Bulletin 0002-T1/USA

Technical Guide

Effective: April 1, 2003

Partek Operation

⚠ WARNING

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Fluorinated Polymers Overview

Chemical Properties
- Resistivity to corrosive agents
- Non-solubility
- Long term weatherability
- Non-adhesiveness
- Nonflammability

Electrical Properties
- Low dielectric constant
- Low dissipation factor
- High arc resistance
- High surface resistance
- High volume resistivity

Mechanical Properties
- Flexibility at low temperatures
- Low coefficient of friction
- Stability at high temperatures

PTFE: Polytetrafluoroethylene
PTFE is a fluorocarbon resin that is isostatically compression molded into various shapes and configurations. It is chemically resistant to all chemicals and solvents with the exception of some molten alkali metals, molten sodium hydroxide, elemental fluorine and certain fluorinating agents. This unique chemical resistance stems from the following characteristics of the PTFE molecule: (1) the strong interatomic bonds between fluorine and carbon atoms, (2) shielding of the polymer's carbon atom backbone by fluorine atoms, and (3) high molecular weight. At Partek we use PTFE for machining the bodies and components of various valves and manifolds. It offers chemical resistance and stability at high temperatures.

PTFE: Modified
The modified PTFE material is used primarily for diaphragms and bellows in our products. This material has several advantages over PTFE material including better creep resistance and five times the flexural life of conventional PTFE. This material has the same processing and chemically resistant characteristics as the standard product but offers superior cycle life and integrity in diaphragm products.

PFA: Perfluoroalkoxy
PFA is a copolymer of tetrafluoroethylene and perfluoroalkyl vinyl ether. The resultant polymer contains the carbon-fluorine backbone chain typical of PTFE, but unlike PTFE, does not require special fabricating techniques. PFA pellets have good melt flow characteristics that allow for processing via extrusion, compression, blow, transfer and injection molding methods. It has outstanding chemical and solvent resistant characteristics over a temperature range even greater than PTFE. PFA is offered in various grades of purity and cleanliness making it the material of choice for the semiconductor market.

FEP: Fluorinated Ethylene Propylene
FEP is a copolymer of tetrafluoroethylene and hexafluoropropylene. The resultant polymer contains the carbon-fluorine backbone chain similar to PTFE. Unlike PTFE, FEP does not require special fabricating techniques. FEP pellets have good melt flow characteristics that allow for processing via extrusion, compression, and injection molding methods. It exhibits similar properties to PTFE, however it is susceptible to attack by concentrated perchloric acid. As well, it does not exhibit as broad a temperature range as PTFE or PFA.

PVDF: Polyvinylidene Fluoride
PVDF is a partially fluorinated, high molecular weight thermoplastic polymer. The PVDF molecule contains the carbon-fluorine backbone chain similar to PTFE with the addition of 3% hydrogen by weight. The combination of high impact and tensile strength makes it the ideal choice for trim materials and non-wetted structural members. It is highly resistant to oxidizing agents and halogens but is unsuitable for use with strong alkalis, fuming acids, polar solvents, amines, ketones and esters. PVDF can be processed via extrusion, compression and injection molding.

ETFE: Ethylene-Tetra Fluoroethylene
ETFE is a copolymer of ethylene and tetrachloroethylene. The resultant polymer is a material with high impact resistance, chemical resistance, electrical properties similar to fully fluorinated polymers. ETFE is available in pellet grades for extension and molding and in powder form for rota-molding. ETFE's is low specific gravity makes it ideal for aerospace applications where weight and durability are critical factors.

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Typical PFA Physical and Mechanical Properties

Property	*ASTM Method*	*Industrial Tubing PFA*	*High Purity Component PFA*	*High Purity Tubing PFA*
Specific Gravity		2.12 - 2.17	2.13 - 2.16	2.12 - 2.17
Nominal Melting Point	DTA-E168	575 - 590° F (302 -310° C)	575 - 590° F (302 -310° C)	575 - 590° F (302 -310° C)
Melt Flow Rate, gms./10 min. Continuous Use Temperature	D-3307	2 500° F (260° C)	14 500 ° F (260° C)	2 500° F (260° C)
Tensile Yield, PSI/MPA 73° F (23° C) 482° F (250° C)	D-3307	2,200 / 152	2,000 / 138 500 / 3.5	2,200 / 152
Tensile Strength, PSI/MPA 73° F (23° C) 482° F (250° C)	D-3307	4,000 / 28 2,000 / 14	3,600 / 25 1,800 / 12	4,000 / 28 2,000 / 14
Ultimate Elongation, % 73° F (23° C) 482° F (250° C)	D-3307	300 500	300 480	300 500
Flexural Modulus, PSI/MPA 73° F (23° C) 482° F (250° C)	D-790	90,000 / 625 10,000 / 69	85,000 / 590 5,000 / 55	90,000 / 625 10,000 / 69
Creep Resistance Tensile Modulus, PSI/MPA* 73° F (23° C) 482° F (250° C)	 D-695 D-695	 40,000 / 270 6,000 / 41	 40,000 / 270 6,000 / 41	 40,000 / 270 6,000 / 41
Hardness Durometer, D	D-2240	55	55	55
MIT Folding Endurance, cycles 7 - 8 mils	D2176	500,000	50,000	500,000
Water Absorption, %	D-570	< 0.03	< 0.03	< 0.03
Coefficient of Linear Thermal Expansion, in./in./mm/mm 70 - 212° F (20 - 100° C) 212 - 300° F (100 - 150° C) 300 - 408° F (150 - 212° C)	D-696	 7.8 X 10^{-5} (14 X 10^{-5}) 9.8 X 10^{-5} (18 X 10^{-5}) 12.1 X 10^{-5} (22 X 10^{-5})	 7.6 X 10^{-5} (14 X 10^{-5}) 9.2 X 10^{-5} (17 X 10^{-5}) 11.5 X 10^{-5} (21 X 10^{-5})	 7.8 X 10^{-5} (14 X 10^{-5}) 9.8 X 10^{-5} (18 X 10^{-5}) 12.1 X 10^{-5} (22 X 10^{-5})

* 10 hour apparent modulus: stress = 1,000 PSIG at RT, 100 PSIG at 482°

Typical PTFE, FEP, and Modiifed PTFE Physical and Mechanical Properties

Property	*ASTM Method*	*PTFE*	*FEP*	*Modified PTFE*
Specific Gravity	D-792	2.16	2.15	2.15
Nominal Melting Point	-	621° F (327° C)	520° F (271° C)	-
Continuous Use Temperature	-	500° F (260° C)	400° F (204° C)	500° F (260° C)
Tensile Strength, PSI/MPA 73° F (23° C)	D-638	5,900 / 41.3	3,130 / 21.6	6,350 / 44.5
Flexural Modulus, PSI/MPA 73° F (23° C)	D-790	27,000 / 186	90,000 / 619	26,500 / 182
Hardness Durometer, D	D-2240	50	55	50
Water Absorption, %	D-570	< 0.01	0.01	< 0.01
Ultimate Elongation, %	D-1708	410	410	420

