

Liquid Data & Material Compatibility Guide

A GUIDE FOR BLACKMER POSITIVE DISPLACEMENT SLIDING VANE PUMPS

BULLETIN 30



Where Innovation Flows

BLACKMER LIQUID DATA AND MATERIAL COMPATIBILITY GUIDE

Bulletin 30

Section

10

Effective

Aug-20

Replaces

Nov-17

This bulletin is intended as a guide for the proper selection of Blackmer positive displacement rotary-vane pumps for use in specific fluid transfer applications. For detailed information and specifications of the pump types listed within the bulletin, please refer to the Blackmer Product Bulletins described in the chart below.

Bulletin 30 contains a list of commonly transferred liquids and their compatibility with the materials of construction available in Blackmer Pumps. The information provided on the various liquids was compiled from several different sources of corrosion data and fluid characteristics. The information is presumed to be accurate, however, Blackmer/A Dover Company, assumes no liability for its accuracy or suitability. A qualified expert should be consulted for specific compatibility of materials and limitations.

All selections of Blackmer pump types listed in the bulletin are based upon specific conditions of temperature, viscosity, vapor pressure, concentration, etc. Assumptions should not be made as to the suitability of the pump type at other conditions. The material compatibilities listed do not necessarily imply that a certain pump material is suitable for service on the liquid being pumped. Factors such as temperature, viscosity, abrasiveness and lubricity should also be considered. Limitations for pump components are given on the following page, and are also described in the Blackmer Material Spec Sheets for individual pump models. in the "Pump Type" column which

BASIC PUMP TYPES

The data tables within this bulletin list general Blackmer pump types that are commonly applied with the various liquids shown. A letter "Key" appears refers to one or more of the basic pump types available, and described in the following chart. Alternate pump selections can often be used for the same liquid application.

PUMP TYPE KEY	PUMP CONSTRUCTION	FLUID CHARACTERISTICS FOR PROPER APPLICATION	ALTERNATE PUMP SELECTIONS
X / XL	EX ternal Ball Bearings with Blackmer Mechanical Seals. XL same as X Type with Replaceable Liner.	Clean, lubricating or non-lubricating, low to medium viscosity, non-abrasive fluids.	GNX, XL, HXL, MLX, MI
XRL	Same as XL Type Pump, Fitted with Reduced Capacity Liner .	Same as X above	XRLF
XLF	Same as XL Type Pump, Fitted with an Integral Bracket for Direct Flange Mounting to a NEMA C-Face Motor.	Same as X above	XL
NP	IN ternal Sleeve Bearings with Shaft Packing (Std) or Commercial Mechanical Seal.	Lubricating, low to high viscosity fluids. Wide temperature range.	MLN, MI
SNP	316 Stainless Steel , IN ternal Sleeve Bearings with Shaft Packing (Std) or Commercial Mechanical Seal.	Clean, corrosive or non-corrosive, non-abrasive fluids.	SX, STX,
SX / STX	316 Stainless Steel , EX ternal Ball Bearings, Blackmer Mechanical Seals.	Clean, corrosive or non-corrosive, non-abrasive fluids.	SNP,PVS, MS
SMVP	316 Stainless Steel , Magnetically-Coupled Vane Pump .	Clean, corrosive or non-corrosive, low to medium viscosity fluids.	MS
XLW	EX ternal Ball Bearings, Hardened Liner, Wear Resistant Construction with Mechanical Seals.	Abrasive, non-lubricating, low to medium viscosity fluids.	MLX with Wear Resistant Options
ML	Modular Hub Design with Liner MLX: X Type Construction MLN: NP Type Construction	Same as X or XLW above Same as NP above	X, XL NP, MI
LGL	Liquefied Gas Pump with Replaceable Liner, External Bearings and Mechanical Seals.	Liquefied petroleum gases compatible with ductile iron construction and UL approval.	LG, LGLD, TLGLF
CRL	Carbon Dioxide (CO₂) Refrigeration Pump with Replaceable Liner, External Bearings and Mechanical Seals.	Liquid CO ₂ compatible with ductile iron construction.	TCRL
SGL	Special Gas Pump with Replaceable Liner, External Bearings and Mechanical Seals.	Liquefied gasses other than Propane, Anhydrous Ammonia and Liquid CO ₂ .	
MI	Magnes Magnetically-Coupled Iron Vane Pump	Clean , Hazardous, Toxic, non-corrosive, low-viscosity fluids.	NP
MS	Magnes Magnetically-Coupled Stainless Steel Vane Pump	Clean , Hazardous, Toxic, corrosive, low-viscosity fluids.	SNP, SMVP

MATERIAL SPECIFICATIONS continued.....

The Material Specification Charts provide technical data on the various materials of construction available for Blackmer pumps. Models are available in cast iron, ductile iron, cast steel or 316 stainless steel construction. A wide selection of internal components are available for specific application requirements.

Note: Not all of the materials shown in the chart are available for all pump models. Please refer to the individual Blackmer Material Spec Sheets for material options available on specific models.

WARNING

Several liquids covered in the following tables have been noted as being extremely flammable, toxic or corrosive, and can be hazardous if mishandled or misused. Improper handling or usage can result in severe damage to equipment or property and/or serious personal injury or death. Special care should be given when handling these liquids, and warning given to end users as to the risks involved.

METRIC CONVERSION FACTORS

To convert from. . .	To. . .	Multiply by
Seconds Saybolt Universal (SSU).	Centistokes (cSt)	See Tables*
Pounds Per Square Inch (psi).	Bar.	.06897
U.S.Gallons Per Minute (U.S.GPM)	Liters per Minute (lpm).	3.785
Fahrenheit (°F).	Celsius (°C).	(°F - 32) x .56
* For Viscosity Tables and additional conversion data, refer to Blackmer Hydraulic Data Bull. 33.		

PUMP HOUSING

MATERIAL	STANDARD	PHYSICAL & MECHANICAL PROPERTIES	TYPICAL USAGE
Cast Iron	ASTM A48 Class 40 ASTM A48 Class 30	Minimum Tensile - 40,000 psi (275.6 MPa) Minimum Tensile - 30,000 psi (206.8 MPa)	Basic iron materials for general purpose applications.
Ductile Iron	ASTM A536 Grade 60-40-18 ASTM A536 Grade 65-40-12	Minimum Tensile - 60,000 psi (413.4 MPa) Minimum Yield - 40,000 (275.6 MPa) Minimum Elongation - 18% Minimum Tensile - 65,000 psi (448.1 MPa) Minimum Yield - 45,000 (310.2 MPa) Minimum Elongation - 12%	Thermal shock resistant ductile irons. A recognized alternative for cast steel in the refinery and chemical industries.
316 Stainless Steel	ASTM A743 CF-8M	Minimum Tensile - 70,000 psi (482.3 MPa) Minimum Yield - 30,000 psi (206.7 MPa) Minimum Elongation - 30%	A stainless steel grade widely used in chemical, pharmaceutical and food process industries.
17-4PH Stainless Steel	ASTM ASTM A747 UNS J92180 CB7Cu-1	Minimum Tensile - 135,000 psi (931 MPa) Minimum Yield - 105,000 psi (724 MPa) Minimum Elongation - 8%	A high strength stainless steel grade widely used in chemical processing and oil field applications. It can be slightly less corrosion resistant than 316 Stainless Steel.
Cast Steel	ASTM A216	Minimum Tensile - 90,000 psi (620.1 MPa) Minimum Yield - 60,000 psi (413.4 MPa) Minimum Elongation - 22%	A low alloy cast carbon steel for hydrocarbons, petrochemical and general refinery service.

VANES

MATERIAL	COMPOSITION	SIZE	MAX. TEMP.	VISCOSITY RANGE	TYPICAL USAGE
Duravane®	PPS/PTFE/Glass	STD	240°F (115°C)	0 - 20,000 SSU (0 - 4,250 cSt)	An economical, general purpose, self-lubricating vane with a wide chemical compatibility range.
Laminate	Melamine Formaldehyde Resin/Fiber	STD EC	240°F (115°C) 400°F (204°C)	0 - 20,000 SSU (0 - 4,250 cSt) 0 - 40,000 SSU (0 - 8,500 cSt)	Excellent vane where added strength/wear resistance is required. Self-lubricating, abrasion resistant.
Bronze	ASTM B30-54-3A	EC	500°F (260°C)	500-500,000 SSU (105-108,000 cSt)	Use for viscous fluids and elevated temperature applications.
Iron	Cast Iron ASTM A48 Minimum Class 25	EC	500°F (260°C)	500-500,000 SSU (105-108,000 cSt)	An economical vane for viscous fluids and elevated temperature applications.
Hardened Iron	Heat Treated Cast Iron	EC	500°F (260°C)	500-500,000 SSU (105-108,000 cSt)	A wear resistant vane for abrasive applications.
Carbon	Impregnated Carbon	STD	500°F (260°C)	0 - 20,000 SSU (0 - 4,250 cSt)	A chemically inert vane suitable for a wide range of fluids and temperature capabilities. NOTE: 100 psi (689 kPa) maximum differential pressure. Carbon vanes will not tolerate cavitation or discharge spikes (Hydraulic Shock).

