CHEMICAL RESISTANCE CHART

شرکت پمپ جت
PUMP JET Co.

CHEMICAL RESISTANCE DATA

These recommendations are based upon information from material suppliers and careful examination of available published information and are believed to be accurate. However, since the resistance of metals, plastics and elastomers can be affected by concentration, temperature, presence of other chemicals and other factors. **This information should be considered as a general guide rather than an unqualified guarantee. Ultimately, the customer must determine the suitability of the pump used in various solutions.**

All recommendations assume ambient temperatures unless otherwise noted.

RATINGS — CHEMICAL EFFECT

A — No effect—Excellent
B — Minor effect—Good
C — Moderate effect—Fair
D — Severe effect—Not recommended

FOOTNOTES

1. P.V.C. — Satisfactory to 72° F.
2. Polypropylene — Satisfactory to 72° F.
3. Polypropylene — Satisfactory to 120° F.
4. Buna-N — Satisfactory for “O” Rings
5. Polyacetal — Satisfactory to 72° F.
6. Ceramag — Satisfactory to 72° F.

The ratings for these materials are based upon the chemical resistance only. Added consideration must be given to pump selections when the chemical is abrasive, viscous in nature, or has a Specific Gravity greater than 1.1.

NOTE: The materials shown below in **BOLDFACE TYPE** are used in the construction of Little Giant chemical pumps.

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (CYCOLAC®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET “A”**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Acetaldehyde[5]	A	A	A		B	**A**	**A**	D			C		D	D	A		A	A	D	C	**B**	**A**	**A**	**A**		**D**	**B**	B	D	B	C	A
Acetamide		B	A								C						B							**A**		**A**	**A**		A	A	D	A
Acetate Solvent[2]	A	B	A	B	B			A	C	B	A		B	D	A			A		B	**D**		**A**	**A**		**D**	**D**		D			A
Acetic Acid, Glacia[1]		B	A	A	B	**A**	**A**	C	C	D	A		C	B	A	C	D	D	D	B	**B**	**A**	**A**	**A**		**D**	**D**	B	C	B	C	B
Acetic Acid 20%		B	A			**A**	**A**		C			**A**	B		A	A		D			**A**	**A**		**A**		**A**	**C**		C			B
Acetic Acid 80%		B	A			**A**	**A**		C			**A**	D		A	B		D			**B**			**A**		**A**	**C**		D			B
Acetic Acid		B	A	B	B	**A**	**A**	C	C	D	C	**B**	A	B	A	A	D	D	C	B	**A**	**A**	**A**	**A**		**C**	**C**		C	B	C	A
Acetic Anhydride	B	A	A	B	B	**A**	**A**	C	D	B	D	**D**	D	D	A	D	D	D	D	A	**A**	**A**	**A**	**A**		**D**	**A**	C	B	B	C	A
Acetone[6]	A	A	A	B	A	**A**	**A**	A	A	A	A	**D**	D	D	A	D	B	A	D	C	**B**	**A**	**A**	**A**	**A**	**D**	**D**	B	C	A	D	B
Acetyl Chloride		C	A					D							A							**A**				**A**					A	A
Acetylene[2]	A	A	A	A	A	**B**		B		A	A		B				A	A			**D**	**A**	**A**	**A**		**A**	**A**	C	B	A	C	A
Acrylonitrile	A	A	C		B	**B**	**B**	A		C							B		D		**B**	**A**	**A**	**A**		**C**	**D**		D	D		A
Alcohols: Amyl	A	A	A		C	**A**	**A**	A	B	C	C	**A**	A	B	A	C	A	A	B	B	**B**	**A**	**A**	**A**		**A**	**A**	D	A	A	C	A
Benzyl		A	A		B	**A**	**A**	A	C				D	B		A	A	A	D	D	**A**		**A**	**A**		**A**	**D**		B	B	D	A
Butyl	A	A	A		B	**B**	**A**	B	C	C	C	**A**	A	B	A	A	A	A		B	**B**	**A**	**A**	**A**		**A**	**A**	D	A	A	A	A
Diacetone[2]		A	A		A	**A**	**A**	A	C		A		D			A	A	A			**D**		**A**	**A**		**D**	**D**		D	A	D	A
Ethyl		A	A	A	B	**A**	**A**	A	C	A	A		A	C		A	B	A	B	B	**A**		**A**	**A**	**A**	**A**	**A**	B	A	B	A	A
Hexyl		A	A		A	**A**	**A**	A	C		A					A	A	A			**A**		**A**	**A**		**A**	**A**	D	B	A	A	A
Isobutyl		A	A		B	**A**	**A**	A	C		A					A	A	A	B		**A**		**A**	**A**		**A**	**C**	B	A	A	A	A

A — No effect — Excellent
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1. **P.V.C. — Satisfactory to 72° F.**
2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (CYCOLAC®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Alcohols: Isopropyl		A	A		B	**A**	**A**	A	C	C	A					A	A	A			**A**		**A**	**A**		**A**	**C**	C	B	A	A	A
Methyl[6]		A	A	A	B	**A**	**A**	A	C	A	A		B		A	A	C	A	D	B	**A**		**A**	**A**	**A**	**C**	**B**		A	A	A	A
Octyl		A	A		A	**A**	**A**	A	C		A					A	A	A					**A**	**A**		**A**	**B**		B	A	C	A
Propyl		A	A		A	**A**	**A**	A			A	**B**	A		A	A	A	A			**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Aluminum Chloride 20%		D	C	D	B	**A**	**A**	D		D	A		A	B		A	C	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	A	A
Aluminum Chloride	C	D	C		D	**C**	**A**	C		D	B	**A**	A	A	A	A		D			**A**	**A**	**A**	**A**		**A**	**A**	C	A			A
Aluminum Fluoride		D	C	D		**D**	**B**				A	**A**	A		A	A	C	D		B	**A**		**A**			**A**	**A**	C	A		C	A
Aluminum Hydroxide[6]		A	A	A	A			A		D	A		A		A	A	B	A			**A**		**A**	**A**	**A**	**A**	**A**		A		A	A
Aluminum Potassium Sulfate (Alum), 10%		A			A		**B**			D	A		A		A			A		A			**A**	**A**		**A**			A		A	A
Aluminum Potassium Sulfate (Alum), 100%		D	A	B	B		**B**	C			A		A	B	A	A	C	D		B	**A**		**A**	**A**		**A**	**A**		A		A	A
Aluminum Sulfate		C	C	A	A	**A**	**A**	C	C	D	A	**A**	A	B	A	A	C	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	A	A
Amines	A	A	A		A	**B**	**A**	B		A	B		C	A	A	B	D	A					**A**	**A**		**D**	**D**	C	B	B	C	A
Ammonia 10%			A			**A**	**A**					**D**	A		A	A		A			**A**	**A**		**A**		**A**	**D**		A			B
Ammonia, Anhydrous	A	B	A	A	B	**B**	**A**	D		D	B	**D**	A	B	A	A	D	A		B	**A**	**B**	**C**	**A**		**D**	**B**	B	A	A	D	A
Ammonia, Liquids		A	A	A	D		**B**	D		A	A		A	B	A	A	D			D	**A**		**A**	**A**		**D**	**B**	B	A	A	D	A
Ammonia, Nitrate		A	A	A	C			D			A		B	B		A	C				**A**		**A**	**A**			**A**		C			A
Ammonium Bifluoride		C	A		D		**B**						A			A	D				**A**			**A**		**A**	**A**		A			A
Ammonium Carbonate	B	A	A	A	C	**A**	**B**	B		C	B		A	B	A	A	D	A			**A**		**A**	**A**		**B**	**D**	C	A	A		A
Ammonium Casenite			A													A	D												A			A
Ammonium Chloride	C	A	C	A	C	**D**	**A**	D	C	D	D	**A**	A	B	A	A	B	A		B	**A**	**A**	**A**	**A**		**A**	**A**	C	A	A	A	A
Ammonium Hydroxide	A	A	A	A	C	**A**	**A**	D	D	A	C		A	B	A	A	D	A	B	B	**A**	**A**	**A**	**A**		**B**	**B**	B	A	A	C	A
Ammonium Nitrate	A	A	A	A	B	**A**	**A**	D	D	A	D		A	B	A	A	C	D		B	**A**	**A**	**A**	**A**		**D**	**A**	C	A	A	A	A
Ammonium Oxalate		A	A	A			**A**				A						B						**A**				**A**		A			A
Ammonium Persulfate		A	A	A	C	**C**	**A**	A		D	A	**D**	A		A	A	D	D			**A**		**A**	**A**		**C**	**A**		A	A	A	A
Ammonium Phosphate, Dibasic	B	A	A	A	B	**A**	**A**	C			D		A		A	A	B	A		B	**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Ammonium Phosphate, Monobasic		A	A	A	B	**A**	**A**	D			A		A	A	A	A	B	A		B	**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Ammonium Phosphate, Tribasic	B	A	A	A	B	**A**	**A**	C		C	D		A		A	A	B	A		B	**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Ammonium Sulfate	C	D	B	A	B	**A**	**A**	B	C	C	C	**A**	A	D	A	A	B	D		B	**A**	**A**	**A**	**A**		**D**	**A**	B	A	A	A	A
Ammonium Thio-Sulfate			A			**A**				D	A						B						**A**	**A**			**A**		A			A
Amyl-Acetate	B	A	A	C	B	**A**	**A**	C			C	**C**	D	D	A	D	A	B		D	**D**	**A**	**A**	**A**		**D**	**D**	D	D	A	D	A
Amyl Alcohol		A	A		B	**A**	**A**	A			A	**A**	A	B	A	C	A	A		B	**A**		**A**	**A**		**B**	**B**	D	A	A	C	A
Amyl Chloride		C	B		D		**A**	A			A	**A**	D	C	A	D	A	C		D	**D**		**A**	**A**		**A**	**D**		D	D	D	A
Aniline	B	A	A	A	C	**A**	**B**	C			C	**C**	D	D	A	D	D	C	D	C	**B**	**A**	**A**	**A**		**C**	**D**	C	D	B	D	A
Antifreeze		A	A		A		**A**	B	B	B	C		A	B	A	A	A	A	B	B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	C	A	A	A	A
Antimony Trichloride		D	D		D	**C**	**A**						A	A	A			D		A				**A**		**A**			C		A	A
Aqua Regia (80%, HCL, 20%, HNO)		D	D		D	**A**	**D**	D				**C**	D	D	A	D	D	D		D	**C**			**D**		**C**	**D**	C	D	D	D	D
Arochlor 1248											A					D							**A**			**A**	**D**		D	B	D	A
Aromatic Hydrocarbons			A		A			A		A	A		D			D	A			C			**A**			**A**	**D**		D	D	D	A
Arsenic Acid	B	A	A		D			D	B	D	D	**A**	A	B	A	A	D	A		B	**A**		**A**	**A**		**A**	**A**		A		C	A
Asphalt		B	A		C			A		C			A				A	A			**A**	**A**		**A**	**A**	**A**	**B**	C	B	D	D	A
Barium Carbonate	B	A	A	A	B	**A**	**A**	B		B	B		A	A	A	A	A	A		B	**A**		**A**	**A**	**A**	**A**	**A**		A		A	A
Barium Chloride	C	D	A	A	D	**A**	**A**	B			C	**A**	A	B	A	A	A	B		B	**A**	**A**	**A**	**A**		**A**	**A**	B	A	A	A	A
Barium Cyanide			A					C			A						B			B			**A**			**A**	**C**		A	A		A
Barium Hydroxide	B	C	A	A	D	**B**	**B**	B		C	C	**A**	A		A	A	D	A		B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	C	A	A	A	A

