GASKET RESOURCES INC.

DURLON®

SHEET GASKETING

TECHNICAL HANDBOOK

May 2003

gasket resources incorporated

GASKET RESOURCES INC.

DURLON® GASKETING TECHNICAL HANDBOOK

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DURLON® Products are Manufactured
to ISO 9001 Quality Standards

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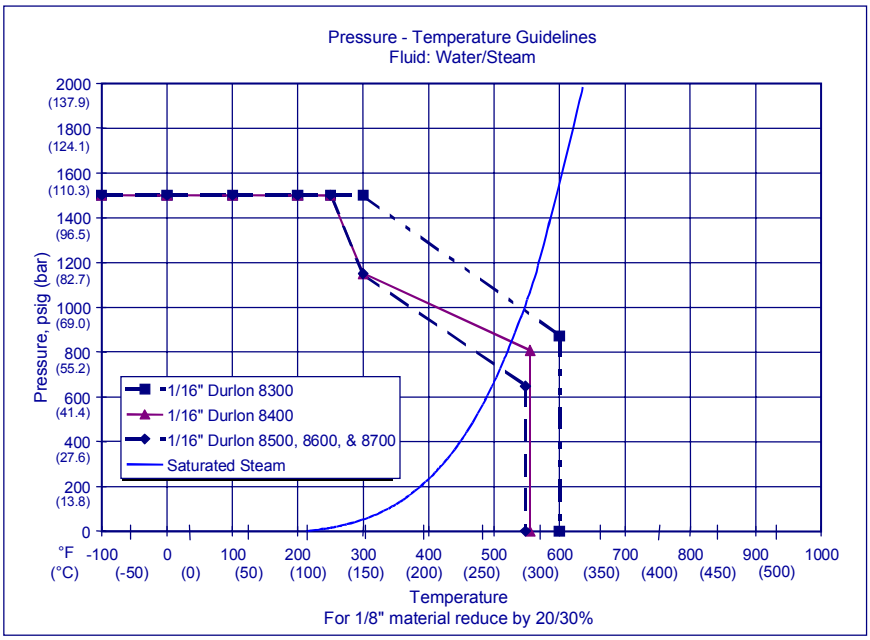
GRI/**DUR**LON® Compressed Sheet

Style	Composition	Description
8300	Carbon/NBR	A premium grade compressed sheet, DURLON 8300 is excellent in steam and hydrocarbon services in the refining, petrochemical and power generation industries. Other applicatons include oil, water, mild alkalis, mild acids, and solvents. DURLON 8300 contains high strength carbon fibers bonded with nitrile (NBR) synthetic rubber.
8400	Phenolic/NBR	With an extremely wide pH application range, DURLON 8400 can be used in process piping and equipment in chemical, pulp and paper, and other general industrial applications.
8500	Aramid-Inorganic/NBR	Our workhorse material, DURLON 8500 is excellent in steam, natural gas, soybean processing and with new generation refrigerants. A high quality general service gasket material for use in a wide range of services in pulp and paper, food, beverage, pharmaceutical, chemical, refinery, gas pipeline and general industry. FIRE TESTED: DURLON 8500 passed a modified API 607 fire test.
8600	Aramid-Inorganic/SBR	A high quality gasket material containing high strength aramid and inorganic fibers bonded with SBR rubber. An excellent choice for steam or services where a white gasket material is required.
8700	Aramid-Inorganic/CR	A high performance compressed gasket material for use in processes that require a neoprene (CR) bonded sheet. Excellent for steam, oils and refrigeration services.
7900/7950	Aramid/NBR	An economy grade general service compressed sheet with NBR rubber binder for mild service in piping and equipment and OEM applications in steam, hydrocarbons and refrigerants. An economical alternative when service ranges and applications are not severe.

Anti-Stick Properties: Much effort has gone into improving the anti-stick release agents of all compressed DURLON® products. All DURLON® compressed gasket materials have passed the MIL-G-24696B Navy Adhesion Test (366°F/48 hrs).

PxT Chart - **DUR**LON® Compressed Gasket Materials



Note: Consult your representative for applications above Class 300

Typical Physical Properties

DURLON® Style	8300	8400	8500	8600	8700	7900/7950
Color:	Black	Gold	Green	White	Blue	7900 - Off-White 7950 - Blue
Fluid Services:	Saturated Steam, Oils, Dilute Acids & Alkalis, Solvents Hydrocarbons	Steam, Oils, Fuels, Solvents, Caustics, Refrigerants, Dilute Acids & Alkalis	Saturated Steam, Oils, Dilute Acids & Alkalis, Solvents, Fuels, Refrigerants	Saturated Steam, Water, Dilute Acids & Alkalis, Inert Gases, Ammonia	Saturated Steam, Oils, Water, Dilute Acids & Alkalis, Refrigerants	Steam, Water, Inert Gases, Oils, Fuels, Dilute Acids & Alkalis
Fiber System:	Carbon	Phenolic	Aramid/Inorganic	Aramid/Inorganic	Aramid/Inorganic	Aramid
Binder:	NBR	NBR	NBR	SBR	CR	NBR
Density, g/cc (lbs/cu. ft):	1.6 (100)	1.7 (106)	1.7 (106)	1.7 (106)	1.7 (106)	1.7 (106)
Temperature, Range: Continuous, max:	 -100 to 800ºF (-73 to 427ºC) 600ºF (315ºC)	 -100 to 800ºF (-73 to 427ºC) 554ºF (290ºC)	 -100 to 700°F (-73 to 371°C) 548ºF (287ºC)	 -100 to 700°F (-73 to 371°C) 548ºF (287ºC)	 -100 to 700°F (-73 to 371°C) 548ºF (287ºC)	 -100 to 700ºF (-73 to 371ºC) 400ºF (204ºC)
Pressure Max:	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1000 psig (70 bar)
ASTM F36, Compressibility	8-16%	8-16%	8-16%	8-16%	8-16%	7-17%
ASTM F36, Recovery	50%	50%	50%	45%	45%	40%
ASTM F38, Creep Relaxation	18%	25%	20%	20%	20%	20%
ASTM F152, Tensile Strength across grain, psi (MPa)	1,800 (12.4)	1,800 (12.4)	2,000 (13.8)	1,800 (12.4)	1,500 (10.3)	1,600 (11.0)
Fluid Resistance, pH Range (room temperature) ASTM F146 IRM 903 Oil 5h/300°F (149°C) Thickness Increase Weight Increase ASTM Fuel B 5h/70°F (21°C) Thickness Increase Weight Increase	 3 to 11 0 to 10% 10% 0 to 10% 12% Max	 2 to 13 0 to 15% 15% 0 to 10% 15% Max	 3 to 11 0 to 15% 15% 0 to 10% 10% Max	 3 to 11 15 to30% 30% 5 to20% 30% Max	 3 to 11 0 to 15% 15% 0 to 15% 15% Max	 3 to 11 0 to 15% 15% 0 to 10% 12% Max
Leachable Halides:	500 ppm max.	1000 ppm max.	1000 ppm max.	-	-	-
Leachable Chlorides:	200 ppm max.	400 ppm max.	100 ppm max.	-	-	-
Leakage: DIN 3535	0.05 cc/min	0.03 cc/min	0.03 cc/min	0.05 cc/min	0.05 cc/min	0.05 cc/min
Volume Resistivity, ASTM D257, 1/16"	5 x 10^9 ohm-cm	3.1 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	4.2 x 10^{13} ohm-cm	-
Dielectric Breakdown, ASTM D149, 1/16"	0.04 kv/mm	14.6 kv/mm	11.7 kv/mm	11.7 kv/mm	11.7 kv/mm	-
Gasket Factors: Gb psi (MPa) a Gs psi (MPa)	1/16" 1/8" 512 (3.5) 1716 (11.8) 0.36 0.21 0.13 (0.0) 0.7(0.01)	1/16" 1/8" 2000 (13.8) – 0.194 – 340 (2.3) –	1/16" 1/8" 650 (4.5) 400 (2.8) 0.33 0.35 200 (1.4) 20 (0.14)	 – – –	 – – –	 – – –
ASTM F147, Flexibility	10x	8x	10x	8x	8x	10x
ASTM F104 Line Call-Out	F712120-B3E22M5	F712120-B4E22M5	F712120-B3E12M6	F712440-B3E24M5	F712330-B5E45M5	F712120-B3E22M5