PPS - Polyphenylene Sulfide

STD - Full size Vanes

EC - Extra-Clearance Vanes / Reduced Length

MATERIAL SPECIFICATIONS continued.....

O-RINGS

MATERIAL	COMPOSITION	USEFUL TEMPERATURE RANGE	TYPICAL USAGE
FKM	Fluorocarbon 69% Fluorine (V1263-75)	-15 to 400°F (-26.1 to 204°C)	Offers wide chemical and temperature compatibility. Good for acids, aromatic and chlorinated solvents, halogenated hydrocarbons / most petroleum products. Note: FKM O-rings used in non-Blackmer seals may be a different grade; consult factory.
PTFE	Tetrafluoroethylene 1) Seal Ring – PTFE with SS Spring 2) O-Rings - PTFE - Encapsulated Silicon	0 to 500°F (-17.8 to 260°C) -50 to 500°F (-45 to 260°C)	Impervious to most fluids, except for certain hallogens. Excellent for use with ketones or mixed blend solvents.
Buna-N	Nitrile Note: Use only Blackmer O-rings in LG/LGL/TLGL pumps to maintain U.L. listing.	-30 to 240°F (-34 to 115°C)	Widely used for general purpose sealing. Excellent on petroleum products and most aliphatic solvents.
Neoprene	Chloroprene	-30 to 300°F (-34 to 148°C)	Primarily refrigeration ammonia / refrigerant applications.

MECHANICAL SEAL FACES

MATERIAL	TYPICAL USAGE
Cast Iron (CI)	A general purpose, economical stationary face for non-corrosive applications.
Steel (S)	A general purpose stationary face for non-corrosive applications, for use over a wide speed range, also designed to handle higher pressures.
Ni-Resist (NR)	General purpose stationary face with good corrosion resistant properties.
Stainless Steel (SS)	For corrosive service.
Silicon Carbide (SC)	Heavy-duty material for severe applications, abrasives, high pressures and/or continuous duty.
Carbon (C)	General purpose rotating face for both lubricating and non-lubricating applications. Maximum viscosity limit of 20,000 SSU (4,250 cSt).
Bronze (BZ)	A rotating face designed for high viscosity applications. Minimum viscosity limit of 500 SSU (105 cSt).
Hardened Steel (HS)	A rotating face designed for abrasive service.

ROTOR & SHAFT

Full size	Maximum viscosity 20,000 SSU (4,250 cSt). Maximum Temperature to 300°F (148°C).
Extra-Clearance	For Viscosities above 20,000 SSU (4,250 cSt) - Consult Material Spec Sheets. Maximum Temperature to 500°F (260°C).

Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes	
		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Acetaldehyde, 100%	X	A	A	A	A	A	A	A	A	A	A	C	D	C	A	.78	30	26	Corrosive if < 100%.	
Acetamide	X	A		B	A	B	A	A	B	A	A	A	C	A	A	1.16				
Acetic Acid, 5-30%	★	SNP SX	A		D	D	D	D	A	D	A¹	A	B	B	A	A	1.05	30	1	Melts @ 62°F (17°C), Strong Irritant.
Acetic Acid, 50%		SNP SX	A		D	D	D	D	A	D	A¹	A	D	B	D	A	1.06			
Acetic Acid, 80-90%		SNP SX	A		D	D	D	D	A	D	A¹	A	C	B	C	A	1.07			
Acetic Acid, Glacial		SNP SX	A		D	C	D	C	A	D	A¹	A	B	D	D	A	1.05	30	1	99.4-100% Pure.
Acetic Anhydride	★	SNP SX	A		D	B	D	B	A	D	A¹	A	D	D	A	A	1.09	30	0.3	
Acetone	★	X	A	A	A	A	A	A	A	A	A	A	D	D	C	A	.80	30	7	Use PTFE or EPR O-Rings.
Acetophenone		X	A	A	A	A	A	A	A	A	A	A	D	D	D	A	1.03	32	<1	Use PTFE or EPR O-Rings.
Acetyl Chloride, Dry		SNP SX	A		A	D	A	D		A	A	A	D	A	D	A	1.11			Very Corrosive if Water Present. Boils at 125 F.
Acetylene		NO PUMP	A	A	A	C	A	C	A	A	A	A	A	A	A	A		Gas	Very High	Explosive, Do Not Pressurize into Liquid Form.
Acrylic Acid (Acrylic Resin)	★	SNP SX SMVP MS	B		B		B		A	A	A	A	D	D	D	A	1.05	40	0.2	Melts @ 54°F (12°C), Consult Factory on Seal-less application. Thermal Sensitive.
Acrylonitrile	★	X	A		A	D	A	D	B	A	A	A	D	C	D	A	.80			Thermal Sensitive, Seal-less, Consult Factory
Alum Solution (Alum Sulfate)	w	SNP SX MS	A		D	B	D	B	A	D	B	A	B	A	A	A	1.62	30		
Aluminum Acetate	w	SNP SX			D	B	D	B		D	A	A	B	D	B	A				
Aluminum Chloride		NO PUMP	A	A	D	D	D	D	A	D	D	A	A	A	A	A	2.44			Strong Irritant, Violent Reaction with Water.
Aluminum Flouride		NO PUMP	A		C	C	C	C	A	C	C	A	A	A	A	A	2.88			Strong Irritant.
Aluminum Hydroxide		X	A		B	B	B	B	A	B	A	A	A	A	A	A	2.42	Solid		Insoluble in Water, Determine Solvent. Special Attention to Sealing.
Aluminum Nitrate		SNP SX			D		D			D	B	A	A	A	A	A		Solid		Determine Solvent, Strong Oxidizer.
Ammonia, Refrigeration			A	C	A	C	A	C	A	A	A	A	B	D	A	A	.70	30		System Design Important. Maximum Speed 420 rpm. Consult Factory.
Ammonia, Anhydrous		LGL	A	C	A	C	A	C	A	A	A	A	B	D	A	A	.62	30	212	System Design Important.
Ammonia, Aqueous to 25% (Ammonium Hydroxide)		X	A	B	A	D	A	D	A	A	A	A	B	C	A	A	.99	30		Extyremely Irritating. Buna-N suitable if Low Concentration. Special Attention to Sealing.
Ammonium Bicarbonate	w	X NP			B	D	B	D	A	B	A	A	A	D	C	A	1.59	50		Decomposes @ 100°F (38°C). Use SS Stationary Seat in XS Pump.

CF=Consult Factory Key: A=Excellent B=Satisfactory C=Doubtful D=Attacked

*=Top 80 chemicals produced in the U.S.A. W=Water Solution **=Maximum speed should be one-half of the maximum rated pump speed.

¹=Chemical Resistance for 17-4 PH Stainless Steel may be Reduced

CAUTION: Above ratings are for chemical compatibility only. Other factors such as viscosity, pump speed, temperature, pressure, duty-cycle, particle concentration, etc. must be considered when applying a pump or option. Refer to pages two and three of this directory, or to the individual pump performance curves for operating limits.

Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes	
		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Ammonium Bifluoride		NO PUMP			B	D	B	D		B	B	A	A	D	C	A	1.21	Solid		Decomposes with Heat.
Ammonium Carbonate	w	X	A		B	D	B	D	A	B	A ¹	A	D	A	A	A				Forms Ammonia & CO2 in Water.
Ammonium Chloride, 10%		SNP SX	A		C	C	C	C	A	D	A ¹	A	A	A	A	A	1.05	50		Corrosive to 316 if Over 15%.
Ammonium Nitrate	w	SNP SX	A		C	D	C	D	A	A	A	A	A	A	B	A	1.73			Solid is Explosive.
Ammonium Persulfate	w	SNP SX			D	D	D	D	A	D	A	A	D	C	A	A	1.98		1	Decomposes with Heat. Avoid Contact with Solvents/Greases.
Ammonium Phosphate	w	SNP SX			C	B	C	B	A	C	A	A	A	C	A	A	1.62	50	1	
Ammonium Sulfate	w	SNP SX	A		C	C	C	C	A	C	B ¹	A	A	D	A	A	1.77			
Amyl Acetate		X	A		A	A	A	A	A	A	A	A	D	D	D	A	.88	30	1	Use PTFE Only.
Amyl Alcohol		X	A	A	A	A	A	A	A	A	A	A	B	B	B	A	.82	40		
Amyl Chloride		X			A	A	A	A	A	B	A	A	D	B	D	A	.88			Fire Risk
Aniline (Aniline Oil)	*	X NP MI	A		A	D	A	D	A	A	A	A	D	C	D	A	1.02	40	5	Use PTFE or EPR O-Rings.
Arsenic Acid		SNP SX SMVP	A		D	B	D	B	A	D	B	A	A	A	A	A	2.00	50		Highly Toxic. Seal-less, Consult Factory.
Asphalt		ML NP	A		A	A	A	A	A	A	A	A	B	A	B	A		1,000-20,000		Normally Pumped at 250-350°F (121-177°C). Can be Viscous/Abrasive, Run Slow**, EC Vanes Needed.
Asphalt Emulsion (Soap Base)		ML NP	A		A	A	A	A	A	A	A	A	B	A	C	A	1.00+	200-7,000	1	Can be Viscous/Abrasive, Run Slow**, EC Vanes Needed.
Asphalt Emulsion (Acid Base)		SNP SX	A		C		C		A	C	A	A					1.00+	200-7,000		Can be Viscous/Abrasive, Run Slow**, EC Vanes Needed.
ASTM Oils # 1 & 2		X	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.90			
ASTM Oils # 3 & 4		X	A	A	A	A	A	A	A	A	A	A	B	A	D	A	.90			
Barium Carbonate		NP	A		A	B	A	B	A	A	B	A	A	A	B	A	4.28	Solid		Melts @ 345°F (174°C), Solid Soluble in Acids.
Barium Chloride (Max. 20% Solution)		X NP	A		B	B	B	B	A	B	A	A	A	A	A	A	3.10	50		
Barium Hydroxide	w	SNP SX	A		B	D	B	D	A	B	A	A	A	A	A	A	1.66	50		Special Attention to Sealing.
Barium Nitrate		X NP			B	C	B	C	A	B	B	A	A	A	A	A	3.24	50		Run Slow.**
Barium Sulfide		X NP	A		B	D	B	D	A	A	B	A	A	A	A	A	4.25			Run Slow.**
Beer, Beer Wort		SNP SX MS	A		D	A	D	A	A	D	A	A	A	A	A	A	1.00	32	2	
Beet Juice or Pulp		SNP SX MS	A		B	C	B	C	A	B	A	A	A	A	A	A				

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Key: A=Excellent B=Satisfactory C=Doubtful D=Attacked

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W=Water Solution

**=Maximum speed should be one-half of the maximum rated pump speed.

¹=Chemical Resistance for 17-4 PH Stainless Steel may be Reduced

CAUTION: Above ratings are for chemical compatibility only. Other factors such as viscosity, pump speed, temperature, pressure, duty-cycle, particle concentration, etc. must be considered when applying a pump or option. Refer to pages two and three of this directory, or to the individual pump performance curves for operating limits.

Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Benzaldehyde	X	D	A	A	D	A	D	A	A	A	A	D	D	D	A	1.05	40		Use PTFE or EPDM O-Rings.
Benzene *	XS MS	A	A	B	A	B	A	A	B	A	A	D	A	D	A	.88	50	3	
Benzene Sulfonic Acid	SNP SX SMVP MS	A		A	C	A	C	A	A	A	A	D	A	B	A		Solid		Corrosive if not 100%, Melts @ 151°F (66°C), Irritant.
Benzoic Acid *	SNP SX MS		C	D	B	D	B	A	D	B	A	D	A	D	A	1.27	Solid		Melts @ 250°F (121°C).
Benzophenone	X NP			B	B	B	B	A	B	B	A		A		A		Solid		Melts @ 118°F (48°C), Insoluble in Water.
Benzyl Alcohol	X	A		A	B	A	B	A	A	A	A	D	A	B	A	1.04		Low	
Benzyl Benzoate	X			B	B	B	B	A	B	B	A	D	A	D	A	1.12		Low	Use FKM Option for X Pump.
Benzyl Chloride, 100%	SNP SX MS	A		A	B	A	B	A	A	B	A	D	A	D	A	1.10		Low	Corrosive if not 100%.
Biodiesel (B100)	X NP MI	A	A	A	D	A	D	A	A	A	A	B	A		A	0.88	40		Viscosity at 105°F (40°C) Cloud Point 26 to 53°F (-3 to 12°C)
Blood	SNP SX MS			C	A	C	A	A	C	A	A	A	B		A				Possible Lumps.
Borax w	SNP SX SMVP MS	A	C	C	B	C	B	A	C	A	A	A	B	D	A	1.73	50		Toxic.
Boric Acid	SNP SX SMVP MS	A		D	B	D	B	A	C	A¹	A	A	A	A	A	1.43	40		
Bromine *	NO PUMP	D		D	D	D	D	D	D	D	A	D	A	D	A	3.11		7	Extremely Toxic.
Bromine Trifluoride	SNP SX SMVP				B	B	B	A	B	B	A	D	D	D		2.49		Low	Melts @ 48°F (9°C). Seal-less, Consult Factory.
Bromobenzene, Dry	SNP SX SMVP			B	B	B	B	A	B	A	A	D	A	D	A	1.50		Low	
Butadiene *	SGL	B		A	A	A	A	A	A	A	A	D	A	D	A	.62	50	36	Sufficient NPSHA Required.
Butane	LGL	A		A	A	A	A	A	A	A	A	A	A	A	A	.60	30	55	Sufficient NPSHA Required.
Butene (1-Butene) *	SGL	A		A	A	A	A	A	A	A	A	A	A	D	A	.60	30		
Butyl Acetate	X	A		A	A	A	A	A	A	A	A	D	D	D	A	.88	30	0.5	Use PTFE or EPDM O-Rings.
Butyl Acrylate	X	A				B		A	A	A	A	D	D	D	A	.90	50		PTFE O-Rings only. Polymerizes with heat.
Butyl Alcohol *	X	A	A	A	A	A	A	A	A	A	A	A	A	A	A	.81	30	0.3	

