# HS5040-W Reference Guide


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# Sealants and Lubricants

| | | |
|---|---|---|
| **Glyptol 1201** | **General Electric Co.** | **Pipe thread compound and sealant. Bake at 125°F for 2 hours.** |
| **Plastic Lead Seal** | **Crane Packing Co.** | **Sealing threads and gaskets. Service range to 550°F.** |
| **Loctite with Teflon** | **Loctite Corp.** | **Sealing pipe and fittings. Temp range -65 to 400°F. Pressure to 600 psi.** |
| **Loctite Thread Locker** | **Loctite Corp.** | **Removable and permanent thread sealers to 300°F.** |
| **KOPR-KOTE** | **Jet Lube, Inc.** | **Not for use on $O_2$ or LP gas thread lubricant service to 1500°F. For higher temp use Jet Lube SS-30. For S.S. threads only. Not a sealant.** |
| **Silver Goop** | **Crawford Fitting Co.** | **Anti-seize compound. For S.S. and high temp alloys. Temp range to 2000°F.** |
| **Blue Goop** | **Crawford Fitting Co.** | **Thread lube for Ti, S.S., and Al to 400°F.** |

# Sealants and Lubricants

| | | |
|---|---|---|
| **Teflon Tape** | **P.E. O'Hair & Co.** | **Spec. MIL-T-T 27730. Dupont seal/lubricant for tapered pipe threads.** |
| **Torr Seal** | | **seals pipe threads on safety manifolds, etc., hard seal.** |
| **Teflon Tape + Fluorolube, Lube 160** | **Hooker Chemical Co.** | **Assembly/disassembly of S.S. pipe threads (prevents galling).** |
| **Fluorolube, Lube 160** | **Hooker Chemical Co.** | **Used on $O_2$ systems, seal surfaces. Don't use with Al or Mg.** |
| **Fomblin, Y-VAC 3 series** | **Fomblin (K.J. Lesker Co.)** | **Perfluorinated for hostile environments, both chemical and physical.** |
| **PLS-2** | **Federal Process Co.** | **Pipe thread sealant (lead base)** |
| **SWAK** | **Cajon Company** | **Anaerobic sealer with TFE, pipe thread sealant.** |
| **Liquid "O" Ring** | **Oil Center Research, Inc.** | **All-purpose sealer and lubricant.** |

# FLUID/SEAL MATERIAL COMPATIBILITY

| RATINGS: | | | |
|---|---|---|---|
| | 1 | — | MINOR EFFECT |
| | 2 | — | MODERATE EFFECT |
| | 3 | — | SEVERE EFFECT, SOME STATIC APPLICATIONS ONLY |
| | 4 | — | NOT RECOMMENDED |
| | | — | INSUFFICIENT DATA |

| | | DYNAMIC AND STATIC | | | | | | | | | STATIC ONLY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLUID | NATIONAL RECOMMENDED COMPOUND | NITRILE (BUNA N) | ETHYLENE-PROPYLENE | NEOPRENE | FLUOROCARBON | STYRENE-BUTASDIENE (SBR) | POLYACRYLATE | POLYURETHANE | BUTYL | EPICHLOROHYDRIN | SILICONE | FLUOROSILICONE | POLYSULFIDE | CHLOROSULFONATED POLYETHYLENE |
| Acetaldehyde | E50-70 | 4 | 1 | 3 | 4 | 3 | 4 | 4 | 1 | — | 2 | 4 | 3 | 3 |
| Acetamide | B46-70 | 1 | 1 | 2 | 2 | 4 | 4 | 4 | 1 | — | 2 | 1 | 4 | 2 |
| Acetic Acid, Glacial | E50-70 | 3 | 1 | 4 | 3 | 2 | 4 | 4 | 2 | 4 | 2 | 4 | 2 | 3 |
| Acetic Acid, 3 | E50-70 | 3 | 2 | 2 | 4 | 2 | 4 | 4 | 2 | 4 | 3 | 4 | 2 | 1 |
| Acetic Anhydride | N11-70 | 4 | 1 | 3 | 4 | 3 | 4 | 4 | 1 | 4 | 3 | 4 | 3 | 2 |
| Acetone | E50-70 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 |
| Acetophenone | E50-70 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 3 | 1 | 4 | 4 |
| Acetyl Chloride | V14-75 | 1 | 1 | 2 | 1 | 2 | 4 | 4 | 1 | — | 2 | | 3 | 2 |
| Acetylene | E50-70 | 1 | 1 | 1 | — | 1 | — | — | 1 | — | — | 1 | — | — |
| Adipic Acid | B46-70 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | — | 4 | 2 | 3 | 4 |
| Alkazene (Dibromoethyl benzene) | V14-75 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | — | 4 | 2 | 3 | 4 |
| Alum-NH,-Cr-K (aq) | B46-70 | 1 | 1 | 1 | 4 | 1 | 4 | — | 1 | — | 1 | 4 | 4 | 1 |
| Aluminum Acetate (aq) | E50-70 | 2 | 1 | 2 | 4 | 2 | 4 | 4 | 1 | 2 | 4 | 4 | 4 | 1 |
| Aluminum Chloride (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 2 | 1 | 4 | 1 |
| Aluminum Fluoride (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | — | 3 | 1 | 1 | 2 | 1 | 4 | 1 |
| Aluminum Nitrate (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | — | 3 | 1 | 1 | 2 | — | 2 | 1 |
| Aluminum Phosphate (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | — | — | 1 | 1 | 1 | — | — | 1 |
| Aluminum Sulfate (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | — | 1 | 1 | 4 | 1 |
| Ammonia, Anhydrous | E50-70 | 2 | 1 | 1 | 4 | 4 | 4 | 4 | 1 | — | 3 | 4 | — | 2 |
| Ammonia Gas (cold) | N11-70 | 1 | 1 | 1 | 4 | 1 | 4 | 3 | 1 | — | 1 | 4 | 1 | 1 |
| Ammonia Gas (hot) | N11-70 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | — | 1 | 4 | 4 | 2 |
| Ammonium Carbonate (aq) | E50-70 | 4 | 2 | 1 | — | 1 | 4 | 4 | 1 | 2 | — | — | — | — |
| Ammonium Chloride (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | — | — | 1 | 1 |
| Ammonium Hydroxide (conc.) | E50-70 | 4 | 1 | 1 | 2 | 4 | 4 | 4 | 1 | 2 | 1 | 2 | 1 | 1 |
| Ammonium Nitrate (aq) | B46-70 | 1 | 1 | 1 | — | 2 | 2 | 4 | 1 | 1 | — | — | — | 1 |
| Ammonium Nitrite (aq) | B46-70 | 1 | 1 | 1 | — | 1 | — | — | 1 | — | 2 | — | — | 1 |
| Ammonium Persulfate (aq) | E50-70 | 4 | 1 | 1 | — | 4 | 4 | 4 | 1 | — | — | — | — | 1 |
| Ammonium Phosphate (aq) | B46-70 | 1 | 1 | 1 | — | 1 | — | — | 1 | — | 1 | — | 1 | 1 |
| Ammonium Sulfate (aq) | B46-70 | 1 | 1 | 1 | 4 | 1 | 4 | 1 | 1 | — | — | — | 4 | 1 |

