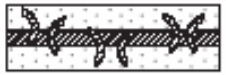
GHR is an adhesively bonded laminate made with GTB facing on a 316/316L stainless steel foil interlayer that is 0.002" thick.

GH™V



GHV is an adhesively bonded laminate made with GTB facing on a 316/316L stainless steel interlayer that is 0.015" thick.

GH™E

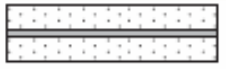


GHE is a mechanically bonded laminate made with GTB facing on a 316/316L stainless steel tang metal interlayer that is 0.004" thick.

Wire Reinforced (WR)

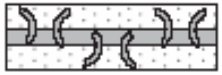
WR is an adhesively bonded laminate made with GTB facing on a 316 stainless steel screen interlayer.

GH™T



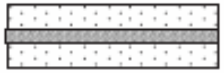
GHT is an adhesively bonded laminate made with GTB facing on a C-276 metal alloy foil interlayer that is 0.002" thick.

GH™O



GHO is a mechanically bonded laminate made with GTB facing on a C-276 tang metal alloy interlayer that is 0.004" thick.

GH™W



GHW is a thermally bonded laminate made with GTB facing on a PTFE impregnated fiberglass cloth interlayer that is 0.0025" thick.

GH™P

GHP is a thermally bonded laminate made with GTB facing on a polymer interlayer that is 0.0015" thick.

Double Sided GRAFKOTE®

Double sided GRAFKOTE is a thermally bonded laminate made with a 0.0005" thick polymer facing top and bottom of a GTB interlayer

GRAFKOTE®

GRAFKOTE is a thermally bonded laminate made with a 0.0005" thick polymer top facing on a GTB bottom layer

GT™H:

GTH is GTB Sheet with a Pressure Sensitive Adhesive (PSA) on a plastic carrier applied to one surface. The PSA is covered with a release paper for protection until use. Available in plain or crinkled styles.

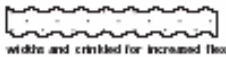
GT™F:

GTF is GTA Sheet with a Pressure Sensitive Adhesive (PSA) layer on one surface. The PSA is covered with a release paper for protection until use. Available in plain or crinkled styles.

GT™Z:

GTZ Ribbon-Pack® is GTB flexible graphite sheet slit to narrow widths and crinkled for increased flexibility. Ribbon-Pack can be used to make formed-in-place or die-molded valve packing rings.

GT™R:



GTR Ribbon-Pack® is GTA flexible graphite sheet slit to narrow widths and crinkled for increased flexibility. Ribbon-Pack can be used to make formed-in-place or die molded valve packing rings.

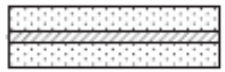
UCAR®323 (PTFE with woven fiberglass)

UCAR 323 is a PTFE gasket material with a woven fiberglass cloth reinforcing

GRAFOIL® Grades for Internal Combustion Applications

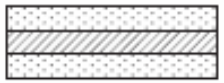
GT™C

GTC is a non-inhibited flexible graphite sheet used as a stand alone product or as the base material to produce the other laminate materials for internal combustion applications. GTC is homogeneous, all flexible graphite formed to thickness on our rolling line. It is available in sheets and rolls from 0.005" to 0.060" thick and 24" wide or meter wide.



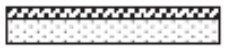
GH™H

GHH is an adhesively bonded laminate made with GTC facing on a low carbon steel foil interlayer that is 0.004" thick.



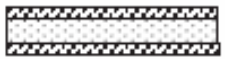
TG-251

TG-251 is an adhesively bonded laminate made with GTC facing on a low carbon steel foil interlayer that is 0.0066" thick.



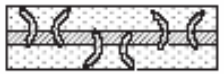
TG-245

TG-245 is an adhesively bonded laminate made with 0.001" thick Aluminum foil bonded to the top surface of GTC.



TG-247

TG-247 is an adhesively bonded laminate made with 0.001" thick Aluminum foil bonded to the top and bottom surface of a GTC interlayer.

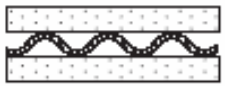


GH™J

GHJ is a mechanically bonded laminate made with GTC facing on a low carbon steel tang metal interlayer that is 0.0066" thick.

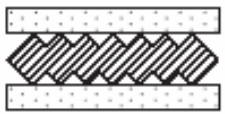
Finished Gaskets

(GrafTech International Ltd. Advanced Energy Technology Inc. supplies facing or filler materials and finished gaskets are made by our distributors.)



Corrugated Metal Reinforced Gasket (CMRG)

CMRG is a finished gasket shape made by adhesively bonding GRAFOIL GTB to a concentrically corrugated metal interlayer. The interlayer is normally 316 stainless steel.

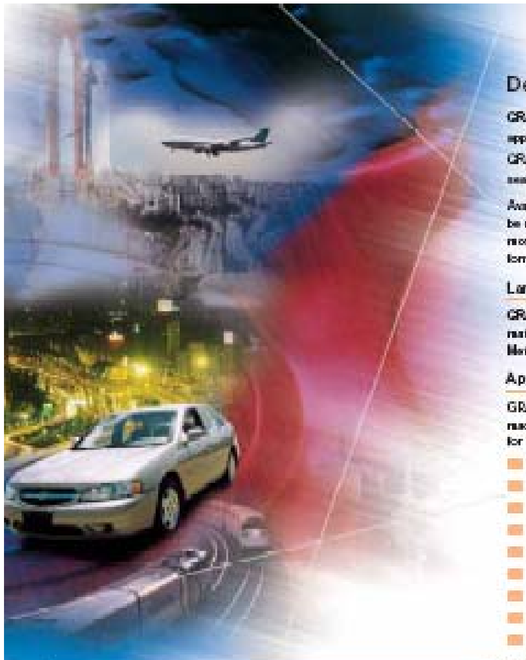


Kammprofile Gaskets

Kammprofile gaskets are a finished gasket shape made by adhesively bonding GTB facing to the top and bottom of a serrated metal ring. The serrated metal is usually 316 stainless steel and may incorporate OD centering rings

Spiral Wound Gasket (SWG) with inner and outer rings

SWG is a finished gasket shape made by spirally wrapping GTB with a thin metal strip to form a sealing ring. The sealing ring is often surrounded by inner and outer centering rings.