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

In General GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Thermoseal**	**Flexitallic**
Durlon 7900/7950	2900, Blue-Gard® 3000	Klinger®sil C-4201, C-4324, C-4401	SF1600, AF 2100
Durlon 8300	HTC-9800, HTC-9850, G-9900, ST-706	Klinger®sil C-4500	SF 5000
Durlon 8400	Blue-Gard® 3700, IFG 5507	Klinger®sil C-7400	–
Durlon 8500	Blue-Gard® 3000, IFG® 5500	Klinger®sil C-4401, C-4430, & C-4433	AF 2100, SF 2400, SF 3300, SF 3500
Durlon 8600	Blue-Gard® 3200, 3400	Klinger®sil C-6400	SF 2420
Durlon 8700	Blue-Gard® 3300	Klinger®sil C-5400	SF 2440

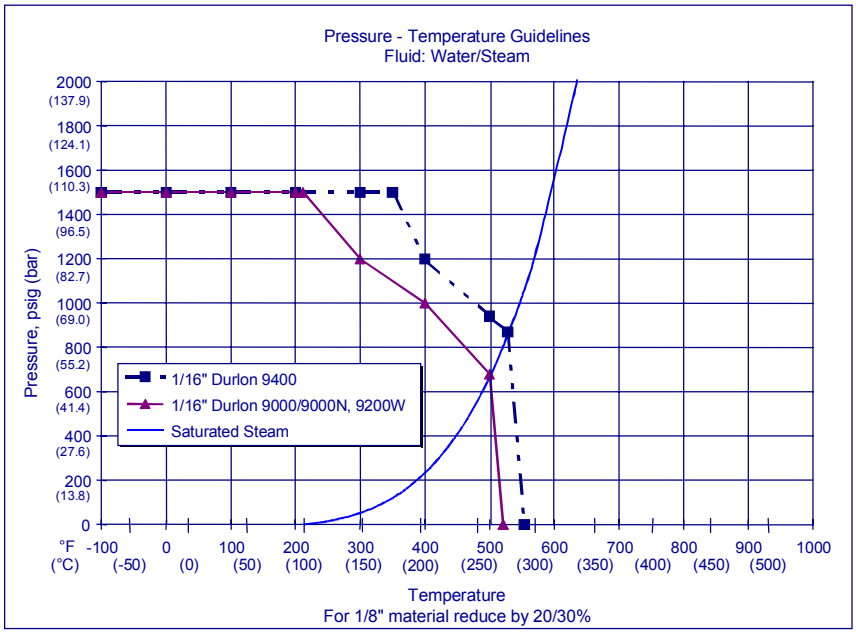
[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

Warning: These materials should never be recommended when both temperature and pressure are at the maximum listed. Properties and applications shown are typical. No application should be undertaken by anyone without independent study and evaluation for suitability. Never use more than one gasket in one flange joint, and never reuse a gasket. Improper use or gasket selection could cause property damage and/or serious personal injury. Data reported in this brochure is a compilation of field testing, field service reports and/or in-house testing. While the utmost care has gone into publishing the information contained herein, we assume no responsibility for errors. Specifications and information contained in this brochure are subject to change without notice. This edition cancels and obsoletes all previous editions.

Style	Composition	Description
9000/9000N	Pure PTFE resins with inorganic fillers	DURLON 9000/9000N is used extensively in chemical, pulp and paper, food and beverage and the railroad tankcar industries. It has been tested and approved for liquid chlorine, caustics, liquid oxygen, and high purity applications in the pharmaceutical industry (9000N, blood components manufacturing). The fillers in DURLON 9000/9000N are engineered shapes, homogeneously blended with pure PTFE resins that do not wick.
9200W	Pure PTFE resins with barium sulfate filler	Suitable for use in aggressive chemicals. Including caustics, hydrogen peroxide, sodium hypochlorite, nitric acid, liquors and digester in pulp and paper service. Applications In the chemical, pharmaceutical and plastics industries include butadiene, hydrofluoric acid, vinyl chloride, methyl methacrylates, and styrene. DURLON 9200W is also used extensively in railroad tankcar applications.
9400	Pure PTFE resins with carbon filler	Carbon filled PTFE is approved as a material of construction for anhydrous hydrogen fluoride (AHF). DURLON 9400 also demonstrates good electrical conducting properties.
9600	Expanded PTFE	DURLON 9600 is an EXPANDED PTFE gasket material made with only pure PTFE resins. It is suitable for use in steel flanges and flanges with irregular surfaces.

Independent testing has shown the fillers in the DURLON method to be more homogeneously blended than calendered, or layered filled PTFE gasket materials, giving DURLON filled PTFE's more consistent physical and mechanical properties without voids, separation and chemical compatibility problems found in the layered construction method.