| FLUID | NATIONAL RECOMMENDED COMPOUND | DYNAMIC AND STATIC: NITRILE (BUNA N) | ETHYLENE-PROPYLENE | NEOPRENE | FLUOROCARBON | STYRENE-BUTASDIENE (SBR) | POLYACRYLATE | POLYURETHANE | BUTYL | STATIC ONLY: EPICHLOROHYDRIN | SILICONE | FLUOROSILICONE | POLYSULFIDE | CHLOROSULFONATED POLYETHYLENE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amyl Alcohol | E50-70 | 2 | 1 | 2 | 2 | 2 | 4 | 4 | 1 | 1 | 4 | 1 | 2 | 1 |
| Amyl Borate | B46-70 | 1 | 4 | 1 | 1 | 4 | — | — | 4 | — | — | — | 1 | 1 |
| Amyl Chloronaphthalene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 3 | 4 |
| Amyl Naphthalene | V14-75 | 4 | 4 | 4 | 1 | 4 | 2 | 4 | 4 | — | 4 | 1 | 3 | 4 |
| ASTM Fuel A | B46-70 | 1 | 4 | 2 | 1 | 4 | 2 | 2 | 4 | 1 | 4 | 1 | 1 | 3 |
| ASTM Fuel B | B46-70 | 1 | 4 | 3 | 1 | 4 | — | 3 | 4 | 1 | 4 | 1 | 1 | 3 |
| ASTM Fuel C | C9-70 | 1 | 4 | 3 | 1 | 4 | — | 3 | 4 | 1 | 4 | 1 | 1 | 3 |
| ASTM Fuel D | C9-70 | 1 | 4 | 3 | 1 | 4 | — | 3 | 4 | 1 | 4 | 1 | 1 | 3 |
| ASTM Oil One | B46-70 | 1 | 4 | 1 | 1 | 4 | 1 | 1 | 4 | 1 | 3 | 1 | 1 | 1 |
| ASTM Oil Two | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | 1 | 3 | 1 | 1 | 2 |
| ASTM Oil Three | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | 1 | 3 | 1 | 1 | 2 |
| Benzene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 4 |
| Benzene Sulfonic Acid | V14-75 | 4 | 3 | 2 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 4 | 1 |
| Benzine (Ligroin) (Nitrobenzine) | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | — | 4 | 1 | 1 | 3 |
| Benzoic Acid | V14-75 | 3 | 3 | 4 | 1 | 4 | 3 | 4 | 4 | — | 3 | 2 | 2 | 4 |
| Benzyl Chloride | V14-75 | 4 | 4 | 4 | 1 | 4 | 3 | — | 4 | — | — | 2 | 4 | 4 |
| Benzyl Alcohol | V14-75 | 4 | 1 | 3 | 1 | 4 | 4 | 4 | 1 | — | 2 | 2 | 4 | 2 |
| Benzyl Benzoate | V14-75 | 4 | 2 | 4 | 1 | 4 | 4 | — | 2 | — | — | 1 | 4 | 4 |
| Benzyl Chloride | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 4 | 4 |
| Boric Acid | B46-70 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Brine | B46-70 | 1 | 1 | 1 | 1 | 1 | 4 | 2 | 1 | — | 1 | 1 | 4 | 1 |
| Butane | B46-70 | 1 | 4 | 1 | 1 | 4 | 1 | 1 | 4 | 1 | 4 | 1 | 1 | 2 |
| Butyl Alcohol | B46-70 | 1 | 2 | 1 | 1 | 1 | 4 | 4 | 2 | — | 2 | 2 | 2 | 1 |
| Calcium Chloride (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Calcium Hydroxide (ac) | B46-70 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 4 | 1 |
| Calcium Hypochlorite (aq) | E50-70 | 2 | 1 | 3 | 1 | 3 | 4 | 4 | 1 | 2 | 2 | 2 | 4 | 1 |
| Calcium Nitrate (aq) | B46-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 |
| Calcium Sulfide (aq) | B46-70 | 1 | 1 | 1 | 1 | 2 | 4 | 1 | 1 | 2 | 2 | 1 | 4 | 1 |
| Carbolic Acid (Phenol) | V14-75 | 4 | 2 | 3 | 1 | — | 4 | 3 | 2 | — | 4 | 1 | 4 | 4 |
| Carbon Dioxide | B46-70 | 1 | 2 | 2 | 1 | 2 | — | 1 | 2 | 1 | 2 | 1 | 2 | 2 |
| Carbonic Acid | E50-70 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Carbon Monoxide | B46-70 | 1 | 1 | 2 | 1 | 2 | — | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| Carbon Tetrachloride | V14-75 | 3 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 3 | 4 |
| Chlorine (dry) | V14-75 | 4 | 4 | 3 | 1 | 4 | 4 | 4 | 4 | 2 | 4 | 1 | 4 | 2 |
| Chlorine (wet) | V14-75 | 4 | 3 | 3 | 1 | 4 | 4 | 4 | 3 | 2 | 4 | 2 | 3 | 3 |
| Chlorine Dioxide | V14-75 | 4 | 3 | 4 | 1 | 4 | 4 | 4 | 3 | — | — | 2 | 4 | 3 |
| Chlorine Trifluoride | V14-75 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 |
| Chromic Acid | V14-75 | 4 | 3 | 3 | 1 | 4 | 4 | 4 | 3 | — | 3 | 3 | 4 | 2 |
| Detergent Solutions | E50-70 | 1 | 1 | 2 | 1 | 2 | 4 | 4 | 1 | 1 | 1 | 1 | — | 2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diacetone | E50-70 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | — | 4 | 4 | 2 | 4 |
| Diacetone Alcohol | K4-60 | 4 | 1 | 2 | 4 | 4 | 4 | 4 | 1 | 4 | 2 | 4 | 2 | 2 |
| Dibenzyl Ether | V14-75 | 4 | 2 | 3 | 4 | 4 | — | 2 | 2 | 4 | — | — | 2 | 4 |
| Diphenyl (Phenylbenzene) | B46-70 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 2 | 4 |
| Ethane | E50-70 | 1 | 4 | 2 | 1 | 4 | 1 | 3 | 4 | — | 4 | 2 | 1 | 2 |
| Ethyl Acetate | E50-70 | 4 | 2 | 3 | 4 | 4 | 4 | 4 | 2 | 4 | 2 | 4 | 3 | 4 |
| Ethyl Acetoacetate | E50-70 | 4 | 2 | 3 | 4 | 3 | 4 | 4 | 2 | — | 2 | 4 | 2 | 4 |
| Ethyl Acrylate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | — | 2 | 4 | 2 | 4 |
| Ethyl Alcohol | E50-70 | 1 | 1 | 1 | 3 | 1 | 4 | 4 | 1 | 2 | 1 | 1 | 1 | 1 |
| Ethyl Benzene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 1 | 4 | 4 |
| Ethyl Benzoate | V14-75 | 4 | 1 | 4 | 1 | 1 | 4 | 4 | 1 | — | 4 | 1 | 2 | 4 |
| Ethyl Cellosolve | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | — | 4 | 4 | 2 | 4 |
| Ethyl Cellulose | B46-70 | 2 | 2 | 2 | 4 | 2 | 4 | 2 | 2 | — | 3 | 4 | 4 | 2 |
| Ethyl Chloride | B46-70 | 1 | 3 | 4 | 1 | 4 | 4 | 2 | 4 | 2 | 4 | 1 | 4 | 4 |
| Ethyl Chlorocarbonate | V14-75 | 4 | 2 | 4 | 1 | 4 | 4 | 4 | 3 | — | 4 | 2 | 4 | 4 |
| Ethyl Chloroformate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 3 | — | 4 | 4 | 4 | 4 |
| Ethyl Ether | K4-60 | 3 | 3 | 3 | 4 | 4 | 4 | 3 | 3 | 2 | 4 | 3 | 2 | 4 |
| Ethyl Formate | V14-75 | 4 | 2 | 2 | 1 | 4 | — | — | 2 | 4 | — | 1 | 4 | 2 |
| Ethyl Mercaptan | V14-75 | 4 | 3 | 3 | 2 | 4 | — | — | 4 | 4 | 3 | — | 4 | 2 |
| Ethyl Oxalate | V14-75 | 4 | 1 | 3 | 1 | 1 | 4 | 1 | 1 | 4 | 4 | 2 | 1 | 4 |
| Ethyl Pentachlorobenzene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 3 | 4 | 2 | 3 | 4 |
| Ethyl Silicate | E50-70 | 1 | 1 | 1 | 1 | 2 | — | — | 1 | 1 | — | 1 | 2 | 2 |
| Ethylene | B46-70 | 1 | 2 | 3 | 1 | 3 | — | — | 2 | — | — | 1 | — | — |
| Ethylene Chloride | V14-75 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 3 | — | 4 | 3 | 2 | 4 |
| Ethylene Chlorohydrin | V14-75 | 4 | 2 | 2 | 1 | 2 | 4 | 4 | 2 | — | 3 | 2 | 2 | 2 |
| Ethylene Diamine | E50-70 | 1 | 1 | 1 | 4 | 2 | 4 | 4 | 1 | 1 | 1 | 4 | 4 | 2 |
| Ethylene Dichloride | V14-75 | 4 | 3 | 4 | 1 | 4 | 4 | 4 | 3 | 4 | 4 | 3 | 4 | 4 |
| Ethylene Glycol | E50-70 | 1 | 1 | 1 | 1 | 1 | 3 | 4 | 1 | 1 | 1 | 1 | 3 | 1 |
| Ethylene Oxide | | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | — | 4 | 4 | — | 4 |
| Ethylene Trichloride | V14-75 | 4 | 3 | 4 | 1 | 4 | 4 | 4 | 3 | — | 4 | 3 | 4 | 4 |
| Fluorine (liquid) | | 4 | 4 | 4 | — | 4 | 4 | 4 | 4 | — | 4 | — | 4 | — |
| Freon 11 | B46-70 | 2 | 4 | 3 | 1 | 4 | — | 4 | 4 | — | 4 | 2 | 1 | 1 |
| Freon 12 | N11-70 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 4 | 3 | 1 | 1 |
| Freon 13 | | 1 | 1 | 1 | 1 | 1 | — | — | 1 | 1 | 4 | 4 | 1 | 1 |
| Freon 21 | N11-70 | 4 | 4 | 4 | 4 | 4 | — | — | 4 | 2 | 4 | — | 4 | 4 |
| Freon 22 | | 4 | 1 | 1 | 4 | 1 | 2 | 4 | 1 | 1 | 4 | 4 | 4 | 1 |
| Freon 31 | N11-70 | 4 | 1 | 2 | 4 | 2 | — | — | 1 | — | — | — | 3 | 2 |
| Freon 32 | N11-70 | 1 | 1 | 1 | 4 | 1 | — | — | 1 | — | — | — | 1 | 1 |
| Freon 112 | V14-75 | 2 | 4 | 3 | 1 | 3 | — | — | 4 | — | 4 | — | 1 | 2 |
| Freon 113 | N11-70 | 1 | 3 | 1 | 2 | 2 | — | 2 | 4 | 1 | 4 | 4 | 1 | 1 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Freon 114 | N11-70 | 1 | 1 | 1 | 2 | 1 | — | 1 | 1 | 1 | 4 | 2 | 1 | 1 |
| Freon 115 | B46-70 | 1 | 1 | 1 | 2 | 1 | — | — | 1 | — | — | — | 1 | 1 |
| Freon 142b | N11-70 | 1 | 2 | 1 | 4 | 2 | — | — | 1 | — | — | — | 1 | 1 |
| Freon 152a | N11-70 | 1 | 1 | 1 | 4 | 1 | — | — | 1 | — | — | — | 1 | 3 |
| Freon 218 | N11-70 | 1 | 1 | 1 | 1 | 1 | — | — | | — | — | — | | |
| Freon C316 | N11-70 | 1 | 1 | 1 | | 1 | — | — | 1 | — | — | — | 1 | 1 |
| Freon C318 | N11-70 | 1 | 1 | 1 | 2 | 1 | — | — | 1 | — | — | — | 1 | 1 |
| Freon 13B1 | N11-70 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | — | 4 | — | 1 | 1 |
| Freon 114B2 | N11-70 | 2 | 4 | 2 | 2 | 3 | — | — | 4 | — | 4 | — | 2 | 1 |
| Freon 502 | N11-70 | 2 | 1 | 1 | 2 | 1 | — | — | 1 | — | — | — | — | — |
| Freon TF | N11-70 | 1 | 4 | 1 | 2 | 3 | — | 1 | 4 | 1 | 4 | — | 1 | 1 |
| Freon T-WD602 | V14-75 | 2 | 2 | 2 | 1 | 3 | — | 1 | 2 | — | 4 | — | 1 | 2 |
| Freon TMC | V14-75 | 2 | 3 | 3 | 1 | 4 | — | 2 | 3 | — | 3 | — | 1 | 2 |
| Freon T-P35 | B46-70 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | — | 1 | — | 1 | 1 |
| Freon TA | B46-70 | 1 | 2 | 2 | 3 | 3 | — | 1 | 2 | — | 3 | — | 1 | 1 |
| Freon TC | B46-70 | 1 | 2 | 1 | 1 | 3 | — | 1 | 2 | — | 4 | — | 1 | 1 |
| Freon MF | B46-70 | 1 | 4 | 3 | 2 | 4 | — | 3 | 4 | — | 4 | — | 1 | 2 |
| Freon BF | B46-70 | 2 | 4 | 3 | 1 | 4 | — | — | 4 | — | 4 | — | 1 | 2 |
| Gasoline | B46-70 | 2 | 4 | 3 | 1 | 4 | 4 | 2 | 4 | 1 | 4 | 1 | 1 | 3 |
| Glucose | C22-70 | 1 | 1 | 1 | 1 | 1 | — | 4 | 1 | 1 | 1 | 1 | 4 | 1 |
| Glycerin | B46-70 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 |
| Glycols | E50-70 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| N-Hexaldehyde | E50-70 | 4 | 1 | 1 | 4 | 4 | — | 2 | 2 | — | 2 | 4 | 2 | 3 |
| Hexane | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | 1 | 4 | 1 | 1 | 2 |
| N-Hexene 1 | V14-75 | 2 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | — | 4 | 1 | 1 | 2 |
| Hexyl Alcohol | B46-70 | 1 | 3 | 2 | 1 | 2 | 4 | 4 | 3 | — | 2 | 2 | 2 | 2 |
| Hydrazine | V14-75 | 2 | 1 | 2 | 4 | 1 | — | 4 | 1 | — | 3 | 4 | 4 | 2 |
| Hydraulic Oil (Petroleum) | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | 1 | 3 | 1 | 1 | 2 |
| Hydrobromic Acid | E50-70 | 4 | 1 | 4 | 1 | 4 | 4 | 4 | 1 | — | 4 | 3 | 2 | 1 |
| Hydrobromic Acid 40% | E50-70 | 4 | 1 | 2 | 1 | 4 | 4 | 4 | 1 | — | 4 | 3 | 3 | 1 |
| Hydrochloric Acid (cold) 37% | E50-70 | 3 | 1 | 2 | 1 | 2 | 4 | 4 | 1 | 2 | 3 | 2 | 1 | 1 |
| Hydrochloric Acid (hot) 37% | V14-75 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 2 | 4 |
| Hydrocyanic Acid | E50-70 | 2 | 1 | 2 | 1 | 2 | 4 | — | 1 | — | 3 | 2 | 4 | 1 |
| Hydrofluoric Acid (conc.) cold | V14-75 | 4 | 3 | 4 | 1 | 4 | 4 | 3 | 3 | — | 4 | 4 | 4 | 1 |
| Hydrofluoric Acid— Anhydrous | | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | — | 4 | 4 | 4 | 1 |
| Hydrogen Gas | E50-70 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | — | 3 | 3 | 3 | 1 |
| Isobutyl Alcohol | E50-70 | 2 | 1 | 1 | 1 | 2 | 4 | 4 | 1 | — | 1 | 2 | 2 | 1 |

