GASKET RESOURCES INC.

DURLON®

SHEET GASKETING

TECHNICAL HANDBOOK

July 2002

gasket resources incorporated

GASKET RESOURCES INC.

DURLON® TECHNICAL HANDBOOK

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DURLON® **Products are Manufactured to ISO 9001 Quality Standards**

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DURLON® Compressed Non-Asbestos

DURLON® 8300 Black

A premium grade compressed sheet suitable for steam, oil, water, mild alkalis, mild acids, hydrocarbons and solvents. Durlon 8300 contains high strength carbon fibers bonded with nitrile (NBR) synthetic rubber.

Color:	Black, branded
Binder:	Nitrile (NBR)
Fiber:	Carbon
Temperature Range:	-100 to 800ºF (-73 to 427ºC)
Continuous Temperature:	600ºF (315ºC)
Pressure, Max:	1500 psig (103 bar)
Leachable Halides:	500 ppm (max.)
Leachable Chlorides:	200 ppm (max.)
Gas Permeability:	
DIN 3535 Part 4	0.05 cc/min
ASTM F104 Line Call-Out:	F712120-A9B3E22K5M5

Fluid Services:	Saturated Steam, Oils, Dilute Acids & Alkalis, Hydrocarbons, Solvents	
Fluid Resistance – pH Range:	3 to 11 at room temperature	
Volume Resistivity, 1/16”	5×10^9 ohm-cm (ASTM D257)	
Dielectric Breakdown, 1/16”	0.04 kv/mm (ASTM D149)	
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	512 (3.5)	1716 (11.8)
a	0.355	0.209
Gs, psi (MPa)	0.13 (0.0009)	0.70 (0.005)

DURLON® 8400 Gold

The widest pH application range of any compressed gasket material produced today, for use in process piping and equipment in chemical, pulp and paper, power generation and other general industrial applications. Can be used in applications similar to the Durlon 8500 but especially well suited for high pH services where aramid fiber based materials might be limited.

Color:	Gold, branded
Binder:	Nitrile (NBR)
Fiber:	Phenolic
Temperature Range:	-100 to 800°F (-75 to 427°C)
Continuous:	554ºF (290ºC)
Pressure, Max:	1500 psig (103 bar)
Leachable Halides:	1,000 ppm (max.)
Leachable Chlorides:	400 ppm (max.)
Gas Permeability:	
DIN 3535 Part 6	0.03 cc/min
ASTM F104 Line Call-Out:	F712120-A9B4E22K5M5

Fluid Services:	Steam, Oils, Solvents, Caustics, Fuels, Hydrocarbons, Acids, Refrigerants	
Fluid Resistance – pH Range:	2 to 13 at room temperature	
Volume Resistivity, 1/16”	1.0×10^{14} ohm-cm (ASTM D257)	
Dielectric Breakdown, 1/16”	9.84 kv/mm (ASTM D149)	
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	2000 (13.8)	
a	0.194	
Gs, psi (MPa)	340 (2.3)	

DURLON® 8500 Green

Excellent performance in steam, hydrocarbons and new generation refrigerants. A high quality general service gasket material for use in process industries including pulp and paper, food and beverage, pharmaceutical, hydrocarbon, chemical, and refinery, as well as general industry.

Color:	Green, branded
Binder:	Nitrile (NBR)
Fiber:	Aramid-Inorganic
Temperature Range:	-100 to 700°F (-73 to 371°C)
Continuous:	548ºF (287ºC)
Pressure, Max:	1500 psig (103 bar)
Leachable Halides:	1000 ppm (max.)
Leachable Chlorides:	300 ppm (max.)
Gas Permeability:	
DIN 3535 Part 6	0.03 cc/min
ASTM F104 Line Call-Out:	F712120-A9B3E12K5M6

Fluid Services:	Saturated Steam, Oils, Fuels, Dilute Acids & Alkalis, Solvents, Refrigerants	
Fluid Resistance – pH Range:	3 to 11 at room temperature	
Volume Resistivity, 1/16”	4.1×10^{13} ohm-cm (ASTM D257)	
Dielectric Breakdown, 1/16”	8.8 kv/mm (ASTM D149)	
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	650 (4.5)	400 (2.8)
a	0.33	0.35
Gs, psi (MPa)	200 (1.38)	20 (0.14)

(See page 6 for additional physical properties.)

DURLON® 8600 White

A high quality gasket material containing high strength aramid fibers bonded with SBR rubber. An excellent choice for steam and other services where a "white" gasket material is required.