Typical PVDF Physical and Mechanical Properties

Property	*ASTM Method*	*PVDF*
Specific Gravity	ISO 1183 D	1.77 - 1.79
Melting Point	ISO 12086	336 - 342° F (169 - 172° C)
Tensile Yield, PSI / MPA 77° F (23° C)	ISO R 527-2 ISO 12086	7,100 - 7,830 / 49 - 54
Tensile Strength, PSI / MPA 77° F (23° C)	ISO R 527-2 ISO 12086	5,080 - 6,530 / 35 - 45
Ultimate Elongation, % 77° F (23° C)	ISO R 527-2 ISO 12086	20 - 100
Hardness Durometer, D	ISO 868	75 - 80

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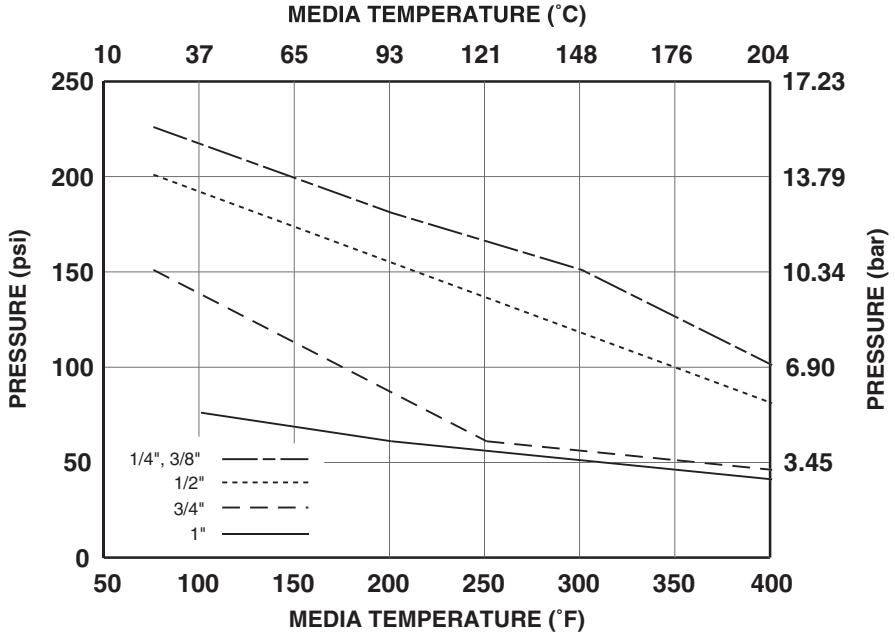
For high temperature applications (>100° C) use high temperature nuts on Parflare fittings, and follow Pressure vs. Temperature Chart below.

HIGH TEMPERATURE (HT) FLARE FITTINGS

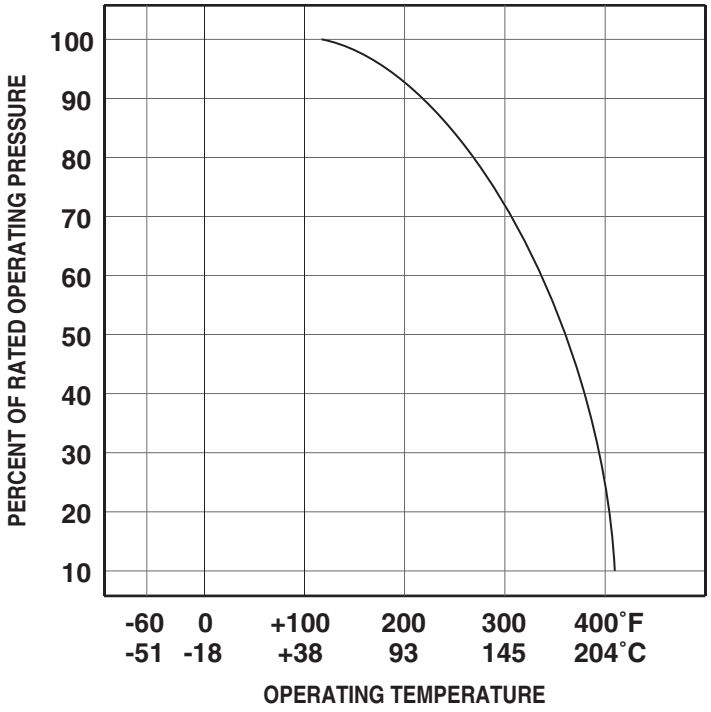
PRESSURE VS. TEMPERATURE



Ratings determined using a 1.5 safety factor
from data obtained through static tests using N^2 media.

For operation at temperatures above ambient conditions, please refer to the chart below for reduced pressure ratings.

PERCENT OF RATED PRESSURE VS. TEMPERATURE



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Volume Conversions

To / From	cm^3	liter	m^3	in^3	ft^3	yd^3	Fl. Oz.	Fl. Pt.	Fl. Qt.	Gal.
cm^3	1	0.001	1×10^{-6}	0.06102	3.53×10^{-5}	1.31×10^{-6}	0.03381	0.00211	0.00106	2.64×10^{-4}
liter	1,000	1	0.001	61.02	0.035352	0.00131	33.81	2.113	1.057	0.2642
m^3	1×10^6	1,000	1	6.1×10^4	35.31	1.308	3.38×10^4	2,113	1,057	264.2
in^3	16.39	0.01639	1.64×10^{-5}	1	5.79×10^{-4}	2.14×10^{-5}	0.5541	0.03446	0.01732	0.0036
ft^3	2.83×10^4	28.32	0.02832	1,728	1	0.03704	957.5	59.84	29.92	6.229
yd^3	7.65×10^5	764.5	0.7646	4.67×10^4	27	1	2.59×10^4	1,616	807.9	202
Fl. Oz.	29.57	0.02957	2.96×10^{-5}	1.805	0.00104	3.87×10^{-5}	1	0.0625	0.03125	0.00781
Fl. Pt.	473.2	0.4732	4.73×10^{-4}	28.88	0.01671	6.19×10^{-4}	16	1	0.5	0.1041
Fl. Qt.	946.4	0.9463	9.46×10^{-4}	57.75	0.03342	0.00124	32	2	1	0.25
Gal.	3,785	3.785	0.00379	231	0.1337	0.00495	128	8	4	1