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Barium Nitrate		A	A			**A**		D		A	A		B			A	A						**A**	**A**		**A**	**A**		A	A		B
Barium Sulfate	B	A	A	A	D	**A**	**A**	C		C	C	**A**	A		A	A	A	A		B	**A**	**A**	**A**	**B**		**A**	**A**	D	A	A		B
Barium Sulfide	B	A	A		D	**B**		C		C	C		A	A	A	A	A	A		B	**A**		**A**	**A**		**A**	**A**	C	A	A	A	A
Beer[2]	A	A	A		A	**A**	**A**	A	B	D	D	**A**	A		A	A	B	D	B	B	**D**		**A**	**A**		**A**	**D**	C	A	A	A	A
Beet Sugar Liquids	A	A	A		A			A	B	A			A		A	A	B	A	B		**A**		**A**	**A**		**A**	**A**		B	A	A	A
Benzaldehyde[3]	A	A	A		B	**A**	**A**	A		B	A	**C**	D	D	A	D	A	C	D	D	**D**	**A**	**A**	**A**		**D**	**D**	B	D	A	D	A
Benzene[2]	B	A	A	A	B	**A**	**B**	B	A	B	C	**B**	D	C	A	D	A	A	D	D	**D**	**A**	**A**	**A**	A	**A**	**D**		D	D	D	A
Benzoic Acid[2]	B	A	A	A	B	**A**	**A**	B		D		**A**	A	B	A	A	B	D		B	**D**		**A**	**B**		**A**	**D**		D	D	D	A
Benzol		A	A		B	**A**	**A**	B	A				D		A	D	A	A			**A**		**A**	**A**	A	**D**	**D**		D			A
Borax (Sodium Borate)		A	A	A	C	**B**	**A**	A	B	A	C	**A**	A	A	A	A	A	A		B	**A**	**A**	**A**	**A**	A	**A**	**B**	C	A	A	C	A
Boric Acid	B	A	A	A	B	**A**	**A**	B	C	D		**A**	A	B	A	A	A	A		B	**A**		**A**	**A**	A	**A**	**A**		A	A	A	A
Brewery Slop			A					A		A							A						**A**	**A**		**A**	**A**		A			A
Bromine[2] (wet)	D	D	D	D	D	**A**	**A**	C		D	D	**A**	B	B	A	D	D	D	D	D	**D**	**D**	**D**	**A**	D	**A**	**D**	D	D	D	D	C
Butadiene	A	A	A		A			C	A	C	C	**A**	A		A		A	A				**B**	**A**	**A**		**A**	**A**		B	A		A
Butane[2] [1]	A	A	A		A			A	A	C	C	**A**	A	C	A	D	A	A	B	C	**D**	**A**	**A**	**A**		**A**	**A**	D	B	D	D	A
Butanol		A	A		A		**A**	A							A																
Butter		B	A		A			D		D				B		B	A		B				**A**	**A**		**A**	**A**		B	A	D	A
Buttermilk	A	A	A	A	A			D		D				B	A	A	A	A	B				**A**	**A**		**A**	**A**		A		D	A
Butylene	A	B	A		A			A	A	A	A		B		A		A					**A**	**A**	**A**		**A**	**B**			D	D	A
Butyl Acetate[1]			C		A		**A**	A			A	**C**	D	D	A	D	A			C	**D**	**A**	**A**	**A**		**D**	**B**	D	D	B	D	A
Butyric Acid[1]	B	B	A	A	B	**A**	**A**	C		D		**A**	B		A	A	C	D	D		**A**		**A**	**D**		**D**	**D**		D	B		A
Calcium Bisulfate	C	D	A		D			D	D	D			A	A	A			A								**A**	**A**	C	C		A	A
Calcium Bisulfide			B		C	**A**	**A**	C					A		A	A	D	A		B	**A**		**A**	**A**		**A**	**A**		A	D		A
Calcium Bisulfite		B	A		C	**A**	**A**	C				**A**	A		A	A		A			**A**			**A**		**A**	**A**		A		A	
Calcium Carbonate	B	A	A	A	C	**A**	**A**	C		D			A	A	A	A	A	A		B	**A**		**A**	**A**		**A**	**A**		A		A	A
Calcium Chlorate		B	A			**B**	**B**	C					A	A	A			A		A			**A**			**A**			A		A	A
Calcium Chloride	C	A	D	C	C	**A**	**A**	B		C		**A**	A	A	A	A	D	A	B	B	**A**	**A**	**A**	**A**	B	**A**	**A**	B	D	A	A	A
Calcium Hydroxide	B	A	A		C	**A**	**A**	B					A	A	A	A	B	A		B	**A**		**A**	**A**	A	**A**	**A**	C	A	A	A	A
Calcium Hypochlorite	D	D	C	C	C	**A**	**B**	D		D		**A**	D		A	A	D	D		B	**A**		**A**	**A**		**A**	**B**	C	D	A	C	A
Calcium Sulfate	B	A	A	A	B	**A**	**B**	B				**A**	A	A	A	A	A	A	C	B	**A**	**A**	**A**	**A**		**A**	**A**		D		C	A
Calgon		A	A					C		D						A	B				**A**		**A**	**A**		**A**	**A**		A			A
Cane Juice[2]		A	A		B			B	C	A			A				A	A			**D**		**A**	**A**			**A**		A		A	A
Carbolic Acid (See Phenol)																																
Carbon Bisulfide[2]	B	A	A	A	A			C		B			D	D			A	A			**D**		**A**	**A**	A	**A**	**D**		D	D	D	A
Carbon Dioxide (wet)		A	A		C		**A**	C	C	C					A								**A**	**A**								
Carbon Disulfide[2]		B	A		C			C	C	B	C		D	C	A	D	A	A		D	**D**	**A**	**A**	**B**		**A**	**D**		D	D	D	A
Carbon Monoxide		A	A		A								A			B	A	A		B	**A**		**A**	**A**		**A**	**A**	B	B	A	C	A
Carbon Tetrachloride[2] [1]	B	B	B	A	C	**A**	**A**	C	A	C	D	**A**	C	C	A	D	A	A	D	D	**D**	**C**	**A**	**A**	A	**A**	**C**	C	D		D	C
Carbonated Water	B	A	A	A	A			B		D			A			A	A	A			**A**		**A**	**A**		**A**	**A**		A	A		A
Carbonic Acid	B	A	B	A	A		**A**	B		D		**A**	A		A	A	A	A		B	**A**		**A**	**A**		**A**	**B**	B	A	A	A	A
Catsup		A	A	A	D			C		D			A			A	B	A	B		**A**		**A**	**A**		**A**	**A**		C			A
Chloracetic Acid[2]	D	D	D	D	C	**A**	**A**	D		D		**D**	A	D	A		D	D		D	**D**		**A**	**A**		**D**	**D**		D	B	D	B
Chloric Acid		D	D										D		A												**D**		D			D
Chlorinated Glue		A	A		D			C		D						C		C	D					**A**		**A**	**C**		D	B	D	A

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1. **P.V.C. — Satisfactory to 72° F.**
2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Chlorine, Anhydrous Liquid		D	D	D	D	**D**	**A**	D		C			D	B	A	A	D	D		D	**D**	**C**	**A**	**D**		**A**	**D**		D	B	D	B
Chlorine (dry)	B	A	A		D	**D**	**A**	A	B	A					A							**C**	**A**	**A**		**D**			D		D	D
Chlorine Water	D		D		D	**A**	**B**	D	D	D		**A**	A		A	C		D			**D**	**C**	**C**	**A**		**A**	**D**	C	D			
Chlorobenzene (Mono)	A	A	A		B		**A**	B		B	C	**A**	D	D	A	D	A	A	D	D	**D**	**A**	**A**	**A**		**A**	**D**		D	D	D	A
Chloroform	A	A	A	A	D	**A**	**A**	B		D	C	**C**	D	C	A	D	A	C	D	D	**D**	**C**	**A**	**A**	**A**	**A**	**D**	D	D	D	D	A
Chlorosulfonic Acid[1]	D	D		D	D	**A**	**B**	D			D	**D**	C	C	A	D	D	D		D	**D**	**D**		**C**		**D**	**D**	D	D	D	D	C
Chlorox (Bleach)		A	A		C		**A**	A		D	C		A	B	A	A	D	D	B		**D**	**C**	**A**	**A**		**A**	**C**		B	B	D	A
Chocolate Syrup		A	A		A					D						A	A	A			**A**			**A**		**A**	**A**		A		D	A
Chromic Acid 5%		A	A	B	C	**A**	**A**	D	D	D			A	B		C	D	D	B	B	**A**	**A**	**D**	**C**		**A**	**D**	C	D	A	B	B
Chromic Acid 10%		B				**A**	**A**		D			**A**	A		A	A		D			**A**			**A**		**A**	**D**		D			C
Chromic Acid 30%		B				**A**	**A**		D			**B**	A		A	D		D			**A**			**A**		**A**	**D**		D			D
Chromic Acid 50%	C	B	B		C	**A**	**A**	D	D	D		**C**	B	B	A	D	D	D	C	C	**B**	**B**	**D**	**A**		**A**	**D**		D	A	D	C
Cider		A	A	A	B			A		D			A			A	B			B			**A**	**A**		**A**	**A**		A			A
Citric Acid		A	A	A	C	**A**	**A**	D	C	D		**A**	A		A	A	B	C	C	B	**B**		**A**	**A**	**B**	**A**	**D**	C	A	A	A	A
Citric Oils		A	A		C			B								A	B				**A**		**A**	**A**		**A**	**A**	C	D			A
Coffee	A	A	A	A	A			B		C					A	A	A	A			**A**		**A**	**A**		**A**	**A**		A		A	A
Copper Chloride	C	D	D	B	D	**A**	**A**	D		D		**A**	A	B	A	A	B	D		B	**A**	**A**		**A**		**A**	**A**		A	A	A	A
Copper Cyanide		A	A	A	D	**A**	**A**	C		D		**A**	A		A	A	B	A		B	**A**	**A**	**A**	**A**		**B**	**B**		A	A	A	C
Copper Fluoborate		D	D		D		**B**	D		D			A		A		B			A			**A**			**A**	**B**		A		A	A
Copper Nitrate	B	A	A	B	D	**A**	**A**	D				**A**	A		A	A	B	D		B	**A**		**A**	**A**		**A**	**A**		A			A
Copper Sulfate (5% Solution)		A	A	A	D	**A**	**A**	D	D	D			A		A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**A**	C	A		C	A
Copper Sulfate	B	B				**A**	**A**	C	D			**A**	A		A	A		C			**A**			**A**		**B**	**B**		A	A		A
Cream		A	A		A			C		D						A	A	A			**A**		**A**	**A**		**A**	**A**		C			A
Cresols[2]		A	A		B			D	C				D	D			D		D	D	**C**	**A**	**A**	**A**		**D**	**D**	D	D	D	D	A
Cresylic Acid	B	A	A		C	**A**	**B**	C				**B**	B	D	A		D	D		C			**A**	**A**		**A**	**D**		D	D	D	A
Cyclohexane		A			A	**A**		A			A			D		D	A				**D**	**A**	**A**	**A**		**A**	**A**	D	D	D	D	A
Cyanic Acid		A															D										**C**		D			A
Detergents		A	A		A			A			A		A			A	B	A	B	B	**A**		**A**	**A**		**A**	**A**		B	A	C	A
Dichlorethane		A	A				**A**						D	D	A			A		D						**B**			D		D	A
Diesel Fuel	A	A	A		A			A		A	A					D	A				**D**	**A**	**A**	**A**		**A**	**A**		D	D	D	A
Diethylamine	A	A			A			A					D		A	B	D				**C**		**A**	**A**		**D**	**B**		B	B	C	A
Diethylene Glycol		A						A								A	A	A	B	B			**A**	**A**		**A**	**A**	C	A	A	A	A
Diphenyl Oxide		A						A									A						**A**	**A**		**A**	**D**		D	D	D	A
Dyes		A	A		B			C								A	A									**A**			C			A
Epsom Salts (Magnesium Sulfate)	B	A	A	A	A	**A**	**B**	B					A			A	A				**A**		**A**	**A**		**A**	**A**		A		C	A
Ethane	A	A			A			A								D	A						**A**	**A**		**A**	**A**		B	D	D	A
Ethanolamine		A	A								C						D					**A**	**A**	**A**		**D**	**B**	C	B		C	A
Ether[3]	A	A	A	A	A		**B**	B	A		B		D	C		D	A	C				**A**	**A**	**A**	**A**	**C**	**D**		D	C	D	A
Ethyl Acetate[2]		A	A		B		**B**	B			C	**D**	D	D	A	D	A	A	D	C	**C**	**A**	**A**	**A**		**D**	**D**	C	D	B	D	A
Ethyl Chloride		A	A	A	B	**A**	**B**	B		C	D	**A**	D	D	A	D	A	A		D	**D**	**A**	**A**	**A**		**A**	**D**	D	C	A	A	A
Ethyl Sulfate		D															B						**A**	**A**		**A**	**A**					A
Ethylene Chloride[2]		A	A		C	**B**	**B**	A		C	C		D		A	D	A		D		**D**	**A**	**A**	**A**		**A**	**D**	D	D	C	D	A
Ethylene Dichloride		A	A		D	**A**	**B**	C			C		D	D	A	D	A	A		D	**A**	**A**	**C**	**A**		**A**	**D**	D	D	C	D	A
Ethylene Glycol[4]		A	A		A		**A**	B	B	B	C	**A**	A	B	A	A	A	A	B	B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	C	A	A	A	A