| | | DYNAMIC AND STATIC | | | | | | | | | STATIC ONLY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLUID | NATIONAL RECOMMENDED COMPOUND | NITRILE (BUNA N) | ETHYLENE-PROPYLENE | NEOPRENE | FLUOROCARBON | STYRENE-BUTASDIENE (SBR) | POLYACRYLATE | POLYURETHANE | BUTYL | EPICHLOROHYDRIN | SILICONE | FLUOROSILICONE | POLYSULFIDE | CHLOROSULFONATED POLYETHYLENE |
| Isopropyl Acetate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | 2 | 4 |
| Isopropyl Alcohol | E50-70 | 2 | 1 | 2 | 1 | 2 | 4 | 3 | 1 | 1 | 1 | 2 | 1 | 1 |
| Isopropyl Chloride | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 3 | 1 | 3 |
| Isopropyl Ether | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | 1 | 4 | 1 | 2 | 3 |
| Kerosene | B46-70 | 4 | 1 | 4 | 2 | 4 | 4 | 4 | 1 | — | 3 | 3 | 4 | 4 |
| Lindol (Hydraulic fluid) | E50-70 | 1 | 4 | 2 | 1 | 4 | 3 | 1 | 4 | 1 | 3 | 3 | 1 | 2 |
| Liquefied Petroleum Gas | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | 1 | 4 | 1 | 3 | 2 |
| Lubricating Oils (petroleum) | B46-70 | 1 | 1 | 1 | 1 | 1 | — | — | 1 | 1 | — | — | — | 1 |
| Mercury Chloride (aq) | E50-70 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 1 | — | — | 1 | 1 |
| Mercury | E50-70 | 1 | 4 | 2 | 2 | 4 | 1 | 3 | 4 | 1 | 4 | 2 | 1 | 2 |
| Methane | B46-70 | 4 | 1 | 2 | 4 | 3 | 4 | 4 | 1 | 4 | 4 | 4 | 2 | 4 |
| Methyl Acetate | E50-70 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | 2 | 4 |
| Methyl Acrylate | E50-70 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | 2 | 4 |
| Methylacrylic Acid | E50-70 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | — | 4 |
| Methyl Alcohol | E50-70 | 1 | 1 | 1 | 4 | 1 | 4 | 4 | 1 | 2 | 1 | 1 | 2 | 1 |
| Methyl Bromide | V14-75 | 2 | 4 | 4 | 1 | 4 | 3 | — | 4 | — | — | 1 | — | 4 |
| Methyl Butyl Ketone | E50-70 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | — | 3 | 4 | 2 | 4 |
| Methyl Cellosolve | E50-70 | 3 | 2 | 3 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | — | 2 |
| Methyl Chloride | V14-75 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 3 | — | 4 | 2 | 3 | 4 |
| Methyl Cyclopentane | V14-75 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | — | 4 | 2 | 2 | 4 |
| Methylene Chloride | V14-75 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 4 | — | 4 | 2 | 4 | 4 |
| Methyl Ether | B46-70 | 1 | 4 | 3 | 1 | 4 | 4 | — | 4 | — | 1 | 1 | 2 | 3 |
| Methyl Ethyl Ketone | E50-70 | 4 | 1 | 3 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 |
| Methyl Formate | N11-70 | 4 | 2 | 2 | — | 4 | — | — | 2 | 4 | — | — | 3 | 2 |
| Methyl Isobutyl Ketone | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 2 | 4 |
| Methyl Methacrylate | K4-60 | 4 | 3 | 4 | 4 | 4 | 4 | — | 4 | 4 | 4 | 4 | 2 | 4 |
| Methyl Oleate | V14-75 | 4 | 2 | 4 | 2 | 4 | — | — | 2 | — | — | 2 | — | 4 |
| Methyl Salicylate | E50-70 | 4 | 2 | 4 | — | 3 | — | — | 2 | — | — | — | — | 4 |
| Naphtha | V14-75 | 2 | 4 | 3 | 1 | 4 | 2 | 2 | 4 | 1 | 4 | 2 | 2 | 4 |
| Nitrobenzene | E50-70 | 4 | 1 | 4 | 2 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 |
| Nitrobenzene (Ligroin) | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | — | 4 | 1 | 1 | 3 |
| Nitroethane | N11-70 | 4 | 2 | 3 | 4 | 2 | 4 | 4 | 2 | — | 4 | 4 | — | 2 |
| Nitrogen | E50-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nitrogen Tetroxide | | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 3 | — | 4 | 4 | 4 | 4 |
| Nitromethane | E50-70 | 4 | 2 | 2 | 4 | 2 | 4 | 4 | 2 | — | 4 | 4 | 3 | 3 |
| N-Octane | B46-70 | 2 | 4 | 2 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 2 | 2 |
| Octyl Alcohol | V14-75 | 2 | 3 | 1 | 1 | 2 | 4 | 4 | 3 | — | 2 | 2 | 2 | 2 |
| Oleic Acid | V14-75 | 3 | 4 | 3 | 2 | 4 | 4 | 2 | 4 | 1 | 4 | — | 3 | 3 |
| Oxygen—Cold | E50-70 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 |