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69°F)	Neoprene	PTFE				
Butyl Amine	X	B		A	A	A	A	A	A	A	A	C	D	D	A	.74	30	1.6 @68°F	Use PTFE or EPR O-Rings. Boils @ 170°F (77°C).
Butyl Benzoate	NP MI			B	B	B	B	A	B	B	A	D	A	D	A	1.00		Low	Freezes @ -7°F (-22°C).
Butyl Butyrate	X			A	A	A	A	A	A	A	A	D	A	D	A	.87		Low	
Butyl Cellosolve	X NP MI			A	A	A	A	A	A	A	A	C	D	C	A	.90	50		Use PTFE or EPR O-Rings.
Butylene (Butene)	SGL	A		A	A	A	A	A	A	A	A	B	A	C	A	.60			
Butyl Stearate	X			B	B	B	B	A	B	B	A	B	A	D	A	.86		Low	Melts @ 66°F (19°C), Iron May Color Product.
Butyraldehyde	X	A		A	A	A	A	A	A	A	A	D	D	D	A	.80	30	3.8	Use PTFE or EPR O-Rings.
Butyric Acid	SNP MS	A		D	B	D	B	A	D	B	A	D	B	D	B	.96	30		
Calcium Acetate	w SNP MS			C	B	C	B	A	B	B	A	B	D	B	A			1	
Calcium Bisulfite	SNP MS	A		D	C	D	C	A	D	B	A	B	B	B	A	1.06	50		
Calcium Chloride	* SNP NP MI	A		B	A	B	A	A	B	B	A	A	A	A	A	2.15	50		Use SNP if PH<7
Calcium Hydroxide (0 - 20%)	w SNP NP MI MS	B	B	B	B	B	B	A	B	B	A	A	A	A	A	2.34		1	Use EC Laminate or Iron Vanes, Check Viscosity. Special Attention to Sealing. Temperature limited to 70°F for MI and MS pumps due to compatibility with PEEK
Calcium Hypochlorite	* NO PUMP	D		C	D	D	C	A	D	C	A	B	A	B	A		50		No Suitable Pump Construction.
Calcium Nitrate	X NP MI	A		B	C	B	C	A	B	B	A	A	A	A	A	1.82			Temperature limited to 70°F for MI and MS pumps due to compatibility with PEEK
Calcium Phosphate	NP MI			B	B	B	B	A	B	B	A	A	A	B	A		Solid		Determine Solvent. Temperature limited to 70°F for MI and MS pumps due to compatibility with PEEK
Calcium Sulfide	w NP MI	A		B	D	B	D	A	B	B	A	A	A	A	A	2.80		1	
Cane Sugar Liquids	NP MI			A	A	A	A	A	A	A	A	A	A	A	A		MAX 5,000		
Carbon Black Slurry	XLW	A	A	A	A	A	A	A	A	A	A	D	A	D	A	1.8			Solvent Based. Abrasive, Run Slow.
Carbon Dioxide	CRL	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.10		320 @ 0°F	System Design Critical, Pump at 0 to -30°F (+32 to - 34°C) Only.
Carbon Disulfide	X	A	A	A	A	A	A	A	A	A	A	D	A	D	A	1.26	30	11	
Carbon Monoxide	NO PUMP	A		A	A	A	A	A	A	A	A	A	A	A	A	.97			Very Toxic and Flammable.
Carbon Tetrachloride	* X SMVP MS	B	A	B	A	B	A	A	C	A	A	B	A	D	A	1.59	30	1	Corrosive with Water. Use SS or SC Stationary Seat. No Aluminum.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70 °F	Vapor Pressure PSI at 100 °F	Notes	
		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Carbonic Acid	SNP SX MS			D	D	D	D	A	D	A	A	B	A	A	A	2.44	30			
Castor Oil	X NP MI	A	A	B	A	B	A	A	B	A	A	A	A	A	A	A	.96	5,000		
Cathodic Resin	ML NP MI	A		B	B	B	B	A	A	A	A	C	A		A	1.2	100		Avoid Air Contact and Heat. Use Double Seal or Sealless.	
Catsup (Ketchup)	SNP SX MS			D	C	D	C	A	C	A	A	A	A	C	A	1.11	2,500 @145°F		Check Viscosity.	
Caustic Soda, 0-25% (Cold) *	X SMVP MS	B	C	B	B	B	B	B	B	A	A	B	B	B	A	1.53	150		Use SS or SC Stationary Seat. If using stainless above 150°F (66°C) then Consult Factory. Special Attention to Sealing.	
Caustic Soda, 26-50% (Cold) *	X SMVP MS	B	C	B	B	B	B	B	B	B	A	B	B	B	A	1.53	150		Use SS or SC Stationary Seat. If using stainless above 150°F (66°C) then Consult Factory. Special Attention to Sealing.	
Chlordane	X NP MI			B	B	B	B	A	B	B	A	B	A	C	A	1.67	600 @130°F		Usually Pumped with Solvent. Seal-less, Consult Factory	
Chloric Acid	NO PUMP			D	D	D	D	A	D	D	A	D		D	A				Toxic, Strong Oxidizer.	
Chlorine, Dry Only *	NO PUMP	D	C	A	B	A	B	A	A	A	A	D	B	B	A	1.47	30	155	No Suitable Vane Material. Corrosive if Water Present.	
Chloroacetic Acid	NO PUMP	A		D	D	D	D	A	D	D	A	D	D	D	A	1.58			No Suitable Pump Construction.	
Chloroacetone	SNP MS			B	B	B	B	A	C	B	A	D	D	D		1.16		Low	Boils @ 246°F (119°C).	
Chlorobenzene, Dry	X MI	A		B	C	B	C	A	B	C	A	D	A	D	A	1.10	30		Seal-less, Consult Factory. Temperature limit for MI pump is 212 °F due to compatibility with PEEK.	
Chlorobromomethane, Dry	X			B	B	B	B	A	B	B	A	D	B	D	B	1.93			Boils @ 153°F (67°C), Volatile, Use SS or SC Stationary Seat. No Aluminum. Seal-less, Consult Factory.	
Chloroform, Dry *	SMVP MS	C	A	A	A	A	A	A	A	A	A	D	A	D	A	1.49	30		Corrosive if Water Present. Known Carcinogen. Temperature limit for MS pump is 212 °F due to compatibility with PEEK.	
Chlorosulfonic Acids	NO PUMP	D		D	D	D	D	D	D	B	A	D	D	D	A	1.77			Extremely Toxic.	
Chocolate	ML NP SNP SX	A	A	B	C	B	C	A	B	A	A	A	A	A	A		50,000-100,000	0	Shear Sensitive. Run Slow. Maximum speed 155 rpm/125 rpm or less recommended.	
Cholesterol	NP	A		B	B	B	B	A	B	B	A	A	A	A	A	1.07				
Chromic Acid	NO PUMP	A	D	C	D	C	D	D	C	D	A	D	A	D	A	2.82			Extremely Toxic.	
Citric Acid (Citric Oils) *	SNP SX MS	A		D	C	D	C	A	D	A	A	A	A	A	A	1.54	50	1		

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Clorox, Bleach	SNP SX	A		D	D	D	D	A	D	A	A	B	A	B	A		50		
Cocoa Nut Oil	X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	C	A	.86			
Copper Nitrate	SNP SX SMVP MS	A		D	D	D	D	A	D	B	A	A	A	A	A	2.17	50	1	Seal-less, Consult Factory.
Copper Sulfate	SNP SX SMVP MS	A	A	D	B	D	B	A	D	B	A	A	A	A	A	2.28	50		Strong Irritant. Seal-less, Consult Factory.
Corn Oil	X NP MI	A	A	A	C	A	C	A	A	A	A	A	A	C	A	.92	500		
Cottonseed Oil	X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	C	A	.92	375		
Cresol	SNP SX SMVP MS	A		C	A	C	A	A	C	A	A	D	A	D	A	1.04	100		Toxic, Burns Skin.
Cresylic Acid	SNP SX SMVP MS			C	C	C	C	A	C	A	A	D	A	D	A		100		Burns Skin.
Crude Oils	XLW NP MI	A	A	B	A	B	A	A	B	A	A	B	A	D	A	.80-1.00	Varies		Check Viscosity & Abrasiveness.
Cumene *	X			B	B	B	B	A	B	B	A	D	A	D	A	.86			Seal-less, Consult Factory.
Cyclohexane *	X	A		B	B	B	B	A	B	B	A	A	A	C	A	.78	50		
Cyclohexanol	X	A		A	A	A	A	A	A	A	A	A	A	B	A	.94		Low	Toxic.
Decyl Alcohol (N-Decyl Alcohol) *		A		A	A	A	A	A	A	A	A				A	.83	30	0	
Diacetone Alcohol	X	A		A	A	A	A	A	A	A	A	D	D	B	A	.94	35	Low	
Dibenzyl Ether	X			B	B	B	B	A	B	B	A	D	D	D	A	1.04		Low	Use PTFE or EPR O-Rings.
Dibutyl Amine	NP MI			A	D	A	D	A	A	A	A	D	D	D	B	.76	30	0	Mechanical Seals Not Acceptable. Flammable and Toxic. Consult Factory.
Dichlorobenzene, Ortho	X			B	B	B	B	A	B	B	A	D	A	D	B	1.25	30	0	Use SS or SC Stationary Seat. Seal-less, Consult Factory.
Diesel Fuel	X	A	A	A	A	A	A	A	A	A	A	B	A	A	A	.90	30-100	0	
Diesel Fuel (Low Sulphur – LSD)	X	A	A	A	A	A	A	A	A	A	A	B	A	A	A	.90	30-100	0	Maximum 500 PPM
Diesel Fuel (Ultra Low Sulphur - ULSD)	X	A	A	A	A	A	A	A	A	A	A	B	A	A	A	.90	30-100	0	Maximum 15 PPM. Lower sulphur content = Lower fluid lubricity.

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		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Diethanolamine	X	A		A	A	A	A	A	A	A	A	B	D	B	A	1.09	Solid	0	Melts @ 82°F (28°C). Check Viscosity.	
Diethylene Glycol	X NP MI	A		A	A	A	A	A	A	A	A	A	A	A	A	1.12	150	0	PTFE mechanical seals not recommended.	
Diisobutylene	X	A		B		B		A			A	B	A	D	A	.72				
Dimethylamine (DMA)	SGL	B		B	A	B	A	A	B	A	A	B	D	C	A	.68	30	45	Boils @ 44°F (7°C).	
Dimethyl Ether (DME)	SGL	A						A	A										Consult Factory.	
Dimethyl Formamide	X SNP SX SMVP MS	A	A	A	A	A	A	A	A	A	A	B	D	C	A	.95		Low	Boils @ 307°F (153°C), Use SNP if, <90% Concentration.	
Diocetyl Phthalate	X	A		A	A	A	A	A	A	A	A	D	B	D	A	.99	320	Low		
Dioxane	CF	A		A	A	A	A	A	A	A	A	D	D	D	A	1.04		2	Toxic, Carcinogen, 200°F (93°C) Max.	
Dipentene	X	A		A	A	A	A	A	A	A	A	B	A	D	A	.85				
Diphenyl Oxide	X	A		A	A	A	A	A	A	A	A	D	A	D	A				Melts @ 189°F (87°C).	
Epichlorohydrin	*	CF	A		A	A	A	A	A	A	A	D	D	D	A	1.18		Low	Extremely Toxic.	
Ethane	NO PUMP	A		A	A	A	A	A	A	A	A	A	A	B	A	.45		Very High	Extremely Flammable.	
Ethanolamine (MEA)	*	X NP MI	A		A	A	A	A	A	A	A	B	D	B	A	1.02		0	Melts @ 51°F (11°C).	
Ethyl Acetate, Cold	X XL NP MI	A	A	A	A	A	A	A	A	A	A	D	D	D	A	.89	30	3		
Ethyl Acrylate	CF	A	A	A	A	A	A	A	A	A	A	D	D	D	A	0.92		1	Polymerizes Readily. Toxic and Fire Hazard.	
Ethyl Alcohol, Ethanol	*	X	A	A	A	A	A	A	A	A	A	A	A	A	A	.79	30	2	Consult Factory if commercial seals w/ FKM are used.	
Ethylene	*	SGL	A		A	A	A	A	A	A	A	A	A	C	A	.61		445 @ 10°F	Pump Below 10°F (-12°C).	
Ethylene Chloride	SNP SX SMVP MS	A		C	A	C	A	A	C	A	A	D	B	D	A	1.26	30	2	Dry Only.	
Ethylene Dibromide	*	SNP SX SMVP MS	A	B	C	C	C	C	A	C	B	A	D	A	D	A	2.18		0.5	Dry Only. Seal-less, Consult Factory.
Ethylene Dichloride	*	SNP SX MS	B		C	C	C	C	A	C	B	A	D	A	D	A	1.26	30		
Ethylene Glycol (Anti-Freeze)	*	X	A	A	B	A	B	A	A	B	A	A	A	A	A	1.12	100	0	PTFE Mechanical Seals Not Recommended.	
Ethylene Oxide	*	SGL	C		A	A	A	A	A	A	A	D	D	D	A	.88	30	40	Marginal SGL Application if EPR O-Rings Used.	