Flow Rate Conversions

To / From	ltr. / sec.	gal. / min.	ft^3 / sec.	ft^3 / min.
ltr. / sec.	1	15.85	0.03532	2.119
gal. / min.	0.06309	1	0.00223	0.1337
ft^3 / sec.	28.32	448.8	1	60
ft^3 / min.	0.4719	7.481	0.01667	1

Pressure Conversions

To / From	mm / hg	in. / hg	in. / H_2O	ft./ H_2O	atm	lb. / $in.^2$	kg. / $cm.^2$	kPa	BAR
mm / hg	1	0.03937	0.5353	0.04461	0.00132	0.01934	0.00136	0.1333	0.0013
in. / hg	25.4	1	13.6	1.133	0.03342	0.4912	0.03453	3.387	0.0339
in. / H_2O	1.868	0.07355	1	0.08333	0.00246	0.03612	0.00254	0.249	0.0025
ft./ H_2O	22.42	0.8826	12	1	0.0295	0.4334	0.03048	2.998	0.0299
atm	760	29.92	406.8	33.9	1	14.7	1.033	101.3	1.013
lb. / $in.^2$	51.71	2.036	27.69	2.307	0.06805	1	0.07031	6.895	0.0689
kg. / $cm.^2$	735.6	28.96	393.7	32.81	0.9678	14.22	1	98.05	0.981
kPa	7.5	0.2953	4.016	0.3347	0.00987	0.1451	0.0102	1	0.01
BAR	750	29.53	401.6	33.47	0.987	14.51	1.02	100	1

Decimal Conversions (mm = inch)

1 = 0.039	4 = 0.157	7 = 0.276	10 = 0.394	13 = 0.512	16 = 0.630	19 = 0.748	22 = 0.866	25 = 0.984
2 = 0.079	5 = 0.197	8 = 0.315	11 = 0.433	14 = 0.551	17 = 0.669	20 = 0.787	23 = 0.905	25.4 = 1.000
3 = 0.118	6 = 0.236	9 = 0.354	12 = 0.472	15 = 0.590	18 = 0.748	21 = 0.827	24 = 0.944	-

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Temperature Conversions

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
-200	-328	-20	-4	85	185	190	374	295	563	400	752
-180	-292	-15	5	90	194	195	383	300	572	405	761
-160	-256	-10	14	95	203	200	392	305	581	410	770
-140	-220	-5	23	100	212	205	401	310	590	415	779
-120	-184	0	32	105	221	210	410	315	599	420	788
-100	-148	5	41	110	230	215	419	320	608	425	797
-95	-139	10	50	115	239	220	428	325	617	430	806
-90	-130	15	59	120	248	225	437	330	626	435	815
-85	-121	20	68	125	257	230	446	335	635	440	824
-80	-112	25	77	130	266	235	455	340	644	445	833
-75	-103	30	86	135	275	240	464	345	653	450	842
-70	-94	35	95	140	284	245	473	350	662	455	851
-65	-85	40	104	145	293	250	482	355	671	460	860
-60	-76	45	113	150	302	255	491	360	680	465	869
-55	-67	50	122	155	311	260	500	365	689	470	878
-50	-58	55	131	160	320	265	409	370	698	475	887
-45	-49	60	140	165	329	270	518	375	707	480	896
-40	-40	65	149	170	338	275	527	380	716	485	905
-35	-31	70	158	175	347	280	536	385	725	490	914
-30	-22	75	167	180	356	285	545	390	734	495	923
-25	-13	80	176	185	365	290	554	395	743	500	932

Conversion Formula- °C = (°F - 32) / 1.8, °F = (°C * 1.8) + 32

Flow Factors

"C_v" flow factor is the number of gallons of fluid that pass through a given orifice area in one minute, at a pressure drop of 1 PSIG.

"K_v" flow factor is the number of liters of fluid that pass through a given orifice area in one minute, at a pressure drop of 1 bar.

C_V and K_V Formulas

$$Q = C_V \sqrt{\frac{\Delta P}{SG}}$$

Q = Flow (GPM)
ΔP = Pressure Drop (PSIG)
SG = Specific Gravity

$$Q = K_V \sqrt{\frac{\Delta P}{Y}}$$

Q = Flow (LPM)
ΔP = Pressure Drop (BAR)
Y = Specific Gravity (kg/cm^3)

$1\ K_V = 14.26\ C_V$

Basic System Design Formulas

Pipe Diameter Estimate

$$D = .639 \sqrt{\frac{\Delta P}{Y}}$$

Flow Estimate

$$Q = 2.449\ VD^2$$

Q = Gallons per minute
V = Velocity, FPS
D = Inside Diameter, Inches

Velocity Estimate

$$V = .408 \left(Q/D^2 \right)$$

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Pressure Loss Due to Friction Hazen and Williams Formula

$$\Delta P_{100} = \frac{452\ Q^{1.85}}{C^{1.85} D^{4.86}}$$

$$\Delta P_{100} = \frac{\text{Frictional Pressure Loss}}{\text{100 Feet of tubing or pipe}}$$

Q = Gallons per minute (SG = 1.0)
C = Friction factor coefficient (155 for PFA)
D = Inside Diameter, Inches

Fitting Pressure Drop Formula

$$L_e = K(ID)$$

K = Configuration constant from below
ID = Fitting inside diameter (feet)
L_e = Inside Diameter, Inches

Pipe Support

Long lengths of Parbond pipe must be supported to provide trouble-free service. This will minimize the degree of stress and strain within the pipe wall. The minimum recommended distance between pipe supports has been calculated by taking into account the weight of the pipe, its contents, and allowable stress. Please refer to chart below for various span distances versus system temperature.

Size	*73° F (23° C)*	*212° F (100° C)*	*350° F (177° C)*
1/4"	26.9" (68 cm)	21.5" (55 cm)	14.5" (37 cm)
1/2"	32.4" (82 cm)	26.4" (67 cm)	18.0" (46 cm)
3/4"	36.0" (91 cm)	28.8" (73 cm)	19.2" (49 cm)
1"	39.6" (101 cm)	31.2" (79 cm)	21.6" (55 cm)
2"	48.0" (122 cm)	38.4" (98 cm)	25.2" (64 cm)

The specific gravity of fluids greater than 1.0 can adversely affect the spacing of the pipe support. Please refer to the following chart for adjustments to recommended spacing of pipe supports.