| FLUID | NATIONAL RECOMMENDED COMPOUND | DYNAMIC AND STATIC: NITRILE (BUNA N) | ETHYLENE-PROPYLENE | NEOPRENE | FLUOROCARBON | STYRENE-BUTASDIENE (SBR) | POLYACRYLATE | POLYURETHANE | BUTYL | EPICHLOROHYDRIN | STATIC ONLY: SILICONE | FLUOROSILICONE | POLYSULFIDE | CHLOROSULFONATED POLYETHYLENE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Oxygen—(200-400°F) | S59-70 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 2 | 4 | 2 | 4 | 4 | 4 |
| Ozone | E50-70 | 4 | 1 | 3 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 2 | 1 | 1 |
| Petroleum—below 250°F | B46-70 | 1 | 4 | 2 | 1 | 4 | 2 | 2 | 4 | 1 | 2 | 2 | 4 | 2 |
| Petroleum—above 250°F | V14-75 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 4 |
| Phosphoric Acid—20% | E50-70 | 2 | 1 | 2 | 1 | 2 | — | 1 | 2 | — | 2 | 2 | 4 | 1 |
| Phosphoric Acid—45% | E50-70 | 4 | 1 | 2 | 1 | 3 | — | 1 | 2 | — | 3 | 2 | 4 | 2 |
| Phosphorus | E50-70 | 4 | 1 | 4 | 1 | 4 | — | — | 1 | — | — | 1 | — | 4 |
| Potassium Nitrate (aq) | E50-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Potassium Sulfate (aq) | E50-70 | 1 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 1 | 2 | 2 |
| Producer Gas | B46-70 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | — | 2 | 2 | 4 | 2 |
| Propane | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 3 | 4 | 1 | 4 | 2 | 1 | 2 |
| i-Propyl Acetate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 2 | 4 |
| n-Propyl Acetate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 | 4 | 2 | 4 |
| Propyl Acetone (Methyl Butyl Ketone) | E50-70 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 1 | — | 3 | 4 | 2 | 4 |
| Propyl Alcohol | E50-70 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Propyl Nitrate | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | — | 2 | — | 4 | 4 | — | 4 |
| Propylene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 2 | 4 |
| Propylene Oxide | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 2 | — | 4 | 4 | — | 4 |
| Pydraul, 10E, 29 ELT | V14-75 | 4 | 1 | 4 | 1 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | — | 4 |
| Pydraul, 30E, 50E, 65E, 90E | V14-75 | 4 | 1 | 4 | 1 | 4 | 4 | 4 | 1 | 4 | 1 | 1 | — | 1 |
| Pydraul, 115E | V14-75 | 4 | 1 | 4 | 1 | 4 | 4 | 4 | 1 | 4 | 4 | 3 | — | 4 |
| Pydraul, 230E, 312C, 540C | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | — | 4 |
| Pyranol, Transformer Oil | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 2 | 4 | 4 | 4 | 1 | 4 | 3 |
| Radiation | E50-70 | 3 | 2 | 2 | 4 | 3 | 3 | 3 | 4 | — | 3 | 4 | 4 | 3 |
| Rapeseed Oil | E50-70 | 2 | 1 | 2 | 1 | 4 | 2 | 2 | 1 | 1 | 4 | 1 | 4 | 2 |
| Red Oil (MIL-H-5606) | D25 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | — | 4 | 1 | 1 | 2 |
| RJ-1 (MIL-F-25558 B) | C69 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | — | 4 | 1 | 1 | 2 |
| RP-1 (MIL-F-25576 C) | C69 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | — | 4 | 1 | 1 | 2 |
| Silicone Greases | E50-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 |
| Silicone Oils | E50-70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 1 |
| Silver Nitrate | E50-70 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | — | 1 | 1 | 2 | 1 |
| Skydrol 500 | E79 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 3 | 3 | 4 | 4 |
| Skydrol 7000 | E79 | 4 | 1 | 4 | 2 | 4 | 4 | 4 | 1 | 4 | 3 | 3 | 4 | 4 |
| Sulfur Chloride (aq) | V14-75 | 3 | 4 | 3 | 1 | 4 | 4 | — | 4 | — | 3 | 1 | 4 | 2 |
| Sulfur Dioxide(Dry) | E50-70 | 4 | 1 | 4 | 1 | 2 | 4 | — | 2 | — | 2 | 2 | 4 | 2 |
| Sulfur Dioxide (Wet) | E50-70 | 4 | 1 | 2 | 1 | 4 | 4 | — | 1 | — | 2 | 2 | 4 | 1 |
| Sulfur Dioxide (liquefied under pressure) | E50-70 | 4 | 1 | 4 | 1 | 4 | 4 | — | 2 | — | 2 | 2 | 4 | 4 |
| Sulfur Hexafluoride | N11-70 | 2 | 1 | 1 | 1 | 4 | 4 | — | 1 | 1 | 2 | 2 | 3 | 2 |

| | | DYNAMIC AND STATIC | | | | | | | | | STATIC ONLY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLUID | NATIONAL RECOMMENDED COMPOUND | NITRILE (BUNA N) | ETHYLENE-PROPYLENE | NEOPRENE | FLUOROCARBON | STYRENE-BUTASDIENE (SBR) | POLYACRYLATE | POLYURETHANE | BUTYL | EPICHLOROHYDRIN | SILICONE | FLUOROSILICONE | POLYSULFIDE | CHLOROSULFONATED POLYETHYLENE |
| Sulfur Trioxide | V14-75 | 4 | 2 | 4 | 1 | 2 | 4 | — | 2 | — | 2 | 2 | 4 | 4 |
| Sulfuric Acid (dilute) | V14-75 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 4 | 3 | 1 | 1 |
| Sulfuric Acid (conc.) | V14-75 | 4 | 3 | 4 | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 1 |
| Sulfuric Acid (20% Oleum) | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Sulfurous Acid | E50-70 | 2 | 2 | 2 | 1 | 2 | 4 | 3 | 2 | — | 4 | — | 4 | 1 |
| Tannic Acid | E50-70 | 1 | 1 | 1 | 1 | 2 | 4 | 1 | 1 | — | 2 | — | 1 | 1 |
| Tertiary Butyl Alcohol | V14-75 | 2 | 2 | 2 | 1 | 2 | 4 | 4 | 2 | — | 2 | 2 | 2 | 2 |
| Tertiary Butyl Catechol | V14-75 | 4 | 2 | 2 | 1 | 2 | 4 | 4 | 2 | — | — | 1 | 4 | 2 |
| Tertiary Butyl Mercaptan | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | — | 4 | 4 |
| Tetrabromoethane | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | — | 4 | — | 4 | 2 | — | 4 |
| Tetrabromomethane | V14-75 | 4 | 4 | 4 | 1 | 4 | — | — | 4 | — | 4 | 2 | — | — |
| Tetrabutyl Titanate | E50-70 | 2 | 1 | 2 | 1 | 2 | — | — | 2 | — | — | 1 | — | 1 |
| Tetrachloroethylene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 3 | 4 |
| Tetrahydrofuran | E50-70 | 4 | 2 | 4 | 4 | 4 | 4 | 3 | 3 | — | 4 | 4 | 1 | 4 |
| Transmission Fluid Type A | B46-70 | 1 | 4 | 2 | 1 | 4 | 1 | 1 | 4 | 1 | 2 | 1 | 1 | 2 |
| Trichloroethane | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | — | 4 | 2 | 4 | 4 |
| Trichloroethylene | V14-75 | 4 | 4 | 4 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 4 | 4 |
| Turbine Oil | V14-75 | 2 | 4 | 4 | 1 | 4 | 1 | 1 | 4 | 1 | 4 | 2 | 1 | 4 |
| Wagner 21B Brake Fluid | E50-70 | 3 | 1 | 2 | 4 | 1 | — | — | 2 | 4 | 3 | 4 | 4 | 2 |
| Water | C22-70 | 1 | 1 | 1 | 1 | 1 | 4 | 3 | 1 | 1 | 1 | 1 | 4 | 1 |