Color:	White, branded	**Fluid Services:**	Saturated Steam, Water, Inert Gases, Alcohols, Dilute Acids & Alkalis, Ammonia
Binder:	SBR		
Fiber:	Aramid-Inorganic		
Temperature Range:	-100 to 700°F (-73 to 371°C)		
Continuous:	548ºF (287ºC)	**Fluid Resistance – pH Range:**	3 to 11 at room temperature
Pressure, Max:	1500 psig (103 bar)	**Volume Resistivity, 1/16"**	4.1 x 10^{13} ohm-cm (ASTM D257)
Gas Permeability:		**Dielectric Breakdown, 1/16"**	8.8 kv/mm (ASTM D149)
DIN 3535 Part 4	0.05 cc/min		
ASTM F104 Line Call-Out:	F712440-A9B3E24K5M5		

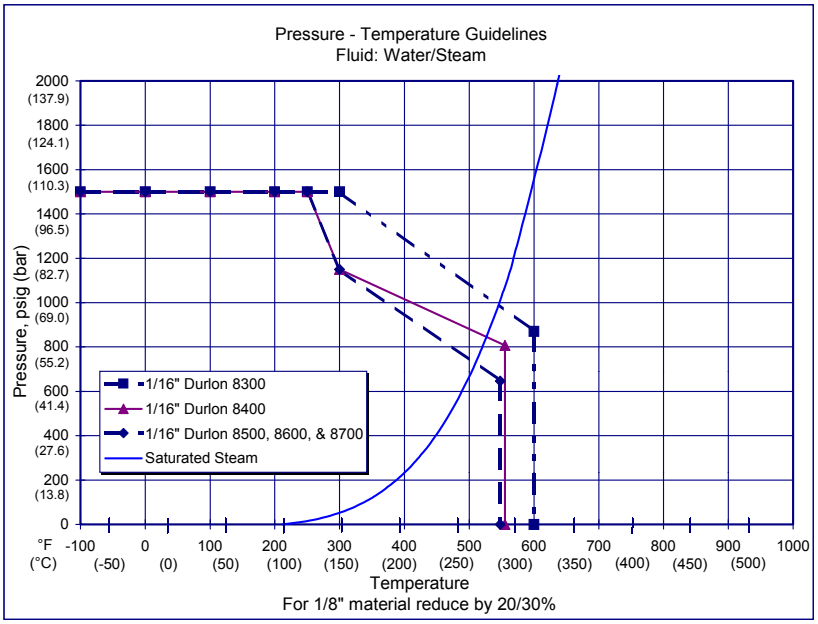
DURLON® 8700 Blue

A high performance compressed gasket material for use in processes which require a neoprene (CR) bonded sheet. Excellent for steam, oils and many refrigeration services.

Color:	Blue, branded	**Fluid Services:**	Saturated Steam, Oils, Water, Dilute Acids & Alkalis, Refrigerants
Binder:	Neoprene (CR)		
Fiber:	Aramid-Inorganic		
Temperature Range:	-100 to 700°F (-73 to 371°C)		
Continuous:	548ºF (287ºC)	**Fluid Resistance – pH Range:**	3 to 11 at room temperature
Pressure, Max:	1500 psig (103 bar)	**Volume Resistivity, 1/16"**	4.1 x 10^{13} ohm-cm (ASTM D257)
Gas Permeability:		**Dielectric Breakdown, 1/16"**	8.8 kv/mm (ASTM D149)
DIN 3535 Part 4	0.05 cc/min		
ASTM F104 Line Call-Out:	F712330-A9B5E45K5M5		

(See page 6 for additional physical properties.)

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



Note: Consult you representative for applications above Class 300

DURLON® 9000/9000N

DURLON 9000 is designed for use in process piping and equipment in chemical, pulp and paper, food and beverage and other general industrial applications where resistance to highly aggressive chemicals is required.

DURLON 9000 has been tested and approved for Chlorine and Caustics service. Unlike generic skived PTFE, the various shapes of fillers in DURLON 9000 are homogeneously blended with pure PTFE resins and do not wick and cause corrosion on flange faces. Additionally, independent testing has shown the fillers in DURLON 9000 to be more evenly dispersed than filled PTFE with layered construction. Therefore DURLON 9000 has more consistent physical and mechanical properties and does not have voids, separation and chemical compatibility problems found in layered PTFE.