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2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
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	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Ethylene Oxide			A		A			A					D		A	A	A	A					**A**	**A**		**D**	**D**	D	D	C	D	A
Fatty Acids		A	A		B	**A**	**A**	C		D		**A**	A	B	A	B	A	A		B	**A**		**A**	**A**		**A**	**C**	C	B	C	C	A
Ferric Chloride		D	D	D	D	**A**	**B**	D	D	D		**A**	A	B	A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**D**	C	B	A	A	A
Ferric Nitrate		A	A	A	D	**A**	**A**	D				**A**	A		A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**A**	D	A	A	A	A
Ferric Sulfate		A	C	A	D	**A**	**A**	D	D	D		**A**	A	B	A	A	B	A	C		**A**	**A**	**C**	**A**		**A**	**B**	C	A		A	A
Ferrous Chloride		D	D		D	**A**	**B**	C		D		**A**	A	B	A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**B**	C	A		A	A
Ferrous Sulfate	B	A	C		D	**A**	**B**	C		D	D	**A**	A	B	A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**B**		A		A	A
Fluoboric Acid		D	B			**D**	**A**			D		**A**	A	B	A	B	B	C		B	**A**		**A**	**D**		**A**	**B**		A			A
Fluorine	D	D	D		D	**D**	**A**	D		D	D		C		C			D		C			**D**									D
Fluosilicic Acid			B		D	**D**	**B**			D		**A**	A	B	A	A	B	D		B	**A**		**A**	**D**		**B**	**A**		A			C
Formaldehyde 40%			A			**A**	**A**					**B**	B		A	A		D			**A**	**A**		**A**		**D**	**B**	B	A			A
Formaldehyde	A	A	A		A	**A**	**B**	A	B	D	A		A	B	A	D	A	A		B	**A**	**A**	**A**	**A**		**D**	**C**	B	D	B	C	A
Formic Acid[6]	C	A	B	B	D	**C**	**A**	C	C	D	D	**A**	D	B	A	A	D	D		B	**A**	**A**	**A**	**A**	**B**	**B**	**D**	C	D	A	C	B
Fruit Juice	A	A	A	A	B			B		D	D		A		D	A	B	A		B	**A**		**A**	**A**	**A**	**A**	**A**		A			A
Fuel Oils	A	A	A		A	**A**	**A**	B		C	B	**A**	A		A	A	A	A		D	**B**	**A**	**A**	**A**		**A**	**A**	C	B	D	D	A
Furan Resin		A	A		A			A		A	A				A		A					**A**		**A**		**A**	**D**		D		D	A
Furfural[1]	A	A	A		A		**B**	A			A	**D**	D		A	D	B	A	D	D	**D**	**A**	**A**	**A**		**D**	**D**	D	D	B	D	A
Gallic Acid	B	A	A		A		**A**	A		D	D		A	A	A			A								**B**	**A**					
Gasoline[1] [4]	A	A	A	A	A	**D**	**A**	A		A	A	**A**	C		A	D	A	A	D	D	**C**	**A**	**A**	**A**	**A**	**A**	**A**	D	D	C	D	A
Gelatin	A	A	A	A	A		**A**	A	C	D	D		A		A	A	A	A			**A**		**A**	**A**		**A**	**A**		A	A	A	A
Glucose	A		A		A			A	A	B	B		A	B	A	B	A	A	B	B	**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Glue P.V.A.[1]	B	B	A		B	**A**		A			A		A	B	A		A	A					**A**	**A**		**A**	**A**		A			A
Glycerine	A	A	A	A	A	**A**	**A**	A	B	B	B	**A**	A	B	A	A	A	A	C		**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Cycolic Acid							**A**							A		A	C			B	**A**	**A**	**A**			**A**	**A**		A			A
Gold Monocyanide			A					A		D							A						**A**	**A**		**A**	**A**		A			A
Grape Juice		A	A		B			B		D			A			A	B		B	B			**A**	**A**		**A**	**A**		A			A
Grease[4]	A	A	A		A			B		A	A				A		A	A					**A**	**A**		**A**	**A**		D			A
Heptane[1]	A		A		A		**A**	A			B	**A**	A		A	D	A	A	C	D	**D**	**A**	**A**	**A**		**A**	**A**		B	D		A
Hexane[1]	A	A	A		A		**A**	B			B	**A**	C		A	D	A	A	D		**C**	**A**	**A**	**A**		**A**	**A**	B	B	D	D	A
Honey		A	A		A			A		A			A			A	A	A	B		**A**		**A**	**A**		**A**	**A**		A	A		A
Hydraulic Oils (Petroleum)[1]	A	A	A		A			B		A	A				A		A	A			**D**		**A**	**A**		**A**	**A**		B	D	D	A
Hydraulic Oils (Synthetic)[1]		A	A		A			A		A							A	A			**D**		**A**	**A**		**A**	**C**	D				A
Hydrazine		A	A							C							D						**A**			**A**	**B**	D	B	A	C	A
Hydrobromic Acid 20%			D			**A**	**A**					**A**	A		A	A		D			**A**			**B**		**A**	**D**		C			B
Hydrobromic Acid[4]	D	D	D	D	D	**A**	**A**	D		D	D	**A**	A	B	A	C	D	D		B	**B**		**A**	**A**		**A**	**D**	D	D	A	A	A
Hydrochloric/Muratic Acid (Dry gas)	D	C	A		D		**A**				D		A		A								**A**							A		A
Hydrochloric/Muratic Acid (20%)[4]		D	D	D	D	**C**	**B**	D		D		**A**	A	B	A	A	D	D	B	A	**A**	**D**	**A**	**A**	**D**	**A**	**C**		C	A	C	A
Hydrochloric/Muratic Acid (37%)[4]		D	D	D	D	**C**	**B**	D		D		**A**	A	B	A	A	D	D	C	A	**A**	**D**	**A**	**C**	**D**	**A**	**C**	C	C	C	D	A
Hydrochloric/Muratic Acid (100%)		D	D		D	**D**	**C**	D		D			A	A	A			D		A			**A**	**C**		**C**	**D**		C		A	A
Hydrocyanic Acid	A	A	A	C	A	**A**	**A**	D	D		C		A	B	A	A	B	A		B	**A**		**A**	**A**		**A**	**C**		B		A	A
Hydrocyanic Acid (Gas 10%)		D	D										A		A														C	A	C	A
Hydrofluoric Acid (20%)[1]		D	D	D	D	**D**	**B**	D		D			D	B	A	A	D	D		C	**A**	**C**	**B**	**C**	**D**	**A**	**D**		C	A	C	B
Hydrofluoric Acid (75%)[1] [2]		C	D		D	**D**	**C**	D		D		**A**	C	B	A	D	D	D		C	**B**	**C**	**D**	**D**	**D**	**A**	**D**	D	D	C	C	C
Hydrofluoric Acid 100%	D	D	D		D	**D**	**B**	D		D	D		C	D	A					D		**C**	**D**	**D**			**D**		D		D	A

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	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Hydrofluosilicic Acid (20%)		D	D		D	**D**	**B**	A		D			D		A	B	D	D			**A**		**A**	**D**		**A**	**B**		B	A	A	C
Hydrofluosilicic Acid		D	D		C		**C**	D						C	A								**A**					D	A			
Hydrogen Gas	A	A	A		A			A		B	B	**A**	A		A											**A**						A
Hydrogen Peroxide 10%		C	C		A	**C**	**A**	D	D	D			A	A	A			D		A		**B**	**A**	**A**			**A**		D		C	D
Hydrogen Peroxide 30%			B			**B**	**A**		D				A		A			D			**A**	**C**				**A**	**D**		C			B
Hydrogen Peroxide		A	B	A	A	**B**	**A**	D	D	D	D	**C**	A	C	A	B	D	D		B	**A**	**C**		**A**	**A**	**A**	**D**	C	D	C	C	A
Hydrogen Sulfide, Aqueous Solution		D	A	C	C	**A**	**A**	D	C	D		**A**	A	B	A	A	D	D		B	**A**	**A**	**A**	**A**	**A**	**D**	**C**		B	A	D	A
Hydrogen Sulfide (dry)	A	C	A		D		**A**	D	C	B	B		A		A			D				**A**		**A**		**D**					A	A
Hydroxyacetic Acid (70%)					D	**B**							A				D						**A**	**A**		**A**	**A**		A	A		A
Ink	A	A	A		C			C		D	D					B	A	A		B			**A**	**A**	**A**	**A**	**A**		A			A
Iodine		D	D	D	D	**A**	**B**	D		D			D	B	A	A	C	D	D	D	**D**		**D**	**A**		**A**	**B**		D	B	D	A
Iodine (In Alcohol)			B			**D**	**A**						D		A	C		D			**B**			**A**		**A**	**D**		D			
Iodoform	B	C	A		A			C		C	B				A			A								**A**						
Isotane[2]					A											D	A				**D**			**A**		**A**	**A**				D	A
Isopropyl Acetate			B		C												A						**A**	**A**		**D**	**D**		D	B	D	A
Isopropyl Ether[2]	A		A		A			A			A				A	D	A				**D**		**A**	**A**		**D**	**B**		D	D	D	
Jet Fuel (JP#, JP4, JP5)	A	A	A		A			A		A	A	**A**	A		A	D	A	A			**D**	**A**	**A**	**A**		**A**	**A**	D	D	D	D	A
Kerosene[2]	A	A	A	A	A	**A**	**A**	A	A	A	B	**A**	A	D	A	D	A	A	B	D	**D**	**A**	**A**	**A**	**A**	**A**	**A**	D	D	A	D	A
Ketones	A	A	A		B	**A**	**A**	A		A	A	**D**	D	D	A	D	B	A		D	**D**	**A**	**C**	**A**		**D**	**D**		D	D	C	C
Lacquers	A	A	A		A			A	C	C	C			D		C	A	A			**A**		**A**	**A**		**D**	**D**		D		D	A
Lacquer Thinners			A			**A**	**A**		C				C		A	D		A			**B**			**A**			**D**		D	A		
Lactic Acid	A	A	B	C	C	**A**	**A**	D		D	D	**C**	A	B	A	A	B	C		B	**A**	**A**	**A**	**A**		**B**	**B**		A	B	A	A
Lard	B	A	A	A	A			A		A	C		A				A	A	C		**A**		**A**	**A**		**A**	**A**	C	B		D	A
Latex		A	A		A			A								A	A	A		B				**A**		**A**	**A**		C	A		A
Lead Acetate	B	A	A		D	**A**	**A**	C			D		A	B	A	A	A	A		B	**A**		**A**	**A**		**D**	**B**		D	A	A	A
Lead Sulfamate																	A				**A**					**A**	**B**	C	A	D	C	A
Ligroin[3]			A					A								D	A				**D**			**A**		**A**	**A**		B	A	D	A
Lime		A	A		C	**A**		A		A			A			A	D		C				**A**	**A**		**A**	**A**	C	B	D		A
Lubricants		A	A		A	**A**	**A**	B					A		A		A	A	B		**A**	**A**	**A**	**A**		**A**	**A**	C	D		D	A
Magnesium Carbonate		A	A	A			**B**						A			A	A			B	**A**			**A**			**A**		A	A		A
Magnesium Chloride	B	B	B	A	D	**A**	**A**	B	C	D	C		A	B	A	A	A	A		B	**A**	**A**		**A**		**A**	**A**		A	A	A	A
Magnesium Hydroxide	A	A	A		D	**A**	**A**	C	B	B	B	**A**	A		A	A	A	A		B	**A**	**A**	**A**	**A**		**A**	**B**		B		C	A
Magnesium Nitrate		A	A	A		**A**	**A**						A		A	A	A	A		B	**A**			**A**		**A**	**A**		A			A
Magnesium Oxide		A	A														A							**A**			**A**		A	A		A
Magnesium Sulfate	B	B	A		B	**A**	**B**	B	B	C	B		A	B	A	A	A	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	D	C	A
Maleic Acid	C	A	A	A	B	**A**	**A**	C			B		A	B	A	A	C	A			**C**		**A**	**A**		**A**	**D**		A	D	D	A
Maleic Anhydride							**A**										C						**A**	**A**		**A**	**D**		D		D	A
Malic Acid	B	A	A		C		**A**	D			D		A		A			A						**A**		**B**			A		A	
Mash		A	A					A								A	A						**A**	**A**			**A**		A			A
Mayonnaise	A	A	A		D			D		D	D				A	A	A	A	B		**A**		**A**	**A**		**A**	**A**					A
Melamine		D	D					D									D						**A**	**A**			**C**					A
Mercuric Chloride (Dilute Solution)	D	D	D	D	D	**A**	**B**	D	D	D	D		A	A	A	A	A	A		B	**A**		**A**	**A**		**A**	**A**		A	A	A	A
Mercuric Cyanide	A	A	A		D	**A**		D			D		A		A	A	A			B	**A**		**A**	**A**			**A**					A
Mercury	A	A	A	A	C	**C**	**A**	D	D	A	A		A		A	A	A	A		B	**A**		**A**	**A**		**A**	**A**		A	A	A	A

A — No effect — Excellent
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C — Moderate effect — Fair
D — Severe effect — Not recommended