Specific Gravity	*Factor*
1.00	1.00
1.25	0.94
1.50	0.89
1.75	0.86
2.00	0.82
2.25	0.79
2.50	0.76
2.75	0.74
3.00	0.72

Tubing Support

To provide trouble free service, long lengths of PFA/FEP tubing must be supported when installed. Supporting the tubing minimizes stress within the tube wall and accommodates draining. Tube support distances are dependent on the tubing size (I.D. and O.D.), the specific gravity of the media, the average temperature of the tubing, and the acceptable amount of vertical tubing deflection between supports. Please refer to the formula below for proper suggested support spacing.

$$L = \frac{384 Y_{MAX} E(I^4)}{5_W}$$

L = Length between pipe suports
Y_{MAX} = Maximum allowable tube deflection between suports
E = Modulus of elasticity
I = Tubing moment of inertia
W = Weight of tubing with media

Safety in Handling Fluoropolymers

Exposure to heated fluoropolymer resins can cause a temporary condition known as polymer fume fever. Symptoms of polymer fume fever resemble the flu and usually occur one to two hours after exposure. The effects usually pass within 48 hours with no lasting or cumulative effects on the body.

In order to safeguard against the possibility of polymer fume fever, proper ventilation should be used when dealing with resins at high temperatures. During the welding of Partek Parbond pipe and piping components, additional ventilation is usually not required. This is due to the relatively small quantity of PFA that is heated. It is recommended that the welder exhale during close inspection of PFA components while they are heating.

Finally, the smoking of tobacco should never be done while welding PFA components or while machining any fluoropolymer. This will eliminate the possibility of inhaling fumes that are generated by airborne fluoropolymer particulates coming to rest on the lit cigarette.

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Fluoropolymer Chemical Compatibility

The following table is intended as a guide to the user in the selection of materials for fluid compatibility. The information in the table is based on chemical resistance ratings at ambient temperatures (20°C, 68°F). Generally, resistance decreases at higher temperatures. Consult factory for details.

No one material can be expected to be compatible with the wide variety of fluids found in the world today. Users must test under their own operating conditions to determine the suitability of any material in a particular application.

Parker Hannifin Corporation is not responsible for the accuracy of this data and assumes no obligations or liability in connection with its use. This information is accepted at the user's sole risk.

EXPLANATION OF RATINGS

A-Recommended **B**-Satisfactory
NR-Not Recommended **Blank**-No Information

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Acetamide	A	A	A	NR	A	A
Acetate Solvents Crude	A	A	A	A	A	A
Acetate Solvents Pure	A	A	A	A	A	A
Actaldehyde	A	A	A	NR	A	A
Acetic Acid	A	A	A	B	A	A
Acetic Acid Vapors	A	A	A	NR	A	A
Acetic Acid Glacial	A	A	A	NR	A	A
Acetic Anhydride	A	A	A	NR	A	A
Acetone	A	A	A	NR	A	A
Acetonitrile	A	A	A	NR	A	A
Acetonphenone	A	A	A	NR	A	A
Acetelyne	A	A	A	B	A	A
Acetyl Chloride	A	A	A	B	A	A
Acid Mine Water	A	A	A	A	A	A
Acrylonitrile	A	A	A	NR	A	
Adipic Acid	A	A	A	A	A	
Alcohols General	A	A	A	A	A	A
Alcohol Amyl	A	A	A	A	A	A
Alcohol Butyl (BUTANOL)	A	A	A	A	A	A
Alcohol Ethyl (ETHANOL)	A	A	A	A	A	A
Alcohol, 2 Aminoethanol	A	A	A	NR	A	NR
Allyl Alcohol	A	A	A		A	
Allyl Chloride	A	A	A	A	A	A
Aluminum Chloride 10%	A	A	A	A	A	A
Aluminum Chloride 10% Boiling	A	A	A	A	A	A
Aluminum Chloride 100%	A	A	A	A	A	A
Aluminum Fluoride	A	A	A	A	A	
Aluminum Hydroxide	A	A	A	A	A	A
Aluminum Nitrate	A	A	A	A	A	
Aluminum Potassium Sulfate (ALUM)	A	A	A	A	A	A
Aluminum Sulfate 100%	A	A	A	A	A	A
Aluminum Sulfate 10%	A	A	A	A	A	A

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Aluminum Sulfate <10% Boiling	A	A	A	A		A
Aluminum Sulfate >10% Boiling	A	A	A	A		A
Aluminum Chlorohydroxide Wet	A	A	A		A	A
Amines	A	A	A		A	A
Ammonia 100% Anydrous	A	A	A	A	A	A
Ammonia Aqueous	A	A	A	A	A	A
Ammonium Bifluoride	A	A	A	A	A	
Ammonium Carbonate	A	A	A	A	A	
Ammonium Chloride Saturated	A	A	A	A	A	A
Ammonium Chloride 10%	A	A	A	A	A	A
Ammonium Chloride <10% Boiling	A	A	A	A	A	A
Ammonium Chloride >10% Boiling	A	A	A	A	A	A
Ammonium Fluoride	A	A	A	A	A	
Ammonium Hydroxide	A	A	A	A	A	A
Ammonium Nitrate	A	A	A	A	A	A
Ammonium Persulfate	A	A	A	A	A	A
Ammonium Phosphate Dibasic	A	A	A	A	A	A
Ammonium Sulfate Saturated	A	A	A	A	A	A
Ammonium Sulfate 10%	A	A	A	A	A	A
Ammonium Sulfate 10% Boiling	A	A	A	A	A	A
Ammonium Sulfate	A	A	A		A	A
Amyl Chloride	A	A	A	A	A	A
Amyl Acetate	A	A	A	NR	A	A
Aniline	A	A	A	B	A	B
Aniline Hydrochloride	A	A	A	B	A	A
Antimony Trichloride	A	A	A	A	A	A
Aroclor	A	A	A		A	A
Aqua Regia	A	A	A	A	A	A
Arsenic Acid	A	A	A	B	A	
Asphalt	A	A	A	A		A
Asphalt Emulsions	A	A	A	A		A
Barium Carbonate	A	A	A	A	A	A