Color:	Style 9000	Blue, branded
	Style 9000N	Unpigmented White, branded
Temperature Range:		-350 to 520°F (-212 to 271°C)
Pressure, Max:		1500 psig (103 bar)
DIN 3535 Part 4		0.01 cc/min
ASTM F104 Line Call-Out:		F452111-A9B5E11K6M6
Certified for Oxygen Service		Federal Institute for Materials Testing & Research: Berlin

*** Conforms to FDA Regulations**

** Listed in Pamphlet 95 of the Chlorine Institute as an acceptable gasket material for chlorine service.

Fluid Services:		Steam, Oils, Liquid Chlorine**, Acids, Caustics, Alcohols, Liquid & Gaseous Oxygen, Refrigerants
Fluid Resistance – pH Range:		0 to 14 at room temperature
Volume Resistivity, 1/16”		1.0 x 10^5 ohm-cm (ASTM D257)
Dielectric Breakdown, 1/16”		16 kv/mm (ASTM D149)
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	550 psi (3.79)	424 psi (2.92)
a	0.244	0.242
Gs, psi (MPa)	0.042 (0.0003)	19 (0.13)
Hot Blow-Out Temperature Test (HOBT)		
@ 750 psig, (51.7 bar)	588°F (309ºC)	

DURLON® 9200/9200W

DURLON 9200/9200W is designed for use in process piping and equipment in chemical, pulp and paper, pharmaceutical, food and other general industrial applications where resistance to highly aggressive chemicals is required.

DURLON 9200/9200W is manufactured by the same DURLON process outlined above using only barium suflate fillers and pure PTFE resins homogeneously blended together resulting in uniform physical and mechanical properties versus layered PTFE. It is suitable for use in aggressive chemicals including sodium and potassium hydroxide, hydrogen and aluminum fluoride, Chrome Plating Solutions and Vinyl Compounds.

Color:	Style 9200	Green, branded
	Style 9200W	Granite White, branded
Temperature Range:		-350 to 520°F (-212 to 271°C)
Pressure, Max:		1500 psig (103 bar)
DIN 3535 Part 4		0.01 cc/min
ASTM F104 Line Call-Out:		F452111-A9B5E11K6M5
*** Conforms to FDA Regulations**		

Fluid Services:		Steam, Caustics, Hydrogen Fluoride, Aluminum Fluoride, Chrome Plating Solutions, Refrigerants
Fluid Resistance – pH Range:		0 to 14 at room temperature
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	5.2 (0.034)	2.3 (0.016)
a	0.73	0.873
Gs, psi (MPa)	0.033 (0.0002)	25.7 (0.18)
Hot Blow-Out Temperature Test (HOBT)		
@ 750 psig, (51.7 bar)	542°F (283ºC)	480°F (249ºC)

DURLON® 9400

DURLON 9400 gasket material is a high performance carbon filled PTFE manufactured using the DURLON process designed for use in piping and equipment in chemical, pharmaceutical, food and other general industrial applications where resistance to highly aggressive chemicals (including hydrofluoric acid) is required.

It can also be used as gasketing for anhydrous hydrogen fluoride (AHF) in railroad tankcars and in plants as a material of construction where barium sulfate filled PTFE may not prove suitable. DURLON 9400 also demonstrates good electrical conducting properties.

Color:	Black, branded
Temperature Range:	-350 to 550°F (-212 to 288°C)
Pressure, Max:	1500 psig (103 bar)
DIN 3535 Part 4	0.01 cc/min
ASTM F104 Line Call-Out:	F452111-A9B5E11K6M6
*** Conforms to FDA Regulations**	
Volume Resistivity of Electrically Conductive Products, 1/16"	61 ohm-cm (ASTM D991)

(See page 6 for additional physical properties.)

Fluid Services:		Aqueous and Anhydrous Hydrogen Fluoride, Steam, Oils, Caustics, Acids
Fluid Resistance – pH Range:		0 to 14 at room temperature
Dielectric Breakdown, 1/16”		1 kv/mm (ASTM D149)
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	1701 (11.7)	1412 (9.7)
a	0.173	0.164
Gs, psi (MPa)	99 (0.68)	248 (1.7)
Hot Blow-Out Temperature Test (HOBT)		
@ 750 psig, (51.7 bar)		549°F (287ºC)

DURLON® 9600

DURLON® 9600 is an EXPANDED PTFE gasket material designed for use in process piping and equipment in chemical, pulp and paper, food and beverage and other general industrial applications where resistance to highly aggressive chemicals is required.