PxT Chart - **DUR**LON® PTFE Gasket Materials



Note: Consult your representative for applications above Class 300

Typical Physical Properties

DURLON® Style	9000/9000N	9200W	9400	9600
Color:	9000 - Blue 9000N- White	Granite White	Black	White
Fluid Services:	Steam, Oils, TiO2, ClO2, Liquid Chlorine[1], Acids, Caustics, H2O2, Liquid Oxygen[2], Oleum	Steam, Nitric Acid, TiO2, ClO2, H2O2, Liquors, Sulfur Dioxide, Brown Stock, Phosphoric Acid	Acids, Aqueous and Anhydrous Hydrogen Fluoride, Steam, Fuels, Oils, Alcohols	Aqueous and Anhydrous Hydrogen Fluoride, Steam, Oils, Caustics, Acids, Alcohols
Filler System:	Inorganic	Barium Sulfate	Carbon	N/A
Resin System:	Pure PTFE	Pure PTFE	Pure PTFE	Pure Expanded PTFE
Temperature, Range: Continuous, max:	-350 to 520°F (-212 to 271°C) 500ºF (260ºC)	-350 to 520°F (-212 to 271°C) 500ºF (260ºC)	-350 to 550°F (-212 to 288°C) 500ºF (260ºC)	-350 to 600°F (-212 to 316°C) 500ºF (260ºC)
Pressure Max:	1500 psig (103 bar)	1500 psig (103 bar)	1500 psig (103 bar)	1800 psig (124 bar)
Density, g/cc (lbs/cu. ft):	2.2 (138)	2.5 (156)	2.1 (135)	0.8 (49.9)
ASTM F36, Compressibility	8-16%	8-16%	5-12%	40-60%
ASTM F36, Recovery	40%	35%	40%	12%
ASTM F38, Creep Relaxation	30%	30%	30%	30%
ASTM F152, Tensile Strength across grain, psi (MPa)	2,000 (13.8)	1920 (13.2)	2100 (14.5)	—
Fluid Resistance, pH Range (room temperature)	0 to 14	0 to 14	0 to 14	0 to 14
Leakage: DIN 3535	0.01 cc/min	0.01 cc/min	0.01 cc/min	0.01 cc/min
Volume Resistivity, 1/16"	1.0 x 10^5 ohm-cm (ASTM D257)	—	61 ohm-cm (ASTM D991)	—
Dielectric Breakdown, ASTM D149, 1/16"	16 kv/mm (406 V/mil)	—	1 kv/mm (33 V/mil)	—
Gasket Factors Gb psi (MPa) a Gs psi (MPa)	1/16" 1/8" 639 (4.4) 495 (3.41) 0.22 0.262 55 (0.38) 65 (1.45)	1/16" 1/8" 153 (1.05) 96 (0.66) 0.36 0.437 15 (0.1) 14 (0.1)	1/16" 1/8" 1701 (11.7) 1412 (9.7) 0.173 0.164 99 (0.68) 248 (1.7)	1/16" 1/8" 1200 (8.3) 1400 (9.65) 0.2 0.2 3.5 (.024) 1.5 (0.01)
ASTM F104 Line Call-Out:	F452111-A9B5E11K6M6	F452111-A9B5E11K6M5	F452111-A9B5E11K6M6	F428111-A9B5
Notes:	1. Pamphlet 95, The Chlorine Institute 2. O2 Certified - BAM 3. Conforms to FDA	Conforms to FDA	—	Conforms to FDA

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Flexitallic**	**Thermoseal**
Durlon 9000/9000N	Gylon 3500, 3504[2], 3510[3]	Sigma 500, 511[2], 533[3]	TopChem 2000, 2003, 2005, 2006[3]
Durlon 9200W	Gylon 3510	Sigma 533	TopChem 2003
Durlon 9400	Gylon 3530	**W.L. Gore**	**Intertech®**
Durlon 9600	Gylon 3540, 3545	Gore-Tex® GR	SQ-S

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.
[2] Check torque for non-metallic flanges. [3] Exception, hydrofluoric acid.

Warning: These materials should never be recommended when both temperature and pressure are at the maximum listed. Properties and applications shown are typical. No application should be undertaken by anyone without independent study and evaluation for suitability. Never use more than one gasket in one flange joint, and never reuse a gasket. Improper use or gasket selection could cause property damage and/or serious personal injury. Data reported in this brochure is a compilation of field testing, field service reports and/or in-house testing. While the utmost care has gone into publishing the information contained herein, we assume no responsibility for errors. Specifications and information contained in this brochure are subject to change without notice. This edition cancels and obsoletes all previous editions.

Corrugated Flexible Graphite

Style	Composition	Description
CFG	Flexible Graphite / Corrugated Stainless 316 Core	Designed for severe service conditions, the proprietary design of the corrugations gives **CFG** its superior sealing and recovery characteristics for tough conditions in the refining, chemical, petrochemical and pulp and paper industries. **CFG** is suitable for service in steam, oil, water, mild alkalis, hydrocarbons mild acids, and solvents.

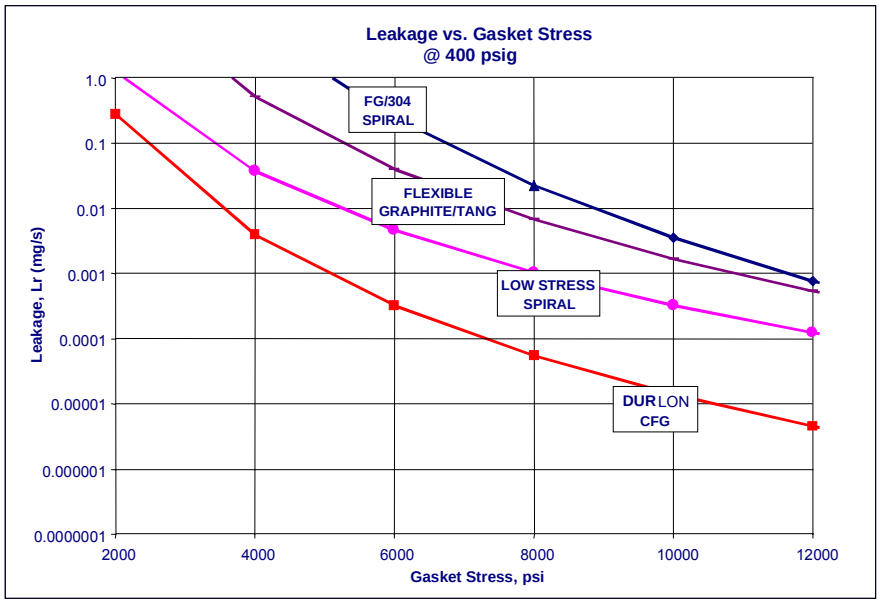
DURLON CFG will maintain a tigh seal in a wide range of initial seating stresses making it the universal replacement for spiral wound, double jacketed and traditional flexible graphite.

Sizes & Types:

- Standard ANSI Class 150 and 300 Ring and Full Face: 1/2" – 24"
- Non Standard MSS SP-44 & API 605: 26" – 96"
- Non Standard Ovals: Handhole and Manway Gaskets
- All Heat Exchanger Styles
- Different metals available to match flange metallurgy, temperature or chemical.

Advantages:

- **Fire tested/fire resistant** – Passed the modified API 607 fire test
- **Recovery/Spring Back** characteristics for excellent sealing and thermal cycling.
- **Blow Out Resistant** – Metal core counteracts internal pressure spikes.
- **Superior Emissions Control** – DIN 3535 gas permeability/leakage <0.01 cc/min
- **Easy to handle, easy to install.**
- Seals tightly with lower bolt loads vs. spiral wounds.
- **One thickness** – 3/32" for all applications



Physical Properties:

Temperature, Min:	-328°F (200°C)
Max, In Air:	850°F (454°C)
In Steam:	1200°F (650°C)
Pressure, Max:	3,000 psi (207 bar)
pH Range:	0-14

Gasket Factors:

Gb	557 psi (3.8 MPa)
a	0.325
Gs	2.21 psi (0.02 MPa)

Cross-Reference

In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**JM Clipper**
CFG	Graphonic	ElastaGraph™

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

Flexible Graphite Sheet

Style	Composition	Description
FGS95	Homogeneous Flexible Graphite	Standard industrial grade sheet containing no binders or resins. Used in industrial applications such as oil refineries, power plants and chemical process plants.
FGL316	Laminated 0.002" Stainless 316 Foil Core/Flexible Graphite	Standard industrial grade sheet laminated with an adhesive bond on both sides of a .002" thick 316 stainless steel foil insert. Used where high performance and handleability is important.
FGT316	Laminated 0.004" Stainless 316 Tang Core/Flexible Graphite	Standard industrial grade sheet mechanically bonded on both sides of a .004" thick 316 stainless steel metal tang core. Used where stresses and pressures are high and improved handleability is important.