# Pressure Conversion Chart

multiply no. of by →

To obtain ↓

| To obtain | Atmospheres | Bars | Millibars | In. of Hg (0°C) | In. of $H_2O$ (4°C) | $lb/in^2$ (psi) | $lb/ft^2$ | ft of $H_2O$ | mm of Hg (Torr) | Microns | Pascals (Newtons/$Meter^2$) | Kilopascals | Megapascals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Atmospheres** | | $9.869 \times 10^{-1}$ | $9.869 \times 10^{-4}$ | $3.342 \times 10^{-2}$ | $2.458 \times 10^{-3}$ | $6.804 \times 10^{-2}$ | $4.725 \times 10^{-4}$ | $2.9486 \times 10^{-2}$ | $1.3157 \times 10^{-3}$ | $1.3157 \times 10^{-6}$ | $9.863 \times 10^{-6}$ | $9.863 \times 10^{-3}$ | 9.863 |
| **Bars** | 1.013 | | $10^{-3}$ | $3.385 \times 10^{-2}$ | $2.491 \times 10^{-3}$ | $6.895 \times 10^{-2}$ | $4.786 \times 10^{-4}$ | $2.9869 \times 10^{-2}$ | $1.333 \times 10^{-3}$ | $1.333 \times 10^{-6}$ | $10^{-5}$ | $10^{-2}$ | 10 |
| **Millibars** | 1013 | 1000 | | 33.85 | 2.491 | 68.95 | $4.786 \times 10^{-1}$ | 29.869 | 1.333 | $1.333 \times 10^{-3}$ | $10^{-2}$ | 10 | $1 \times 10^{4}$ |
| **In. of Hg (0°C)** | 29.92 | 29.53 | $2.953 \times 10^{-2}$ | | $7.355 \times 10^{-2}$ | 2.036 | $1.414 \times 10^{-2}$ | 0.8822 | $3.937 \times 10^{-2}$ | $3.937 \times 10^{-5}$ | $2.953 \times 10^{-4}$ | .2953 | $2.953 \times 10^{2}$ |
| **In. of $H_2O$ (4°C)** | 406.8 | $4.015 \times 10^{2}$ | 0.4015 | 13.6 | | 27.68 | 0.1922 | 11.92 | 0.5353 | $5.3533 \times 10^{-4}$ | $4.015 \times 10^{-3}$ | 4.015 | $4.015 \times 10^{3}$ |
| **$lb/in^2$ (psi)** | 14.696 | 14.5 | $1.45 \times 10^{-2}$ | 0.4912 | $3.613 \times 10^{-2}$ | | $6.944 \times 10^{-3}$ | 0.4333 | $1.934 \times 10^{-2}$ | $1.934 \times 10^{-5}$ | $1.45 \times 10^{-4}$ | .145 | 145 |
| **$lb/ft^2$** | 2116 | $2.089 \times 10^{3}$ | 2.089 | 70.73 | 5.204 | 144 | | 62.4 | 2.785 | $2.785 \times 10^{-3}$ | $2.089 \times 10^{-2}$ | 20.89 | $2.089 \times 10^{4}$ |
| **ft of $H_2O$** | 33.9 | 33.456 | $3.3456 \times 10^{-2}$ | 1.1329 | $8.33 \times 10^{-2}$ | 2.3076 | $1.6018 \times 10^{-2}$ | | $4.459 \times 10^{-2}$ | $4.459 \times 10^{-5}$ | $33.46 \times 10^{-4}$ | 3.346 | $3.346 \times 10^{3}$ |
| **mm of Hg (Torr)** | 760 | 750 | 0.75 | 25.399 | 1.868 | 51.71 | 0.3591 | 22.409 | | $10^{-3}$ | $7.502 \times 10^{-3}$ | 7.502 | $7.502 \times 10^{3}$ |
| **Microns** | $760 \times 10^{3}$ | $750 \times 10^{3}$ | $0.75 \times 10^{3}$ | $25.399 \times 10^{3}$ | $1.868 \times 10^{3}$ | $51.71 \times 10^{3}$ | 359.1 | $22.409 \times 10^{3}$ | 1000 | | 7.502 | $7.502 \times 10^{3}$ | $7.502 \times 10^{6}$ |
| **Pascals (Newtons/$Meter^2$)** | $1.013 \times 10^{5}$ | $10^{5}$ | $10^{2}$ | $3.386 \times 10^{3}$ | $2.491 \times 10^{2}$ | $6.895 \times 10^{3}$ | 47.88 | 2986.9 | 133.3 | 0.1333 | | 1000 | $10^{6}$ |
| **Kilopascals** | 101.39 | 100 | 0.1 | 3.386 | .249 | 6.897 | $4.788 \times 10^{-2}$ | 2.987 | .1333 | $1.333 \times 10^{-4}$ | $10^{-3}$ | | 1000 |
| **Megapascals** | .1014 | 0.1 | $10^{-4}$ | $3.386 \times 10^{-3}$ | $2.491 \times 10^{-4}$ | $6.897 \times 10^{-3}$ | $4.788 \times 10^{-5}$ | $2.987 \times 10^{-3}$ | $1.333 \times 10^{-4}$ | $1.333 \times 10^{-7}$ | $10^{-6}$ | $10^{-3}$ | |

# Volume Conversion Chart

| *To obtain* ↓ / *Multiply number of* → *BY* | Cubic Meters | Cubic Centimeters | Liters | Cubic Inches | Cubic Feet | Gallons |
|---|---|---|---|---|---|---|
| Cubic Meters | | $10^{-6}$ | $10^{-3}$ | $1.639 \times 10^{-5}$ | 0.028 | $3.785 \times 10^{-3}$ |
| Cubic Centimeters | $10^{6}$ | | $10^{3}$ | 16.39 | $2.832 \times 10^{4}$ | $3.785 \times 10^{3}$ |
| Liters | $10^{3}$ | $10^{-3}$ | | 0.0164 | 28.317 | 3.785 |
| Cubic Inches | $6.1 \times 10^{4}$ | 0.061 | 61.01 | | 1728 | 231 |
| Cubic Feet | 35.31 | $3.53 \times 10^{-5}$ | 0.035 | $5.79 \times 10^{-4}$ | | 0.134 |
| Gallons | 264 | $2.64 \times 10^{-4}$ | 0.064 | $4.33 \times 10^{-3}$ | 7.481 | |

# Conversion Factors

| To convert from . . . | And obtain . . . | Multiply by . . . |
|---|---|---|
| atm | torr (mmof Hg @ 0°C) | 760 |
| atm | psi | 1.4500E+01 |
| atm | in. of Hg (@ 0°C) | 2.9920E+01 |
| atm | cm. of Hg (@ 0°C) | 7.6000E+01 |
| atm | ft. of water (@ 4°C) | 3.3900E+01 |
| in. of water (@ 4°C) | atm | 2.4580E-03 |
| in. of water (@ 4°C) | in. of Hg | 7.3550E-02 |
| in. of water (@ 4°C) | psi | 3.6130E-02 |
| in. of water (@ 4°C) | $kg/cm^2$ | 2.5400E-03 |
| in. of Hg | torr (mmof Hg @ 0°C) | 2.5400E+01 |
| in. of Hg | atm | 3.3420E-02 |
| in. of Hg | ft. of water | 1.133 |
| in. of Hg | $kg/cm^2$ | 3.4530E-02 |
| in. of Hg | psi | 4.9120E-01 |
| bars | atm | 9.8690E-01 |
| bars | psi | 1.4500E+01 |
| bars | $dynes/cm^2$ | 1.0000E+06 |
| bars | $kg/m^2$ | 1.0200E+04 |
| bars | kpascals | 1.0000E+02 |
| pascals | psi | 1.4500E-04 |
| pascals | $kg/m^2$ | 2.0620E+07 |
| joules | Btu | 9.4860E-04 |
| joules | ft-lb | 7.3760E-01 |
| watts | joules/s | 1 |
| watts | Btu/hr | 3.4129 |
| Btu | ft-lb | 7.7816E+02 |
| Btu | joules | 1.0550E+03 |
| lb TNT | joules | 1.9300E+06 |
| lb TNT | ft-lb | 1.4200E+06 |