DURLON® 9600 is suitable for service to a maximum temperature of 600°F (316°C) or with pressures up to 1800 psi (12.4 MPa). Style 9600 conforms to FDA requirements.

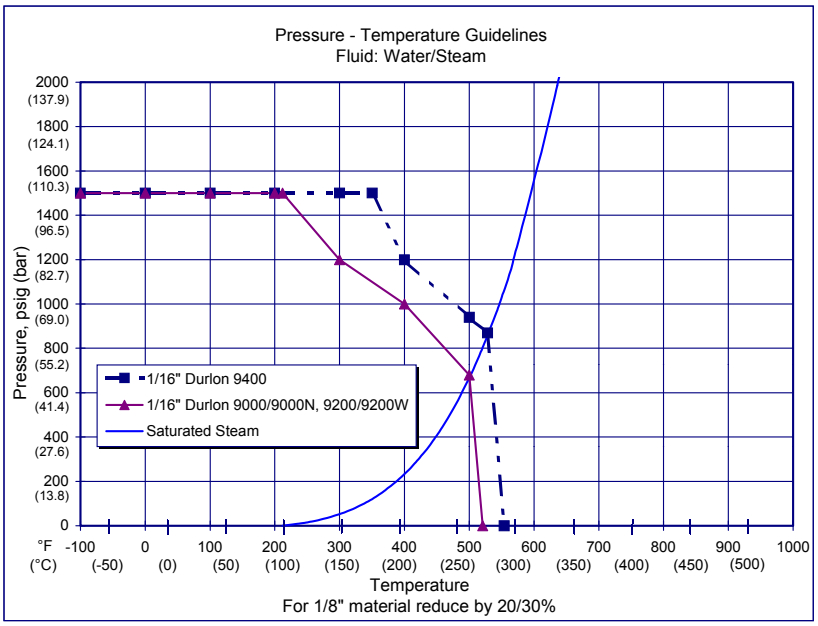
Color:	White, branded
Temperature Range:	-350 to 600°F (-212 to 316°C)
Pressure, Max:	1800 psig (124 bar)
DIN 3535 Part 4	0.01 cc/min
ASTM F104 Line Call-Out:	F428111-A9B5
*** Conforms to FDA Regulations**	

(See page 6 for additional physical properties.)

Fluid Services:	Aqueous and Anhydrous Hydrogen Fluoride, Steam, Oils, Caustics, Acids, Alcohols, Liquid & Gaseous Oxygen,	
Fluid Resistance – pH Range:	0 to 14 at room temperature	
Proposed ASME Gasket Factors:	**1/16”**	**1/8”**
Gb, psi (MPa)	1200 (8.27)	1400 (9.65)
a	0.2	0.19
Gs, psi (MPa)	3.5 (0.024)	1.5 (0.01)

PxT Chart

DURLON® Filled PTFE Gasket Materials



Note: Consult your representative for applications above Class 300

DURLON® Flexible Graphite

DURLON® Flexible Graphite is available in several styles. These include homogeneous sheet and laminated styles with various types of core materials. Additionally, grades with oxidation inhibitors or high purity grades for nuclear service are available on special order.

DURLON® Flexible Graphite is unaffected by heat over a wide range of temperatures. It exhibits low electrical resistivity and high thermal conductivity and is suitable to cryogenic temperatures. This product is suitable for applications in the automotive, refining and petrochemical plant processes.

Typical Properties for Standard Industrial Grade Homogeneous Flexible Graphite

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)

DURLON® Flexible Graphite Gasket Material is available in four styles:

FGS95	Standard industrial grade sheet containing no binders or resins. Used in industrial applications such as oil refineries, power plants and chemical process plants.
FGLPE	Standard industrial grade sheet laminated with an adhesive bond on both sides of a polyester core. A general purpose material for use where some reinforcement is required for handleability combined with ease of cutting.
FGL316	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	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.

2 *Nuclear grade, oxidation inhibitors and other styles available on request*

Test Method	Physical Properties	FGS95	FGLPE	FGL316	FGT316
ASTM F36	Compressibility, % Recovery, %	35-40 20	35-40 18	35-40 18	30-35 20
ASTM F38	Creep Relaxation, %	5	5	5	5
ASTM F495	Ignition Loss, % @ 850°F (454°C) @1200°F (650°C)	 1 8	 1 8	 1 6	 1 6
ASTM F37	Sealability, ASTM F37 Fuel A, mL/hr Nitrogen, mL/hr	 0.5 1.0	 0.5 2.0	 0.5 2.0	 0.5 5.0
DIN 3535 Part 4	Gas Permeability, cc/min.	0.40	0.40	0.40	0.80
	ASTM Specifications:	F104: F517000B1M3	F868: 9FPF2	F868: 9FMF2	F868: 9FMF1

(Note: See page 6 for additional physical properties.)