Typical Properties

Carbon, % min.	95
Moisture, % max.	1
Sulfur ppm max.	1200
Leachable Chlorides, ppm max.	100
Temperature Range:	1200°F (650°C) Saturated Steam
Oxidizing:	-450 to 850°F (-260 to 454°C)
Non-oxidizing	-450 to 5,432°F (-260 to 3,000°C)
Pressure Max:	3,000 psig (207 bar)
Fluid Resistance - pH Range:	0 to 14 at room temperature (except strong oxidizers)

Test Method	Physical Properties	FGS95	FGL316	FGT316
ASTM F36	Compressibility, % Recovery, %	35-40 20	35-40 18	30-35 20
ASTM F38	Creep Relaxation, %	5	5	5
ASTM F495	Ignition Loss, % @ 850°F (454°C) @1200°F (650°C)	 1 8	 1 6	 1 6
DIN 3535 Part 4	Gas Permeability, cc/min.	0.40	0.40	0.80
ASTM	Specifications:	F104: F517000B1M3	F868: 9FMF2	F868: 9FMF1

Note: ASTM and DIN properties based on 1/16" sheet thickness, except ASTM F38 which is based on 1/32" sheet thickness. This is a general guide only and should not be the sole means of accepting or rejecting this material. The data listed here falls within the normal range of product properties, but should not be used to establish specification limits nor used alone as the basis of design.

Cross-Reference

In General, GRI/**DUR**LON® Gasketing Can Be Used In The Same Conditions and Services As The Following: [1]

GRI/**DUR**LON	**Garlock**	**Flexitallic**	**Thermoseal**	**Graphoil**
FGS95	Graph-Lock 3123	Flexicarb LS	HL	GT™B
FGL316	Graph-Lock 3125SS	Flexicarb SR	SLS	GH™R
FGT316	Graph-Lock 3125TC	Flexicarb ST	PSM	GH™E

[1] Refer to the manufacturer for PxT, chemical resistance and other compatibility information. Be sure application is within the service limits of each DURLON material.

Pressure - Temperature Considerations

With gasketing, there is a relationship of pressure to temperature. Generally the higher the temperature the lower the allowable gasket working pressure. This is called the PT factor of the gasket (pressure times temperature). For example, if the pressure is 700 psi and the temperature is 500°F, we would need a material with a PT factor of 350,000. Some manufacturers feel this is the maximum level for safety.

With compressed asbestos products there is a common base and structure in the material which makes comparing and using PT factors easy and predictable. Non-asbestos gasketing is not as predictable. Generally we find that all non-asbestos gasket material is temperature sensitive requiring the pressure to drop more quickly as temperature rises to insure the seal is maintained. We have reviewed performance by in-house tests, controlled operating performance, and in the field. **There is no one PxT factor to use**.

Refer to the preceding charts on pages 2 and 4 for the highest operating temperature given for the application. Find the highest pressure within the safety zone. Simple multiplication of the two will give you the PT factor.

It is always assumed the flange is correct and in good condition, the fluid is not aggressive and that the ideal thickness is 1/16". These limits will be increased for 1/32" but will decrease 20% to 30% for 1/8".

Fluid Resistance - pH Range

The pH of an aqueous solution is merely an expression related to the hydrogen ion (H^+) concentration of the solution. Pure water has a pH of 7. This really means that the concentration of hydrogen ions in moles/liter is

.0000001

This can be expressed as 10^{-7}, which is an exponential equivalent of the number with all the zeros. PH is defined as the negative of the exponent of the hydrogen ion concentration. In the above case, pH= - (-7) = 7.

An acidic solution has a pH of less than seven.

A caustic solution has a pH of more than seven.

Our main concern in discussion of pH is the pulp and paper industry. The industry has both acidic and caustic streams and several of these streams go from acidic to caustic and cycle from one to the other due to treatment systems. Some of these streams are:

White water - Kraft - pH 9 - 10
White water - Bleached stock - pH 5.5 - 7
Liquor - black weak - pH 10 - 13
Effluents - Bleach plant - pH 1.5 - 3
Effluents - Chemical prep area - pH 1.5 - 7
Liquor - black strong - pH 11

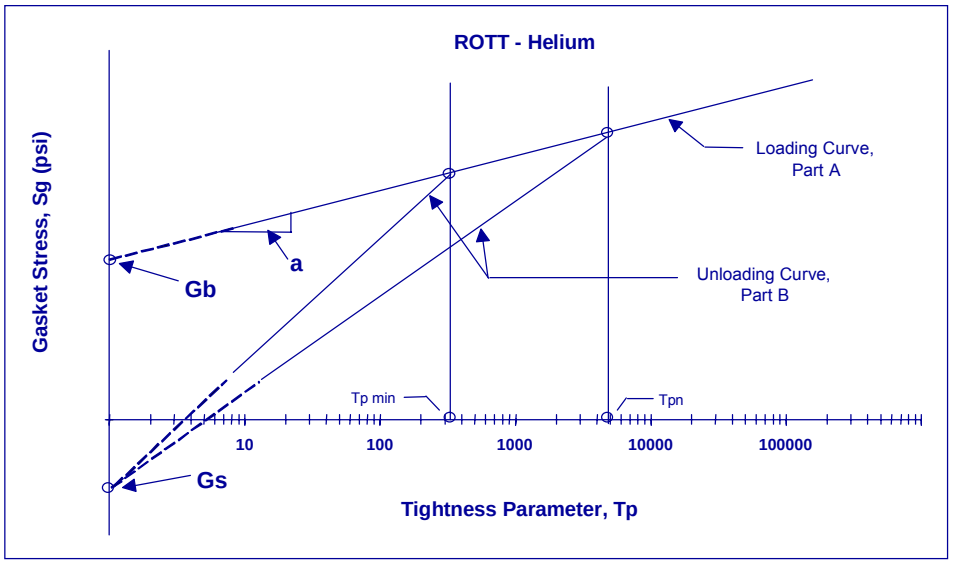
The pH application ranges for Durlon® gasket materials are:

Material	pH Range
Durlon® 8300	3 - 11
Durlon® 8400	2 - 13
Durlon® 8500, 8600 & 8700	3 - 11
Durlon® 9000/9000N, 9200W, 9400 & 9600	0 - 14
Durlon® Flexible Graphite & CFG	0 - 14

This pH range of serviceability is a guide and must always be used in conjunction with the chemical resistance chart. For example, Durlon® 9000 is serviceable from pH 0 to 14 (the entire range) yet we do not recommend it for hydrofluoric acid.