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

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CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Barium Chloride Saturated	A	A	A	A	A	A
Barium Chloride 30%	A	A	A	A	A	A
Barium Chloride 5%	A	A	A	A	A	A
Barium Chloride >5% Hot	A	A	A	A	A	A
Barium Cyanide	A	A	A			
Barium Hydroxide	A	A	A	A	A	A
Barium Nitrate	A	A	A			A
Barium Sulfate	A	A	A	A	A	A
Barium Sulfide	A	A	A	A	A	
Beer	A	A	A	A	A	
Beet Sugar Liquor	A	A	A			A
Benzaldehyde	A	A	A	A	A	A
Benzene	A	A	A	A	A	A
Benzene Hot	A	A	A	B	A	B
Benzene Sulfonic Acid	A	A	A	NR	A	NR
Benzoic Acid	A	A	A	A	A	A
Benzonitrile	A	A	A		A	A
Benzyl Alcohol	A	A	A	A	A	A
Benzyl Chloride	A	A	A	A	A	A
Blood	A	A	A		A	A
Borax	A	A	A	A	A	A
Boric Acid 5%	A	A	A	A	A	A
Boric Acid 10%	A	A	A	A	A	A
Bromine Dry Gas	A	A	A	A	A	A
Bromine Moist Gas	A	A	A	A	A	A
Butadiene	A	A	A	A	A	A
Butane	A	A	A	A	A	A
Buttermilk	A	A	A	A	A	A
Butylene	A	A	A	A	A	A
Butyric Acid 5%	A	A	A	A	A	A
Butyric Acid Concentrated	A	A	A	A	A	A
Butyl Acetate	A	A	A	NR	A	A
Butyl Amine	A	A	A	NR	B	NR
Butyl Ether	A	A	A	A	A	A
Butyl Phthalate	A	A	A	NR	A	A
Butyl Chloride	A	A	A	A	A	A
Calcium Bisulfate	A	A	A	A		A
Calcium Carbonate	A	A	A	A	A	
Calcium Chloride Saturated	A	A	A	A	A	A
Calcium Chloride Dilute	A	A	A	A	A	A
Calcium Chloride 10% Boiling	A	A	A	A	A	A
Calcium Chloride 20% Boiling	A	A	A	A	A	A
Calcium Chloride 30% Boiling	A	A	A	A	A	A
Calcium Hypochlorite 100%	A	A	A	A	A	A
Calcium Hypochlorite 2% Boiling	A	A	A	A	A	A
Carbolic Acid (PHENOL)	A	A	A	A	A	A
Calcium Nitrate	A	A	A	A	A	A
Calcium Sulfate	A	A	A	A	A	A
Carbon Dioxide	A	A	A	A	A	A
Carbon Disulfide	A	A	A	A	A	A
Carbon Monoxide	A	A	A	B	A	A
Carbon Tetrachloride Wet	A	A	A	A	A	A

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Carbon Tetrachloride Dry	A	A	A	A	A	A
Carbonic Acid	A	A	A	A	A	A
Caustic Potash	A	A	A	B	A	A
Caustic Soda (SODIUM HYDROXIDE)	A	A	A	A	A	A
Cellosolves	A	A	A	A	A	A
Chloric Acid	A	A	A			A
Chlorinated Water	A	A	A	A	A	A
Chlorine Dry	A	A	A	A	A	NR
Chlorine Wet	A	A	A	A	A	B
Chloroacetic Acid	A	A	A	A	A	A
Chlorobenzene	A	A	A	A	A	A
2 Chloroethanol	A	A	A	A	A	A
Chloroform	A	A	A	A	A	B
Chlorophenol	A	A	A	B	A	
Chlorosulfonic Acid	A	A	A	C	A	A
Chlorosulfonic Acid Dilute	A	A	A		A	A
Chromic Acid Dilute	A	A	A	A	A	A
Chromic Acid Concentrated	A	A	A	A	A	A
Chromic Acid <10% Boiling	A	A	A	NR	A	A
Chromic Acid >10% Boiling	A	A	A	NR	B	A
Citric Acid Concentrated	A	A	A	A	A	A
Citric Acid Dilute	A	A	A	A	A	A
Copper Cyanide	A	A	A	A	A	
Copper Fluoride	A	A	A	A	A	
Copper Nitrate	A	A	A	A	A	A
Copper Sulfate	A	A	A	A	A	A
Cotton Seed Oil	A	A	A	A		A
Creosote Hot (WOOD & COAL TAR)	A	A	A			A
M Cresol (CRUDE)	A	A	A	A	A	A
Crude Oil	A	A	A	A	A	A
Cresylic Acid	A	A	A	B	A	
Cresyldiphenyl Phosphate	A	A	A			A
Cupric Chloride <2%	A	A	A	A	A	A
Cupric Chloride	A	A	A	A	A	A
Cyanic Acid	A		A			
Cyclohexane	A	A	A	A	A	A
Cyclohexanol	A	A	A	A	A	A
Cyclohexanone	A	A	A	A	A	A
Detergents General	A	A	A		A	A
Diacetone Alcohol (ACETOL)	A	A	A	A	A	
Dibutyl Phthalate	A	A	A	NR	A	A
Dichlorobenzene	A	A	A	A	A	
Dichloroethane	A	A	A	A	A	A
Dichlorodifluoro Methane (F-12)	A	A	A	A	A	A
Dichloroethylene	A	A	A	A	A	A
Diesel Fuel	A	A	A	A	A	A
Diethanolamine	A	A	A			
Diethylamine	A	A	A	A	A	A
Diethylene Glycol	A	A	A		A	
Diethyl Ether	A	A	A	B	A	A
Diisobutylene	A	A	A	A	A	A
Dimethyl Aniline	A	A	A	A	A	A

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

Parker Hannifin Corporation
Partek Operation
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CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Dimethyl Formamide	A	A	A	NR	A	A
Dimethyl Phthalate	A	A	A	A	A	A
Dimethyl Sulfoxide	A	A	A		A	A
Diphenyl	A		A		A	
Diphenyl Ether	A	A	A		A	A
Diphenyl Oxide	A			B	A	
Dipropylene Glycol	A	A	A	B	A	
Dioctyl Phthalate	A	A	A	B	A	A
P-Dioxane	A	A	A	NR	A	A
Dow Therm	A	A	A		A	A
Epichlorohydrin Dry	A	A	A	NR	A	A
Ethane	A	A	A		A	
Ethanolamine	A	A	A	NR	A	NR
Ethers	A	A	A	B	A	B
Ethyl Acetate	A	A	A	A	A	A
Ethyl Benzoate	A	A	A		A	
Ethyl Benzene	A	A	A		A	
Ethyl Butyrate	A	A	A		A	
Ethyl Chloride Wet	A	A	A	A	A	B
Ethyl Ether	A	A	A	A	A	A
Ethyl Sulfate	A	A	A			
Ethylene Bromide	A	A	A	A	A	
Ethylene Chlorohydrin	A	A	A	A	A	A
Ethylene Chloride	A	A	A	A	A	A
Ethylene Diamine	A	A	A	B	A	NR
Ethylene Dibromide	A	A	A	A		
Ethylene Dichloride	A	A	A	A	A	A
Ethylene Glycol (DIHYDROXYETHANE)	A	A	A	A	A	A
Ethylene Oxide	A	A	A	A	A	A
Fatty Acids	A	A	A	A	A	A
Ferric Chloride Concentrated	A	A	A	A	A	A
Ferric Chloride <1%	A	A	A	A	A	A
Ferric Chloride >1%	A	A	A	A	A	A
Ferric Chloride <1% Boiling	A	A	A	A	A	A
Ferric Chloride >1% Boiling	A	A	A	A	A	A
Ferric Nitrate	A	A	A	A	A	A
Ferric Sulfate	A	A	A	A	A	A
Ferrous Chloride	A	A	A	A	A	B
Ferrous Sulfate	A	A	A	A	A	A
Fluoboric Acid	A	A	A	A	A	
Fluosilic Acid	A	A	A	A	A	A
Fluorine Gas Dry	A	A	A	A	A	NR
Fluorine Gas Wet	A	A	A	NR	NR	A
Formaldehyde (FORMALIN)	A	A	A	A	A	A
Formic Acid	A	A	A	A	A	A
Freon Dry	A	A	A	A	A	A
Freon Wet	A	A	A	A	A	A
Fuel Oils	A	A	A	B	A	A
Furan	A	A	A	NR	A	A
Furfural (FURFURALDEHYDE)	A	A	A	B	A	B
Gallic Acid	A	A	A	A	A	A
Gas Natural	A	A	A	A	A	