TYPICAL PHYSICAL & MECHANICAL PROPERTIES - **DUR**LON® GASKET MATERIAL

Style/Color	Gasket Type (Binder)	Fiber/ Filler or Reinforcement	Temp. Range, Limits	Pressure Limits	Sealability ASTM F37 (mL/hr)	Creep ASTM F38 *	Gas Perm. DIN 3535	Compressibility ASTM F36	Recovery ASTM F36	Tensile ASTM F152
Durlon 8300 Black	NBR	Carbon	-100 to 800ºF 600ºF (315ºC)	1500 psi (103 bar)	N2- 0.5 Fuel A- 0.03	18%	0.05 cc/min	8-16%	50%	1800 psi (12.4 MPa)
Durlon 8400 Gold	NBR	Phenolic	-100 to 800ºF 554ºF (290ºC)	1500 psi (103 bar)	N2- 0.3 Fuel A- 0.01	25%	0.03 cc/min	8-16%	50%	1800 psi (12.4 MPa)
Durlon 8500 Green	NBR	Aramid/ Inorganic	-100 to 700ºF 548ºF (287ºC)	1500 psi (103 bar)	N2-0.4 Fuel A- 0.01	20%	0.03 cc/min	8-16%	50%	2000 psi (13.8 MPa)
Durlon 8600 White	SBR	Aramid/ Inorganic	-100 to 700ºF 548ºF (287ºC)	1500 psi (103 bar)	N2- 0.5 Fuel A- 0.03	20%	0.05 cc/min	8-16%	45%	1800 psi (12.4 MPa)
Durlon 8700 Blue	CR	Aramid/ Inorganic	-100 to 700ºF 548ºF (287ºC)	1500 psi (103 bar)	N2- 0.7 Fuel A- 0.03	20%	0.05 cc/min	8-16%	45%	1500 psi (10.3 MPa)
Durlon 9000, 9000N	PTFE	Inorganic Fillers	-350 to 520ºF 500ºF (260ºC)	1500 psi (103 bar)	N2- 0.02 Fuel A- 0.01	30%	0.01 cc/min	8-16%	40%	2000 psi (13.8 MPa)
Durlon 9200, 9200W	PTFE	Barium Sulfate	-350 to 520ºF 500ºF (260ºC)	1500 psi (103 bar)	N2- 0.02 Fuel A- 0.01	30%	0.01 cc/min	8-16%	35%	1920 psi (13.2 MPa)
Durlon 9400 Black	PTFE	Carbon	-350 to 550ºF 500ºF (260ºC)	1500 psi (103 bar)	N2- 0.02 Fuel A- 0.01	30%	0.01 cc/min	5-12%	40%	2100 psi (14.5 MPa)
Durlon 9600 White	PTFE	Expanded	-350 to 600ºF 500ºF (260ºC)	1800 psi (124 bar)	N2- 0.02 Fuel A- 0.01	30%	0.01 cc/min	40-60%	12%	1600 psi (11.0 MPa)
Durlon FGS95	Flexible Graphite	None	-450 to 5400ºF 850ºF Oxidizing	3000 psi (207 bar)	N2- 1.0 Fuel A- 0.5	5%	0.40 cc/min	35-40%	20%	700 psi (4.8 MPa)
Durlon FGLPE	Flexible Graphite	Mylar	-450 to 5400ºF 850ºF Oxidizing	3000 psi (207 bar)	N2- 2.0 Fuel A- 0.5	5%	0.40 cc/min	35-40%	18%	780 psi (5.4 MPa)
Durlon FGL316	Flexible Graphite	.002" SS 316 foil	-450 to 5432ºF 850ºF Oxidizing	3000 psi (207 bar)	N2- 2.0 Fuel A- 0.5	5%	0.40 cc/min	35-40%	18%	4465 psi (30.8 MPa)
Durlon FGT316	Flexible Graphite	.004" SS 316 Tang	-450 to 5400ºF 850ºF Oxidizing	3000 psi (207 bar)	N2- 5.0 Fuel A- 0.5	5%	0.80 cc/min	30-35%	20%	5,167 psi (35.6 MPa)

Note: ASTM and DIN properties based on 1/16" sheet thickness, except when designated by an * 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.