1. **P.V.C. — Satisfactory to 72° F.**
2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon	Cycolac (ABS)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Methanol (See Alcohol Methyl)																																
Methyl Acetate	A		A		A		**A**	A			B				A		A		D				**A**	**A**		**D**	**D**	D	B	B	D	
Methyl Acrylate																	A						**A**	**A**		**D**	**D**		B	B	D	A
Methyl Acetone	A		A		A			A		A	A				A	D	A							**A**		**D**	**D**		D			C
Methyl Alcohol 10%	A		A		C		**A**	C			B		A		A			A									**B**				A	A
Methyl Bromide																	A			D			**A**	**A**		**A**	**B**		D	D	D	B
Methyl Butyl Ketone			A		A											D	B						**A**	**A**		**D**	**D**	C	D	A	D	B
Methyl Cellosolve					A			A								C	B				**A**		**A**	**A**		**D**	**D**		D	B	D	C
Methyl Chloride		A	A		D	**A**	**A**	A				**A**	D		A	D	A	A		D	**D**		**A**	**A**		**A**	**D**	D	D	C	D	A
Methyl Dichloride																D	A						**A**	**A**		**A**	**D**		D	D	D	A
Methyl Ethyl Ketone		A	A		A	**A**	**A**	A				**D**	D		A	D	B	A	D	D	**A**	**A**	**A**	**A**		**D**	**D**	C	D	A	D	B
Methyl Isobutyl Ketone[2]			A			**A**	**A**					**D**	D		A	D	B	A	D		**C**	**A**	**A**	**A**		**D**	**D**	C	D	C	D	B
Methyl Isopropyl Ketone			A													D	B	A					**A**	**A**		**D**	**D**	B	D	B	D	B
Methyl Methacrylate																	A						**A**	**A**		**D**	**D**		D	D	D	A
Methylamine	A		A		A			D		B	B					B	D						**A**	**A**			**B**					A
Methylene Chloride	A	A	A		A	**A**	**A**	A	C		B	**D**	D		A	D	A	D		D	**D**		**A**	**A**		**D**	**D**		D	D	D	A
Milk	A	A	A	A	A			C	C	D	D		A			A	A	A	B	B	**A**		**A**	**A**	**A**	**A**	**A**	B	A	A	A	A
Molasses	A	A	A	A	A			A	B	A	A		A			B	A	A		B	**A**		**A**	**A**	**A**	**A**	**A**		A			A
Mustard	A	A	A	A	B			B		C	B		A			B	B	A	B		**A**		**A**	**A**		**A**	**B**	C	C			A
Naphtha	A	A	A	A	A	**A**	**A**	B		B	B	**A**	A	C	A	D	A	A	C	D	**A**	**A**	**A**	**A**		**A**	**B**	D	D	D	D	A
Naphthalene	B	A	B		B	**A**	**A**	C		B	A	**A**	D		A	D	A			D	**B**	**A**	**A**	**A**		**B**	**D**		D	D	D	A
Nickel Chloride		A	B		D	**A**	**A**	D		D		**A**	A	B	A	A	B	A		B	**A**		**A**	**A**		**A**	**A**		A	A	A	A
Nickel Sulfate	B	A	B		D	**A**	**B**	C	C	D	D	**A**	A	A	A	A	B	A		B	**A**		**A**	**A**		**A**	**A**		A	A	C	A
Nitric Acid (10% Solution)	A	A	A	A	D	**A**	**A**	D		D	D	**A**	A	B	A	A	D	D	C	B	**A**	**D**	**C**	**B**	**D**	**A**	**D**		D	B	D	A
Nitric Acid (20% Solution)		A	A	A	D	**A**	**A**	D		D		**B**	A	B	A	A	D	D	D	B	**A**	**C**	**D**	**C**	**D**	**A**	**D**		D	D	D	B
Nitric Acid (50% Solution)		A	A	A	D	**A**	**A**	D		D		**B**	A	B	A	A	D	D	D	C	**D**	**C**	**D**	**A**		**A**	**D**		D	D	D	D
Nitric Acid (Concentrated Solution)		D	B	A	B	**A**	**B**	D	D	D			D	C	A	D	D	D	D	D	**D**	**C**	**D**	**A**	**C**	**B**	**D**		D	D	D	D
Nitrobenzene[2]	B	A	B		C	**A**	**B**	D		B	B	**D**	D	D	A	D	B	C	D	D	**C**	**B**	**A**	**A**		**D**	**D**	D	D	D	D	B
Oils: Aniline		A	A		C	**A**	**D**	A		A			D		A	D	D	C	D		**A**		**A**	**A**		**A**	**D**		D	B	D	A
Anise		A	A														A						**A**	**A**					D			A
Bay		A	A														A						**A**	**A**		**A**			D			A
Bone		A	A					A									A						**A**	**A**		**A**	**A**		D			A
Castor		A	A		A			A		A			A				A						**A**	**A**	**A**	**A**	**A**		A	B	A	A
Cinnamon		A	A												A		A				**A**		**A**	**A**		**D**			D			A
Citric		A	A					D		D							A	A			**A**		**A**	**A**		**A**	**A**		D			A
Clove		A	A														A	A			**B**		**A**	**A**			**A**					A
Coconut		A	A		B			A		A							A	A			**A**		**A**	**A**		**A**	**A**		A	A	D	A
Cod Liver		A	A		B												A	A	C		**A**		**A**	**A**		**A**	**A**		B	A	D	A
Corn		A	A	A	B			B		A							A	A	C		**A**		**A**	**A**		**A**	**A**		D	C	D	A
Cotton Seed	B	A	A	A	B			B		A	C		A		A		A	A	C		**A**	**A**	**A**	**A**		**A**	**A**		D	C	D	A
Creosote[2]		A	A		A												D				**D**		**A**	**A**		**A**	**A**		B	D	D	A
Diesel Fuel (2D, 3D, 4D, 5D)		A	A		A			A								D	A	A			**A**	**A**	**A**	**A**		**A**	**A**		D	D	D	A
Fuel (1, 2, 3, 5A, 5B, 6)		A	A		A	**A**	**A**	A					A		A	D	A				**B**		**A**	**A**		**A**	**B**		D	D	D	A
Ginger		A	A														A						**A**	**A**		**A**	**A**		A			A

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2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Oils: Hydraulic (See Hydraulic)																																
Lemon		A	A														A				**D**		**A**	**A**		**A**			D			A
Linseed		A	A	A	A			A		A			A	B			A	A	C		**A**		**A**	**A**	**A**	**A**	**A**		D	D	D	A
Mineral	A	A	A	A	A			A		A	B		A			B	A	A			**B**	**A**	**A**	**A**	**A**	**A**	**A**		B	D	D	A
Olive	A	A	A		A			B		A	B		A		A		A	A			**A**		**A**	**A**		**A**	**A**	C	B		D	A
Orange		A	A												A		A	A			**A**		**A**	**A**		**A**	**A**		D			A
Palm		A	A		A			B					A				A	A					**A**	**A**		**A**	**A**		D			A
Peanut[3]		A	A		A			A		A			A				A				**D**		**A**	**A**		**A**	**A**		D		D	A
Peppermint[2]		A	A					A									A				**D**		**A**	**A**		**A**	**D**		D			A
Pine	A	A	A		A			D		C	B		A		A		A						**A**	**A**		**A**	**A**		D		D	A
Rape Seed		A	A					A					A				A						**A**	**A**		**A**	**B**		D		D	A
Rosin		A	A		A												A	A			**A**		**A**	**A**		**A**	**A**					A
Sesame Seed		A	A		A			A		A			A				A						**A**	**A**		**A**	**A**		D			A
Silicone		A	A					A		A						A	A	A			**A**		**A**	**A**	**A**	**A**	**A**		A		A	A
Soybean		A	A		A			B		A			A				A	A			**A**		**A**	**A**		**A**	**A**		D		D	A
Sperm		A	A					A					A				A						**A**	**A**		**A**	**A**		D			A
Tanning		A	A														A						**A**	**A**		**A**	**A**		D			A
Turbine		A	A		A			A		A			A				A		C				**A**	**A**		**A**	**A**		D		D	A
Oleic Acid	B	A	A	B	B		**B**	B	C	C	C		A	C	A	C	B	A	B	D	**C**		**A**	**A**		**D**	**B**	D	D	D	D	A
Oleum 25%							**A**					**B**	D		A	D								**A**		**A**	**D**	D	D	D		D
Oleum	B		A		B			C	C		B	**D**	D		A		D				**D**			**A**		**A**	**C**	D	D	D	D	A
Oxalic Acid (cold)	C	A	B	A	C	**C**	**B**	B	C	D	D		A	B	A	C	C	D		A	**A**		**A**	**A**		**A**	**B**	C	B	A	C	A
Paraffin	A	A	A	A	A			A		B	B	**A**	A		A	B	A	A	B		**A**		**A**	**A**		**A**	**A**					A
Pentane	A	C	C		A		**B**	A		B	B				A	D	A	A	D				**A**	**A**		**A**	**A**		B	D	D	A
Perchloroethylene[2]	B	A	A		A			C		B	B	**A**			A	D	A		D		**D**	**A**	**A**	**A**		**A**	**C**	D	D	D	D	A
Petrolatum	A		A		B			B		C	C				A	D	A	A	B				**A**	**A**		**A**	**A**		B	A	D	A
Phenol 10%	B	A	A		A		**B**	C		B	D		A	C	A			D				**A**				**B**	**D**		C	D	C	C
Phenol (Carbolic Acid)	B	A	A	A	B	**C**	**A**	B	D	D	D	**A**	A	C	A	C	D	D		D	**B**	**A**	**A**	**D**	**A**	**A**	**D**		D	D	D	B
Phosphoric Acid (40% Solution)		B	A	A	D	**A**	**A**	D	D	D			A	B	A	A	D	D	C	B	**A**	**A**	**B**	**C**	**D**	**A**	**D**		D	B	C	A
Phosphoric Acid (40% - 100% Solution)		C	B	B	D	**B**	**A**	D	D	D			A	B	A	A	D	D	D	C	**A**	**A**	**B**	**D**	**D**	**A**	**D**		D	B	C	C
Phosphoric Acid (Crude)		D	C	C	D	**C**	**A**	D	D	D	D	**A**			A		D	D	D	C		**A**	**C**	**D**		**A**	**D**		D	B		A
Phosphoric Anhydride (Dry or Moist)		A	A						D				D	D	A								**A**			**D**	**D**		D		A	
Phosphoric Anhydride (Molten)		A	A		D			D	D				D		A			A		D						**D**	**C**		D		D	A
Photographic (Developer)		C	A	C	C	**A**	**A**			D			A			A	C			B	**A**		**A**	**A**		**A**	**A**		A			A
Phthalic Anhydride	B	A	B		B		**A**	B		C	C				A			A								**A**	**C**					
Picric Acid	B	A	A		C		**A**	D	D	D	D		A	A	A			A		A						**A**	**A**	D	A		A	A
Plating Solutions																																
Antimony Plating 130° F			A			**A**	**A**						A		A	A		D			**A**			**A**		**A**	**A**	D	A			B
Arsenic Plating 110° F			A			**A**	**A**						A		A	A		A			**A**			**C**		**A**	**A**	D	A			B
Brass Plating																																
Regular Brass Bath 100° F			A			**A**	**A**						A		A	A		A			**A**			**C**		**A**	**A**	D	A			B
High Speed Brass Bath 110° F			A			**A**	**A**						A		A	A		A			**A**			**D**		**A**	**A**	D	A			B
Bronze Plating																																
Copper Cadmium Bronze Bath R.T.			A			**A**	**A**						A		A	A		A			**A**			**C**		**A**	**A**	D	A			B
Copper-Tin Bronze Bath 160° F			A			**A**	**A**						D		A	A		A			**A**			**D**		**A**	**A**	D	B			C
Copper-Zinc Bronze Bath 100° F			A			**A**	**A**						A		A	A		A			**A**			**C**		**A**	**A**		A			B
Cadmium Plating																																
Cyanide Bath 90° F			A			**A**	**A**						A		A	A		A			**A**			**C**		**A**	**A**		A			B