GRADE	DESCRIPTION	STANDARD THICKNESSES* mm / Inches								
GTC	[illegible]	0.13	0.25	0.38	0.51	0.64	0.76	0.89	1.02	1.52
		0.005	0.010	0.015	0.020	0.025	0.030	0.035	0.040	0.060
GHC	[illegible]		0.76	1.02	1.27	1.52	2.03			
			0.030	0.040	0.050	0.060	0.080			
GHH	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]			
				[illegible]	[illegible]	[illegible]	[illegible]			
TG251	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
GHJ™	[illegible]			[illegible]	[illegible]	[illegible]	[illegible]			
				[illegible]	[illegible]	[illegible]	[illegible]			
TG245	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
TG247	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
			[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

[illegible]

Demand GRAFOIL Flexible Graphite!

GRAFOIL flexible graphite material, is engineered for critical sealing applications for internal combustion engines and related systems. GRAFOIL flexible graphite maintains the utmost in performance and sealability.

Available in rolls, sheets and laminates, GRAFOIL flexible graphite can be molded, cut or otherwise formed to fit virtually any configuration in most any application requiring a durable, low maintenance, high performance gasket.

Laminates

GRAFOIL flexible graphite can be combined with various interlayer materials to improve performance and handling. Carbon Steel, Tanged Metal, Aluminum and PTFE are available.

Applications

GRAFOIL flexible graphite is an extremely versatile sealing material made without binders, resins or other additives; it is the obvious choice for such internal combustion applications as:

- Gasoline/diesel engine head gaskets
- Exhaust manifold gaskets
- Exhaust ring seals
- Turbo charger gaskets
- Intake manifold and crossover gaskets
- Gas turbine seals and gaskets
- Heat shields
- Air bags
- Noise and vibration harshness (NVH)

Grades

Single Layer Material Available As Cut Sheets Or Rolls

GT™C: The standard grade of flexible graphite sheet for most internal combustion applications. It can be provided as full-width 24 in. or meter-wide rolls, slit widths, or as sheets.

Super GTO™: Premium inhibited sheet grade where a higher level of oxidation resistance is required.

EXPANDOGRAF™: An all graphite sheet material containing no binders, which is designed for use in high temperature applications where sealability is critical.

Metal Reinforced GRAFOIL Laminates

GH™J: Laminate consisting of 0.0066 in. thick low carbon steel tang core with grade GTC mechanically clinched to both sides.

GH™H: Laminate consisting of a 0.0042 in. thick low carbon steel core with grade GTC adhesively bonded to both sides.

TG251: Laminate consisting of a 0.0066 in. thick low carbon steel core with grade GTC adhesively bonded to both sides.

Exterior Metal Faced

TG245: Laminate consisting of GTC with a layer of aluminum foil adhesively bonded to one side.

TG247: Laminate consisting of GTC with a layer of aluminum foil adhesively bonded to both sides.

Nuclear Certifiable Thread Sealant Paste

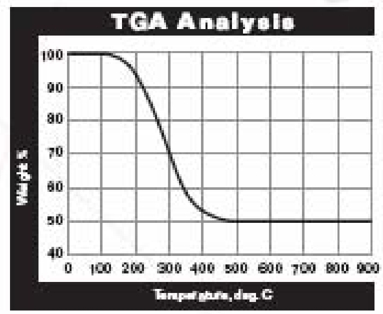
GRAFOIL GTS® Graphite Thread Sealant is a patented product consisting of a high purity paste made from a combination of nuclear grade graphite and a nuclear quality petroleum based carrier. It has all the characteristics needed for long life performance, even under the most severe conditions. It is made to seal smaller diameter, close tolerance threaded pipe joints in critical service applications to 635°C (1200°F) and 52 MPa (7500 psi).

GTS thread sealant paste can be certified to meet many nuclear specifications because of its purity and thermal stability. Supplied in a form that permits easy application, GTS thread sealant paste is an ideal replacement for Teflon thread sealant tape and other conventional thread sealant materials in critical high temperature and high pressure service applications.

Each lot of GRAFOIL GTS thread sealant paste is tested and approved to exacting specifications after manufacture and packaged in 125 gram nuclear grade polyethylene "squeezable" tubes to protect it against contamination.

Because of its resistance to heat and corrosion, GRAFOIL GTS thread sealant paste will provide an effective seal for long periods of time, and will outperform conventional thread sealants in high temperature applications. The purity level of GTS thread sealant paste allows it to meet the stringent certification requirements of the nuclear power generation industry such as the General Electric nonmetallic material specification D50YP12 Rev 2.

GRAFOIL GTS thread sealant paste can also be used as an effective bolt lubricant or antiseize compound, having out performed conventional lubricants under tests performed by the General Electric Corp. GTS thread sealant paste does not harden or cure with time or temperature. Joints sealed with GTS paste will be easy to disassemble even after years of high temperature service.