MANUFACTURERS' CROSS REFERENCE

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

Compressed Sheet

Gasket Resources	Garlock	Thermoseal
Durlon 8300	HTC-9800, HTC-9850, G-9900, ST-706	Klinger®sil C-4500
Durlon 8400 Gold	Blue-Gard 3700, IFG 5507	Klinger®sil C-7400
Durlon 8500 Green	Blue-Gard 3000, IFG 5500	Klinger®sil C-4401, C-4430, & C-4433
Durlon 8600 White	Blue-Gard 3100, 3200/3400	Klinger®sil C-6400
Durlon 8700 Blue	Blue-Gard 3300	Klinger®sil C-5400

PTFE

Gasket Resources	Garlock	Thermoseal	Flexitallic
Durlon 9000/9000N	Gylon 3500, 3504[2], 3510[3]	Top-Chem 2000-06[3]	Sigma 500, 511[2], 533[3]
Durlon 9200/9200W	Gylon 3510	Top-Chem 2003	Sigma 533
Durlon 9400 Black	Gylon 3530		**W.L. Gore**
Durlon 9600	Gylon 3540, 3545	Soft-Chem	Gore-Tex GR® Sheet

Flexible Graphite

Gasket Resources	Garlock	Thermoseal	Graphoil®
Durlon FGS95	Graph-Lock 3123	HL	GT™B
Durlon FGLPE			GH™P
Durlon FGL316	Graph-Lock 3125SS	SLS	GH™R
Durlon FGT316	Graph-Lock 3125TC	PSM	GH™E

[1] Refer to respective manufacturers' PxT and chemical resistance information. Consult your representative for specific applications.
[2] Check Torque for nonmetallic 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.

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

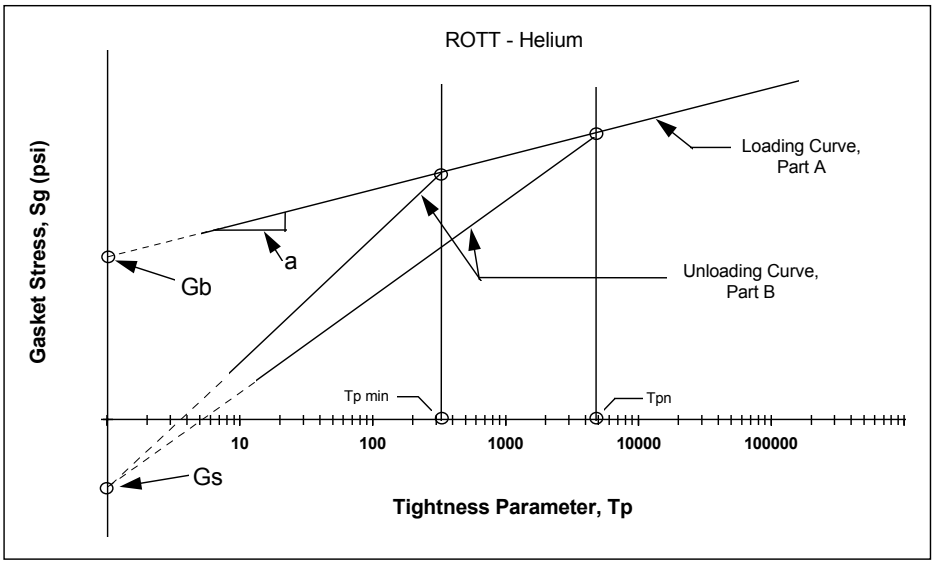
The pH application ranges for Durlon® gasket materials are:

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

Gasket Installation

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.

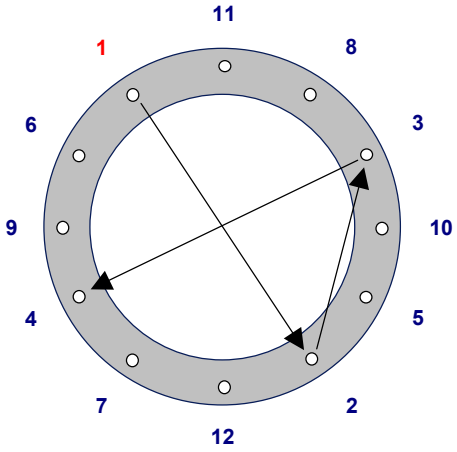
Gasket Installation

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 ...