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1. **P.V.C. — Satisfactory to 72° F.**
2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Cadmium Plating																															
Fluoborate Bath 100° F			A			**D**	**A**						A		A	A		D			**A**			**D**		**A**	**B**		C			B
Chromium Plating																															
Chromic-Sulfuric Bath 130° F			C			**A**	**A**						A		A	D		D			**A**			**A**		**C**	**D**		D			D
Fluosilicate Bath 95° F			C			**C**	**A**						A		A	D		D			**A**			**B**		**C**	**D**		D		D	D
Fluoride Bath 130° F			D			**C**	**A**						A		A	D		D			**A**			**B**		**C**	**D**		D			D
Black Chrome Bath 115° F			C			**A**	**A**						A		A	D		D			**A**			**A**		**C**	**D**		D			D
Barrel Chrome Bath 95° F			D			**C**	**A**						A		A	D		D			**A**			**A**		**C**	**D**		D			D
Copper Plating (Cyanide)																															
Copper Strike Bath 120° F					A	**A**	**A**								A	A								**C**		**B**			A			
Rochelle Salt Bath 150° F			A			**A**	**A**						D		A	A		A			**A**			**D**		**A**	**A**		B			C
High Speed Bath 180° F			A			**A**	**A**						D		A	A		A			**A**			**D**		**A**	**A**		B			C
Copper Plating (Acid)																															
Copper Sulfate Bath R.T.			D			**A**	**A**						A		A	A		D			**A**			**D**		**A**	**A**		A			D
Copper Fluoborate Bath 120° F			D			**D**	**A**						A		A	A		D			**A**			**D**		**A**	**B**		C			D
Copper (Misc.)																															
Copper Pyrophosphate 140° F			A			**A**	**A**						A		A	A		A			**A**			**B**		**A**	**A**		A			B
Copper (Electroless) 140° F								D					A		A	A		A			**A**			**D**		**A**	**D**		D			B
Gold Plating																															
Cyanide 150° F			A			**A**	**A**	C					D		A	A		A			**A**			**B**		**A**	**A**		A			D
Neutral 75° F			C			**A**	**A**						A		A	A		A			**A**			**A**		**A**	**A**		A			A
Acid 75° F			C			**A**	**A**						A		A	A		A			**A**			**A**		**A**	**A**		A			A
Indium Sulfamate Plating R.T.			C			**A**	**A**						A		A	A		D			**A**			**A**		**A**	**A**		A			A
Iron Plating																															
Ferrous Chloride Bath 190° F			D			**A**	**D**						D		A	A		D			**C**			**A**		**A**	**B**		D			D
Ferrous Sulfate Bath 150° F			C			**A**	**A**						D		A	A		D			**A**			**A**		**A**	**A**		B			D
Ferrous Am. Sulfate Bath 150° F			C			**A**	**A**						D		A	A		D			**A**			**A**		**A**	**A**		B			D
Sulfate-Chloride Bath 160° F			D			**A**	**D**						D		A	A		D			**A**			**A**		**A**	**B**		C			D
Fluoborate Bath 145° F			D			**D**	**B**						D		A	A		D			**A**			**D**		**A**	**B**		C			D
Sulfamate 140° F			D			**A**	**B**						A		A	A		D			**A**			**A**		**A**	**A**		A			A
Lead Fluoborate Plating			C			**D**	**A**						A		A	A		D			**A**			**D**		**A**	**B**		C			A
Nickel Plating																															
Watts Type 115 - 160° F			C			**A**	**A**						D		A	A		A			**A**			**A**		**A**	**A**		A			D
High Chloride 130 - 160° F			C			**A**	**A**						D		A	A		D			**A**			**A**		**A**	**A**		B			D
Fluoborate 100 - 170° F			C			**D**	**A**	D					D		A	A		D			**A**			**D**		**A**	**B**		C			D
Sulfamate 140° F			C			**A**	**A**						A		A	A		A			**A**			**A**		**A**	**A**		A			A
Electroless 200° F													D		A	D		D			**D**			**A**		**A**	**D**		D			B
Rhodium Plating 120° F			D			**D**	**D**						A		A	A	D	D			**A**			**A**		**A**	**A**		B			A
Silver Plating 80 - 120° F			A			**A**	**A**						A		A	A		A			**A**			**B**		**A**	**A**		A			A
Tin-Fluoborate Plating 100° F			C			**D**	**A**						A		A	A		D			**A**			**D**		**A**	**B**		C			A
Tine-Lead Plating 100° F			C			**D**	**A**						A		A	A		D			**A**			**D**		**A**	**B**		C			A
Zinc Plating																															
Acid Chloride 140° F			D			**A**	**D**						A		A	A		D			**A**			**A**		**A**	**A**		A			A
Acid Sulfate Bath 150° F			C			**A**	**A**						D		A	A		D			**A**			**A**		**A**	**A**		B			D
Acid Fluoborate Bath R.T.				C		**D**							A		A	A		D			**A**			**D**		**A**	**B**		C			A
Alkaline Cyanide Bath R.T.				A		**A**	**A**						A		A	A		A			**A**			**D**		**A**	**A**		A			A
Potash		A		A	C		**A**	C		B			A	B		A	B	A		B	**A**		**A**	**A**	**A**	**A**	**A**		B		B	A
Potassium Bicarbonate		A		B	C	**A**	**B**	B		D		**A**	A		A	A	C	A	C	B	**A**	**A**	**A**	**A**		**A**	**A**		A		B	A
Potassium Bromide	A	A		B	C	**A**	**B**	C		D	D	**A**	A		A	A	A	C		B	**A**	**C**	**A**	**A**		**A**	**A**		A	A	B	A

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Potassium Carbonate	B	A		A	C	**A**	**A**	C		B	B	**A**	A	B	A	A	B	A		B	**A**	**A**	**A**	**A**	**A**	**A**	**B**		A		B	A
Potassium Chlorate	B	A	A	A	B	**A**	**B**	B		B	B	**A**	A	B	A	A	B	D		B	**A**	**A**	**A**	**A**		**A**	**A**		A		B	A
Potassium Chloride	C	A	A	B	B	**A**	**A**	C	C	B	B	**A**	A	A	A	A	A	B	C	B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	A	A
Potassium Chromate			B	B	A		**B**	A		A			A			A	C			B		**A**	**A**	**D**		**A**	**A**		A		B	C
Potassium Cyanide Solutions	B	A	B	A	D	**A**	**A**	D		B	B	**A**	A		A	A	C	A		B	**A**	**A**	**C**	**A**		**B**	**A**		A	A	A	A
Potassium Dichromate	B	A	A	A	A	**A**	**B**	C		B	C	**A**	A		A	A	C	D		B	**A**	**A**	**A**	**A**		**B**	**A**		A	A	A	A
Potassium Ferrocyanide	B	A		A	C		**B**	A			C		A		A			A		A							**D**				A	A
Potassium Hydroxide (50%)	A	B	B	B	D	**C**	**A**	D	D	C	A	**D**	A	B	A	A	D	A	C	B	**A**	**A**		**D**	**A**	**D**	**B**	C	A	A	C	A
Potassium Nitrate	B	A	B	A	B	**A**	**B**	B			B	**A**	A	C	A	A	B	C		B	**A**	**C**	**A**	**A**		**B**	**A**		A	A	A	A
Potassium Permanganate	B	A	B	B	B	**B**	**B**	B		B	B	**A**	A		A	A	C	D	C	B	**B**	**A**	**A**	**A**		**B**	**A**		A		B	B
Potassium Sulfate	B	A	B	B	A	**A**	**A**	B	B	B	B	**A**	A	A	A	A	B	C		B	**A**	**A**	**A**	**A**		**A**	**A**	C	A	A	C	A
Potassium Sulfide	A	A		A	B		**B**	B		B	B		A		A												**A**					
Propane (Liquified)[1 2]	A	A		A	A			A	A		B		D		A	D	A	A			**D**		**A**	**A**		**A**	**A**	D	B	D	D	A
Propylene Glycol	B	B		A	A			B		B	B				A		B	B	B	B			**A**	**A**		**A**	**A**		C			A
Pyridine		C		B	B					B	A	**D**		D	A	D	D			C	**B**	**A**	**A**	**A**		**D**	**D**		D	B	D	A
Pyrogallic Acid	B	A	A	A	B		**A**	B		B	B		A		A		D	A					**A**	**A**		**A**	**A**					A
Rosins	A	A	A	A	A		**B**	A	C		C				A		B	A			**A**		**A**	**A**			**A**					A
Rum		A		A									A			A	A	A			**A**		**A**	**A**		**A**	**A**		A			A
Rust Inhibitors		A		A				A		A							A				**A**		**A**	**A**		**A**	**A**		C			A
Salad Dressing		A		A	B			B		D			A			A	A	A			**A**		**A**	**A**		**A**	**A**					A
Sea Water	A	A	C	A	C	**A**		C			D		A		A	A	A	A		B	**A**		**A**	**A**	**A**	**A**	**A**	B	B	A	A	A
Shellac (Bleached)	A	A		A	A			A	B	B	A				A		A	A			**A**			**A**			**A**					A
Shellac (Orange)	A	A		A	A			A	C	C	A				A		A	A			**A**			**A**			**A**					A
Silicone		B		A	B			A								A	A	A			**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
Silver Bromide		C	C	B	D											A	C						**A**									A
Silver Nitrate	B	A	B	A	D	**A**	**A**	D		D	D	**A**	A	B	A	A	C	A		B	**A**		**A**	**A**		**A**	**C**		A	C	A	A
Soap Solutions[1]	A	A	A	A	C	**A**	**B**	B		B	A		B	B	A	A	A	A		B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	B	B		C	A
Soda Ash (See Sodium Carbonate)																																
Sodium Acetate	B	A	A	B	B	**A**		B		C	C	**A**	A		A	A	B	A		B	**A**		**A**	**A**		**D**	**D**		C		A	A
Sodium Aluminate	B			A	C	**B**	**B**	B			C				A	A	B	A				**A**	**A**	**A**		**A**	**A**		A	A	B	A
Sodium Bicarbonate	B	A	A	A	A	**A**		B	A	C	C	**A**	A	B	A	A	B	A	B	B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	C	A	A	A	A
Sodium Bisulfate	A	A		A	D	**B**	**B**	C	C	D	D	**A**	A	B	A	A	B	C	C	B	**A**	**A**	**A**	**A**		**B**	**A**	C	A		A	A
Sodium Bisulfite		A		A	A	**A**	**B**	C		D		**A**	A	B	A	A	B	D	B	B	**A**	**A**	**A**	**A**		**A**	**A**	C	A		A	A
Sodium Borate	B	A		A	C		**A**	A		C	C		C		A			A		A						**A**		B	A			
Sodium Carbonate	B	A	B	B	C	**A**	**A**	B	B	B	B	**A**	A	B	A	A	A	A	C	B	**A**	**A**	**B**	**A**		**A**	**A**		A	A	A	A
Sodium Chlorate	B	A		A	B	**A**	**B**	B			C	**A**	A	B	A	A	D	A		B	**A**	**A**	**A**	**A**		**A**	**D**		A		A	A
Sodium Chloride	B	A	C	B	C	**A**	**A**	B	C	B	C	**A**	A	B	A	A	A	A	B	B	**A**	**A**	**A**	**A**	**A**	**A**	**A**	C	A	A	B	A
Sodium Chromate	A	A	A		D		**B**	B		B	B				A	A	D	A			**A**	**A**	**A**	**B**		**B**	**A**		A			C
Sodium Cyanide	B	A		A	D	**A**		D	D	B	B	**A**	A		A	A	D	C		B	**A**	**A**	**A**	**A**		**A**	**A**	D	A	A	A	A
Sodium Fluoride	B	C		C	C	**A**	**A**	C		D	D		D	D	A			A		C						**B**	**D**		D		D	A
Sodium Hydrosulfite					A		**A**	C					C	A	A			A						**A**		**A**			A		A	
Sodium Hydroxide/Caustic Soda (20%)		A	A	A	D	**A**	**A**	C	D	A		**A**	A	B	A	A	D	C	C	B	**A**	**A**	**C**	**D**	**A**	**A**	**A**	D	B	A	A	A
Sodium Hydroxide/Caustic Soda (50%)		A	B		D	**A**	**A**	C	D	B		**D**	A	B	A	A	D	C	C	C	**A**	**B**	**C**	**D**	**A**	**D**	**D**	D	C		A	A
Sodium Hydroxide/Caustic Soda (80%)		A	D		D	**A**	**B**	C	D	C			A	B	A	A	D	C	C	C	**A**	**B**	**C**	**D**	**A**	**B**	**D**	D	C		B	A