TGA of GTS Pipe Thread Sealant Paste

Weight Loss vs. Temperature

Weight loss begins at about 125°C (255°F), and there is a 6% weight loss at 200°C (390°F). GRAFOIL GTS thread sealant paste will have good lubricating properties up to 200°C (390°F) for a considerable period of time.

Directions for Use:

1) Thoroughly clean threaded surfaces prior to application.
2) Knead tube well. (for best results, remove cap, snip tip, squeeze out air, place cap back on tightly, and knead well.)
3) Apply the paste evenly and fill the threads completely. Carefully assemble and tighten the threaded joint.
4) Close cap tightly after use.

Technical Information

Composition:
Nuclear grade GRAFOIL graphite flake material and a percentage composition of high purity petroleum based carriers.

Carbon Content:
99.5% minimum in graphite flake.

Shelf Life:
Minimum of two years from date of first use.

Recommended storage:
Store below 38°C (100°F).

Pipe Size Limitations:
GRAFOIL GTS thread sealant paste is recommended for use in close fitting threaded joints of two inch and smaller diameter pipe sizes.

Purity Level

Element	Typical (ppm)	Specification (ppm)
Total Halogen (as Cl)	<25	450 max.
Leachable Chloride	<10	50 max.
Total Chlorine	<10	500 max.
Total Fluorine	<25	300 max.
Total Nitrite	<1	1 max.
Total Nitrate	<10	820 max.
Total Sulfur	<250	630 max.
Embrittling Metals*	<250	500 max.

*No single embrittling metal more than 200 ppm.

GRAFOIL®

Flexible Graphite

GRAFOIL® Grades GH™R and GH™E Branded Stainless Steel Reinforced Gaskets*

GRAFOIL GHE laminate with 316/316L stainless steel tanged insert (0.004"/0.005" thick). Made from Standard Industrial Grade GT™B sheet of 98% typical carbon content, less than 50 ppm typical leachable chloride content, and with 550 ppm typical sulfur content mechanically bonded to a tanged metal insert. Non-fibrous and non-asbestos.

GRAFOIL GHR laminate with flat 316/316L stainless steel insert (0.002" thick). Made from Standard Industrial Grade GTB sheet of 98% typical carbon content, less than 50 ppm typical leachable chloride content and with 550 ppm typical sulfur content. "Micro-thin" adhesive bond. Non-fibrous and non-asbestos.

GRAFOIL GHR and GHE

Two proven metal reinforced laminate materials ideal for 95% of all sheet gasket applications.

GRAFOIL flexible graphite laminates GHR and GHE are surface identified. At a glance, you can be certain your gaskets are the original, quality GRAFOIL flexible graphite gaskets.

GRAFOIL Laminate Characteristics

- Surface "branded" to prevent substitution of inferior materials.
- Meets most refinery, petrochemical and industrial service requirements.
- Unsurpassed leaktight sealability over extended periods of time and service temperatures.
- Permanently resilient, non-hardening, non-aging.
- Non-asbestos and non-fibrous.
- High temperature creep and blow-out resistant.
- Exceeds the most stringent sealability regulations for VOC or hazardous emissions.
- Over 5 year shelf life.
- Naturally lubricious, requires no flange release agent.
- Recommended, but not limited to 150 and 300 class service. For service above 300 class, contact our Sales Office.
- Either GHR or GHE can be used in 95-100% of all your sheet gasket applications.
- GHE is interchangeable with spiral wound gaskets.
- Alloy C276 metal inserts are available for chlorine and chloride service. Refer to grades GH™O and GH™T.
- Chemically compatible with a wide range of fluids and gases.
- Fire-Safe!

* Specially designed GRAFOIL flexible graphite metal reinforced gasket laminates other than the above can be quoted upon request.

Design Data

Typical Properties

Property	English	Metric
"m" factor	2	2
"y" stress GH™R	900 psi	6 MPa
"y" stress GH™E	2500 psi	17 MPa

Note: For non-metallic flanges, multiply calculated clamping force x 2.

Gasket Constants Per ASME Appendix BFJ

GHR

	English	Metric
Gb	816 psi	5.62 N/mm^2
a	0.377	0.377
Gs	0.066 psi	4.5x10^{-4} N/mm^2

GHE

	English	Metric
Gb	1400 psi	9.65 N/mm^2
a	0.324	0.324
Gs	0.01 psi	6.9x10^{-5} N/mm^2

	English	Metric
Maximum Gasket Unit Load	24000 psi	165 MPa
Functional Temperature Range (in air or oxygen environment)	-400°F to 975°F	-240°C to 525°C

Note: In a non-oxidizing environment, working temperature could go to 1000°F (538°C). GRAFOIL without the stainless steel can be used to 5,400°F (3,000°C). Can also be used at temperatures to 1200°F (650°C) in steam service.

Because teeth of the tanged metal interlayer may indent metals softer than 316/316L s.s., Grade GHE gaskets are not normally recommended for use with glass, bronze, aluminum or other soft metal flanges.