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Gasoline Leaded Refined	A	A	A	A	A	A
Gelatin	A	A	A	A		
Glucose	A	A	A	A		
Glue	A	A	A			
Glycerine (GLYCEROL)	A	A	A	A	A	A
Glycolic Acid (HYDROXY ACETIC)	A	A	A	A	A	A
Glycol (ETHYLENE GLYCOL)	A	A	A	A	A	A
Helium	A	A	A			A
Heptane	A	A	A	A	A	A
Hexane	A	A	A	A	A	A
Hexamine		A	A			
Hexanol Teritiary	A	A	A			
Hydrazine	A	A	A	A	A	
Hydraulic Fluid (PETROLEUM)	A	A	A		A	A
Hydraulic Fluid (SYNTHETIC)	A	A	A		A	A
Hydrobromic Acid	A	A	A	A	A	A
Hydrochloric Acid >20%	A	A	A	A	A	A
Hydrochloric Acid 1-20%	A	A	A	A	A	A
Hydrochloric Acid <1%	A	A	A	A	A	A
Hydrochloric Acid 1% 175°F	A	A	A	A	A	
Hydrochloric Acid 0.5% to 2% 175°F	A	A	A	A	A	A
Hydrochloric Acid >2% 175°F	A	A	A	A	A	A
Hydrochloric Acid <0.25% Boiling	A	A	A	A	A	A
Hydrochloric Acid <1% Boiling	A	A	A	A	A	A
Hydrochloric Acid >1% Boiling	A	A	A	A	A	A
Hydrocyanic Acid	A	A	A	A	A	
Hydrofluoric Acid <40%	A	A	A	A	A	A
Hydrofluoric Acid 35%	A	A	A	A	A	A
Hydrofluoric Acid >40%	A	A	A	A	A	A
Hydrofluoric Acid Boiling	A	A	A	A	A	A
Hydrofluosilicic Acid	A	A	A	A	A	A
Hydrofluorosilicic Acid	A	A	A	A	A	A
Hydrogen Gas	A	A	A	A	A	A
Hydrogen Chloride Gas Dry	A	A	A	B	A	A
Hydrogen Chloride Gas Wet	A	A	A	A	A	A
Hydrogen Cyanide	A	A	A	A	A	
Hydrogen Fluoride Anhydrous	A	A	A		A	
Hydrogen Peroxide	A	A	A	A	A	A
Hydrogen Sulfide Dry	A	A	A	A	A	A
Hydrogen Sulfide Wet	A	A	A	A	A	A
Hypochlorous Acid	A	A	A	A	A	
Iodine	A	A	A	A	A	A
Isobutyl Alcohol	A	A	A	A	A	A
Isooctane	A	A	A	A	A	A
Isopropyl Acetate	A	A	A		A	
Isopropyl Alcohol	A	A	A	A	A	
Isopropyl Ether	A	A	A			A
Jet Fuel (JP3, JP4, JP5)	A	A	A	A	A	A
Kerosene	A	A	A	A	A	A
Keytones	A	A	A	NR	A	B
Lactic Acid	A	A	A	B	A	A
Lacquers and Lacquer Solvents	A	A	A			A

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

Parker Hannifin Corporation
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CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
LPG (PROPANE)	A	A	A	A	A	A
Lard	A	A	A	A	A	
Latex	A	A	A			
Lead Acetate	A	A	A	A	A	A
Lead Nitrate	A	A	A		A	
Lead Sulfamate	A	A	A		A	
Lime Sulfur (CALCIUM SULFIDE)	A	A	A	B	A	
Lineoleic Acid	A	A	A	A	A	
Linseed Oil	A	A	A	A	A	
Lithium Chloride	A	A	A		A	
Lithium Hydroxide	A	A	A		A	
Lubricating Oil	A	A	A	A	A	A
Lye	A	A	A	A	A	A
Lime (CALCIUM OXIDE)	A	A	A	B	A	
Magnesium Carbonate	A	A	A	A	A	
Magnesium Chloride	A	A	A	A	A	A
Magnesium Bisulfate	A	A	A		A	
Magnesium Hydroxide	A	A	A	A	A	
Magnesium Nitrate	A	A	A	A	A	
Magnesium Sulfate	A	A	A	A	A	A
Malic Acid	A	A	A	A	A	
Maleic Acid	A	A	A	A	A	
Manganese Chloride	A	A	A			A
Manganese Sulfate	A	A	A			A
Mercuric Chloride	A	A	A	A	A	A
Mercuric Cyanide	A	A	A	A	A	A
Mercurous Nitrate	A	A	A	A	A	
Mercury	A	A	A	A	A	A
Methane	A	A	A	A	A	A
Methyl Acetate	A	A	A		A	
Methyl Acetone	A	A	A			
Methyl Alcohol (METHANOL)	A	A	A	A	A	A
Methyl Amine	A	A	A			
Methyl Bromide	A	A	A	A	A	
Methyl Cellosolve	A	A	A	A	A	
Methyl Chloride Wet	A	A	A	A	A	A
Methyl Chloride Dry	A	A	A	A	A	A
Methyl Ethyl Keytone	A	A	A	NR	A	A
Methyl Isobutyl Keytone	A	A	A	A	A	A
Methylene Chloride	A	A	A	B	A	A
Milk	A	A	A	A		A
Mineral Oil	A	A	A	A	A	A
Mixed Acids	A	A	A	A	A	
Molasses	A	A	A	B		A
Morpholine	A	A	A	B	A	A
Motor Oil	A	A	A	A	A	A
Mustard	A	A	A		A	A
Monochlorobenzene	A	A	A	A	A	A
Monochlorodifluoromethane (F-22)	A	A	A	B	A	
Monoethanolamine	A	A	A	NR	A	NR
Monochloroacetic Acid	A	A	A	A	A	A
Naphtha	A	A	A	A	A	A