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Sodium Hypochlorite/Bleach[3] (to 20%)		C	C	C	C	**A**	**A**	D	D	D			A	B	A	A	D	A		B	**C**	**C**	**D**	**A**	**B**	**A**	**C**	D	D	B	C	B
Sodium Hypochlorite/Bleach	D		D		D	**A**	**A**	D		D	D	**A**	A		A	A		A			**C**	**C**		**D**		**B**	**B**	C	A			A
Sodium Hyposulfate		A	A		D			D							A														C		C	C
Sodium Metaphosphate[2]	A		A		A			C	C	B	B				A		B	A			**D**		**A**	**A**		**A**	**A**		B	A	A	A
Sodium Metasilicate	A		A		B			B		C	C				A		D						**A**			**A**	**A**	D	A			A
Sodium Nitrate	B	A	A	A	A	**A**	**B**	B	C	A	B	**A**	A	B	A	A	B	A		B	**A**		**A**	**A**	**A**	**D**	**C**	D	B	A	C	A
Sodium Perborate	B		C		B			C	C	B	B				A	A	B	A			**A**		**A**	**A**		**A**	**B**	D	B	A	C	A
Sodium Peroxide	B	A	A		C		**B**	C	C	D	C		A		A		D	D					**A**	**A**		**A**	**C**	D	B	A	C	A
Sodium Polyphosphate (Mono, Di, Tribasic)		A	A		D	**A**	**A**	C							A	A	B						**A**	**A**		**A**	**A**		D	A	A	A
Sodium Silicate	B	A	B	A	C	**A**	**B**	C	C		B		A	B	A	A	C	A			**A**		**A**	**A**		**A**	**A**		A	A	A	A
Sodium Sulfate	B	A	A	C	B	**A**	**B**	B	B	A	B		A		A	A	B	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	C	A
Sodium Sulfide	B	A	B		D	**A**	**B**	D	D	A	B		A	B	A	A	B	A		B	**A**	**A**	**A**	**A**		**A**	**C**		A	A	C	A
Sodium Sulfite		C	C		C	**A**	**A**	C		A			A	A	A			D		A			**A**	**A**		**A**	**A**		A		A	A
Sodium Tetraborate			A										A			A	B						**A**	**A**		**A**	**A**					A
Sodium Thiosulphate ("Hypo")	A	A	A		B	**A**		D	D	C	B		A		A	A	C	A			**A**	**A**	**A**	**A**		**A**	**B**		A	A	C	A
Sorghum		A	A							A							A	A					**A**	**A**		**A**	**A**		A			A
Soy Sauce		A	A		A			A		D						A	A	A					**A**	**A**		**A**	**A**		A		D	A
Stannic Chloride	D	D	D		D	**A**	**B**	D		D	D	**A**	A		A	A	C	A		B	**A**			**A**		**A**	**A**	D	A	A	A	A
Stannic Fluoborate			A							D						A	C							**A**		**A**	**A**		A			A
Stannous Chloride	D	D	C		D	**A**	**A**	D		D	D		A	A	A			D		A						**B**	**C**	D	D		A	A
Starch	B	A	A		A			B		C	C		A		A	A	A	A		B			**A**	**A**		**A**	**A**		A			A
Stearic Acid[2]	B	A	A	A	B	**A**	**A**	C	C	C	C	**A**	A	B	A	A	A	A		B	**D**		**A**	**A**	**A**	**A**	**B**	D	B	B	C	A
Stoddard Solvent	A	A	A	A	A	**A**	**A**	A	A	B	B	**A**	A	D	A	D	A	A	B	D	**D**	**A**	**A**	**A**		**A**	**B**	D	D	D	D	A
Styrene	A	A	A		A			A			A				A	A	A						**A**	**A**		**B**	**D**	D	D	D	D	A
Sugar (Liquids)	A	A	A	A	A		**A**	A		B	B				A	A	A	A	B		**A**		**A**	**A**	**A**	**A**	**A**		B		A	A
Sulfate Liquors		C	C		B		**A**	C									D				**A**		**A**	**A**					C			A
Sulfur Chloride		D	D	D	D			C	D				A	C	A	A	D	A		A	**D**		**A**	**C**		**A**	**D**		D	D	D	C
Sulfur Dioxide[2]		A	A	C	A	**A**	**B**	B				**B**	D	B	A	D	B	D	D	C	**D**	**A**	**A**	**A**		**D**	**D**	C	B	A	D	A
Sulfur Dioxide (dry)	A	A	A		A		**A**	A	C	A	B		D		A			A		D			**A**	**A**		**D**			D		D	D
Sulfur Trioxide (dry)	A	A	C		A			B		B	B		A	B	A	D	D	D					**B**	**A**		**A**	**D**		D	B	C	A
Sulfuric Acid (to 10%)		D	C	C	C	**A**	**A**	D	D	D		**A**	A	B	A	A	D	D	B	B	**A**	**A**	**A**	**A**		**A**	**C**		D	D	C	A
Sulfuric Acid (10% - 75%)[2]		D	D	D	D	**C**	**B**	D	D	D		**A**	A	B	A	B	D	D	B	C	**A**	**B**	**A**	**A**	**C**	**A**	**D**		D	D	D	B
Sulfuric Acid (75% - 100%)			D			**D**	**B**		D			**A**	B		A	A		D			**B**	**C**		**A**		**A**	**D**		D			D
Sulfurous Acid	C	C	B	C	C	**A**	**B**	D		D	D		A	B	A	A	D	D		B	**A**		**B**	**A**		**A**	**C**	D	B	B	C	A
Sulfuryl Chloride													A		A									**A**								A
Syrup		A	A	A	A			D					A			A	A	A	B		**A**		**A**	**A**	**A**	**A**	**A**		B		A	A
Tallow		A	A		A											A	A	A		C			**A**	**A**		**A**	**A**					A
Tannic Acid	B	A	A	A	C	**A**	**B**	B		C	C	**A**	A	B	A	A	B	D		B	**A**		**A**	**A**	**A**	**A**	**D**	C	A	A	A	A
Tanning Liquors		A	A		C	**A**	**A**	A					A	B	A		B				**A**		**A**	**A**		**A**	**C**					A
Tartaric Acid	B	A	B	B	C	**A**	**B**	A	C	D	D	**A**	A	B	A	A	B	A		B	**A**		**A**	**A**		**A**	**D**	C	A		A	A
Tetrachlorethane			A			**A**	**A**						D		A	D	A	A			**A**		**A**	**A**		**A**	**D**			D	D	A
Tetrahydrofuran		A	A		D			D		D	A	**D**	D		A	D	A	A		D	**C**	**A**	**A**	**A**		**D**	**D**		D	B	D	A
Toluene, Toluol[3]	A	A	A		A	**A**	**A**	A	A	A	A	**A**	D	D	A	D	A	A	D	D	**D**	**A**	**A**	**A**	**A**	**C**	**D**	D	D	D	D	A
Tomato Juice	A	A	A		A			C		C	C				A	A	B	A	B		**A**	**A**	**A**	**A**		**A**	**A**		A			A

A — No effect — Excellent
B — Minor effect — Good
C — Moderate effect — Fair
D — Severe effect — Not recommended

1. **P.V.C. — Satisfactory to 72° F.**
2. **Polypropylene — Satisfactory to 72° F.**
3. **Polypropylene — Satisfactory to 120° F.**
4. **Buna-N — Satisfactory for "O" Rings**
5. **Polyacetal — Satisfactory to 72° F.**
6. **Ceramag — Satisfactory to 72° F.**

	302 Stainless Steel	304 Stainless Steel	316 Stainless Steel	440 Stainless Steel	Aluminum	**TITANIUM**	**NICKEL ALLOY C276 (HASTELLOY®)**	Cast Bronze	Brass	Cast Iron	Carbon Steel	**POLYVINYLIDENE FLOURIDE (KYNAR®)**	PVC (Type 1)	Tygon (E-3606)	Teflon®	Polyphenylene Oxide (Noryl®)	Polyacetal	Nylon®	ABS (Cycolac®)	Polyethylene	**POLYPROPYLENE**	**POLYPHENYLENE SULFIDE (RYTON®)**	**CARBON**	**CERAMIC**	**CERAMAGNET "A"**	**FLUOROELASTOMER (VITON®)**	**BUNA N (NITRILE)**	Silicon	Neoprene	Ethylene Propylene (EPM)	Rubber (Natural)	Epoxy
Trichlorethane		C	A		C	**A**	**A**	C		C					A	D	A						**A**	**A**		**A**	**D**	D	D	D	D	A
Trichlorethylene[2]	B	A	A		B	**A**	**A**	B	A	C	B	**A**	D		A	D	A	C	D	D	**D**	**C**	**A**	**A**	**C**	**A**	**D**	D	D	D	D	A
Trichloropropane			A					A								D	A		D				**A**	**A**		**A**	**A**		A			A
Tricresylphosphate			A			**B**	**A**	A					D		A	C	C						**A**	**A**		**B**	**D**		D	A		A
Triethylamine								A					A			B	D						**A**	**A**		**A**	**A**	D	B			A
Turpentine[3]	B	A	A		C		**A**	B	C	B	B	**A**	A	B	A	D	A	A		D	**B**	**A**	**A**	**A**		**A**	**D**		D	D	D	A
Urine		A	A		B			C		B			A			A	A	A		B	**A**		**A**	**A**		**A**	**A**		D	A		A
Vegetable Juice		A	A		A			C		D						A	A	A					**A**	**A**		**A**	**A**	B	D		D	A
Vinegar	A	A	A	A	D	**A**	**A**	B	B	C	D	**A**	A		A	A	B	A	B	B	**A**	**A**	**A**	**A**	**A**	**A**	**C**		B	A	C	A
Varnish (Use Viton for Aromatic)	A	A	A	A	A			A	B		C				A	D	A	A			**A**		**A**	**A**	**A**	**A**	**B**	C	D		D	A
Water, Acid, Mine		A	A		C			C	D	C			A	B		A	D	A	B		**A**	**B**	**A**	**A**		**A**	**A**		B		B	A
Water, Distilled, Lab Grade 7		A	A		B			A		D			A	B	A	A	A	A	A		**A**	**A**	**A**	**A**	**A**	**A**	**A**		B	A	A	A
Water, Fresh	A	A	A		A			A	C	B	D		A	B	A	A	A	A	A	A	**A**	**A**	**A**	**A**	**A**	**A**	**A**		B	A	A	A
Water, Salt		A	A		B			B	C	D			A	B		A	A	A			**A**	**A**	**A**	**A**	**A**	**A**	**A**		B	A	A	A
Weed Killers		A	A		C			C									A	A					**A**	**A**		**A**	**B**		C			A
Whey		A	A		B												A						**A**	**A**		**A**	**A**					A
Whiskey and Wines	A	A	A	A	D			B	B	D	D		A		A	A	A	A		B	**A**		**A**	**A**		**A**	**A**	B	A	A	A	A
White Liquor (Pulp Mill)		A	A				**A**	D		C			A		A	A	D	A			**A**		**A**	**A**		**A**	**A**		A			A
White Water (Paper Mill)		A	A					A									B	A			**A**		**A**	**A**		**A**			A			A
Xylene[2]	A	A	A		A		**A**	A	A	A	B	**A**	D		A	D	A	A	D	D	**D**	**A**	**A**	**A**	**A**	**A**	**D**	D	D	D	D	A
Zinc Chloride	D	D	B	B	D	**A**	**B**	D	D	D	D	**A**	A		A	A	C	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	A	A
Zinc Hydrosulphite			A		D			D		D						A	C					**A**	**A**	**A**			**A**		A	A		A
Zinc Sulfate	B	A	A	A	D	**A**	**B**	B	C	C	D	**A**	C	B	A	A	C	A		B	**A**	**A**	**A**	**A**		**A**	**A**		A	A	C	A

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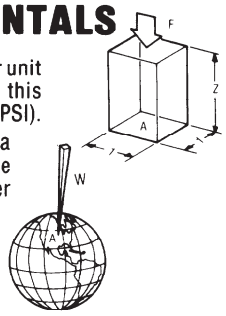
NOTES

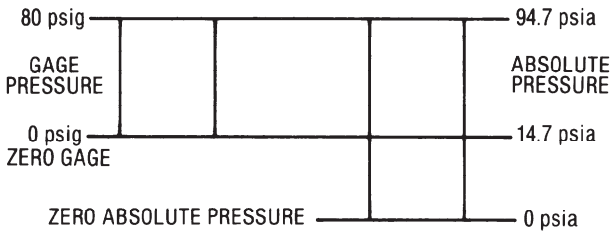
HYDRAULIC FUNDAMENTALS



Pressure The basic definition of pressure is force per unit area. As commonly used in hydraulics and in this manual, it is expressed in pounds per square inch (PSI).

Atmospheric Pressure is the force exerted on a unit area by the weight of the atmosphere. At sea level, the atmospheric standard pressure is 14.7 pounds per square inch.

Gage Pressure Using atmospheric pressure as a zero reference, gage pressure is a measure of the force per unit area exerted by a fluid. Units are PSIG.



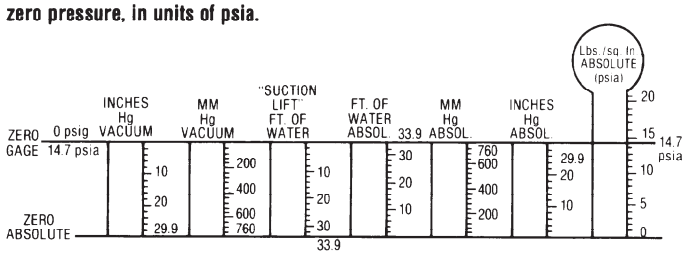
Absolute Pressure is the total force per unit area exerted by a fluid. It equals atmospheric pressure plus gage pressure. Units are expressed in PSIA.

Outlet Pressure or discharge pressure is the average pressure at the outlet of a pump during operation, usually expressed as gage pressure (psig).

Inlet Pressure is the average pressure measured near the inlet port of a pump during operation. It is expressed either in units of absolute pressure (psig) preferably, or gage pressure (psig).

Differential Pressure is the difference between the outlet pressure and the inlet pressure. Differential pressure is sometimes called Pump Total Differential pressure.

Vacuum or Suction are terms in common usage to indicate pressures in a pumping system below normal atmospheric pressure, and are often measured as the difference between the measured pressure and atmospheric pressure in units of inches of mercury vacuum, etc. **It is more convenient to discuss these in absolute terms; that is from a reference of absolute zero pressure, in units of psia.**



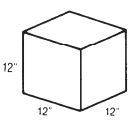
FLUID FUNDAMENTALS

Fluids include liquids, gases, and mixtures of liquids, solids, and gases. For the purposes of this manual, the terms **fluid** and **liquid** are used interchangeably to mean pure liquids, or liquids mixed with gases or solids which act essentially as a liquid in a pumping application.

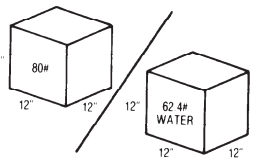
Density or Specific Weight of a fluid is its weight per unit volume, often expressed in units of pounds per cubic foot, or grams per cubic centimeter.

Example: If weight is 80#; density is 80#/cu. ft.

The density of a fluid changes with temperature.



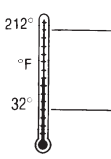
Specific gravity of a fluid is the ratio of its density to the density of water. As a ratio, it has no units associated with it.