Property	Value
Elevated Temperature Sealability in 580 psig (4.0 MPa) N_2 at 750°F (400°C) and 4650 psi (32 MPa) clamping force (Modified DIN 3535)	
GHR	1.5 ml/min
GHE	3.0 ml/min
Cryogenic Sealability at -220°F (-140°C), 580 psig (4.0 MPa) N_2 and 4650 psi (32 MPa) clamping force.	5 ml/min
Elevated Temperature Creep Relaxation (BS F-125) 750°F (400°C)	
GHR	3%
GHE	3%
Carbon Content*	98%
Ash Content (ASTM C561)*	2%
Leachable Chloride (ASTM F1277)*	50 ppm
Sulfur Content (LECO Combustion)*	550 ppm

*Facing material only

Sizes Available

	English (inches)	Metric (mm)
GHR (width x length)	24 x 24	610 x 610
	39.4 x 39.4	1000 x 1000
	39.4 x 78.8	1000 x 2000
	60 x 60	1524 x 1524
	39.4 wide coils*	1000 x coils**
GHE (width x length)	24 x 24	610 x 610
	39.4 x 39.4	1000 x 1000
	39.4 x 78.8	1000 x 2000
	60 x 60	1524 x 1524
	39.4 wide coils*	1000 x coils**
Thickness:	1/32, 1/16, 1/8	0.8, 1.6, 3.2
	*coils available in 1/32" or 1/16" thickness, length to 500'	**coils available in 0.8 or 1.6 mm thickness, length to 160 m

Installation Tips and Recommendations

- Remove all projecting particles, scale, and burrs of the old gasket material from joint surfaces.
- Part flanges enough to slide gasket in place, using a few bolts for positioning.
- Handle the GRAFOIL gasket with care to avoid damaging the sealing surfaces.
- Insert remaining bolts. Draw flanges together evenly. Tighten all nuts with recommended procedure and pressure test system in accordance with engineering standards.
- Do not use screwdriver, hammer or other sharp instrument to push the gasket into place.
- Wear adequate hand protection to protect against exposed metal edges.
- Flange release agents are not required.
- Alloy C276 metal inserted GHO (tang) and GHT (foil) are available for chlorine and chloride services.

GRAFOIL®
Flexible Graphite

Advantages:

- Easily Cut
- No Sharp Edges
- Compatible with a wide range of chemicals, including chlorine compounds
- Superior sealability under low flange loads
- Out performs asbestos gasket materials at elevated temperatures
- Contains no asbestos
- High surface conformity
- Low leachable chlorides
- Unlimited shelf life
- Large 60" x 60" sheet sizes available
- No hot retorquing required
- Maximum continuous use temperature 750°F (400°C)
- Surface branded
- Meets refinery petrochemical and industrial service requirements

Grade GH™W Flexible Graphite

Advanced Energy Technology Inc. produces a non-metallic composite gasket laminate material consisting of a PTFE impregnated high temperature continuous fiberglass cloth, fused between two sheets of GRAFOIL flexible graphite.

GRAFOIL Grade GHW is a patented product (U.S. Patent No. 4,961,991), which can be cut into large one-piece gaskets up to 60" (1524 mm) in diameter and has excellent strength and handling characteristics. GHW can replace PTFE, compressed nonasbestos, and barrier-add sheet gaskets in most applications.

In addition, GHW has excellent low load sealability and high temperature creep relaxation characteristics when compared to good quality asbestos, aramid, and carbon fiber gasket materials.

GRAFOIL GHW can be used in standard ASME class 150 and 300 flanges up to 750°F (400°C) in temperature. GHW is Fire Safe!

Elevated temperature testing proves that GHW outperforms asbestos gasket materials.

Characteristics

- Functional Temperature Range: -400°F to 750°F (-240°C to 400°C)
- Carbon content of GRAFOIL facing: 98% minimum
- Leachable chlorides: 10 ppm typical (ASTM F1277)
- Sulfur: 500 ppm typical
- "m" factor: 2
- "y" stress: 900 psi (6.21 MPa)
- Max Gasket Unit Load: 24,000 psi (166 MPa)
- Compressibility: 40% typical (ASTM F36)
- Recovery: 15% typical (ASTM F36)
- Max Operating Pressure: rated for ASME class 150 or class 300 flanges
- Consult GRAFOIL technical service for higher class service

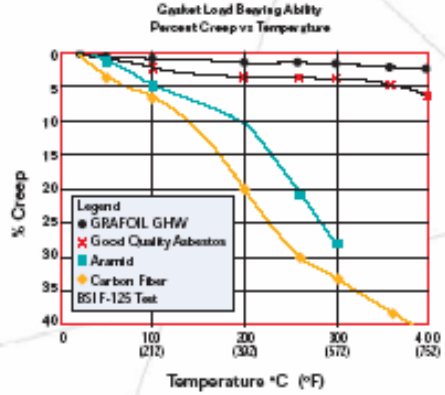
Typical Applications

- Pipe flange gaskets/ASME/API/DIN flanges
- Valve gaskets
- Pump gaskets
- Glass-lined or low load flange gaskets
- Steam trap gaskets
- Compressor gaskets

Available Sizes

English	Metric	Catalog#
1/32" x 40" x 60"	(0.8 mm x 1016 mm x 1524 mm)	G-3764
1/16" x 40" x 60"	(1.6 mm x 1016 mm x 1524 mm)	G-3765
1/8" x 40" x 60"	(3.2 mm x 1016 mm x 1524 mm)	G-3766
1/32" x 60" x 60"	(0.8 mm x 1524 mm x 1524 mm)	G-3767**
1/16" x 60" x 60"	(1.6 mm x 1524 mm x 1524 mm)	G-3768
1/8" x 60" x 60"	(3.2 mm x 1524 mm x 1524 mm)	G-3769**

**Consult sales office for availability.



High Temperature Creep Relaxation

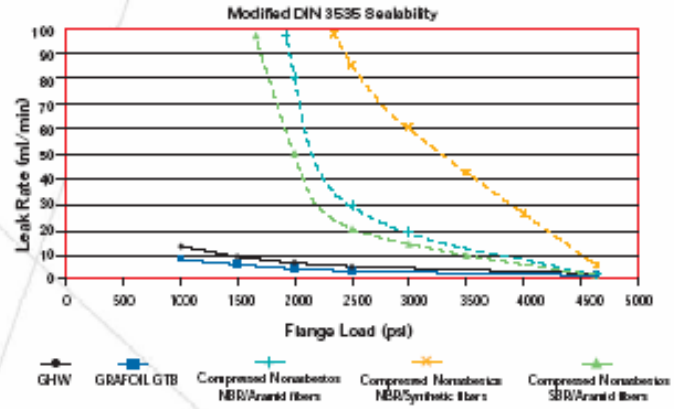
High temperature creep relaxation testing was performed on the GHW gasket laminate material according to a modified BSI F-125 test procedure.