Proposed ASME Gasket Factors: Gb, a and Gs

New gasket factors to replace the ASME Code *m* and *y* are currently being developed by the Pressure Vessel Research Council (PVRC) and ASME. The current *m* and *y* are difficult to replicate for non-asbestos gaskets and do not consider joint leakage. The new approach to bolted joint design makes the *tightness* of the joint a design parameter.



In a manner similar to the traditional ASME Code method, the design bolt load for a joint is calculated for operating and seating requirements from the new constants *Gb, a* and *Gs* and the required tightness class associated with the minimum tightness. *Gb* and *a*, gives the gasket seating load and are similar to *y* in the present Code. *Gs* is associated with the operating stress and is similar to the *m* value in the Code.

The proposed ASME constants *Gb, a,* and *Gs* give a design bolt load obtained by interpretation of leakage test data as plots of gasket stress Sg, vs. a tightness parameter, Tp. Tp is the pressure (in atmospheres) normalized to the atmospheric pressure required to cause a helium leak rate of 1 mg/sec for a 150 mm OD gasket in a joint. Since this is about the same as the OD of an NPS 4 joint, the pressure to cause a leak of 1 mg/sec of helium for that joint is its tightness. A standard test procedure, the PVRC Room Temperature Tightness Test (ROTT) has been designed to produce the constants *Gb, a* and *Gs.* Low values for *Gb, a* and *Gs* are desirable while a higher value of Tp means a tighter joint.

Torque Loss

Torque loss is inherent in any bolted joint. The combined effects of bolt relaxation, (approximately 10% during the first 24 hours after installation), gasket creep, vibration in the system, thermal expansion and elastic interaction during bolt tightening contribute to torque loss. When torque loss reaches an extreme, the internal pressure exceeds the compressive force holding the gasket in place and a leak or blow-out occurs.

A key to reducing these effects is proper gasket installation. By bringing the flanges together slowly and parallel when installing a gasket and taking a minimum of four bolt tightening passes, following the correct bolt tightening sequence, there is a payoff in reduced maintenance costs and increased safety. Proper gasket installation technique is covered in the *Gasket Materials* catalog.

Proper gasket thickness is also important. The thicker the gasket, the higher the gasket creep which in turn can result in torque loss. On standard ANSI raised face flanges a 1/16" thick gasket is normally recommended. Thinner gasket materials can take a higher gasket load and therefore higher internal pressures

Even when the installation is ideal, where the bolt stress is uniformly applied to each bolt, and the gasket is properly compressed, problems can still arise. Inherently with time, loosening will occur due to the factors already mentioned. If other factors such as cycling, thermal upsets, water hammer or just a piping system with inadequate pipe supports are present, periodic retorquing might be necessary.

For problem areas, high temperature applications or where there is temperature cycling, or where a flange cannot be retorqued, conical spring washers have been found to be very helpful as an aid to torque retention. They act as a spring and help lessen the effects of torque loss.

Other factors affecting torque loss include:

Rate of heat up.
New vs. used bolts or studs
Use of hardened steel washers
Lubrication of bolts, nuts and nut facings
Method of bolt up. Order of efficiency from least to greatest:

1. Wrench and cheater bar or sledge hammer
2. Air impact gun
3. Torque wrench
4. Hydraulic torque wrench
5. Hydraulic stud tensioners

Finally, having the torque information for the gasket material is helpful as well. Please refer to the torque data that follows.

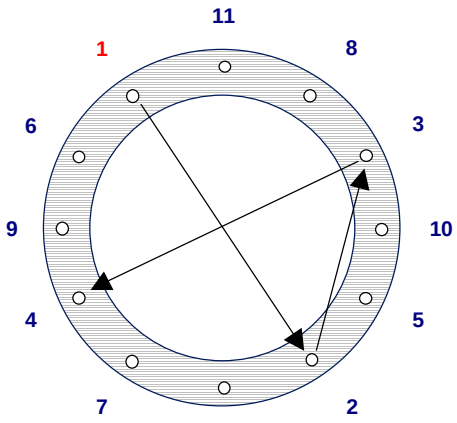
Gasket Installation

The importance of proper gasket installation cannot be stressed enough. The following is a basic explanation of how to properly bring the flanges together parallel and in stages, once the gasket is in place to properly compress the gasket. As a minimum, four passes are required. Using the right torque value for the lubricant being used to get the proper gasket compression is important as well.

In the torque tables that follow for Durlon® gasket materials, it is assumed the flanges are in good condition, anti-seize has not been used on any gasket contact surfaces and a proper installation technique such as what is outlined below is used. Never use any sheet gasket material as insulating washers in flange insulation kits.

Step 1:

- Lubricate the bolts, nuts and nut facings.
- Install gasket, bolts and nuts. Be sure gasket is properly centered.
- Hand tighten the bolts and nuts.
- Starting at the #1 bolt, follow a cross-over or star bolt tightening pattern.
- Tighten to 30% of final torque ...



Step 2:

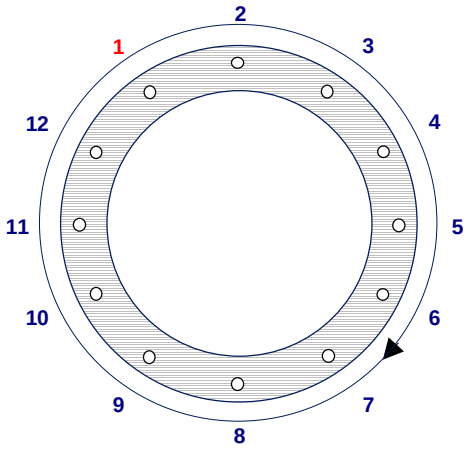
- Start at the #1 bolt.
- Following the same star bolt tightening sequence as in step 1.
- Tighten to 60% of final torque ...

Step 3:

- Start at the #1 bolt.
- Following the same star bolt tightening sequence as in step 1.
- Tighten to 100% of final torque ...

Step 4:

- Starting at the #1 bolt,
- Follow a circular bolt tightening pattern. (Clockwise or counter clockwise)
- Tighten to 100% of final torque ...



Step 5:

- Repeat step 4, as many times as required until equilibrium is achieved, starting over at the #1 bolt each time.

Finally:

- Retorque 24 to 72 hours after installation following a circular bolt tightening pattern at 100% of torque.