Example: Specific gravity is $\frac{80\#}{62.4\#}$

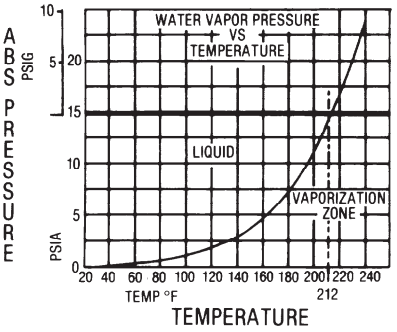
or SG = 1.282

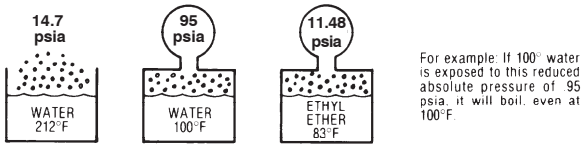
Temperature is a measure of the internal energy level in a fluid. It is usually measured in units of degrees fahrenheit (°F) or degrees centigrade (°C). The temperature of a fluid at the pump inlet is usually of greatest concern.



See °F - °C conversion chart on Technical Data page.

Vapor Pressure of a liquid is the absolute pressure (at a given temperature) at which a liquid will change to a vapor. Vapor pressure is best expressed in units of psi absolute (psia). Each liquid has its own vapor pressure-temperature relationship.





For example: If 100° water is exposed to this reduced absolute pressure of .95 psia, it will boil, even at 100°F.

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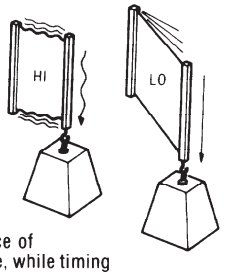


Viscosity — the viscosity of a fluid is a measure of its tendency to resist a shearing force. High viscosity fluids require a greater force to shear at a given rate than low viscosity fluids.

The CENTIPOISE (cps) is the most convenient unit of absolute viscosity measurement.

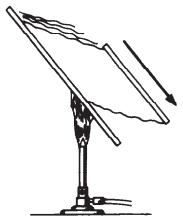
Other units of viscosity measurement such as the centistoke (cks) or Saybolt Second Universal (SSU) are measures of Kinematic viscosity where the specific gravity of the fluid influences the viscosity measured. Kinematic viscometers usually use the force of gravity to cause the fluid to flow down a calibrated tube, while timing its flow.

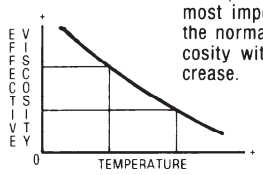
The absolute viscosity, measured in units of centipoise (1/100 of a poise) is used throughout this manual as it is a convenient and consistent unit for calculation.

Other units of viscosity can easily be converted to centipoise.

Kinematic viscosity	X	Specific Gravity	Absolute Viscosity
Centistokes	X	S.G.	Centipoise
SSU X .216	X	S.G.	Centipoise

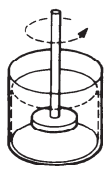
Viscosity unfortunately is not a constant, fixed property of a fluid, but is a property which varies with the conditions of the fluid and the system.

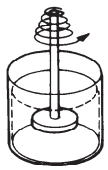


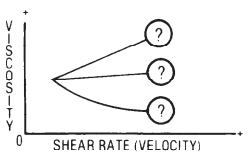


In a pumping system, the most important factors are the normal decrease in viscosity with temperature increase.

And the viscous behavior properties of the fluid in which the viscosity can change as shear rate or flow velocity changes.







EFFECTIVE VISCOSITY is a term describing the real effect of the viscosity of the ACTUAL fluid, at the SHEAR RATES which exist in the pump and pumping system at the design conditions.

Centrifugal pumps are generally not suitable for pumping viscous liquids. When pumping more viscous liquids instead of water, the capacity and head of the pump will be reduced and the horsepower required will be increased.

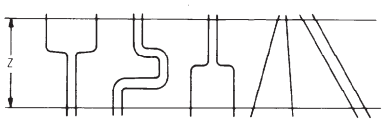
pH value for a fluid is used to define whether the aqueous solution is an acid or base (with values of pH usually between 0 and 14):

1. Acids or acidic solutions have a pH value less than 7
2. Neutral solutions have pH value of 7 at 25°C (example: pH of pure water = 7)
3. Bases or alkaline solutions have a pH value **greater** than 7

RELATION OF PRESSURE TO ELEVATION

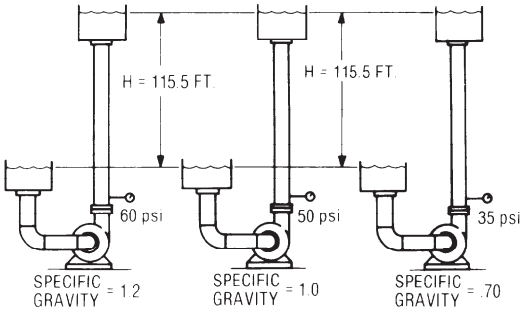
In a static liquid (a body of liquid at rest) the pressure difference between any two points is in direct proportion **only** to the **vertical** distance between the points.

This pressure difference is due to the weight of the liquid and can be calculated by multiplying the vertical distance by the density (or vertical distance x density of water x specific gravity of the fluid). In commonly used units:

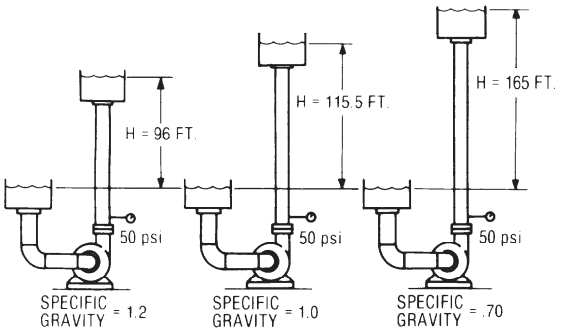


$$P \text{ static (in PSI)} = Z \text{ (in feet)} \times \frac{62.4 \text{ lbs./cu. ft.} \times SG}{144 \text{ sq. in./sq. ft.}}$$

PUMP HEAD — PRESSURE — SPECIFIC GRAVITY — in a centrifugal pump the head developed (in feet) is dependent on the velocity of the liquid as it enters the impeller eye and as it leaves the impeller periphery and, therefore, is independent of the specific gravity of the liquid. The pressure head developed (in psi) will be directly proportional to the specific gravity.



Pressure-Head relationship of identical pumps handling liquids of differing specific gravities.



Presure-head relationship of pumps delivering same pressure handling liquids of differing specific gravity.

This relationship, the elevation equivalent of pressure, is commonly called head and is still frequently used. Pressure converted to the equivalent height of fluid that would produce that pressure can be referred to as ligad.

Static Head • The hydraulic pressure at a point in a fluid when the liquid is at rest.

Friction Head • The loss in pressure or energy due to frictional losses in flow.

Velocity Head • The energy in a fluid due to its velocity, expressed as a head unit.

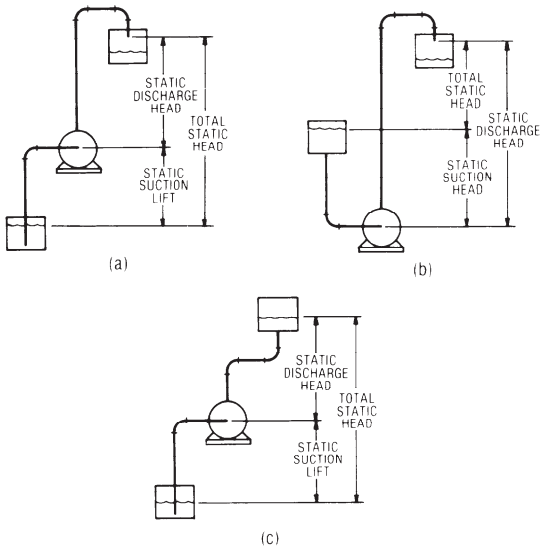
Pressure Head • A pressure measured in equivalent head units.

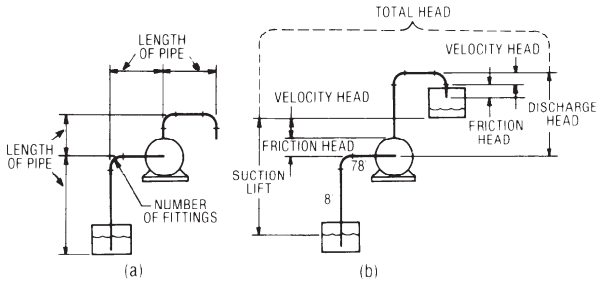
Discharge Head • The outlet pressure of a pump in operation.

Total Head • The total pressure difference between the inlet and outlet of a pump in operation.

Suction Head • The inlet pressure of a pump when above atmospheric.

Suction Lift • The inlet pressure of a pump when below atmospheric.





FRICTIONAL LOSSES

The nature of frictional losses in a pumping system can be very complex. Losses in the pump itself are determined by actual test, and are allowed for in the manufacturers curves and data. Similarily, manufacturers of processing equipment, heat exchangers, static mixers etc. usually have data available for friction losses.

Frictional losses due to flow in pipes are directly proportional to the:

— length of pipe
— flow rate
— pipe diameter
— viscosity of fluid

Pipe friction tables have been established by the Hydraulic Institute and many other sources which can be used to compute the friction loss in a system for given flow rates, viscosities and pipe sizes.

Tables of equivalent lengths for fittings and valves are also available. See page 3 in this manual.

NPSH

Fluid will only flow into the pump head by atmospheric pressure or atmospheric pressure plus a positive suction head. If suction pressure at suction pipe is below the vapor pressure of the fluid, the fluid may flash into a vapor. A centrifugal pump cannot pump only vapor. If this happens, fluid flow to the pump head will drop off and cavitation may result.

NET POSITIVE SUCTION HEAD, AVAILABLE ($NPSH_A$) is based on the design of the system around the pump inlet. The average pressure (in psia) is measured at the inlet port during operation, minus the vapor pressure of the liquid at operating temperature. It indicates the amount of useful pressure energy available to fill the pump head.

NET POSITIVE SUCTION HEAD, REQUIRED ($NPSH_R$) is based on pump design. This is determined by test of the pump of what pressure energy (in psia) is needed to fill the pump inlet. It is a characteristic which varies primarily with the pump speed and the viscosity of the fluid.

For satisfactory pump operation under any set of conditions (capacity versus head) the NPSH, available, must be greater than the NPSH, required. Generally, a two foot head safety margin is normally used.

TECHNICAL DATA

Standard Formulas

PRESSURE AND HEAD

$$\text{Pressure (lbs. per sq. in.)} = \frac{\text{Head in feet X Specific Gravity}}{2.31}$$

$$= \text{Head in ft. X Spec. Grav. X .434}$$

$$\text{Head in feet} = \frac{\text{lbs. per sq. in. X 2.31}}{\text{Specific Gravity}}$$

TEMPERATURE

(1.8 X °C) + 32 = °F
.555 (°F—32°) = °C
Degrees Kelvin — 273.2 = Degrees Centigrade

VELOCITY

$$\text{Pipe Velocity (ft./sec.)} = \frac{.408 \times GPM}{(\text{pipe diameter})^2} \quad \frac{.321 \times GPM}{\text{pipe area}}$$

$$\text{Velocity head (feet)} = \frac{(\text{pipe velocity, ft./sec.})^2}{64.4}$$

POWER

$$HP = \frac{T\ (Ft\ Lb) \times RPM}{5250} \quad \frac{T\ (In\ Lb) \times RPM}{63025}$$

$$HP = \frac{Disp\ (Gals) \times RPM \times PSI}{1714 \times EEF}$$

Horsepower X .746 = Kilowatts
Horsepower X 42.44 = BTU/Min
Metric Horsepower X .9863 = Horsepower

$$RPM = \frac{120 \times \text{Frequency}}{\text{No. of Poles}}$$

PIPE FRICTION HAZEN AND WILLIAMS:

$$h_f = 0.002083\ L \left(\frac{100}{C}\right)^{1.85} \times \frac{gpm^{1.85}}{d^{4.8655}}$$

CONVERSION OF THERMOMETER READINGS

DEGREES CENTIGRADE TO DEGREES FAHRENHEIT

C	F	C	F	C	F	C	F
-40	-40.0	+ 5	+ 41.0	+ 40	+104.0	+175	+347
-38	-36.4	6	42.8	41	105.8	180	356
-36	-32.8	7	44.6	42	107.6	185	365
-34	-29.2	8	46.4	43	109.4	190	374
-32	-25.6	9	48.2	44	111.2	195	383
-30	22.0	10	50.0	45	113.0	200	392
-28	18.4	11	51.8	46	114.8	205	401
-26	14.8	12	53.6	47	116.6	210	410
-24	11.2	13	55.4	48	118.4	215	419
-22	7.6	14	57.2	49	120.2	220	428
-20	- 4.0	15	59.0	50	122.0	225	437
-19	- 2.2	16	60.8	55	131.0	230	446
-18	- 0.4	17	62.6	60	140.0	235	455
-17	+ 1.4	18	64.4	65	149.0	240	464
-16	3.2	19	66.2	70	158.0	245	473
-15	5.0	20	68.0	75	167.0	250	482
-14	6.8	21	69.8	80	176.0	255	491
-13	8.6	22	71.6	85	185.0	260	500
-12	10.4	23	73.4	90	194.0	265	509
-11	12.2	24	75.2	95	203.0	270	518
-10	14.0	25	77.0	100	212.0	275	527
- 9	15.8	26	78.8	105	221.0	280	536
- 8	17.6	27	80.6	110	230.0	285	545
- 7	19.4	28	82.4	115	239.0	290	554
- 6	21.2	29	84.2	120	248.0	295	563
- 5	23.0	30	86.0	125	257.0	300	572
- 4	24.8	31	87.8	130	266.0	305	581
- 3	26.6	32	89.6	135	275.0	310	590
- 2	28.4	33	91.4	140	284.0	315	599
- 1	30.2	34	93.2	145	293.0	320	608
0	32.0	35	95.0	150	302.0	325	617
+ 1	33.8	36	96.8	155	311.0	330	626
2	35.6	37	98.6	160	320.0	335	635
3	37.4	38	100.4	165	329.0	340	644
4	39.2	39	102.2	170	338.0	345	653