Test procedure modifications included increasing the upper test temperature to 752°F (400°C). The criteria for acceptance is less than 10% creep up to 752°F (400°C).

The percentage thickness decrease at final temperature as shown in the graph gives credence to the GHW gasket performance at these higher temperatures. The small amount of PTFE used to impregnate the woven fiberglass cloth does not have any negative impact on GHW creep relaxation at temperatures up to 400°C.

Test Parameters:

Gasket Size: 75 mm OD x 55 mm ID
Flange Load: 6525 psi (45 MPa)
Heating Rate: 10°C per minute
Smooth Flanges
Failure defined as the temperature where creep exceeds 10%



Room Temperature Sealability

Room temperature sealability testing was performed on GHW gasket laminate material according to a Modified DIN 3535 test procedure. Modifications included testing total leakage and testing low flange load performance. This testing showed that GHW outperformed compressed nonasbestos gasket materials at low flange loads.

Test Parameters:

Internal Nitrogen Pressure: 580 psi
No Plastic Layer
Gasket Size: 90 mm OD x 50 mm ID
Room Temperature
Serrated ASME flange
Gasket Thickness: 1/16" (1.5 mm)

Chemical Resistance

GHW is chemically resistant to most process fluids including:

- Steam
- Water
- Gasoline
- Oils
- Alcohol
- Acetone
- MEK
- Many acids
- Many bases
- Antifreeze
- Dowtherm

Construction:

GRAFOIL GTB flexible graphite thermally fused to both sides of a PTFE impregnated high temperature continuous woven fiber glass interlayer 0.0025" (0.06 mm) thick. The GRAFOIL facing layers are nominal 70 lbs/ft³ (1.12 g/cc) density and meet the requirements of Technical Bulletin 103.

GRAFKOTE®

All the advantages of GRAFOIL flexible graphite at a price comparable to compressed sheet.

GRAFKOTE LAMINATES

Multi-Purpose Gasket Materials Single and Double Sided Polymer Coated GRAFOIL flexible graphite

GRAFKOTE is a new generation of GRAFOIL flexible graphite gasket material with a strong, thin polymer coating. The GRAFOIL flexible graphite sheet is manufactured with no binders, therefore giving it the excellent thermal stability, thermal conductivity and chemical inertness inherent to graphite. In addition several complimentary features include compactability and resiliency. The thin polymer coating enhances the product handleability and durability. The unique properties of GRAFOIL flexible graphite along with the strength of the polymer coating make GRAFKOTE an excellent gasketing material. GRAFKOTE can be used for applications at temperatures up to 400°C (750°F) and flange loads less than 45 MPa (6526 psi).

Typical Applications:

- Valves
- Pumps
- Pipe Flanges/ASME/API/DIN Flanges
- Glass-lined Equipment
- Steam Traps
- Heat Exchangers
- Compressors

Advantages of GRAFKOTE LAMINATES:

- Compatible with a wide range of chemicals
- Superior bolt load retention at elevated temperatures
- No hot retorquing necessary
- Superior sealability under low flange loads
- Maximum continuous use temperature 400°C (750°F)
- High surface conformability
- No shelf life limit
- Material availability in rolls allows for maximum material utilization
- Low leachable chloride
- Improved handleability and durability
- Cost effective
- Easily cut

Typical Characteristics:

Double Sided Thickness:	1.5 mm (1/16") available in rolls and sheets 2.0 mm (0.080") available in sheets 3.0 mm (1/8") available in sheets
Single Sided Thickness:	0.8 mm (1/32") available in rolls and sheets 1.0 mm (0.040") available in rolls and sheets 1.5 mm (1/16") available in rolls and sheets 2.0 mm (0.080") available in sheets 3.0 mm (1/8") available in sheets
Size:	meter wide rolls meter wide sheets made to order sizes available upon request
Compressibility:	ASTM F-36 at 34.5 MPa (5000 psi): 40%
Recovery:	ASTM F-36 after 34.5 MPa (5000 psi): 15%
Carbon Content:	98%
Leachable Chloride:	ASTM F-1277: 10 ppm

GRAFKOTE LAMINATES SPECIFICATIONS

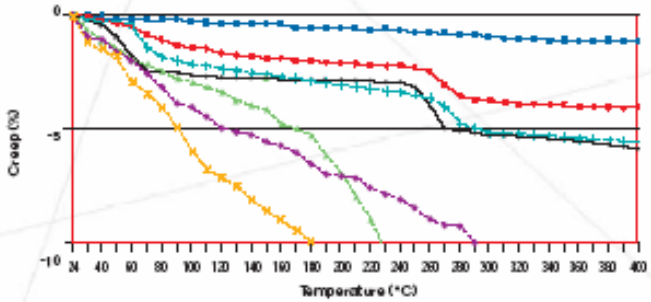
Single-sided and Double-sided GRAFKOTE is a gasketing material consisting of GRAFOIL GT™B flexible graphite sheet and a strong, thin polymer coating on one or both surfaces.

The polymer coating is 0.01 mm (0.0005") thick and is thermally bonded to the GTB flexible graphite inner layer.

The GTB flexible graphite inner layer is nominal 1.12 g/cc (70 lb/ft³) density and meets the requirements of Technical Bulletin 103.