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Naphthalene	A	A	A	A	A	A
Nickel Chloride	A	A	A	A	A	A
Nickel Nitrate	A	A	A	A	A	
Nickel Sulfate	A	A	A	A	A	A
Nitric Acid	A	A	A	A	A	A
Nitric Acid Fuming >70%	A	A	A	B	A	A
Nitric Acid Boiling	A	A	A	NR	NR	A
Nitrobenzene	A	A	A	A	A	A
Nitrogen	A	A	A	A	A	A
Nitromethane	A	A	A	A	A	A
Nitrous Acid	A	A	A	A	A	A
Nitrous Oxide	A	A	A	NR	A	A
N-Octane	A	A	A	A	A	
Oils Animal	A	A	A			
Oils Crude	A	A	A	A	A	
Oils Mineral	A	A	A	A	A	A
Oils Olive	A	A	A	A		
Oils Vegetable	A	A	A	A		A
Oleic Acid (RED OIL)	A	A	A	A	A	A
Oxalic Acid	A	A	A	A	A	A
Oxygen	A	A	A	A	A	A
Ozone	A	A	A	A	A	
Palmitic Acid	A	A	A	A	A	
Paraffin	A	A	A			
Pentane	A	A	A			
Perchloroethylene	A	A	A	A	A	A
Perchloric Acid	A	A	A	A	B	A
Petroleum	A	A	A	A	A	
Petroleum Ether	A	A	A	B	A	
Phosphoric Acid Aerated	A	A	A	A	A	A
Phosphoric Acid Air Free	A	A	A	A	A	A
Phosphoric Acid Air Boiling	A	A	A	A	A	
Phosphorus	A	A	A			
Phosphorus Trichloride	A	A	A	A	A	A
Phosphorus Pentachloride	A	A	A	A	A	
Phenol Sulfonic Acid	A	A	A	B	A	A
Photographic Solutions (DEVELOPERS)	A	A	A	A	A	A
Photographic Solutions	A	A	A	B	A	A
Phthalic Acid	A	A	A	A	A	
Phthalic Anhydride	A	A	A		A	
Picric Acid	A	A	A	A	A	A
Plating Solutions Brass	A	A	A	B	A	
Plating Solutions Cadmium	A	A	A	B	A	
Plating Solutions Chrome	A	A	A	B	A	
Plating Solutions Copper	A	A	A	B	A	
Plating Solutions Gold	A	A	A	B	A	
Plating Solutions Lead	A	A	A	B		
Plating Solutions Nickel	A	A	A	A		
Plating Solutions Silver	A	A	A	A		
Plating Solutions Tin	A	A	A	B		
Plating Solutions Zinc	A	A	A	B		
Potassium Acetate	A	A	A			

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

Parker Hannifin Corporation
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CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Potassium Aluminum Sulfate (ALUM)	A	A	A	A	A	A
Potassium Bicarbonate	A	A	A	B	A	A
Potassium Bichromate	A	A	A	A	A	A
Potassium Bromide	A	A	A	A	A	A
Potassium Carbonate	A	A	A	A	A	A
Potassium Chlorate	A	A	A	A	A	A
Potassium Chloride	A	A	A	A	A	A
Potassium Chromate	A	A	A	B	A	
Potassium Cyanide	A	A	A	A	A	A
Potassium Dichromate	A	A	A	A	A	A
Potassium Ferricyanide	A	A	A	A	A	A
Potassium Ferrocyanide	A	A	A	A	A	A
Potassium Hydrate	A	A	A			
Potassium Hydroxide	A	A	A	A	A	A
Potassium Hypochlorite	A	A	A	A	A	A
Potassium Iodide	A	A	A	A	A	
Potassium Nitrate	A	A	A	A	A	A
Potassium Oxalate	A	A	A			
Potassium Permanganate	A	A	A	A	A	A
Potassium Silicide	A	A	A			
Potassium Sulfate	A	A	A	A	A	A
Potassium Sulfide	A	A	A	A	A	A
Potassium Sulfite	A	A	A	A	A	
Propane	A	A	A	A	A	A
Propyl Acetate	A	A	A			A
Propyl Alcohol (PROPANOL)	A	A	A	A	A	
Propylene	A	A	A			
Propylene Chlorohydrin	A	A	A	A		
Propylene Glycol	A	A	A		A	A
Propylene Oxide	A	A	A	NR	A	
Pydraul		A	A			
Pyridine	A	A	A	NR	A	A
Pyrogallic Acid	A	A	A	B	A	A
Pyroligneous Acid	A	A	A	A	A	A
Quinne Bisulfate		A	A			
Quinne Sulfate		A	A			A
Rosin		A	A			
Resorcinol	A	A	A		A	
Salicylic Acid	A	A	A	A	A	A
Salicylaldehyde	A	A	A	A	A	
Salt Brine	A	A	A	A	A	A
Sea Water	A	A	A	A	A	A
Sewage	A	A	A	A	A	
Shellac	A	A	A			
Silicone Oil	A	A	A		A	A
Silver Bromide	A	A	A			A
Silver Chloride	A	A	A		A	A
Silver Cyanide	A	A	A	A	A	
Silver Nitrate	A	A	A	A	A	A
Skydrol 500 & 7000	A	A	A		A	
Soap Solutions	A	A	A	A		
Sodium Acetate	A	A	A	A	A	A