Torque Values – ASME B16.5 Raised Face Flanges

ANSI B16.21 - RING GASKETS

1/16" & 1/8" DURLON® Gasket Material

Torque: ft-lbs

CLASS 150
INTERNAL PRESSURE = 285 psi

Flange Size:	8300, 8500, 8600, 8700, FGS95	8400	9000/9000N 9200W 9400, 9600	FGL316, FGT316	# Bolts & Diameter
1/2"	13	13	13	11	4 @ 1/2"
3/4"	19	19	19	17	4 @ 1/2"
1"	25	25	25	23	4 @ 1/2"
1-1/4"	37	37	37	36	4 @ 1/2"
1-1/2"	37	39	37	51	4 @ 1/2"
2"	75	78	75	103	4 @ 5/8"
2-1/2"	75	91	75	113	4 @ 5/8"
3"	106	113	106	113	4 @ 5/8"
3-1/2"	75	75	75	98	8 @ 5/8"
4"	75	95	75	113	8 @ 5/8"
5"	135	144	135	185	8 @ 3/4"
6"	142	183	142	202	8 @ 3/4"
8"	193	202	193	202	8 @ 3/4"
10"	218	246	218	327	12 @ 7/8"
12"	243	327	243	327	12 @ 7/8"
14"	328	415	328	492	12 @ 1"
16"	328	396	328	492	16 @ 1"
18"	487	600	487	731	16@1-1/8"
20"	487	537	487	731	20@1-1/8"
24"	691	783	691	1036	20@1-1/4"

CLASS 300
INTERNAL PRESSURE = 740 psi

8300, 8500, 8600, 8700, 8400	9000/9000N 9200W	9400, 9600	FGS95	FGL316	FGT316	# Bolts & Diameter
13	12	16	16	11	23	4 @ 1/2"
24	22	30	30	22	37	4 @ 5/8"
32	29	40	40	29	49	4 @ 5/8"
49	44	61	62	40	75	4 @ 5/8"
77	70	97	108	78	119	4 @ 3/4"
52	47	65	75	58	88	8 @ 5/8"
73	66	91	133	81	135	8 @ 3/4"
106	96	133	135	117	180	8 @ 3/4"
119	107	135	135	131	201	8 @ 3/4"
136	135	135	135	180	202	8 @ 3/4"
174	135	135	135	202	202	8 @ 3/4"
149	135	135	135	202	202	12 @ 3/4"
246	218	218	218	323	327	12 @ 7/8"
261	235	327	328	338	442	16 @ 1"
391	352	487	487	543	661	16@1-1/8"
341	307	426	487	473	576	20@1-1/8"
488	432	600	691	529	811	20@1-1/4"
542	488	678	691	767	917	24@1-1/4"
598	538	691	691	659	1011	24@1-1/4"
927	834	1158	1254	1311	1566	24@1-1/2"

Note: It is assumed that new ASTM A193 Gr. B7 studs with 2H heavy hex nuts and hardened steel washers are used and studs, nuts and nut facings are lubricated with a never-seize paste using the installation and bolt tightening practices outlined above. Torque is based the higher of 40% of bolt yield, T3 or 4800 psi gasket stress up to either the maximum allowable material stress or a maximum bolt yield of 60%. The above was calculated using the proposed ASME Gasket Constants (ROTT Testing, Ecole Polytechnique) for each material.

DURLON® Chemical Resistance Chart

The following information is a general guide only for the selection of a suitable gasket material as there are unlimited combinations of fluid, pressure and temperature conditions

A - Acceptable
C - Caution - Depends on Conditions
NS - Not Suitable

FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE				FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE			
	8300	8400	8500	8600	8700	9000	9200W	9400	9600		8300	8400	8500	8600	8700	9000	9200W	9400	9600
Acetic Acid, Glacial (100%)	C	C	C	C	C	A	A	A	A	Detergent Solutions	A	A	A	A	A	A	A	A	A
Acetic Acid, 37%	A	A	C	A	A	A	A	A	A	Diacetone Alcohol	NS	NS	NS	NS	NS	A	A	A	A
Acetic Anhydride	A	C	C	C	C	A	A	A	A	Dibenzyl Ether	NS	C	C	NS	NS	A	A	A	A
Acetone	C	C	C	C	C	A	A	A	A	Dibutylamine	C	C	C	NS	C	A	A	A	A
Acetylene	A	A	A	C	A	A	A	A	A	Diesel Fuel	A	A	A	C	C	A	A	A	A
Air	A	A	A	A	A	A	A	A	A	Dimethyl Acetamide	NS	C	NS	NS	NS	A	A	A	A
Alum	A	A	A	A	A	A	A	A	A	Dimethylformamide	NS	C	NS	NS	NS	A	A	A	A
Aluminum Acetate	A	A	A	A	A	A	A	A	A	Dioxane	NS	NS	NS	NS	NS	A	A	A	A
Amines	C	C	C	A	C	A	A	A	A	Dowtherm A, E	NS	C	C	NS	NS	A	A	A	A
Ammonia, Gas > 150°F	NS	NS	NS	NS	C	A	A	A	A	Epichlorohydrin	NS	NS	NS	NS	NS	A	A	A	A