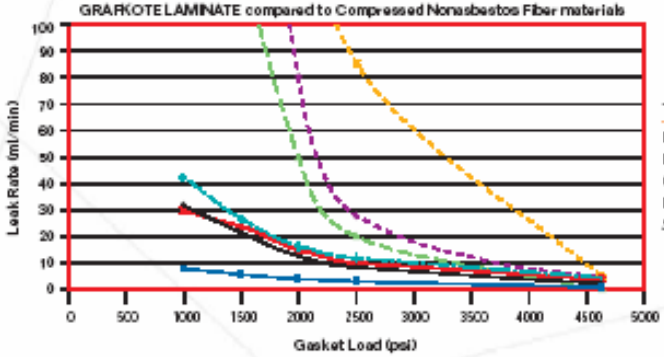
US Patent Nos. 5,188,063 and 5,830,809

High Temperature Creep Relaxation BSI-F125
GRAFKOTE LAMINATE compared to
Compressed Nonasbestos Fiber materials



GRAFKOTE LAMINATE single and double sided gasket materials exhibit stability and creep relaxation of less than 10% at temperatures up to 400°C. They maintain a higher bolt torque retention and a better seal in applications of thermal cycling and continued exposure to elevated temperatures. The creep relaxation of GRAFKOTE LAMINATE stabilizes and holds constant with continued elevated temperature exposure, especially when compared to the Compressed Nonasbestos Fiber (CNF) gasket materials. CNF materials continue to creep and degrade with on-going exposure to elevated temperatures.

Modified DIN 3535 Sealability
GRAFKOTE LAMINATE compared to Compressed Nonasbestos Fiber materials



Test Parameters

Internal Nitrogen pressure: 580 psi
No plastic layer
Gasket size: 90 mm OD x 50 mm ID
Room Temperature
Serrated ASME flange.

GRAFKOTE LAMINATE single and double sided gasket materials have excellent sealability even under low gasket loads. At low gasket loads, GRAFKOTE LAMINATE seals much better than compressed non-asbestos fiber gaskets with rubber binders. The excellent sealability of GRAFKOTE LAMINATE is maintained at temperatures as high as 400°C.

GRAFOIL GTB (1.5 mm) | Double Sided GRAFKOTE (1.5 mm) | Double Sided GRAFKOTE (2.0 mm) | Single Sided GRAFKOTE (1.5 mm) | Compressed Nonasbestos NBR/Aramid fibers (1.5 mm) | Compressed Nonasbestos SBR/Aramid fibers (1.5 mm) | Compressed Nonasbestos NBR/Synthetic fibers (1.5 mm)

UCAR-323® Reinforced PTFE Gasketing

Introducing the low creep, high strength PTFE material that outperforms the market leader.

The new UCAR-323® reinforced PTFE gasketing is revolutionizing the world of PTFE gasketing. Its unique advanced composite construction - woven continuous glass, not lined beads - means there is nothing to shift, nothing to move, nothing to change shape. It features a soft surface that is easy to handle, a hard, durable interior, and a tensile strength of 12,000 psi (82.7 MPa) ...greater than five times the strength of the market leader in PTFE.

But tensile strength alone is not what makes UCAR-323 reinforced PTFE gasketing so outstanding. It is extremely tolerant to process changes, specifically changes in temperature and pressure. Its design and material give you up to 14 times the sealability rate when only low clamping force is available, with 70% less creep and an absorption rate of less than 0.1%.

UCAR-323 reinforced PTFE gasketing is 100% asbestos-free, and is easily cut from convenient, versatile 36" x 48" (914 mm x 1219 mm) sheets.

UCAR-323 is compliant with the U.S. Federal Regulations for food contact applications.

Creep Relaxation

UCAR-323 reinforced PTFE gasketing exhibits stability and creep relaxation of less than 3% in temperatures ranging from -350°F to 475°F (-212°C to 245°C). It maintains a higher bolt torque retention and a better seal in applications of thermal cycling and continued exposure to elevated temperatures.

Chemical Resistance

UCAR-323 reinforced PTFE gasketing has a wide range of chemical resistance including strong mineral acids and oxidizing chemicals. It is particularly suited for use with sulfuric acid, nitric acid and other strong oxidizing chemicals.

Electrical Isolation

UCAR-323 reinforced PTFE gasketing is excellent for use in electrical isolation of pipelines and equipment. Unlike flexible graphite, UCAR-323 reinforced PTFE gasketing is completely nonconductive.

Typical Physical Properties

Room Temp. Sealability	ASTM F-37; 0.8 psi (68 kPa) internal pressure, Fuel "A" (Isooctane), 1,000 psi (6.89 MPa) gasket load	0.02 ml/hr
High Temp. Sealability	Modified DIN-3535	<0.1 ml/min
Creep Relaxation	BSI F-125	<3%
Compressibility	ASTM F-36	3%
Recovery	ASTM F-36	70%
Specific Gravity	ASTM D-792	2.3 grms/cm³
Tensile Strength	ASTM F-152	12,000 psi (82.8 MPa)
Thermal Conductivity	ASTM F-433	0.18 BTU • ft/hr • ft² • °F
Dielectric Strength	ASTM D-149	250 V/Mil
Continuous Working Temp.		475°F (245°C)
Min. Working Temp.		-350°F (-212°C)
Flammability		Will not support combustion
Bacterial Growth		Will not support bacteria

Sheet Sizes Available

Size Thickness	English	Metric
	36" x 48"	914 x 1219
	1/32"	0.8
	1/16"	1.6
	1/8"	3.0

Typical Design Properties

Traditional M & Y Values:

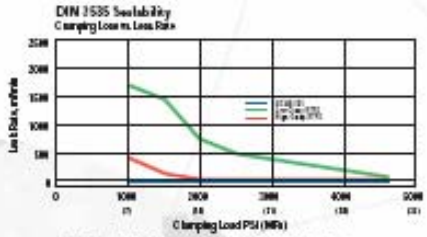
	English	Metric
"m" Factor	3	3
"y" Stress	2200 psi	15.2 MPa

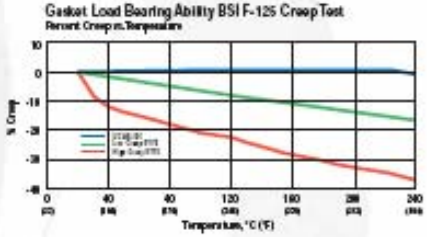
Note: For non-perfect flanges: multiply calculated clamping force x2.

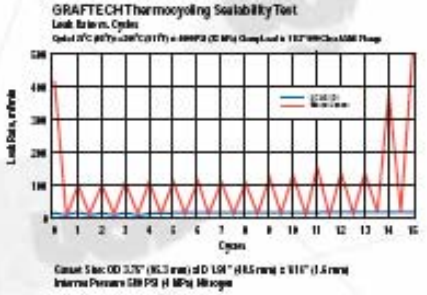
Gasket Constants for (T 2-3) Tightness Parameter

	English	Metric
Gb	5 psi	0.0345 MPa
a	0.921	0.921
Ga	0.078 psi	0.00054 MPa

Note: The new PVRC tightness based gasket constants are determined from the results of two or more ROTT tests. Low values of G_b, "a" and G, are favorable.







UCAR-323™ PTFE Gasketing Material

The Chemical Compatibility of UCAR-323 with Ethylene Oxide and Other Harsh Chemicals

Union Carbide Test Results:

Union Carbide Corporation conducted laboratory studies at their South Charleston, West Virginia technical center and the results showed that the new PTFE based material, UCAR-323, was chemically compatible with ethylene oxide.

Test samples of UCAR-323 were immersed in ethylene oxide for 90 days at 25°C (77°F). After exposure, the samples were evaluated for changes in hardness, dimensions, weight, and visual appearance. According to the test data shown below, the UCAR-323 material appears to be resistant to attack in ethylene oxide.

The UCAR-323 gasket material is now generally accepted and recommended by Union Carbide as a replacement for other brands of PTFE materials on the market that usually exhibit high creep and cold flow problems during and after installation.

	UCAR-323 Before	After
Weight	5.7890 g	5.8219 g
Dimensions	2" x 0.50"	Same
Hardness	61D	60D
Comments	No apparent attack	

Resistance to Other Chemicals:

UCAR-323 has a very wide range of general chemical resistance including strong mineral acids and oxidizing chemicals that are not always compatible with other leading gasket materials such as flexible graphite. It is virtually inert to aggressive chemicals, and is particularly suited for use with sulfuric acid, nitric acid, and other strong oxidizing chemicals.

Its unique advance composite construction of a high temperature continuous woven glass fiber interlayer, encapsulated in PTFE, means there are less compatibility problems. The PTFE is generally known to have excellent chemical resistance properties by itself and can withstand some of the most severe caustic environments.

However, because of the high temperature "E" glass woven fiber, the UCAR-323 gasket material does have some limitations that are worth noting. For better performance and results, it should not be used with gaseous fluorine, hydrofluoric acid, and chlorine trifluoride and oxygen difluoride. These chemicals have been known to attack the PTFE and the woven glass fiber cloth.

Availability:

UCAR-323 is 100% asbestos-free, easily cut from convenient, versatile 36" x 48" (914 mm x 1219 mm) sheets and is available in standard 1/32" (0.8 mm), 1/16" (1.6 mm) and 1/8" (3.0 mm) thickness.

FDA Food Contact:

UCAR-323 (1/32", 1/16" or 1/8" thickness) is in compliance with FFDCA (Federal Food, Drug and Cosmetic Act) requirements. The product is compliant for direct contact with food under the provisions set forth in 21 CFR Parts 170-199, and more specifically, Section 177.1550. UCAR-323 is rated for continuous service up to 246°C (475°F). This product may be cleaned per any state or federal standards.

Chemical Compatibility

GRAFOIL flexible graphite gaskets and packing are all graphite products containing no resin binders or organic fillers. Their outstanding resistance to corrosion, even at high temperature, and their ability to retain compressibility at all temperatures, recommend them for service in the many inorganics and organics listed. In addition, GRAFOIL gaskets and packing are performing successfully in a number of unusual applications – in some cases, they are the only materials which have been able to withstand certain rigorous service demands. Here are examples of just a few field installations.

- Gaskets in molten aluminum at 1350°F and 5000 psig pressure
- Gaskets in reactor handling lethal gas at 700°F and 55 psig pressure
- Packing in a boiler feed water centrifugal pump, 350°F
- Gaskets in piping conveying molten plastics at 600°F and 600 psig pressure

Whatever your requirements for gasket and packing materials, ask for our recommendation. Chances are we can help solve your problem with GRAFOIL products for economical long-life and dependable service.