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Sodium Acid Sulfate	A	A	A			
Sodium Aluminate	A	A	A			
Sodium Aluminum Sulfate	A	A	A			
Sodium Benzoate	A	A	A	A	A	
Sodium Bicarbonate	A	A	A	A	A	A
Sodium Bichromate	A	A	A	B	A	
Sodium Bisulfate	A	A	A	A	A	A
Sodium Bisulfite	A	A	A	A	A	
Sodium Borate (BORAX)	A	A	A	A	A	A
Sodium Bromide	A	A	A	A	A	A
Sodium Carbonate (SODA ASH)	A	A	A	A	A	A
Sodium Chlorate	A	A	A	A	A	A
Sodium Chloride	A	A	A	A	A	A
Sodium Chromate	A	A	A		A	A
Sodium Citrate	A	A	A			
Sodium Cyanide	A	A	A	A	A	A
Sodium Dichromate	A	A	A	B	A	
Sodium Ferricyanide	A	A	A	B		
Sodium Fluoride	A	A	A	A	A	
Sodium Hydroxide (CAUSTIC SODA)	A	A	A	NR	A	A
Sodium Hypochlorite	A	A	A	A	A	A
Sodium Hyposulfite	A	A	A	A	A	A
Sodium Metaphosphate	A	A	A			
Sodium Metasilicate	A	A	A		A	
Sodium Nitrate	A	A	A	A	A	A
Sodium Perborate	A	A	A		A	A
Sodium Peroxide	A	A	A	A	A	A
Sodium Phosphates	A	A	A	A	A	A
Sodium Silicate (WATER GLASS)	A	A	A	A	A	A
Sodium Sulfate	A	A	A	A	A	A
Sodium Sulfide	A	A	A	A	A	A
Sodium Sulfite	A	A	A	A	A	A
Sodium Thiosulfate (HYPO)	A	A	A	A	A	A
Sodium Tetraborate (BORAX)	A	A	A	A	A	A
Soy Bean Oil	A	A	A			
Stannic Chloride	A	A	A	A	A	A
Stannous Chloride	A	A	A	A	A	A
Starch	A	A	A			
Stearic Acid	A	A	A	A	A	
Steam	A	A	A	A	A	A
Stoddard Solvent	A	A	A	A	A	A
Styrene	A	A	A		A	
Sugar Juice	A	A	A			
Sulfate Liquor Black	A	A	A	A	A	
Sulfate Liquor Green	A	A	A		A	
Sulfinol	A	A	A	A		
Sulfite Liquor	A	A	A			A
Sulfolane	A	A	A		A	A
Sulfur	A	A	A	A	A	A
Sulfur Molten 266°F	A	A	A		A	A
Sulfur Chloride	A	A	A	A	A	A
Sulfur Dioxide Gas Wet	A	A	A	A	A	A

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

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CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Sulfur Dioxide Gas Dry	A	A	A	A	A	A
Sulfur Trioxide	A	A	A	NR		A
Sulfuric Acid Air Free	A	A	A	NR	A	A
Sulfuric Acid Aerated	A	A	A	NR	A	A
Sulfuric Acid Boiling	A	A	A	NR	A	
Sulfuric Acid Fuming Oleum	A	A	A	NR	A	A
Sulfurous Acid	A	A	A	A	A	A
Tall Oil	A	A	A	A	A	
Tallow	A	A	A			
Tannic Acid	A	A	A	B	A	A
Tanning Liquor (ALUM SOLUTION)	A	A	A			
Tar & Tar Oil	A	A	A			A
Tartaric Acid	A	A	A	B	A	A
Tetrachloroacetic Acid	A	A	A	A	A	
Tetrachloroethane	A	A	A	A	A	A
Tetrachloroethylene	A	A	A	A	A	A
Tetra Ethyl Lead	A	A	A	A	A	
Tetrahydrofuran	A	A	A	B	A	A
Tetrahydronaphthalene (Tetralin)	A	A	A			
Tetraphosphoric Acid	A	A	A	A	A	A
Thionyl Chloride	A	A	A	NR	A	
Tin Tetrachloride	A	A	A	A	A	A
Titanium Tetrachloride	A	A	A	B	A	
Toluene (TOLUOL)	A	A	A	A	A	B
Tomato Juice	A	A	A	A	A	A
Tributyl Citrate	A	A	A		A	
Tributyl Phosphate	A	A	A	A	A	A
Transformer Oil	A	A	A			
Trichloroacetic Acid	A	A	A	A	A	A
Trichloroethane	A	A	A	B	A	A
Trichloroethylene	A	A	A	A	A	A
Trichloromonofluoroethane (F-17)	A	A	A			
Trichloropropane	A	A	A			A
Trichlorotrifluoroethane (F-113)	A	A	A	A	A	A
Tricresyl Phosphate	A	A	A	NR		
Triethanolamine	A	A	A	NR	A	
Triethylamine	A	A	A	A	A	A
Triethylene Glycol	A	A	A		A	
Triethyl Phosphate	A	A	A	NR	A	A

CHEMICALS	FEP	PFA	PTFE	PVDF	ETFE	CTFE
Triethyl Phosphite	A	A	A		A	A
Tripropylene Glycol	A	A	A		A	
Trisodium Phosphate	A	A	A	A	A	A
Tung Oil (CHINA WOOD OIL)	A	A	A			
Turpentine	A	A	A	A	A	A
Undecyl Alcohol (UNDECANOL)	A	A	A		A	
Urea	A	A	A	A	A	
Uric Acid	A	A	A			
Urine	A	A	A	A	A	
Varnish	A	A	A		A	A
Vinegar	A	A	A	A	A	A
Vinyl Acetate	A	A	A	A	A	
Vinyl Chloride	A	A	A	B	A	
Vinylidine Chloride (RESIN)	A	A	A	B	A	
Water, Acid Mine	A	A	A	A	A	A
Water, Boiler Feed	A	A	A		A	A
Water, Distilled	A	A	A	A	A	A
Water, Fresh	A	A	A	A	A	A
Water, Deonized	A	A	A	A	A	A
Water, Demineralized	A	A	A	A	A	A
Water, Brackish	A	A	A		A	A
Water, Salt	A	A	A	A	A	A
Wax	A	A	A	A	A	A
Whiskey	A	A	A	A		A
White Liquor, Pulp Mill	A	A	A	A	A	
White Spirit	A	A	A	A		
Wine	A	A	A	A	A	A
Wood Pulp	A	A	A			
Xylene (XYLOL XYLOLE)	A	A	A	A	A	A
Zinc Carbonate	A	A	A			
Zinc Chloride	A	A	A	A	A	A
Zinc Cyanide	A	A	A			
Zinc Nitrate	A	A	A	A	A	
Zinc Stearate	A	A	A		A	
Zinc Sulfate	A	A	A	A	A	A
Atmosphere, Industrial	A	A	A	A	A	A
Atmosphere, Marine	A	A	A	A	A	A
Atmosphere, Rural	A	A	A	A	A	A
Ultraviolet Light	no effect	no effect	no effect	excellent	no effect	no effect

Ratings: A-Recommended **B**-Satisfactory **NR**-Not Recommended **Blank**-No Information

Parker Hannifin Corporation
Partek Operation
Tucson, AZ

Offer of Sale

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2. Payment: Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Amounts not timely paid shall bear interest at the maximum rate permitted by law for each month or portion thereof that the Buyer is late in making payment. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer's receipt of the shipment.

3. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller's plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller's delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of shipment from Parker Hannifin Corporation. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.**

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6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property, Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. Patents, U.S. Trademarks, copyrights, trade dress and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

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Bulletin 0002-T1
01/04