Ammonia, Liquid	C	C	C	C	A	A	A	A	A	Ethane	A	A	A	C	C	A	A	A	A
Ammonium Bisulfite	A	A	A	C	A	A	A	A	A	Ethyl Acetate	C	C	C	C	NS	A	A	A	A
Ammonium Chloride	A	A	A	A	A	A	A	A	A	Ethyl Alcohol (Ethanol)	A	A	A	A	A	A	A	A	A
Ammonium Hydroxide	A	A	A	A	A	A	A	A	A	Ethylbenzene	NS	NS	NS	NS	NS	A	A	A	A
Amyl Chloride	A	NS	NS	C	NS	A	A	A	A	Ethylchloride	A	A	A	NS	NS	A	A	A	A
Aniline, Aniline Oil	NS	NS	NS	NS	NS	A	A	A	A	Ethylene	A	A	A	NS	C	A	A	A	A
Arsenic Acid	A	A	A	A	A	A	A	A	A	Ethylene Dichloride	NS	NS	NS	NS	NS	A	A	A	A
Aviation Fuels	A	A	A	C	C	A	A	A	A	Ethylene Glycol	A	A	A	A	A	A	A	A	A
Barium Chloride	A	A	A	A	A	A	A	A	A	Ethyl Ether	C	C	C	NS	C	A	A	A	A
Benzene (Benzol)	NS	NS	NS	NS	NS	A	A	A	A	Ethylene Oxide	NS	NS	NS	NS	NS	A	A	A	A
Benzoic Acid	NS	NS	NS	NS	NS	A	A	A	A	Fatty Acids	A	A	A	NS	C	A	A	A	A
Black Sulfate Liquor<350°F	NS	A	A	C	C	A	A	A	A	Ferric Chloride	A	A	A	A	A	A	A	A	A
Black Sulfate Liquor>350°F	NS	C	NS	NS	NS	A	A	A	A	Ferrous Chloride	A	A	A	A	A	A	A	A	A
Bleach Solutions	C	A	C	C	C	A	A	A	A	Fluorine (Gas, Liquid)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Boiler Feed Water	A	A	A	A	A	A	A	A	A	Formaldehyde	A	C	A	C	C	A	A	A	A
Borax	A	A	A	A	A	A	A	A	A	Formic Acid	NS	NS	NS	C	A	A	A	A	A
Brine	A	A	A	A	A	A	A	A	A	Freon	See Refrigerants								
Butadiene	NS	NS	NS	NS	NS	A	A	A	A	Fuel Oil	A	A	A	C	C	A	A	A	A
Butane	A	A	A	NS	C	A	A	A	A	Gas – Natural	A	A	A	NS	A	A	A	A	A
Butyl Acetate	NS	C	NS	NS	NS	A	A	A	A	Gasoline	A	A	A	NS	NS	A	A	A	A
Butyl Alcohol (Butanol)	A	A	A	A	A	A	A	A	A	Glucose	A	A	A	A	A	A	A	A	A
Butyl Methacrylate	NS	NS	NS	NS	NS	A	A	A	A	Glycerin (Glycerol)	A	A	A	A	A	A	A	A	A
Butylene (Butene)	A	A	A	NS	C	A	A	A	A	Green Sulfate Liquor	C	C	C	NS	C	A	A	A	A
Butyric Acid	A	A	C	C	C	A	A	A	A	Heptane	A	A	A	NS	C	A	A	A	A
Calcium Carbonate	A	A	A	A	A	A	A	A	A	Hexane	A	A	A	NS	C	A	A	A	A
Calcium Chloride	A	A	A	A	A	A	A	A	A	Hydraulic Oil (mineral)	A	A	A	C	C	A	A	A	A
Calcium Hydroxide	A	A	A	A	A	A	A	A	A	Hydraulic Oil (phos. ester)	C	C	C	NS	NS	A	A	A	A
Calcium Hypochlorite	C	A	C	C	C	A	A	A	A	Hydrazine	C	C	C	C	C	A	A	A	A
Carbon Dioxide, wet	A	A	A	C	C	A	A	A	A	Hydrochloric Acid, 30%	NS	C	NS	NS	NS	A	A	A	A
Carbon Disulfide	NS	C	NS	NS	NS	A	A	A	A	Hydrochloric Acid, Conc	NS	C	NS	NS	NS	A	A	A	A
Carbon Tetrachloride	NS	C	C	NS	NS	A	A	A	A	Hydrofluoric Acid <150°F	NS	NS	NS	NS	NS	NS	A	A	A
Caustic Soda (NaOH)	NS	A	C	C	NS	A	A	A	A	Hydrofluoric Acid >150°F	NS	NS	NS	NS	NS	NS	NS	A	A
Chlorine, liquid (dry) *	NS	NS	NS	NS	NS	A	A	A	A	Hydrogen	A	A	A	A	A	A	A	A	A
Chlorine (wet) *	NS	C	NS	NS	NS	A	A	A	A	Hydrogen Chloride, (dry)	A	NS	NS	NS	NS	A	A	A	A
Chlorine Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	Hydrogen Peroxide, 10%	C	C	C	C	C	A	A	A	A
Chloroform	C	A	C	NS	NS	A	A	A	A	Hydrogen Sulfide (dry)	A	A	C	C	A	A	A	A	A
Chromic Acid	NS	NS	NS	NS	NS	A	A	NS	A	Hydrogen Sulfide, (wet)	C	C	C	NS	C	A	A	A	A
Citric Acid	A	A	A	A	A	A	A	A	A	Iodine	A	A	A	A	NS	A	A	A	A
Coal Gas	NS	NS	NS	A	C	A	A	A	A	Isooctane	A	A	A	NS	C	A	A	A	A
Copper Sulfate	A	A	A	A	A	A	A	A	A	Isopropyl Alcohol	A	A	A	A	A	A	A	A	A
Corn Oil	A	C	C	NS	C	A	A	A	A	Jet Fuel	A	A	A	NS	C	A	A	A	A
Cotton Seed Oil	A	A	A	NS	C	A	A	A	A	Kerosene	A	A	A	NS	C	A	A	A	A
Creosote (Coal Tar)	A	A	A	NS	NS	A	A	A	A	Lactic Acid	A	A	A	A	A	A	A	A	A
Cresol	C	A	C	NS	NS	A	A	A	A	Linseed Oil	A	A	A	NS	C	A	A	A	A
Crude Oil	A	A	A	NS	C	A	A	A	A	Lubricating Oil	A	A	A	NS	C	A	A	A	A
Cumene	NS	NS	NS	NS	C	A	A	A	A	Magnesium Chloride	A	A	A	A	A	A	A	A	A
Cyclohexane	A	A	C	NS	C	A	A	A	A	Maleic Acid	A	A	A	C	NS	A	A	A	A