FITTING FRICTION LOSS ADD TO PIPE LENGTH

FIGURES GIVE EQUIVALENT IN FEET OF PIPE

PIPE SIZE (NPT)	3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
90° ELBOW	.8	1.0	1.5	1.8	2.4	2.9	3.6
45° ELBOW	.4	.5	.8	1.0	1.3	1.6	2.0
STRAIGHT TEE	2.5	3.0	3.6	4.6	6.4	7.2	9.6
GATE VALVE	.25	.3	.36	.46	.64	.72	.96
ANGLE VALVE	4.0	6.5	9.5	12.0	16.0	19.5	22.5
GLOBE VALVE	7.0	12.0	17.2	22.5	32.0	36.0	48.0

VISCOSITY CONVERSION TABLE

SAYBOLT UNIVERSAL SSU	STOKES	CENTI STOCKES	POISES*	CENTI* POISES	ENGLER SECONDS	REDWOOD NO. 1 SECONDS	TYPICAL LIQUIDS AT 70° F
31	.010	1.00	.008	.8	54	29	Water
35	.025	2.56	.020	2.05	59	32.1	Kerosene
50	.074	7.40	.059	5.92	80	44.3	No. 2 Fuel Oil
80	.157	15.7	.126	12.6	125	69.2	No. 4 Fuel Oil
100	.202	20.2	.162	16.2	150	85.6	Transformer Oil
200	.432	43.2	.346	34.6	295	170	Hydraulic Oil
300	.654	65.4	.522	52.2	470	254	SAE 10W Oil
500	1.10	110	.88	88.0	760	423	SAE 10 Oil
1,000	2.16	220	1.73	173	1.500	896	SAE 20 Oil
2.000	4.40	440	3.52	352	3.000	1.690	SAE 30 Oil
5,000	10.8	1.080	8.80	880	7.500	4.230	SAE 50 Oil
10.000	21.6	2.160	17.0	1.760	15.000	8.460	SAE 60-70 Oil
50.000	108	10.800	88	8.800	75.000	43.660	Molasses B
100.000	216	21.600	173	17.300	150.000	88.160	Molasses C

*Poises and centipoises are given for oil of .8 spec. gravity.
Relationship: centistokes x specific gravity = centipoises.

AVERAGE ABSOLUTE ATMOSPHERIC PRESSURE

Altitude Above Sea Level	PSIA	IN Hg
0	14.7	29.9
500	14.4	29.4
1,000	14.2	28.9
1,500	13.9	28.3
2,000	13.7	27.8
3,000	13.2	26.8
4,000	12.7	25.9
5,000	12.2	24.9
6,000	11.7	24.0
7,000	11.3	23.1
Heat of Fusion of Water	144 BTU/Lb	
Heat of Vaporization of Water	970 BTU/Lb	

CONVERSION TABLE

PRESSURE IN POUNDS PER SQUARE INCH TO FEET OF HEAD

Pounds Pressure	Ft. of Head	Pounds Pressure	Ft. of Head
1	2.31	19	43.9
2	4.62	20	46.2
3	6.93	25	57.7
4	9.24	30	69.3
5	11.6	35	80.8
6	13.9	40	92.4
7	16.2	45	103.9
8	18.5	50	115.5
9	20.8	55	127
10	23.1	60	138.6
11	25.4	65	150.1
12	27.7	70	161.7
13	30.	75	173.2
14	32.3	80	184.8
15	34.6	85	196.3
16	37.	90	207.9
17	39.3	95	219.4
18	41.6	100	230.9

PIPE FRICTION — WATER 60° F

FRICTION LOSS OF WATER IN FEET PER 100 FOOT LENGTH OF PIPE OR TUBE

	NOMINAL SIZE — (INSIDE DIAMETER)													
GAL. PER MIN.	1/4" ID HOSE	1/8" PIPE (.269)	3/8" ID HOSE	1/4" PIPE (.364)	3/8" PIPE (.493)	1/2" ID HOSE	1/2" PIPE (.622)	5/8" ID HOSE	3/4" ID HOSE	3/4" PIPE (.824)	1" PIPE (1.049)	1 1/4" PIPE (1.380)	1 1/2" PIPE (1.610)	
.5	28.7	34.3	4.6	7.9	1.8	2.3	.58							
1	115	123.9	16.0	28.5	6.5	7.0	2.1	1.5						
2			60.0	102.7	23.5	14.0	7.6	4.8	1.3	1.9				
3			115		49.7	28.0	16.1	9.0	3.1	4.1				
4					84.8	46.0	27.4	15.0	6.0	7.0	2.2	.57	.27	
5	2"				128	69.0	41.4	23.0	9.0	10.5	3.3	.86	.40	
6	PIPE	2½"				92.0	58	32.0	13.0	14.8	4.6	1.2	.57	
8	(2.067)	PIPE					98.7	60.0	21.0	25.1	7.8	2.0	.97	
10	43	(2.469)					149	78.0	32.0	38.0	11.7	3.1	1.5	
15	.92	.39	3"					175	69.0	80.5	24.9	6.5	3.1	
20	1.6	.66	PIPE						115	137	42.4	11.2	5.3	
25	2.4	1.0	(3.068)								64.1	16.9	8.0	
30	3.3	1.4	.48								89.9	24	11.2	
35	4.4	1.9	.64								120	32	14.9	
40	5.6	2.4	.83								153	40	19	
45	7.0	3.0	1.0									50	24	
50	8.5	3.6	1.2									61	29	
75	18	7.6	2.6									129	61	
100	31	13	4.5										104	

NOTE: 1. Values in shaded area are recommended for nominal operation.
2. Pipe values based on Hazen and Williams formula using C constant of 100.
3. For new smooth pipe multiply above values by .71.
4. For plastic pipe multiply above values by .54.
5. Above pipe sizes are steel schedule 40.
6. For 15 yr.-old pipe, multiply above values by 1.25.

CONVERSION FACTORS

FLOW

Lbs of Water/Hr x .002	=	Gal Min
Gal/Min x 500	=	Lbs of Water/Hr
$\frac{\text{Lbs of Fluid/Hr}}{\text{Specific Gravity}}$ x .002	=	Gal Min
Liters/Min x .264	=	Gal/Min (US)
GPM x 3.785	=	Liters/Min
Cu Meters/Hr x 4.4	=	Gal/Min (US)
Gal/Min x .227	=	Cu Meters/Hr
Kg of Water/Min x .264	=	Gal/Min (US)
Gal/Min x 3.8	=	Kg of Water/Min

PRESSURE

Ft of Water x .433	=	PSI
PSI x 2.31	=	Ft of Water
Inches Hg x .491	=	PSI
Inches Hg x 1.133	=	Ft of Water
ATM x 14.7	=	PSI
ATM x 33.9	=	Ft of Water
Kg/Sq cm x 14.22	=	PSI
Meters of Water x 1.42	=	PSI
ATM x 760	=	mm Hg
mm Hg x .039	=	Inches Hg
Bar x 14.5	=	PSI
Newton/Meter^2 x 1	=	Pascal
PSI x 6.9	=	kPa (Kilopascal)
kPa x .145	=	PSI

VOLUME

Lbs Water x .119	=	Gal
Gal (Brit) x 1.2	=	Gal (US)
Gal x 128	=	Fluid Ounces
Cubic Ft x 7.48	=	Gal
Cubic In x .00433	=	Gal
Gal x 3.785	=	Liters
Liter x .264	=	Gal
Cubic Meters x 264.2	=	Gallons
Cubic Meter x 1000	=	Liter
Liters x 1000	=	Cubic Centimeters
Cubic Centimeters x .0338	=	Fluid Ounces
Fluid Ounches x 29.57	=	Cubic Centimeters

LENGTH

Mils x .001	=	Inches
Meters x 3.281	=	Feet
Centimeters x .394	=	Inches
Millimeters x .0394	=	Inches
Microns x .0000394	=	Inches

MASS

Gal of Water x 8.336	=	Lbs
Cubic Ft of Water x 62.4	=	Lbs
Ounces x .0625	=	Lbs
Kilograms x 2.2	=	Lbs
Lbs x .454	=	Kilo
Metric Ton x 2205	=	Lbs

METRIC PREFIXES

Mega	=	1,000,000
Kilo	=	1,000
Hecto	=	100
Deca	=	10
Deci	=	.1
Centi	=	.01
Milli	=	.001
Micro	=	000,001

LIQUID PUMP TERMINOLOGY

Flooded suction — Liquid source is higher than pump, and liquid flows to pump by gravity. Preferable for centrifugal pump installations.

Flow — The measure of the liquid volume capacity of a pump. Given in Gallons Per Hour (GPH) or Gallons Per Minute (GPM), as well as Liters Per Minutes, (LPM) and milliliters per minute, (ml/m).

Head — Another measure of pressure, expressed in feet. Indicates the height of a column of water being lifted by the pump, neglecting friction losses in piping.

Lift — (Suction Lift) - Liquid source is lower than the pump. Pumping action creates a partial vacuum and atmospheric pressure forces liquid up to pump. Theoretical limit of suction lift is 34 feet, practical limit is 25 feet or less, depending on pump type and elevation above sea level.

Pressure — The force exerted on the walls of a container (tank, pipe, etc.) by the liquid. Measured in pounds per square inch (PSI).

Prime — A charge of liquid required to begin pumping action of centrifugal pumps when liquid source is lower than pump. May be held in pump by a foot valve on the intake line or a valve or chamber within the pump.

Seal — A device mounted in the pump housing and/or on the pump shaft, to prevent leakage of liquid from the pump. There are two types:

Mechanical — Has a rotating part and stationary part with highly polished touching surfaces. Has excellent sealing capability and life, but can be damaged by dirt or grit in the liquid.

Lip — A flexible ring (usually rubber or similar material) with the inner edge held closely against the rotating shaft by a spring.

Seal-less — (Magnetic Drive). No seal is used, power is transmitted from motor to pump impeller by magnetic force, through a wall that completely separates motor from impeller.

Specific Gravity — The ratio of the weight of a given volume of liquid to the same volume of pure water. Unless stated otherwise, power requirements of all pumps listed herein are based on pumping water. Pumping heavier liquids (Specific Gravity greater than 1.0) will require more drive horsepower.

Static Discharge Head — Vertical Distance (in Feet) from pump to point of discharge.

Sump — A well or pit in which liquids collect below floor level, sometimes refers to an oil reservoir.

Total Head — The sum of discharge head, suction lift and friction losses.

Viscosity — The thickness of a liquid, or its ability to flow. Temperature must be stated when specifying viscosity, since most liquids flow more easily as they get warmer. The more viscous the liquid, the slower the pump speed required.

Gland — A groove made to hold the o-ring seal so that desired compression for proper sealing is maintained.

Strainers — A device installed in the inlet of a pump to prevent foreign particles from damaging the internal parts.

Valves:

Check Valve — Allows liquid to flow in one direction only. Generally used in discharge line to prevent reverse flow.

Foot Valve — A type of check valve with a built-in strainer. Used at point of liquid intake to retain liquid in the system, preventing loss of prime when liquid source is lower than pump.

Relief Valve — Usually used at the discharge of a positive displacement pump. An adjustable, spring-loaded valve opens, or "relieves" when a pre-set pressure is reached. Used to prevent excessive pressure and pump or motor damage if discharge line is closed off.

Unloader Valve — Similar to relief valve, but not adjustable.

Pump Types

Centrifugal — consists of a fan-shaped impeller rotating in a circular housing, pushing liquid towards a discharge opening. Simple design, only wearing parts are the shaft seal and bearings (if so equipped). Usually used where a flow of liquid at relatively low pressure is desired. Not self-priming unless provided with a priming reservoir or foot valve: works best with the liquid source higher than the pump (flooded suction/gravity feed). As the discharge pressure (head) increases, flow and driven power requirements decrease. Maximum flow and motor loading occur at minimum head.

Flexible Impeller — a flexible, vaned member, usually rubber, rotating in an eccentric housing. The volume of the spaces between the vanes changes as the pump rotates, and pumping action is created. Usually used with pressures up to 30 PSI.

Submersible — A pump which operates only when totally submersed in the fluid which is being pumped, with water-proof electrical connections, using a motor which is cooled by the liquid.

Peristaltic Tube — Fluid only contacts tubing. A bushing rotates in a housing squeezing a tube creating a suction which draws fluid through the tubing.

Much of the Technical Data found herein, is reprinted courtesy of Waukesha Foundry Division.

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