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes	
		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Ethyl Hexanol (2-Ethyl Hexanol)	*	X	A		A	A	A	A	A	A	A	A	A	A	A	.83		0		
Fatty Acids		SNP SX MS	A		D	B	D	B	A	D	A	A	B	A	B	A	.82-.95	Varies		Maximum 40 psi if Mixed With Air to Avoid Cavitation.
Ferric Nitrate	w	SNP SX MS	A		D	D	D	D	A	D	B	A	A	A	A	A	1.68		1	
Ferric Sulfate	w	SNP SX MS	A		D	D	D	D	A	D	A	A	A	A	A	A	2.10			
Ferrous Sulfate	w	SNP SX MS	A		D	C	D	C	A	D	B	A	A	A	A	A	1.89	50		
Fertilizer Solutions		X	A		B	D	B	D	A	B	A	A	B	B		A	0.82	50		Keep Pump Flooded or Flushed. Use SS or SC Seals.
Fluoboric Acid	w	X SNP SX	A		B	C	B	C	A	B	B	A	A	A	A	A	1.84		Low	
Flourine, Liquid		NO PUMP	D		C	A	C	A	A	C	A	A	D	D	D	A	1.10			Boils @ -306°F (-188°C).
Fluosilicic Acid		SNP SX MS	A		D	C	D	C	A	D	B	A	A	A	A	A	1.29	300		
Formaldehyde		SNP SX SMVP MS	A	D	C	B	C	B	A	C	A ¹	A	C	D	C	A	.82	30		Toxic, Known Carcinogen.
Formic Acid		SNP SX MS	B	B	D	B	D	B	A	D	A	A	B	C	A	A	1.22	100		Melts @ 47°F (8°C).
Freon® 11		SGL	A		A	C	A	C	A	A	A	A	B	B	D	A	1.48	<30	14	
Freon® 12		SGL	A		A	D	A	D	A	A	A	A	B	A	A	A	1.31	<30	85	
Freon® 13		SGL	A		A		A		A	A	A	A	A	A	A	A	1.30 @-22°F	<30	200 @10°F	
Freon® 14		NO PUMP	A		A		A		A	A	A	A	A	A	A	A	132 @-112°F	<30	500 @-40°F	Vapor Pressure too High.
Freon® 21		SGL	A		A		A		A	A	A	A	D	D	C	A	1.37	<30	27	
Freon® 22		SGL	A	B	A	C	A	C	A	A	A	A	D	D	A	A	1.12	<30	140	
Freon® 31		SGL	A		A		A		A	A	A	A	D	D	A	A		<30		Check Vapor Pressure.
Freon® 112		XL SGL	A		A		A		A	A	A	A	B	A	B	A	1.63	<30	1.8 @100°F	
Freon® 113		XL SGL	A	A	A	B	A	B	A	A	A	A	A	B	A	A	1.57	<30	5.8	
Freon® 114		SGL	A		A		A		A	A	A	A	A	A	A	A	1.46	<30	29	
Freon® 114B2		XL SGL	A		A		A		A	A	A	A	B	B	B	A	2.16	<30	5.8	
Freon® 115		SGL	A		A		A		A	A	A	A	A	A	A	A	1.29	<30	120	
Freon® 116		SGL	A		A		A		A	A	A	A	A	A	A	A	1.59 @-100°F	<30	200 @15°F	