** Durlon 9000 is listed in Pamphlet 95 of the Chlorine Institute, as an acceptable gasket material for dry chlorine (liquid & gas) service. Gaskets for chlorine or oxygen service should be cleaned before installation.*

DURLON® Chemical Resistance Chart

FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE				FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE			
	8300	8400	8500	8600	8700	9000	9200W	9400	9600		8300	8400	8500	8600	8700	9000	9200W	9400	9600
Mercury	A	A	A	A	A	A	A	A	A	Refrigerant 402b	C	C	C	NS	A	A	A	A	A
Methane	A	A	A	NS	C	A	A	A	A	Refrigerant Blend 404a***	A	A	A	NS	A	A	A	A	A
Methyl Alcohol (Methanol)	A	A	A	A	A	A	A	A	A	Sea Water	A	A	A	A	A	A	A	A	A
Methylene Chloride	NS	NS	NS	NS	NS	A	A	A	A	Silver Nitrate	C	A	C	C	C	A	A	A	A
Methyl Ethyl Ketone	C	C	C	NS	C	A	A	A	A	Soap Solutions	A	A	A	A	A	A	A	C	A
Mineral Oil	A	A	A	NS	C	A	A	A	A	Sodium Bisulfite	A	A	A	A	A	A	A	A	A
Muriatic Acid	NS	C	NS	NS	NS	A	A	A	A	Sodium Carbonate	A	A	A	A	A	A	A	A	A
Naphtha	A	A	A	C	NS	A	A	A	A	Sodium Chloride	A	A	A	A	A	A	A	A	A
Natural Gas	A	A	A	NS	A	A	A	A	A	Sodium Hydroxide	C	A	C	C	NS	A	A	A	A
Nickel Sulfate	A	A	A	A	A	A	A	A	A	Sodium Hypochlorite	NS	NS	NS	C	C	A	A	C	A
Nitric Acid, <30%	NS	NS	NS	NS	NS	A	A	NS	A	Sodium Nitrate	A	A	A	C	C	A	A	A	A
Nitrogen	A	A	A	A	A	A	A	A	A	Sodium Silicate	A	A	A	A	A	A	A	A	A
Nitrogen Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	Sodium Sulfate	A	A	A	A	A	A	A	A	A
Nitrogen Tetroxide	NS	NS	NS	NS	NS	A	A	NS	A	Sour Crude Oil	A	A	A	NS	C	A	A	A	A
Octane	A	A	A	NS	C	A	A	A	A	Steam (to 450°F)	A	A	A	A	A	A	A	A	A
Oil, Crude	A	A	A	NS	C	A	A	A	A	Steam (over 450°F)	A	A	A	C	C	NS	NS	NS	A
Oil, Mineral	A	A	A	NS	C	A	A	A	A	Stearic Acid	A	A	A	C	A	A	A	A	A
Oleum (H2SO4)	NS	NS	NS	NS	NS	A	NS	NS	A	Stoddard Solvent	A	A	A	NS	C	A	A	A	A
Oxalic Acid	A	A	C	NS	C	A	A	A	A	Styrene	C	C	C	NS	NS	A	A	A	A
Oxygen, gas, liquid	NS	NS	NS	NS	NS	A	A	A	A	Sulfite Liquors	C	A	C	C	C	A	A	A	A
Pentane	A	A	A	NS	C	A	A	A	A	Sulfur (molten)	C	C	C	NS	C	A	A	A	A
Perchloroethylene	C	A	C	NS	NS	A	A	A	A	Sulfur Dioxide	NS	C	NS	NS	NS	A	A	A	A
Petroleum	A	A	A	NS	C	A	A	A	A	Sulfuric Acid, 20%	NS	NS	NS	NS	NS	A	A	A	A
Phenol	NS	NS	NS	NS	NS	A	A	A	A	Sulfuric Acid, Conc.	NS	NS	NS	NS	NS	A	C	A	A
Phosphoric Acid, 45%	C	C	C	NS	C	A	A	A	A	Sulfuric Acid, Conc>200°F	NS	NS	NS	NS	NS	A	NS	NS	A
Potassium Chloride	A	A	A	A	A	A	A	A	A	Sulfuric Acid, Fuming	NS	NS	NS	NS	NS	A	NS	NS	A
Potassium Hydroxide	C	A	A	C	C	A	A	A	A	SUVA	See Refrigerants								
Potassium Nitrate	C	C	C	C	C	A	A	C	A	Tar	A	A	A	C	C	A	A	A	A
Propane	A	A	A	NS	C	A	A	A	A	Tetrachloroethane	C	C	C	NS	NS	A	A	A	A
Propylene	NS	NS	NS	NS	NS	A	A	A	A	Tetrahydrofuran (THF)	NS	NS	NS	NS	NS	A	A	A	A
Pydrauls, Skydrols	C	C	C	NS	NS	A	A	A	A	Toluene	NS	NS	NS	NS	C	A	A	A	A
Pyridine	NS	NS	NS	NS	NS	A	A	A	A	Transformer Oil	A	A	A	NS	C	A	A	A	A
Red Sulfite Liquor	NS	C	NS	NS	NS	A	A	A	A	Transmission Fluid	A	A	A	NS	C	A	A	A	A
Red Sulfite Liquor > 200°F	NS	NS	NS	NS	NS	A	A	A	A	Trichloroethylene	C	C	C	NS	NS	A	A	A	A
Red Sulfite Liquor > 380°F	NS	NS	NS	NS	NS	C	C	C	A	Triethanolamine	C	C	C	C	A	A	A	A	A
Refrigerant R-11 **	A	A	A	NS	NS	A	A	A	A	Turpentine	A	A	A	NS	C	A	A	A	A
Refrigerant R-12 **	A	A	A	C	A	A	A	A	A	Urea	A	A	A	A	A	A	A	A	A
Refrigerant R-22 **	C	C	C	C	A	A	A	A	A	Varsol	A	A	A	NS	NS	A	A	A	A
Refrigerant R-113 **	A	A	A	C	A	A	A	A	A	Vegetable Oil	A	A	A	NS	C	A	A	A	A
Refrigerant HCFC 123 **	NS	C	C	NS	C	A	A	A	A	Vinegar	A	A	A	C	A	A	A	A	A
Refrigerant HCFC 124 ***	NS	C	C	NS	A	A	A	A	A	Vinyl Acetate	C	C	C	NS	C	A	A	A	A
Refrigerant HFC 125 ***	C	C	C	NS	A	A	A	A	A	Vinyl Chloride	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant HFC 134a ***	A	A	A	C	A	A	A	A	A	Water	A	A	A	A	A	A	A	A	A
Refrigerant HCFC 141b	A	A	A	NS	A	A	A	A	A	White Sulfate Liquor	A	A	A	A	A	A	A	A	A
Refrigerant HFC 236fa	A	A	A	NS	A	A	A	A	A	White Spirit	A	A	A	C	C	A	A	A	A
Refrigerant Blend H 62***	A	A	A	NS	A	A	A	A	A	Xylene	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant Blend HP80	C	C	C	NS	A	A	A	A	A	Zinc Chloride	A	A	A	A	A	A	A	A	A
Refrigerant 402a	C	C	C	NS	A	A	A	A	A	Zinc Nitrate	C	C	C	C	C	A	A	C	A
Refrigerant Blend HP81	C	C	C	NS	A	A	A	A	A	Zinc Sulfate	A	A	A	A	A	A	A	A	A

*** With Mineral Oil,* *** With Polyol Ester Oil*

Gaskets for chlorine or oxygen service should be cleaned before installation.

This information is a general guide for the selection of a suitable gasket material. The substances listed above are evaluated for their effect on the gasket materials at ambient temperature (-40°F to 100°F, or -40ºC to 38ºC) unless stated otherwise. For unusual conditions of fluid concentrates, internal pressures or temperature consult your representative. This evaluation is based on laboratory or field tests, or experience; however, no guarantee can be given as to the actual performance experienced by the end user.

There are several fluids used in food which can be sealed by SBR, however due to flavor pickup, we have used “C” caution on these products.

This Chemical Resistance Chart supersedes and obsoletes all previously issued charts.

Please go to our website for recommendations on **CFG**, **FGS95**, **FGL316**, **FGT316**, and additional chemical listings.

www.gasketresources.com

Useful Conversion Factors

Abbreviations

SI	- International Metric Standard	in	- inch
km	- kilometer	ft	- foot
m	- meter	yd	- yard
cm	- centimeter	oz	- ounce
mm	- millimeter	lb	- pound
N	- Newton	L	- liter
MPa	- MegaPascal	Pa	- Pascal
kgf	- kilogram force	g	- gram

Multiples and sub-multiples of SI units

Factor by which the unit is multiplied		Prefix	Symbol
1,000,000	10^6	mega	M
1,000	10^3	kilo	k
100	10^2	hecto	h
10	10^1	deca	da
0.1	10^{-1}	deci	d
0.01	10^{-2}	centi	c
0.001	10^{-3}	milli	m
0.000,001	10^{-6}	micro	μ

Conversion Factors

A	B	To convert A to B multiply A by	To convert B to A multiply B by
Length			
cm	in	0.3937	2.54
mm	in	0.0394	25.40
m	ft	3.2808	0.3048
in	mils	1000	0.001
Force			
N	lbf	0.22482	4.4482
N	kgf	0.102	9.807
Weight			
kg	lb	2.2046	0.453593
g	oz	0.0352	28.3495
Stress or Pressure			
MPa	psi	145.034	0.006895
MPa	kPa	1000	0.001
N/mm^2	MPa	1	1
bar	psig	14.504	0.06895
bar	MPa	0.1	10
in. mercury	psig	0.4912	2.035
Torque			
g-cm	in-lb	1150	0.00069
N-m	ft-lb	0.738	1.36
Density			
g/cm^3	lbs/ft^3	62.4278	0.016
Volume/Flow			
L	cm^3	1000	0.001
mL	cm^3	1	1
ppm (by mass)	mg/kg	1	1
Temperature			
°C	°F	1.8 before adding 32	0.5556 after subtracting 32