# Fahrenheit to Centigrade

| Deg F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | -17.8 | -17.2 | -16.7 | -16.1 | -15.6 | -15.0 | -14.4 | -13.9 | -13.3 | -12.8 |
| 10 | -12.2 | -11.7 | -11.1 | -10.6 | -10.0 | -9.4 | -8.9 | -8.3 | -7.8 | -7.2 |
| 20 | -6.7 | -6.1 | -5.6 | -5.0 | -4.4 | -3.9 | -3.3 | -2.8 | -2.2 | -1.7 |
| 30 | -1.1 | -0.6 | 0.0 | 0.6 | 1.1 | 1.7 | 2.2 | 2.8 | 3.3 | 3.9 |
| 40 | 4.4 | 5.0 | 5.6 | 6.1 | 6.7 | 7.2 | 7.8 | 8.3 | 8.9 | 9.4 |
| 50 | 10.0 | 10.6 | 11.1 | 11.7 | 12.2 | 12.8 | 13.3 | 13.9 | 14.4 | 15.0 |
| 60 | 15.6 | 16.1 | 16.7 | 17.2 | 17.8 | 18.3 | 18.9 | 19.4 | 20.0 | 20.6 |
| 70 | 21.1 | 21.7 | 22.2 | 22.8 | 23.3 | 23.9 | 24.4 | 25.0 | 25.6 | 26.1 |
| 80 | 26.7 | 27.2 | 27.8 | 28.3 | 28.9 | 29.4 | 30.0 | 30.6 | 31.1 | 31.7 |
| 90 | 32.2 | 32.8 | 33.3 | 33.9 | 34.4 | 35.0 | 35.6 | 36.1 | 36.7 | 37.2 |
| 100 | 37.8 | 38.3 | 38.9 | 39.4 | 40.0 | 40.6 | 41.1 | 41.7 | 42.2 | 42.8 |
| 110 | 43.3 | 43.9 | 44.4 | 45.0 | 45.6 | 46.1 | 46.7 | 47.2 | 47.8 | 48.3 |
| 120 | 48.9 | 49.4 | 50.0 | 50.6 | 51.1 | 51.7 | 52.2 | 52.8 | 53.3 | 53.9 |
| 130 | 54.4 | 55.0 | 55.6 | 56.1 | 56.7 | 57.2 | 57.8 | 58.3 | 58.9 | 59.4 |
| 140 | 60.0 | 60.6 | 61.1 | 61.7 | 62.2 | 62.8 | 63.3 | 63.9 | 64.4 | 65.0 |
| 150 | 65.6 | 66.1 | 66.7 | 67.2 | 67.8 | 68.3 | 68.9 | 69.4 | 70.0 | 70.6 |
| 160 | 71.1 | 71.7 | 72.2 | 72.8 | 73.3 | 73.9 | 74.4 | 75.0 | 75.6 | 76.1 |
| 170 | 76.7 | 77.2 | 77.8 | 78.3 | 78.9 | 79.4 | 80.0 | 80.6 | 81.1 | 81.7 |
| 180 | 82.2 | 82.8 | 83.3 | 83.9 | 84.4 | 85.0 | 85.6 | 86.1 | 86.7 | 87.2 |
| 190 | 87.8 | 88.3 | 88.9 | 89.4 | 90.0 | 90.6 | 91.1 | 91.7 | 92.2 | 92.8 |
| 200 | 93.3 | 93.9 | 94.4 | 95.0 | 95.6 | 96.1 | 96.7 | 97.2 | 97.8 | 98.3 |
| 210 | 98.9 | 99.4 | 100.0 | 100.6 | 101.1 | 101.7 | 102.2 | 102.8 | 103.3 | 103.9 |
| 220 | 104.4 | 105.0 | 105.6 | 106.1 | 106.7 | 107.2 | 107.8 | 108.3 | 108.9 | 109.4 |
| 230 | 110.0 | 110.6 | 111.1 | 111.7 | 112.2 | 112.8 | 113.3 | 113.9 | 114.4 | 115.0 |
| 240 | 115.6 | 116.1 | 116.7 | 117.2 | 117.8 | 118.3 | 118.9 | 119.4 | 120.0 | 120.6 |
| 250 | 121.1 | 121.7 | 122.2 | 122.8 | 123.3 | 123.9 | 124.4 | 125.0 | 125.6 | 126.1 |

| Deg F | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Deg C | 0.0 | 0.06 | 0.11 | 0.17 | 0.22 | 0.28 | 0.33 | 0.39 | 0.44 | 0.50 |

# Centigrade to Fahrenheit

| Deg F | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 32.0 | 33.8 | 35.6 | 37.4 | 39.2 | 41.0 | 42.8 | 44.6 | 46.4 | 48.2 |
| 10 | 50.0 | 51.8 | 53.6 | 55.4 | 57.2 | 59.0 | 60.8 | 62.6 | 64.4 | 66.2 |
| 20 | 68.0 | 69.8 | 71.6 | 73.4 | 75.2 | 77.0 | 78.8 | 80.6 | 82.4 | 84.2 |
| 30 | 86.0 | 87.8 | 89.6 | 91.4 | 93.2 | 95.0 | 96.8 | 98.6 | 100.4 | 102.2 |
| 40 | 104.0 | 105.8 | 107.6 | 109.4 | 111.2 | 113.0 | 114.8 | 116.6 | 118.4 | 120.2 |
| 50 | 122.0 | 123.8 | 125.6 | 127.4 | 129.2 | 131.0 | 132.8 | 134.6 | 136.4 | 138.2 |
| 60 | 140.0 | 141.8 | 143.6 | 145.4 | 147.2 | 149.0 | 150.8 | 152.6 | 154.4 | 156.2 |
| 70 | 158.0 | 159.8 | 161.6 | 163.4 | 165.2 | 167.0 | 168.8 | 170.6 | 172.4 | 174.2 |
| 80 | 176.0 | 177.8 | 179.6 | 181.4 | 183.2 | 185.0 | 186.8 | 188.6 | 190.4 | 192.2 |
| 90 | 194.0 | 195.8 | 197.6 | 199.4 | 201.2 | 203.0 | 204.8 | 206.6 | 208.4 | 210.2 |
| 100 | 212.0 | 213.8 | 215.6 | 217.4 | 219.2 | 221.0 | 222.8 | 224.6 | 226.4 | 228.2 |
| 110 | 230.0 | 231.8 | 233.6 | 235.4 | 237.2 | 239.0 | 240.8 | 242.6 | 244.4 | 246.2 |
| 120 | 248.0 | 249.8 | 251.6 | 253.4 | 255.2 | 257.0 | 258.8 | 260.6 | 262.4 | 264.2 |
| 130 | 266.0 | 267.8 | 269.6 | 271.4 | 273.2 | 275.0 | 276.8 | 278.6 | 280.4 | 282.2 |
| 140 | 284.0 | 285.8 | 287.6 | 289.4 | 291.2 | 293.0 | 294.8 | 296.6 | 298.4 | 300.2 |
| 150 | 302.0 | 303.8 | 305.6 | 307.4 | 309.2 | 311.0 | 312.8 | 314.6 | 316.4 | 318.2 |
| 160 | 320.0 | 321.8 | 323.6 | 325.4 | 327.2 | 329.0 | 330.8 | 332.6 | 334.4 | 336.2 |
| 170 | 338.0 | 339.8 | 341.6 | 343.4 | 345.2 | 347.0 | 348.8 | 350.6 | 352.4 | 354.2 |
| 180 | 356.0 | 357.8 | 359.6 | 361.4 | 363.2 | 365.0 | 366.8 | 368.6 | 370.4 | 372.2 |
| 190 | 374.0 | 375.8 | 377.6 | 379.4 | 381.2 | 383.0 | 384.8 | 386.6 | 388.4 | 390.2 |
| 200 | 392.0 | 393.8 | 395.6 | 397.4 | 399.2 | 401.0 | 402.8 | 404.6 | 406.4 | 408.2 |
| 210 | 410.0 | 411.8 | 413.6 | 415.4 | 417.2 | 419.0 | 420.8 | 422.6 | 424.4 | 426.2 |
| 220 | 428.0 | 429.8 | 431.6 | 433.4 | 435.2 | 437.0 | 438.8 | 440.6 | 442.4 | 444.2 |
| 230 | 446.0 | 447.8 | 449.6 | 451.4 | 453.2 | 455.0 | 456.8 | 458.6 | 460.4 | 462.2 |
| 240 | 464.0 | 465.8 | 467.6 | 469.4 | 471.2 | 473.0 | 474.8 | 476.6 | 478.4 | 480.2 |
| 250 | 482.0 | 483.8 | 485.6 | 487.4 | 489.2 | 491.0 | 492.8 | 494.6 | 496.4 | 498.2 |

| Deg C | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 |
|---|---|---|---|---|---|---|---|---|---|---|
| Deg F | 0.0 | 0.18 | 0.36 | 0.54 | 0.72 | 0.9 | 1.08 | 1.26 | 1.44 | 1.62 |