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		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene					PTFE
Freon®/Refrigerants 123	SGL																	Consult Factory.	
Freon®/Refrigerants 124	SGL																	Consult Factory.	
Freon®/Refrigerants 125	SGL																	Consult Factory.	
Freon®/Refrigerants 134A	SGL	A		A		A		A	A	A	A	D	D	B	A	1.21	<30	140	
Freon®/Refrigerants 134B	SGL																	Consult Factory.	
Freon®/Refrigerants 141B	SGL																	Consult Factory.	
Freon®/Refrigerants 142B	SGL																	Consult Factory.	
Freon®/Refrigerants 143A	SGL																	Consult Factory.	
Freon®/Refrigerants 152A	SGL																	Consult Factory.	
Freon® 502	SGL	A		A		A		A	A	A	A	B	B	A	A	1.22	<30	160	
Freon® TMS, TF	XL SGL	A		A	A	A	A	A	A	A	A	A	B	A	A	1.56	<30	6	
Freon® TA	XL SGL	A		A		A		A	A	A	A	A	C	A	A	1.41	<30	7	
Freon® MF	XL SGL	A		A		A		A	A	A	A	B	B	D	A		<30		
Fruit Juices	SNP SX	A		D	C	D	C	A	C	A	A	A	A	A	A	1.20	100		Some Solids, May be Abrasive.
Fuel Oil #1 - 5	X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	C	A	.90	30-2,000	Low	
Fuel Oil # 6 (Bunker C)	NP XL(W)	A	A	A	A	A	A	A	A	A	A	B	A	C	A	.90	2,000- 10,000		Check Viscosity, 100,000 @ 45°F (7°C). May be abrasive.
Fumaric Acid	W* X SNP SX			A		A		A	A	A	A	A	A	B	A	1.63	30	Low	
Furfural	X NP	A		B	B	B	B	A	B	B	A	D	D	D	A	1.16	50		Use PTFE or EPR O-Rings.
Gallic Acid	SNP SX	A		D	A	D	A	A	D	B	A	B	A	B	A	1.69			
Gasoline - No Lead	X	A	A	A	A	A	A	A	A	A	A	B	A	C	A	.70	30	8-11	Vapor Pressures Vary with Type Suction Lift Reduced, Especially with No-Lead.
Gasolines	X	A	A	A	A	A	A	A	A	A	A	A	A	C	A	.70	30	8-11	Vapor Pressures vary with Type, Suction Lift Reduced.
Glucose	NP	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.40	50,000		Viscosity Varies.
Glue	NP MI	A	A	A	A	A	A	A	A	A	A	A	B	A	A		100,000+		Check Viscosity & Vapor Pressure. Avoid air contact.
Glycerine (Glycerol)	* X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.26	5,000		
Glycidol	X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.12		Low	
Glycols	X NP MI	A		B	A	B	A	A	B	A	A	A	A	A	A	1.11	50-200		Check Specific Type. PTFE Seals not Recommended.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Grease (Petroleum Base)	NP MI	A	A	A	A	A	A	A	A	A	A	A	A	C	A		Very Viscous		Good Inlet Conditions Required Run Slow**.
Heptane	X	A	A	A	A	A	A	A	A	A	A	A	A	A	A	.70	30	2	
Hexane, Dry	XL	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.66	30		
Hexanol	X	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.82		Low	
Honey	NPJ SNPJ	A		A	A	A	A	A	A	A	A	A	A	A	A	1.20	340-7,000 @100°F		Avoid air contact.
Hydraulic Oils	X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.90	300-1,000		Synthetic Oils Require FKM.
Hydrazine	SMVP MS	A		D		D		A	C	A	A	B	D	B	A	1.00			Toxic, Carcinogen, Severe Fire Risk.
Hydrobromic Acid	NO PUMP	D	D	D	D	D	D	A	D	D	A	D	A	D	A	1.49			Extremely Corrosive.
Hydrochloric Acid	*	NO PUMP	C	D	D	D	D	D	A	D	D	A	D	A	D	A	1.19		Extremely Corrosive.
Hydrofluoric Acid		NO PUMP	C	A	D	C	D	C	D	D	D	D	A	D	A				Extremely Corrosive.
Hydrogen Peroxide	*	NO PUMP	C	B	D	D	D	D	D	B	A	B	A	A	A	1.45	30	Low	Carbon Not Compatible. Toxic, Irritant.
Hydrogen Sulfide	SNP SMVP	A	A	B	D	B	D	A	B	A	A	D	D	B	A	1.19	30		Toxic, Strong Irritant.
Ink	ML XLW NP MI	A		B	B	B	B	A	B	B	A	A	A	A	A	1.0-1.4	500-50,000	Low	Thixotropic, Normally Abrasive, Check Viscosity.
Iodine	NO PUMP	D		C	C	C	C	D	C	A	A	B	A	D	A	4.98			Extremely Toxic, Strong Irritant.
Iron Oxide Slurry	XLW	A	A	A		A		A	A	A	A	D	A		A		500		Very Abrasive, Run Slow.
Isobutyl Acetate	X	A		A	A	A	A	A	A	A	A	D	D		A	.87		0	Use PTFE or EPR O-Rings.
Isobutyl Alcohol	X	A			D		D	A		B	A	B	A	A	A	.81	30	0	
Isobutane	SGL																		Consult Factory.
Isocyanate (See TDT or MDI)																			See Specific Type. Viscosity varies. Avoid Air Contact.
Isopropyl Acetate	X NP	A		A	A	A	A	A	A	A	A	D	D	D	A	.87	30		Use PTFE or EPR O-Rings.
Isopropyl Alcohol	*	X	A		A	A	A	A	A	A	A	B	A	B	A	.79	34	Low	
Isopropyl Chloride	X			A	A	A	A	A	A	A	A	D	A	D	A	.86			
Isopropyl Ether	X	A		A	A	A	A	A	A	A	A	B	D	C	A	.72	30		Boils @ 152°F (67°C), Dangerous Fire Risk.
Jet Fuels (JP3,JP4,JP5,JP8,Jet A)	X	A	A	A	A	A	A	A	A	A	A	A	A	D	A	.77	30	2-7	PTFE O-Rings Not Recommended Need Pliability.
Jet Fuels (JP9, JP10, JP11)	X	A	A	A	A	A	A	A	A	A	A	C	A	D	A				Use All FKM Option.
Kerosene	X	A	A	B	A	B	A	A	B	B	A	A	A	B	A	.81	30	2	
Lacquer (Lacquer Solvents)	X NP	A		A	A	A	A	A	A	A	A	D	D	D	A	.95			Check Viscosity. Check Sealing Method.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Lactic Acid, Cold	SNP SX MS	A		C	B	C	B	A	D	A	A	A	A	A	A	1.20			Must Use FKM if Hot. Melts @ 65°F (18°C), Check Viscosity.
Lard	NP MI	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.95	287 @120°F		Melts @ 108°F (42°C).
Lasso (Monsanto Herbicide)	X	A		B	C	B	C	A	B	C	A	C	B	C	A	1.10			Use SS or SC Stationary Seat. Contains Chlorobenzene.
Latex Emulsions		A			A		A	A		A	A	A	A	C	A		10,000- 100,000		Check Viscosity.
Latex Paint	XLW	A		B	A	B	A		A	A	A	A	A	C	A		EST. 15,000		Avoid Air Contact. Consult Factory.
Lead Acetate	SNP SX MS	A		D	C	D	C	A	D	B	A	B	D	B	A	2.50			
Ligroin	X	A		A	A	A	A	A	A	A	A	A	A	B	A		30		Volatile, Boils @ 58-275°F (14 - 135°C), Dangerous Fire Risk.
Linseed Oil	NP MI	A	A	B	A	B	A	A	B	A	A	A	A	C	A	.93	500-1,000		Hardens if Exposed to Air.
Lime Water (0 - 20%)	SNP SX NP	B	B	B	B	B	B	A	B	B	A	A	A	B	A	2.34		Low	(Calcium Hydroxide) Use E.C. Laminate or Iron Vanes. Check Viscosity.
Liquid Sugar	SNP SX	A		B	A	B	A	A	B	A	A	A	A	B	A	1.35	700- 12,000		Keep Pump Flooded and Free of Air.
Lubricating Oils	NP X MI	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.77-.95	200-4,000	Low	Check Viscosity, SAE 40W=50,000 SSU @ 10°F (-12°C)
Magnesium Chloride	SNP SX	A		C	B	C	B	A	C	B¹	A	A	A	A	A	2.32			Temperature must be below 100 °F. Stainless steel not recommended above this temperature.
Magnesium Hydroxide	XLW	A		B	B	B	B	A	B	A	A	B	A	B	A	2.36			Can be Very Abrasive. Special Attention to Sealing.
Magnesium Sulfate	NP MI	A		B	A	B	A	A	B	A	A	A	A	A	A	2.65	50		(Epsom Salts).
Maleic Acid	SNP SX MS	A		D	B	D	B	A	D	B	A	D	A	D	A	1.59			Melts @ 268°F (131°C).
Maleic Anhydride	* SNP SMVP				D		D	A		A	A	D	D	D	A	1.30	Solid	0	Melts@127°F (53°C), 36 SSU@158°F (70°C). Strong Irritant.
Malic Acid	SNP SX MS			D	B	D	B	A	D	A	A	A	A	B	A	1.60			Not Same as Maleic Acid, Melts @ 263°F (128°C).
MAPP Gas	SGL	A						A	A				A						Consult Factory.
Mayonnaise	SNP SX MS			D	D	D	D	A	D	B	A	A	A	D	A	1.00	25,000		
Mercuric Cyanide	CF			B	D	B	D	A	B	B	A	A	A	B	A	4.02		Low	Extremely Toxic. Seal-less, Consult Factory.
Mercury	CF			A	D	A	D	A	A	A	A	A	A	A	A	13.60			Cannot be Lifted, Run Slow**, Toxic.
Methyl Acetate	SNP SX MS	A		D	A	D	A	A	D	A	A	D	D	B	A	.92			Boils @ 129°F (54°C), High Vapor Pressure, Dangerous Fire Risk.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Methyl Acrylate	CF	A		B	B	B	B	A	A	A	A	D	D	B	A	0.96		1	Toxic. Fire Risk
Methyl Alcohol (Methanol) *	X	A	A	B	A	B	A	A	B	A	A	A	A	A	A	.79	30	2 PSIA @70°F	Consult Factory if commercial seals w/ FKM are used.
Methyl Bromide	CF			A		A		A	A	A	A	B	A	D	A	1.73		45	Irritant.
Methyl Diphenyl -Diisocyanate (MDI) *	CF	A		A		A		A	A	A	A	D	A		A		100		Very Toxic, Strong Irritant, Avoid Air Contact.
Methyl Chloride, Dry	SGL	A		B	A	B	A	A	B	A	A	D	A	D	A	.92		116	Corrosive if Water Present.
MEA																			See Ethanolamine.
Methylene Chloride *	X	A	A	B	A	B	A	A	B	B	A	D	B	D	A	1.34	30	14	Eye Irritant. Seal-less, Consult Factory.
Methyl Ethyl Ketone (MEK) *	X	A	A	B	B	B	B	A	B	B	A	D	D	D	A	.80	30	4	Use PTFE or EPR O-Rings. Seal-less, Consult Factory.
Methyl Isobutyl Ketone (MIBK) *	X	A		B	B	B	B	A	B	B	A	D	D	D	A	.80	30	1	Use PTFE or EPR O-Rings, Fire Risk. Seal-less, Consult Factory.
Methyl Isopropyl Ketone	X			A	A	A	A	A	A	A	A	D	D	D	A	.82			Use PTFE or EPR O-Rings.
Methyl Methacrylate *	CF	A		A	A	A	A	A	A	B	A	D	D	D	A	.95	30	1.5	Fire Risk. Seal-less, Consult Factory.
Methyl tert-Butyl Ether (MTBE)	X	A	A	A		A		A	A	A	A	C	D	D	A	0.74	30	8	
Milk	SNP SX MS	A		D	D	D	D	A	D	A	A	A	A	A	A	1.03	50		
Mineral Oil	X	A	A	B	A	B	A	A	B	A	A	A	A	B	A	Varies	Varies	Varies	
Molasses	HXL NP ML MS	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.45	1,000- 100,000		Check Viscosity.
Mustard	SNP SX MS	A		D	D	D	D	A	D	A	A	B	A	A	A				
Naptha (Petroleum or Coal Tar)	X	A		B	A	B	A	A	A	A	A	B	A	D	A	.60-.97	30		
Naphthalene	NP MI	A		A	A	A	A	A	A	A	A	D	A	D	A	1.15	Solid		Melts @ 176°F (80°C), Abrasive Crystals When Cool.
Nickel Chloride	SNP SX	A		D	D	D	D	A	D	B	A	A	A	B	A	3.55			
Nickel Sulfate	SNP SX MS	A		D	B	D	B	A	D	A	A	A	A	A	A	2.0-3.7			
Nitric Acid, 0-40%	NO PUMP	C	D	B	D	B	D	A	B	A	A	D	B	D	A	1.20	50		Use Carbon Vanes. Ambient Temperature Only.
Nitric Acid, 40-60%	NO PUMP	D	D	D	D	D	D	A	D	B	A	D	A	D	A	1.50	100		Use Carbon Vanes. Seal-less, Consult Factory.
Nitrobenzene	X	B	A	A	A	A	A	A	A	A	A	D	B	D	A	1.20	30	Low	Melts @ 42°F (6°C).
Oleic Acid	SNP SX MS	A	D	C	A	C	A	A	C	B	A	C	B	D	A	.90		Low	
Oleum	SMVP MS	B			D		D	D	B	B	A	D	A	D		1.84			Toxic, Strong Irritant. Seal-less, Consult Factory.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
		VANES				SEAL FACES					ELASTOMERS								
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69°F)	Neoprene	PTFE				
Oxalic Acid, Cold	NO PUMP	A		D	A	D	A	A	D	D	A	B	A	B	A				No Suitable Pump Construction
Palm Oil	X	A	A	A	A	A	A	A	A	A	A	A	A	A	A	.95	500		
Paraffin Wax	NPJ	A	A	A	A	A	A	A	A	A	A	A	A	A	A	.90	Solid		Melts @ 120-150°F (49 - 66°C), Poor Lubricant, Run Slow**
Parathion	SMVP	A						A		A	A	A	A		A	1.26			Very Toxic.
Pentaerythritol *	NP			A	A	A	A		A	A					A	1.40		Low	
Pentane	X	A		B	B	B	B	A	B	B	A	A	A	B	A	.63	30	16	
Perchloroethylene, Dry *	X XL	A	A	B	B	B	B	A	B	A	A	B	A	D	A	1.63	30		Moisture Produces HCL, Corrosive. Stainless Steel or Silicon Carbide Stationary Seat Recommended.
Petrolatum (Petroleum Jelly)	NP MI			B	A	B	A	A	B	A	A	A	A	B	A	.88		0	Melts @ 100-140°F (38 - 60°C), Low Viscosity.
Phenol *	X	A	A	A	A	A	A	A	A	B	A	D	A	D	A	1.07			Avoid Air Contact. Melts@110°F (43°C), Low viscosity. Seal-less. Consult Factory.
Phosphoric Acid, 0-90%	SNP SX MS	B	B	D	C	D	C	A	D	C	A	A	A	B	A	1.83			Marginal Application. Limited Shaft Life.
Phosphoric Acid, 90-100%	NO PUMP	B	B	D	A	D	A	A	D	C	A	C	A	C	A	1.88			No suitable Pump Construction.
Phthalic Anhydride *	NP	A		A	A	A	A	A	A	A	A	B	A	A	A	1.53	Solid		Melts @ 268°F (131°C).
Plastisol	ML	A		B	A	B	A	A	A	B	A	D	B		A		5,000-20,000		Avoid Air Contact. Temperature Critical. Seal-less, Consult Factory.
Polyol, Filled	XLW	A	A	A		A		A	A	A	A	D	A		A		1,500-100,000		Very Abrasive, Run Slow.
Polyols, Unfilled	X NP MI	A	A	A		A		A	A	A	A	D	A		A		Varies		Any Polyhydric Alcohol, check Specific Type.
Polypropylene *				A	A	A	A	A	A	A	A	A	A	A	A	.90	Solid		Thermoplastic.
Polyvinyl Alcohol (PVA) *	NP MI	A		A	A	A	A	A	A	A		A	A		A	1.30	Varies		Very Viscous, Check viscosity.
Polyvinyl Chloride	NO PUMP																SOLID		PVC, Synthetic Resin.
Potassium Bicarbonate w	NP MI	A		B	B	B	B	A	B	A	A	A	A	A	A	2.17			Melts @ 250°F (121°C).
Potassium Bromide w	SNP SMVP MI	C		D	B	D	B	A	D	B	A	A	A	A	A	2.75			Seal-less, Consult Factory.
Potassium Carbonate w	NP MI	A		B	C	B	C	A	B	B	A	A	A	A	A	2.43			
Potassium Chlorate w	SNP SX MS	A		C	B	C	B	A	C	A	A	A	A	A	A	2.34			
Potassium Chloride w	SNP SX MS	A		C	A	C	A	A	C	A ¹	A	A	A	A	A	1.99			
Potassium Chromate w	NP	A		B	B	B	B	A	B	B	A	A	A	A	A	2.73			