Chemical Reagent	Concentration Per Cent	Fluid Temperature up to °F
ACIDS		
Acetic acid	All	All
Acetic anhydride	100	All
Arsenic acid	All	All
Boric acid	All	All
Carbonic acid	All	All
Chromium trioxide, aq. soln.	0-10	200
Citric acid	All	All
Formic acid	All	All
Hydrobromic acid	All	All
Hydrochloric acid	All	All
Hydrofluoric acid	All	All
Hydrofluosilicic acid	0-20	All
Hydrogen chloride	All	All
Hydrogen sulfide-water	All	All
Lactic acid	All	All
Monochloracetic acid	100	All
Nitric acid	0-10	185
Nitric acid	10-20	140
Nitric acid	Over 20	100
Oleic acid	100	All
Oxalic acid	All	All
Phosphoric acid	0-85	All
Stearic acid	100	All
Sulfur dioxide	All	All
Sulfuric acid	0-70	All
Sulfuric acid	70-85	338
Sulfuric acid	85-90	300
Sulfuric acid	90-93	160
Sulfuric acid	93-95	160
Sulfuric acid	Over 95	Not Recommended
Sulfurous acid	All	All
Tartaric acid	All	All

Chemical Reagent	Concentration Per Cent	Fluid Temperature up to °F
ALKALIES		
Ammonium hydroxide	All	All
Monoethanolamine	All	All
Sodium hydroxide	All	All
SALT SOLUTIONS		
Alum	All	All
Aluminum chloride	All	All
Ammonium bifluoride	All	All
Ammonium bisulfite	All	All
Ammonium sulfate	All	All
Ammonium thiocyanate	0-63	All
Arsenic trichloride	100	All
Calcium chlorate	0-100	140
Calcium hypochlorite	All	90
Copper sulfate	All	All
Cupric chloride	All	All
Ferric chloride	All	All
Ferrous chloride	All	All
Ferrous sulfate	All	All
Manganous sulfate	All	All
Nickel chloride	All	All
Nickel sulfate	All	All
Phosphorous trichloride	100	All
Sodium chloride	All	All
Sodium chloride	0-4	Room
Sodium hypochlorite	0-25	Room
Stannic chloride	All	All
Sulfur monochloride	100	All
Zinc ammonium chloride	All	All
Zinc chloride	All	All
Zinc sulfate	All	All
HALOGENS, WATER		
Bromine	100	Room
Bromine water	All	Room
Chlorine-dry	100	All
Chlorine dioxide	---	158
Chlorine water	All	Room
Fluorine	100	300
Iodine	100	Room
Steam	---	All Commercial
Water, Deaerated	---	All
Water, Borated	---	All
HEAT TRANSFER FLUIDS		
"Dowtherm" (all types)	100	All
"Mobiltherm"	100	All
Petroleum-Oil Based	100	All
"Therminol" (all types)	100	All
"Ucon" (all types)	100	All

Chemical Reagent	Concentration Per Cent	Fluid Temperature up to °F
ORGANIC COMPOUNDS		
Acetone	0-100	All
Amyl alcohol	100	All
Aniline	100	All
Aniline Hydrochloride	0-60	All
"Aureomycin"	100	All
Benzene	100	All
Benzene hexachloride	100	All
Benzyl sulfonic acid	60	All
Butyl alcohol	100	All
Butyl "Cellosolve"	0-100	All
Carbon tetrachloride	100	All
"Cellosolve" solvent	0-100	All
Chloral hydrate	---	All
Chloroethylbenzene	100	All
Chloroform	100	All
"Dexoxidine"	---	140
Dichloropropionic acid	90-100	338
Diethanolamine	All	All
Dioxane	0-100	All
Ethyl alcohol	0-100	All
Ethyl chloride	All	All
Ethylene chlorohydrin	0-8	All
Ethylene dibromide	100	All
Ethylene dichloride	100	All
Ethyl mercaptan-water	Saturated	All
Fatty acides	All	All
Folic acid	All	All
Refrigerants 11 & 12	100	All
Gasoline	100	All
Glycerine	0-100	All
Isopropyl acetate	100	All
Isopropyl alcohol	0-100	All
Isopropyl ether	100	All
Kerosene	100	All
Mannitol	All	All
Methyl alcohol	0-100	All
Methyl isobutyl ketone	100	All
Monochlorbenzene	100	All
Monovinyl acetate	All	All
Octyl alcohol	100	All
Paradichlorbenzene	100	All
Paraldehyde	100	All
Tetrachlorothane, syn.	100	All
Trichlorethylene	100	All
Xylene	All	All

Chemical Reagent	Concentration Per Cent	Fluid Temperature up to °F
MIXTURES		
Acidified starch solutions	All	All
Amino acid plus hydrochloric and sulfuric acids	---	All
Ammonium persulfate plus sulfuric acid	25 20	All Room
Anodizing solutions	All	All
Butyl acrylate plus acrylic acid	All	All
Calcium chloride plus calcium chlorate	30 10	140
Chlorinated-ethyl alcohols	All	All
Chrome plating solns.	All	Room
Cresylic acid plus sulfuric acid	---	All
Electropolishing solutions (sulfuric plus phosphoric acids)	All	140
Hydrochloric acid sat. with chlorine	Over 20 All	All
Nickel plating solns. (chloride)	All	All
Nickel plating solns. (sulfate)	All	All
Nitric acid plus hydrofluoric acid	15 5	140
"Parkerizing" solution	All	All
Rayon spin bath	All	All
Sodium hypochlorite plus sodium hydroxide	25	200
Sulfuric acid plus plus nitric acid	96 .03	Not Recommended

AIR (OXYGEN)

The threshold of the oxidation of graphite in air is that temperature at which a graphite cube one inch on an edge will lose one percent of weight in 24 hours during bulk exposure.

GRAFOIL® GTB flexible graphite has a threshold of oxidation of 975°F. However, in actual applications, GRAFOIL packing and gasketing is never exposed in bulk form. The "thin edge" exposure of GRAFOIL packing and gasketing has successfully withstood years of exposure to air at process fluid temperatures up to 1500°F.