# ELASTOMER TYPES/CAPABILITIES
## TABLE B — FLUID COMPATIBILITY SUMMARY

| NOMENCLATURE | NITRILE (BUNA N) | ETHYLENE-PROPYLENE | CHLORO-PRENE (NEOPRENE) | FLUORO-CARBON (VITON, FLUOREL) | SILICONE | FLUORO-SILICONE | STYRENE-BUTADIENE (SBR) |
|---|---|---|---|---|---|---|---|
| NATIONAL COMPOUND PREFIX | B, C, D | E | N | V | S | F | G |
| ASTM D2000 PREFIX | BG, BK, CH | CA | BC, BE | HK | FC, FE, GE | FK | AA, BA |
| ASTM D1418 DESIGNATION | NBR | EPDM, EPM | CR | FKM | PVMQ, VMQ | FVMQ | SBR |
| **GENERAL** | | | | | | | |
| HARDNESS RANGE, "A" SCALE | 40-90 | 50-90 | 40-80 | 70-90 | 40-80 | 60-80 | 40-80 |
| RELATIVE O RING COST | LOW | LOW | LOW/MOD | MOD/HIGH | MODERATE | HIGH | LOW |
| CONTINUOUS HIGH TEMP LIMIT | 257°F, 125°C | 302°F, 150°C | 284°F, 140°C | 437°F, 225°C | 482°F, 250°C | 347°F, 175°C | 212°F, 100°C |
| LOW TEMPERATURE CAPABILITY | -67°F,-55°C | 67°F, -55°C | 67°F, -55°C | 40°F-40°C | 103°F, 75°C | 85°F, 65°C | -67°F, 55°C |
| DYNAMIC SERVICE/ABRASION RESISTANCE | EXCELLENT | VERY GOOD | VERY GOOD | VERY GOOD | POOR | POOR | EXCELLENT |
| COMPRESSION SET RESISTANCE | VERY GOOD | VERY GOOD | GOOD | VERY GOOD | EXCELLENT | VERY GOOD | GOOD |
| **FLUID COMPATIBILITY SUMMARY** | | | | | | | |
| ACID INORGANIC | FAIR | GOOD | FAIR/GOOD | EXCELLENT | GOOD | GOOD | FAIR/GOOD |
| ACID, ORGANIC | GOOD | VERY GOOD | GOOD | GOOD | EXCELLENT | GOOD | GOOD |
| AGING, (OXYGEN, OZONE WEATHER) | FAIR/POOR | VERY GOOD | GOOD | VERY GOOD | EXCELLENT | EXCELLENT | POOR |
| AIR | FAIR | VERY GOOD | GOOD | VERY GOOD | EXCELLENT | VERY GOOD | FAIR |
| ALCOHOLS | VERY GOOD | EXCELLENT | VERY GOOD | FAIR | VERY GOOD | VERY GOOD | VERY GOOD |
| ALDEHYDES | FAIR/POOR | VERY GOOD | FAIR/POOR | POOR | GOOD | POOR | FAIR/POOR |
| ALKALIS | FAIR/GOOD | EXCELLENT | GOOD | GOOD | VERY GOOD | GOOD | FAIR/GOOD |
| AMINES | POOR | VERY GOOD | VERY GOOD | POOR | GOOD | POOR | FAIR |
| ANIMAL OILS | EXCELLENT | GOOD | GOOD | VERY GOOD | GOOD | EXCELLENT | POOR |
| ESTERS ALKYL PHOSPHATE (SKYDROL) | POOR | EXCELLENT | POOR | POOR | GOOD | FAIR/POOR | POOR |
| ESTERS ARYL PHOSPHATE | FAIR/POOR | EXCELLENT | FAIR/POOR | EXCELLENT | GOOD | VERY GOOD | POOR |
| ESTERS, SILICATE | GOOD | POOR | FAIR | EXCELLENT | POOR | VERY GOOD | POOR |
| ETHERS | POOR | FAIR | POOR | POOR | POOR | FAIR | POOR |
| HYDROCARBON FUELS, ALIPHATIC | EXCELLENT | POOR | FAIR | EXCELLENT | FAIR | EXCELLENT | POOR |
| HYDROCARBON FUELS, AROMATIC | GOOD | POOR | FAIR/POOR | EXCELLENT | POOR | VERY GOOD | POOR |
| HYDROCARBONS, HALOGENATED | FAIR/POOR | POOR | POOR | EXCELLENT | POOR | VERY GOOD | POOR |
| HYDROCARBON OILS, HIGH ANILINE | EXCELLENT | POOR | GOOD | EXCELLENT | VERY GOOD | EXCELLENT | POOR |
| HYDROCARBON OILS, LOW ANILINE | VERY GOOD | POOR | FAIR/POOR | EXCELLENT | FAIR | VERY GOOD | POOR |
| IMPERMEABILITY TO GASES | GOOD | GOOD | GOOD | VERY GOOD | POOR | POOR | FAIR/GOOD |
| KETONES | POOR | EXCELLENT | POOR | POOR | POOR | FAIR/POOR | POOR |
| SILICONE OILS | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT | GOOD | EXCELLENT | EXCELLENT |
| VEGETABLE OILS | EXCELLENT | GOOD | GOOD | EXCELLENT | EXCELLENT | EXCELLENT | POOR |
| WATER/STEAM | GOOD | EXCELLENT | FAIR | FAIR | FAIR | FAIR | FAIR |

### TYPES OF ELASTOMERS

The following is a brief description of the basic elastomer families from which National O-Ring compounds are made. The Elastomer Capabilities Guide (above) presents a quick reference to each elastomer's overall characteristics and advantages in comparison with other elastomers.

#### Nitrile, Buna N, or NBR

Nitrile is the most widely used elastomer in the seal industry. The popularity of nitrile is due to its excellent resistance to petroleum products and its ability to be compounded for service over a temperature range of -67°F to 257°F (-55°C to 125°C). Nitrile is a copolymer of butadiene and acrylonitrile. Variation in proportions of these polymers is possible to accommodate specific requirements. An increase in acrylonitrile content increases resistance to heat plus petroleum base oils and fuels but decreases low temperature flexibility. Military AN and MS O-ring specifications require nitrile compounds with low acrylonitrile content to insure low temperature performance.

Nitrile provides excellent compression set, tear, and abrasion resistance. The major limiting properties of nitrile are its poor ozone and weather resistance and moderate heat resistance.

**Advantages:**

- Good balance of desirable properties
- Excellent oil and fuel resistance
- Good water resistance

**Disadvantages:**

- Poor weather resistance
- Moderate heat resistance

#### Ethylene-Propylene, EP, EPT, or EPDM

Ethylene-propylene compounds are prepared from ethylene and propylene and usually a third monomer. These compounds are used frequently to seal phosphate ester fire resistant hydraulic fluids such as Skydrol. They are also very effective in brake systems, and for sealing hot water and steam. Ethylene-propylene compounds have good resistance to mild acids, alkalis, silicone oil and greases, ketones, and alcohols. They are not recommended for petroleum oils or di-ester lubricants. Ethylene-propylene has a temperature range of -67°F to 302°F (-55°C to 150°C). It is compatible with polar fluids that adversely affect other elastomers.

**Advantages:**

- Excellent weather resistance
- Good low temperature flexibility
- Excellent chemical resistance
- Good heat resistance.

**Disadvantage:**

Poor petroleum oil and solvent resistance.

| NOMENCLATURE | POLY-ACRYLATE | POLY-URETHANE | BUTYL | POLYSULFIDE (THIOKOL) | CHLOROSUL-FONATED POLYETHY-LENE (HYPALON) | EPICHLORO-HYDRIN (HYDRIN) | PHOSPHO-NITRILIC FLUORO-ELASTOMER (PNF) |
|---|---|---|---|---|---|---|---|
| NATIONAL COMPOUND PREFIX | L | U | J | K | H | Z | Q |
| ASTM D2000 PREFIX | DF, DH | BG | AA, BA | AK, BK | CE | DK, DJ | N/A |
| ASTM D1418 DESIGNATION | ACM | EU | IIR | T | CSM | ECO | PZ |
| **GENERAL** | | | | | | | |
| HARDNESS RANGE, 'A" SCALE | 70-90 | 60-90 | 50-70 | 50-90 | 50-90 | 50-90 | 509-90 |
| RELATIVE O-RING COST | MODERATE | MODERATE | MODERATE | MODERATE | MODERATE | MODERATE | MODERATE |
| CONTINUOUS HIGH TEMP LIMIT | 347°F, -175°C | 212°F, 100ØC | 121°F, 100°C | 121°F, 100°C | 257°F, 125°C | 257°F, 125°C | 347°F, 175°C |
| LOW TEMPERATURE CAPABILITY | -4°F, -20°C | -67°F, -55°C | 67°F, -55°C | 67°F, -55°C | 67°F, -55°C | 67°F, -55°C | -85°F, --65°C |
| DYNAMIC SERVICE/ABRASION RESISTANCE | GOOD | EXCELLECNT | GOOD | FAIR/POOR | POOR | FAIRFAIR/GO | VERY GOOD |
| COMPRESSION SET RESISTANCE | FAIR | FAIR | FAIR/GOOD | FAIR | FAIR/POOR | OD | GOOD |
| **FLUID COMPATIBILITY SUMMARY** | | | | | | | |
| ACID INORGANIC | POOR | POOR | GOOD | POOR | EXCELLENT | FAIR | POOR |
| ACID, ORGANIC | POOR | POOR | VERY GOOD | GOOD | GOOD | FAIR | FAIR |
| AGING, (OXYGEN, OZONE WEATHER) | EXCELLENT | EXCELLENT | VERY GOOD | EXCELLENT | VERY GOOD | VERY GOOD | EXCELLENT |
| AIR | VERY GOOD | GOOD | GOOD | GOOD | EXCELLENT | GOOD | EXCELLENT |
| ALCOHOLS | POOR | POOR | VERY GOOD | FAIR/GOOD | VERY GOOD | GOOD | FAIR |
| ALDEHYDES | POOR | POOR | GOOD | FAIR/GOOD | FAIR/GOOD | POOR | POOR |
| ALKALIS | POOR | FAIR/GOOD | EXCELLENT | POOR | EXCELLENT | FAIR | GOOD |
| AMINES | POOR | POOR | GOOD | POOR | POOR | POOR | GOOD |
| ANIMAL OILS | EXCELLENT | GOOD | GOOD | POOR | GOOD | GOOD | FAIR |
| ESTERS ALKYL PHOSPHATE (SKYDROL) | POOR | POOR | VERY GOOD | POOR | POOR | POOR | POOR |
| ESTERS ARYL PHOSPHATE | POOR | POOR | EXCELLENT | GOOD | FAIR | POOR | EXCELLENT |
| ESTERS, SILICATE | FAIR/POOR | POOR | POOR | FAIR/POOR | FAIR | GOOD | EXCELLENT |
| ETHERS | FAIR/POOR | FAIR | FAIR/POOR | GOOD | POOR | GOOD | POOR |
| HYDROCARBON FUELS, ALIPHATIC | VERY GOOD | GOOD | POOR | EXCELLENT | FAIR | VERY GOOD | EXCELLENT |
| HYDROCARBON FUELS, AROMATIC | POOR | FAIR/POOR | POOR | GOOD | FAIR/POOR | VERY GOOD | EXCELLENT |
| HYDROCARBONS, HALOGENATED | FAIR/GOOD | FAIR | POOR | GOOD | FAIR | EXCELLENT | FAIR |
| HYDROCARBON OILS, HIGH ANILINE | EXCELLENT | EXCELLENT | POOR | VERY GOOD | EXCELLENT | EXCELLENT | EXCELLENT |
| HYDROCARBON OILS, LOW ANILINE | EXCELLENT | VERY GOOD | POOR | GOOD | VERY GOOD | EXCELLENT | EXCELLENT |
| IMPERMEABILITY TO GASES | VERY GOOD | FAIR | EXCELLENT | VERY GOOD | VERY GOOD | EXCELLENT | FAIR |
| KETONES | POOR | POOR | EXCELLENT | GOOD | FAIR | FAIR | POOR |
| SILICONE OILS | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT | EXCELLENT |
| VEGETABLE OILS | GOOD | FAIR | GOOD | POOR | GOOD | EXCELLENT | FAIR |
| WATER/STEAM | POOR | POOR | EXCELLENT | FAIR | FAIR | GOOD | FAIR |