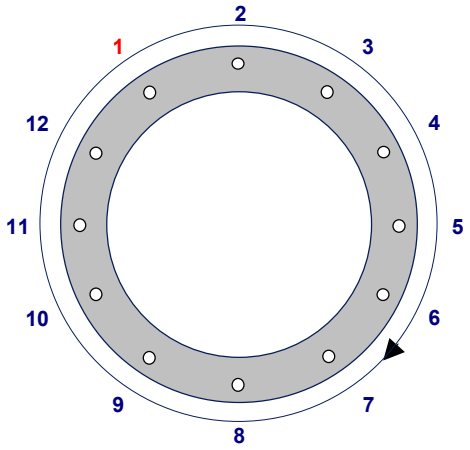
Step 3:

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

Torque Values - ASME B16.5 Flanges

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" **DUR**LON® Gasket Material

Torque: ft-lbs

CLASS 150
INTERNAL PRESSURE = 285 psi

Flange Size:	8300, 8500. 8600, 8700, FGS95	8400	9000/9000N 9200/9200W 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 9200/9200W	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	9200	9400	9600		8300	8400	8500	8600	8700	9000	9200	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.*

DURLON® Chemical Resistance Chart

FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE				FLUID	DURLON® COMPRESSED SHEET					DURLON® PTFE			
	8300	8400	8500	8600	8700	9000	9200	9400	9600		8300	8400	8500	8600	8700	9000	9200	9400	9600
Mercury	A	A	A	A	A	A	A	A	A	Refrigerant Blend 404a***	A	A	A	NS	A	A	A	A	A
Methane	A	A	A	NS	C	A	A	A	A	Sea Water	A	A	A	A	A	A	A	A	A
Methyl Alcohol (Methanol)	A	A	A	A	A	A	A	A	A	Silver Nitrate	C	A	C	C	C	A	A	A	A
Methylene Chloride	NS	NS	NS	NS	NS	A	A	A	A	Soap Solutions	A	A	A	A	A	A	A	C	A
Methyl Ethyl Ketone	C	C	C	NS	C	A	A	A	A	Sodium Bisulfite	A	A	A	A	A	A	A	A	A
Mineral Oil	A	A	A	NS	C	A	A	A	A	Sodium Carbonate	A	A	A	A	A	A	A	A	A
Muriatic Acid	NS	C	NS	NS	NS	A	A	A	A	Sodium Chloride	A	A	A	A	A	A	A	A	A
Naphtha	A	A	A	C	NS	A	A	A	A	Sodium Hydroxide	C	A	C	C	NS	A	A	A	A
Natural Gas	A	A	A	NS	A	A	A	A	A	Sodium Hypochlorite	NS	NS	NS	C	C	A	A	C	A
Nickel Sulfate	A	A	A	A	A	A	A	A	A	Sodium Nitrate	A	A	A	C	C	A	A	A	A
Nitric Acid, <30%	NS	NS	NS	NS	NS	A	A	NS	A	Sodium Silicate	A	A	A	A	A	A	A	A	A
Nitrogen	A	A	A	A	A	A	A	A	A	Sodium Sulfate	A	A	A	A	A	A	A	A	A
Nitrogen Dioxide	NS	NS	NS	NS	NS	A	A	NS	A	Sour Crude Oil	A	A	A	NS	C	A	A	A	A
Nitrogen Tetroxide	NS	NS	NS	NS	NS	A	A	NS	A	Steam (to 450°F)	A	A	A	A	A	A	A	A	A
Octane	A	A	A	NS	C	A	A	A	A	Steam (over 450°F)	A	A	A	C	C	NS	NS	NS	A
Oil, Crude	A	A	A	NS	C	A	A	A	A	Stearic Acid	A	A	A	C	A	A	A	A	A
Oil, Mineral	A	A	A	NS	C	A	A	A	A	Stoddard Solvent	A	A	A	NS	C	A	A	A	A
Oleum (H2SO4)	NS	NS	NS	NS	NS	A	NS	NS	A	Styrene	C	C	C	NS	NS	A	A	A	A
Oxalic Acid	A	A	C	NS	C	A	A	A	A	Sulfite Liquors	C	A	C	C	C	A	A	A	A
Oxygen, gas, liquid	NS	NS	NS	NS	NS	A	A	A	A	Sulfur (molten)	C	C	C	NS	C	A	A	A	A
Pentane	A	A	A	NS	C	A	A	A	A	Sulfur Dioxide	NS	C	NS	NS	NS	A	A	A	A
Perchloroethylene	C	A	C	NS	NS	A	A	A	A	Sulfuric Acid, 20%	NS	NS	NS	NS	NS	A	A	A	A
Petroleum	A	A	A	NS	C	A	A	A	A	Sulfuric Acid, Conc.	NS	NS	NS	NS	NS	A	C	A	A