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Liquid		Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes
			VANES				SEAL FACES					ELASTOMERS								
			Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69°F)	Neoprene	PTFE				
Potassium Hydroxide	w	SNP SX MS	A		B	C	B	C	A	B	B	C	B	D	B	A	2.04	6 cp		Special Attention to Sealing.
Potassium Nitrate	w	NP MI	C		B	B	B	B	A	B	B	A	A	A	A	A	2.11			Explosive Risk.
Potassium Permanganate	w	NP MI	A		B	B	B	B	A	B	B	A	B	A	A	A	2.70			Temperature limit is 70°F for MI pump due to compatibility with PEEK.
Potassium Sulfate	w	SNP SX MS	A		B	A	B	A	A	B	A	A	A	A	A	A	2.66			Temperature limit is 70°F for MS pump due to compatibility with PEEK.
Potassium Sulfide	w	SNP SX MS	A		B	D	B	D	A	C	B	A	A	A	A	A	1.81			
Propane		LGL	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.53	30	225	
Propylene	*	SGL	A		A	A	A	A	A	A	A	A	D	A	D	A	.51	30	227	
Propylene, Dichloride		X SNP SX SMVP	A		A	A	A	A	A	A	A		A				1.16		2	Use SNP if Water Present.
Propylene Glycol	*	X NP	A	A	A	A	A	A	A	A	A	A	A	A	A	A	1.04	300	Low	PTFE Mechanical Seals Not Recommended.
Propylene Oxide	*	X	A		B	B	B	B	A	A	A	A	D	D	D	A	.83		18	Use PTFE or EPR O-Rings.
Pyridine		X NP MI	A		B	B	B	B	A	B	B	A	D	A	D	A	.98	50	Low	Use FKM O-Rings. Fire Risk.
Pyridine Oil		SNP MS			C	B	C	B	A	C	A	A	D	D	D	A				
Rosin, Rosin Oil		X NP			B	B	B	B	A	B	A	A	B	A	D	A	1.08	Wide Range		Fire Risk When Heated. Check Viscosity.
Salicylic Acid	*	SNP SX MS	A	A	C	A	C	A	A	C	A	A	B	A	A	A	1.44			Melts @ 322°F (161°C).
Salt Water (Sea Water)		NO PUMP	A		D	B	D	B	A	D	B	A	A	A	B	A	1.03			Corrosive, Non-Lubricity.
Soda Ash (Sodium Carbonate)	*	X NP MI	A		A	A	A	A	A	A	A	A	A	A	A	A	1.55	50	Low	
Sodium Acetate	w*	X NP MI	A		A	A	A	A	A	A	B	A	B	D	B	A	1.53			
Sodium Bicarbonate	w*	X	A	B	B	B	B	B	A	B	A	A	A	A	A	A	2.16			
Sodium Bisulfate	w	SNP SX MS	A	A	C	B	C	B	A	D	B	A	A	A	A	A	2.44			
Sodium Borate	w	X NP MI	A		B	A	B	A	A	B	B	A	A	A	A	A	1.73			
Sodium Chlorate	w*	SNP SX	A		C	A	C	A	A	C	B¹	A	A	A	A	A	2.49			