**Chloroprene, Neoprene, or CR**

Neoprene is a polymer of chlorobutadiene and is unusual in that it is moderately resistant to both petroleum oils and weather (ozone sunlight, oxygen). This qualifies neoprene for O-ring service where many other elastomers would not be satisfactory. It is also used extensively for sealing refrigeration fluids. Neoprene has good compression set characteristics and a temperature range of -67°F to 284°F (-55°C to 140°C).

**Advantages:**

- Moderate weather resistance
- Moderate oil resistance
- Versatile

**Disadvantage:**

- Moderate solvent and water resistance

**Fluorocarbon, Viton, Fluorel, or FICM**

Fluorocarbon combines resistance to a broader range of chemicals than any of the other elastomers. It constitutes the closest available approach to the universal O-ring elastomer. Although most fluorocarbon compounds become quite hard at temperatures below -4°F (-20°C), they do not easily fracture, so they are serviceable at much lower temperatures. Fluorocarbon compounds provide a continuous 437°F (225°C) high temperature capability.

**Advantages:**

- Excellent chemical resistance
- Excellent heat resistance
- Good mechanical properties
- Good compression set resistance

**Disadvantage:**

- Fair low temperature resistance

**Silicone or PVMQ**

Silicone i5 a semi-organic elastomer with outstanding resistance to extremes of temperature. Specially compounded. it can provide reliable service at temperatures as low as—175-F (—115-C) to as high as 482°F (250C) continuously. Silicone also has good resistance to compression set.

Low physical strength and abrasion resistance combined with high friction limit silicone to static seals. Silicone is used primarily for dry heat static seals. Although it swells considerably in petroleum lubricants, this is not detrimental in most static sealing applications.

**Advantages:**

- Excellent at temperature extremes
- Excellent compression set resistance

**Disadvantage:**

- Poor physical strength

**Fuorosilicone or FVMQ**

Fluorosilicones combine most of the attributes of silicone with resistance to petroleum oils and hydrocarbon fuels. Low physical strength and abrasion resistance combined with high friction limit fluorosilicone to static seals- Fluorosilicones are used primarily in aircraft fuel systems over a temperature range of -85°F to 347°F (-60°C to 1 75°C).

Advantages:

- Excellent at temperature extremes
- Good resistance to petroleum oils and fuels
- Good compression set resistance Disadvantage:
- Poor physical strength

**Styrene-Butadiene or SBR**

Styrene-butadiene compounds have properties similar to those of natural rubber and are primarily used in the manufacture of tires. Their use in O-rings has been mostly in automobile brake systems and plumbing. Ethylene-propylene a more recent development, is gradually replacing styrene-butadiene in brake service. Temperature range is -67°F to 212°F (-55°C to 100°C).

**Advantages:**

- Good resistance to brake fluids
- Good resistance to water

**Disadvantages:**

- Poor weather resistance
- Poor petroleum oil and solvent resistance

**Polyacrylate or ACM**

Polyacrylate compounds retain their properties when sealing petroleum oils at continuous temperatures as high as 34°F (175°C). Polyacrylate O-rings are used extensively in power transmissions and other engine applications. They provide some of the attributes of fluorocarbon O-rings. A recent variation, ethylene-acrylate, provides improved low temperature characteristics with some sacrifice in hot *oil* resistance.

Advantages:

- Excellent resistance to petroleum oils
- Excellent weather resistance

Disadvantages:
- Fair low temperature properties
- Fair to poor water resistance
- Fair compression set resistance

**Polyurethane, AU, or EU**

Polyurethane compounds exhibit outstanding tensile strength and abrasion resistance in comparison with other elastomers. Fluid compatibility is similar to that of nitrile at temperatures up to approximately 158-F (70-C). At higher temperatures, polyurethane has a tendency to soften and lose both strength and fluid resistance advantages over other elastomers. Some types are readily damaged by water, even high humidity. Polyurethane seals offer outstanding performance in high pressure hydraulic systems with abrasive contamination, high shock loads, and related adverse conditions provided temperature is below 158-F (70-C).

Advantages:

- Excellent strength and abrasion resistance
- Good resistance to petroleum oils
- Good weather resistance

Disadvantages:

- Poor resistance to water
- Poor high temperature capabilities

**Butyl or IIR**

Cutyl is a copolymer of isobutylene and isoprene. It has largely been replaced by ethylene-propylene for O-ring usage. Butyl is resistant to the same fluid types as ethylene-propylene and, except for resistance to gas permeation, it is somewhat inferior to ethylene propylene for O-ring service. Temperature range is—67-F to 212-F (—55-C to 100 C).

Advantages:

- Excellent weather resistance
- Excellent gas permeation resistance

Disadvantage:

- Poor petroleum oil and fuel resistance

**Polysulfide, Thiokol, or T**

Polysulfide was one of the first commercial synthetic elastomers Although polysulfide compounds have limited O-ring usage. they are essential for applications involving combinations of ethers, ketones, and petroleum solvents used by the paint industries. Temperature range is—67-F to 212-F (—55 C to 100 C).

**Advantages:**

- Excellent resistance to combinations of solvents
- Excellent weather resistance

**Disadvantages:**

- Poor high temperature capabilities
- Poor mechanical strength
- Poor resistance to compression set

**Chlorosulfonated Polyethylene, Hypalon, or CSM**

Chlorosulfonated polyethylene compounds demonstrate excellent resistance to oxygen, ozone, heat, and weathering. But their mechanical properties and compression set are inferior to most other elastomers, and they are seldom used to advantage as O-ring Temperature range is 65-F to 257-F (—55-C to 125-C).

**Advantages:**

- Excellent resistance to weather
- Good resistance to heat

**Disadvantages:**

- Poor tear and abrasion resistance
- Poor resistance to compression set

**Epichlorohydrin, Hydrin, or ECO**

Epichlorohydrin is a relatively recent development. compounds this elastomer provide excellent resistance to fuels and oils plus a broader temperature range,-65°F to 275°F (-55°C to 135°C), than nitrile Initial usage has been in military aircraft where the particular advantages of epichlorohydrin over nitrile are of immediate benefit.

Advantages:

- Excellent oil and fuel resistance
- Excellent weather-r resistance
- Good low temperature resistance

Disadvantage:

- Fair resistance to compression sot

**Phosphonitrilic Fluoroelastomer, Polyphosphazene, PNF, or PZ**

This is another new elastomer family. O-rings of phosphonitrilic fluoroelastomer are rapidly accommodating aircraft sealing requirements where the physical strength of fluorosilicone is inadequate In other regards, the functional characteristics of phosphonitrilic fluoroelastomer and fluorosilicone are similar. Temperature range -85°F to 34°F (-65°C to 175°C).

**Advantages:**

- Excellent oil and fuel resistance
- Wide temperature range
- Good compression resistance

**Disadvantage:**

- Poor water resistance

The following elastomer namos are registered trademarks:

| | |
|---|---|
| Fluorel | 31X Company |
| Hydrin | B.F. Goodrich Chemical Co. |
| Hypalon | E.I. DuPont De Nemours & Co. |
| Neoprene | E.I. DuPont De Nemours & Co. |
| PNF | Firestone Tire & Rubber Co. |
| Thiokol | Thiokol Chemical Corporation |
| Viton | E.I. DuPont De Nemours & Co. |