Phenol	NS	NS	NS	NS	NS	A	A	A	A	Sulfuric Acid, Conc>200°F	NS	NS	NS	NS	NS	A	NS	NS	A
Phosphoric Acid, 45%	C	C	C	NS	C	A	A	A	A	Sulfuric Acid, Fuming	NS	NS	NS	NS	NS	A	NS	NS	A
Potassium Chloride	A	A	A	A	A	A	A	A	A	SUVA	See Refrigerants								
Potassium Hydroxide	C	A	A	C	C	A	A	A	A	Tar	A	A	A	C	C	A	A	A	A
Potassium Nitrate	C	C	C	C	C	A	A	C	A	Tetrachloroethane	C	C	C	NS	NS	A	A	A	A
Propane	A	A	A	NS	C	A	A	A	A	Tetrahydrofuran (THF)	NS	NS	NS	NS	NS	A	A	A	A
Propylene	NS	NS	NS	NS	NS	A	A	A	A	Toluene	NS	NS	NS	NS	C	A	A	A	A
Pydrauls, Skydrols	C	C	C	NS	NS	A	A	A	A	Transformer Oil	A	A	A	NS	C	A	A	A	A
Pyridine	NS	NS	NS	NS	NS	A	A	A	A	Transmission Fluid	A	A	A	NS	C	A	A	A	A
Red Sulfite Liquor	NS	C	NS	NS	NS	A	A	A	A	Trichloroethylene	C	C	C	NS	NS	A	A	A	A
Red Sulfite Liquor > 200°F	NS	NS	NS	NS	NS	A	A	A	A	Triethanolamine	C	C	C	C	A	A	A	A	A
Red Sulfite Liquor > 380°F	NS	NS	NS	NS	NS	C	C	C	A	Turpentine	A	A	A	NS	C	A	A	A	A
Refrigerant R-11 **	A	A	A	NS	NS	A	A	A	A	Urea	A	A	A	A	A	A	A	A	A
Refrigerant R-12 **	A	A	A	C	A	A	A	A	A	Varsol	A	A	A	NS	NS	A	A	A	A
Refrigerant R-22 **	C	C	C	C	A	A	A	A	A	Vegetable Oil	A	A	A	NS	C	A	A	A	A
Refrigerant R-113 **	A	A	A	C	A	A	A	A	A	Vinegar	A	A	A	C	A	A	A	A	A
Refrigerant HCFC 123 **	NS	C	C	NS	C	A	A	A	A	Vinyl Acetate	C	C	C	NS	C	A	A	A	A
Refrigerant HCFC 124 ***	NS	C	C	NS	A	A	A	A	A	Vinyl Chloride	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant HFC 125 ***	C	C	C	NS	A	A	A	A	A	Water	A	A	A	A	A	A	A	A	A
Refrigerant HFC 134a ***	A	A	A	C	A	A	A	A	A	White Sulfate Liquor	A	A	A	A	A	A	A	A	A
Refrigerant HCFC 141b	A	A	A	NS	A	A	A	A	A	White Spirit	A	A	A	C	C	A	A	A	A
Refrigerant HFC 236fa	A	A	A	NS	A	A	A	A	A	Xylene	NS	NS	NS	NS	NS	A	A	A	A
Refrigerant Blend H 62***	A	A	A	NS	A	A	A	A	A	Zinc Chloride	A	A	A	A	A	A	A	A	A
Refrigerant Blend HP 80	C	C	C	NS	A	A	A	A	A	Zinc Nitrate	C	C	C	C	C	A	A	C	A
Refrigerant Blend HP 81	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*

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.

Useful Conversion Factors

Abbreviations

SI	- International Metric Standard	in	- inch
cm	- centimeter	ft	- foot
mm	- millimeter	yd	- yard
m	- meter	oz	- ounce
km	- kilometer	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	25.4
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			
ksi	psi	1000	0.001
MPa	psi	145.034	0.006895
MPa	ksi	0.145	6.895
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
Area			
in^2	cm^2	6.4516	0.155
ft^2	m^2	0.0929	10.764
Temperature			
°C	°F	1.8 before adding 32	0.5556 after subtracting 32