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			VANES				SEAL FACES					ELASTOMERS								
			Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE				
Sodium Chloride	w	SNP SX MS	A		B	B	B	B	A	C	B	A	A	A	A	A	2.17	30		
Sodium Chromate	w	X	A		A	A	A	A	C	A	A	A	A	A	A	A	2.72	60		
Sodium Cyanide	w	X	A		A	D	A	D	A	A	A	A	A	A	A	A				Toxic.
Sodium Flouride	w	SNP SX SMVP			B	C	B	C	A	B	A	A	A	A	D	A	2.56			Toxic, Strong Irritant.
Sodium Hydrosulfide	w*	SNP SX MS	A	A	C	C	C	C	A	C	A	A	D	A	A	A				
Sodium Hydroxide, 0-25% (Caustic Soda - Cold)	*	X MI	A	B	B	B	B	B	A	B	A	B	B	B	B	A	1.53	150		Corrosive if Heated. Use SS or SC Stationary Seat. Special Attention to Sealing. Temperature limit is 212°F for MI pump due to compatibility with PEEK.
Sodium Hydroxide, 26-50% (Caustic Soda - Cold)	*	X SNP SX SMVP MS	B	C	B	B	B	B	A	B	A ¹	B	B	B	B	A	1.53	150		Corrosive if Over 50% Concentration or if Heated. Use SS or SC Stationary Seat. Special Attention to Sealing. Temperature limit is 212°F for MS pump due to compatibility with PEEK.
Sodium Hydroxide, 51-80% (Caustic Soda - Cold)	*	SNP SX SMVP MS	D	D	D	D	D	D	C	D	A ¹	A	B	B	B	A	1.80	200		Limited Vane and Carbon Life. Carbon Vanes Required. Special Attention to Sealing. Temperature limit is 212°F for MS pump due to compatibility with PEEK.
Sodium Nitrate	w	X NP MI	A		A	B	A	B	A	A	A	A	B	A	B	A	2.27			
Sodium Peroxide	w	X	A		A	D	A	D	A	A	A	A	B	A	B	A	2.81			Explosion Risk, Strong Oxidizer.
Sodium Silicate	*	NP MI	A	D	A	C	A	C	A	A	A	A	A	A	A	A	1.56	Wide Range		Check Viscosity, Keep Air Out - Will Crystallize.
Sodium Sulfate	*	SNP SX MS	A		B	B	B	B	A	B	A	A	A	A	A	A	1.46			Melts @ 91°F (33°C), Water Soluble.
Sodium Sulfide	w	X	A		B	D	B	D	A	C	C	A	A	A	A	A	1.86			Keep <30% Concentration, and <150°F (66°C).
Sodium Thiosulfate		SNP SX MS	A		D	D	D	D	A	D	A	A	B	A	A	A	1.73			Melts @ 118°F (48°C).
Sorbitol, 70%		NP	A		A	A	A	A		A	A					A	1.47			Melts @ 200°F (93°C).
Soybean Oil		X NP MI	A	A	A	A	A	A	A	A	A	A	A	A	C	A	.93	350		Unrefined may be Abrasive.
Stannic Chloride		NO PUMP	A		D	D	D	D	A	D	D	A	A	A	D	A	2.28		Low	Toxic.
Stannous Chloride			A		D	D	D	D		D	B		A	A	A	A	2.71	Solid		Tin Crystals, Soluble in Water.
Starch	w		A		C	A	C	A	A	C	A	A	A	A	A	A	1.50	100-100,000		Check Viscosity and Abrasiveness. Consult Factory.

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Liquid	Pump Type	MATERIAL COMPATIBILITY														Specific Gravity	Viscosity SSU at 70°F	Vapor Pressure PSI at 100°F	Notes	
		VANES				SEAL FACES					ELASTOMERS									
		Duravane®	Laminate	Iron	Bronze	Iron	Bronze	Carbon	Steel	Stainless	Silicon Carbide	Buna-N	FKM (69% F)	Neoprene	PTFE					
Stoddard Solvent	X	A	A	A	A	A	A	A	A	A	A	A	A	B	A	.78	30	3		
Styrene Monomer (Vinyl Benzene) *	X NP MI	A		A	B	A	B	A	A	A	A	D	B	D	A	.90				
Sulfonic Acids	W	SNP SX SMVP MS	A		D	B	D	B	B	D	B	A	D	B	B	A	Varies		Some Types O.K. with Iron. Some Types Toxic. Seal-less, Consult Factory.	
Sulfur Chloride		NO PUMP			D	D	D	D	A	D	D	A	D	A	D	A	1.69		Toxic. Reacts with Water.	
Sulfur Dioxide, SO2		SGL	A	A	B	B	B	B	A	A	B	A	D	D	C	A	1.43	30	90	Use PTFE or EPDM O-Rings Only. Very Toxic. Very Corrosive if with Water. Consult Factory for SGL pump.
Sulfuric Acid (Cold, Over 96%) *		NP SNP SX MS	B	D	B	B	B	B	C	B	A	A	D	A	D	A	1.84	150		Keep Pump Full or Clean, Iron Vanes Recommended, Run Slow **.
Sulfuric Acid (Cold 20-96%)		NO PUMP	B	D	D	D	D	D	A	D	D	A	D	A	D	A	1.75	200		Corrosive.
Sulfuric Acid, (Cold, 0-20%)		SNP SX SMVP MS	A	D	D	B	D	B	B	D	A	A	D	A	C	A	1.50			
Sulfur, Molten Dry Only		NP	A		A	D	A	D	A	A	A	A	D	A	C	A	2.00	Solid		Temperature Critical, Melts @ 250°F (121°C), Viscosity 50 SSU @ 320°F (160°C), 50,000 SSU @ 375°F (191°C), Run Slow **.
Sulfurous Acid		SNP SX SMVP MS	A		D	D	D	D	A	D	B¹	A	B	A	B	A	1.03	50		Toxic, Strong Irritant. Seal-less, Consult Factory.
Tallow, Hot		NPJ	A		B		B		A	B	A	A	A	A		A	.86	Solid		Melts @ 70-130°F (21 - 54°C).
Tannic Acid	W	CF	A		A	A	A	A	A	A	A	A	A	A	B	A	1.70		Low	Known Carcinogen.
Tartaric Acid		SNP SX MS	A		C	A	C	A	A	D	A	A	A	A	B	A	1.76	Solid		Water Soluble.
Tetrachloroethane		X			A	A	A	A	A	A	A	A	D	A	D	A	1.59		Low	SS or SC Stationary Seat Preferred.
Titanium Dioxide Slurry *		ML XLW			A	A	A	A	A	A	A	A	A	A	A	A				Some Slurries too Abrasive. Use Hardened Parts, Slow Speed.
Toluene		X	A	A	A	A	A	A	A	A	A	A	D	A	D	A	.87	30	Low	
Toluene Diisocyanate (TDI)		CF	A	A	A	A	A	A	A	A	A	A	D	B	D	A	1.22	100-500	1	Avoid Air Contact. Toxic.
Trichloroethane *		X	C	A	B	A	B	A	A	A	A	A	D	A	D	A	1.44	30	4	Use SS or SC Stationary Seat. Keep Dry.
Trichloroethylene		X	B		B	B	B	B	A	B	A	A	C	A	D	A	1.47	30	3	Boils @ 164°F (73°C), Use SS or SC Stationary Seat, Keep Dry.
Triethanolamine		X	A		A	C	A	C	A	A	A	A	C	D	B	A	1.13	30		Melts @ 70°F (21°C). Consult Factory if over 150°F (66°C)

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Triethylene Glycol	X NP MI	A		A	A	A	A	A	A	A	A	A	A	A	1.13	250		PTFE seals not recommended.	
Turpentine	X	A		A	A	A	A	A	A	A	A	A	A	D	A	.87	50	Low	
Varnish	NP SNP SX MS	A		C	A	C	A	A	C	A	A	B	A	D	A	.90	1,500+		Check Viscosity.
Vegetable Oil	X NP MI	A		B	B	B	B	A	B	A	A	A	A	D	A	.93	1,000		
Vinyl Acetate *	X	A		A	C	A	C	A	A	A	A		D		A	.93	30	4	
Vinyl Chloride	SGL																		Consult Factory.
Water, Clean	SNP SX MS	A	B	C	A	C	A	A	C	A	A	A	B	B	A	1.00	30		Duravanes Not Recommended due to Non-lubricity, Use EC Laminate Vanes, Run Slow.**
Wine	SNP SX MS	A		D	D	D	D	A	D	A	A	A	A	A	A	.96	30	1	
Wollastonite				A		A		A		A	A		A		A		1,000-10,000		Very Abrasive. Consult Factory.
Xylene/Xylol	X	A	A	B	A	B	A	A	B	A	A	D	A	D	A	.86	30	Low	
Zinc Chloride	SNP SX MS	A	A	C	B	C	B	A	C	A	A	A	A	A	A	2.91	Solid		Determine Solvent.
Zinc Hydrosulfite	SNP SX MS	A		B	D	B	D	A	B	A	A	A	A	A	A			Low	
Zinc Sulfate *	SNP SX MS	A		C	C	C	C	A	C	A	A	A	A	A	A	1.96			

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NOTES:



PSG Grand Rapids
1809 Century Avenue SW
Grand Rapids, MI 49503-1530
USA

P: +1 (616) 241-1611

F: +1 (616) 241-3752

info@blackmer.com

blackmer.com



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