DEFINITIONS

BACK PRESSURE: The pressure that is on the outlet side of a component.

BURST PRESSURE: Four times working pressure unless otherwise specified by customer. Actual burst is when a fracture occurs. Fracture occurs when the force on the weakest part of a unit reaches the ultimate strength of the part.

CRACKING PRESSURE: The pressure at which a component starts to open. Circle Seal Controls definition is 5cc/min air for an elastomer and 0.02 SCFM for Teflon.

C_V: Flow capability indication commonly accepted by the valve industry. The literal definition is that a component with a C_V of one (1) can flow one (1) gallon of water with a ΔP of one (1) PSI. The calculated results from C_V equations must be considered reasonable approximations only.

DIFFERENTIAL PRESSURE (ΔP): Difference between inlet and outlet pressure.

DROOP: The difference between the set pressure of a regulator and the outlet pressure immediately downstream of the regulator at a certain flowing condition.

E.S.E.O.D. Equivalent sharp edge orifice diameter. E.S.E.O.D. = $0.236\sqrt{C_V}$

LOCK UP: The downstream pressure at which a regulator shuts off.

MEDIA: The gas or liquid that a component will be subjected to.

PROOF PRESSURE: 1-1/2 times the working pressure unless otherwise specified by the customer. No permanent deformation is allowed at proof pressure.

RELIEF PRESSURE: The pressure at which a relief valve opens.

RESEAT PRESSURE: The pressure at which a component is closed after it has been open.

SET PRESSURE: The cracking pressure of a relief valve or back pressure regulator, the lockup pressure of a regulator, the shut-off pressure of a gage saver.

SONIC FLOW: Flow is sonic when the ΔP is equal to or greater than 1/2 of the inlet pressure. Also called choked flow.

SPECIFIC GRAVITY: The ratio of the density of one substance to that of a reference substance. Reference substance is water for liquids and air for gases.

SUBSONIC FLOW: Flow is subsonic when the ΔP is less than 1/2 of the inlet pressure.

TRIM: All metal parts in contact with media except the body.

WORKING PRESSURE: Maximum pressure that a component will be subjected to under normal working conditions.

ZERO LEAK: Standard Circle Seal definition of zero leakage is:

3×10^{-4} scc / sec

0.25 bubbles / min

4 minutes / bubble

LIQUID FLOW C_V EQUATION

$$C_v = \frac{Q\sqrt{G}}{\sqrt{\Delta P}}$$

This equation applied to all liquids including cryogenic liquids.

LEGEND

- C_v - Flow coefficient
- Q - Flow in GPM
- ΔP - Differential Pressure (Difference between inlet and outlet pressure) in PSI.
- G - Specific Gravity (Taken from Properties of Liquids)

EXAMPLE

GIVEN: Flow - 20 GPM of Water
Inlet pressure - 100 PSIG
Outlet pressure - 95 PSIG

FIND THE C_v REQUIRED.

SOLUTION

Q = 20 GPM
Inlet pressure = 100 PSI
Outlet pressure = 95
ΔP = 5 PSI
Media = Water
Specific Gravity of Water = 1.0

$$C_V = \frac{Q\sqrt{G}}{\sqrt{\Delta P}} = \frac{20\sqrt{1.0}}{\sqrt{5}}$$

$$C_V = \frac{20 \times 1}{2.24} = 8.9$$

NOTE

1 GALLON OF WATER EQUALS 8.336 LBS.
1 LB. OF WATER EQUALS .1198 GALLONS

GAS FLOW C_v EQUATION
SUBSONIC FLOW

DEFINITION

Flow is subsonic when the ΔP (differential pressure) is less than 1/2 of the inlet pressure.

$$C_v = \frac{Q\sqrt{G}}{\sqrt{P_2 \Delta P}}$$

LEGEND

- C_v - Flow coefficient
- Q - Flow in SCFM
- ΔP - Differential Pressure (Difference between inlet and outlet pressure) in PSI.
- G - Specific gravity of Media (Taken from Properties of Gases)
- P_1 - Inlet pressure in PSIA (PSIG + 14.7)
- P_2 - Outlet pressure in PSIA (PSIG + 14.7)

EXAMPLE

GIVEN: Flow - 100 SCFM of N_2
Inlet Pressure - 100 PSIG
Outlet Pressure - 75 PSIG

FIND THE C_v REQUIRED.

SOLUTION

Q = 100 SCFM N_2
Inlet Pressure = 100 PSIG
P_1 = 100 PSIG + 14.7 = 114.7 PSIA
Outlet Pressure = 75 PSIG
P_2 = 75 PSIG + 14.7 = 89.7 PSIA
$\Delta P = P_1 - P_2$ = 114.7 PSIA - 89.7 PSIA
ΔP = 25 PSI
Media = N_2
Specific Gravity of N_2 = 0.067

$$C_v = \frac{Q\sqrt{G}}{\sqrt{P_2 \Delta P}}$$

$$C_v = \frac{100\sqrt{0.967}}{\sqrt{89.7 \times 25}}$$

$$C_v = \frac{100 \times 0.983}{\sqrt{2242}} = \frac{98.33}{47.4} \qquad C_v = 2.07$$

GAS FLOW C_v EQUATION
SONIC FLOW

DEFINITION

Flow is sonic when the ΔP (Differential Pressure) is equal to or greater than 1/2 of the inlet pressure.

$$C_v = \frac{Q\sqrt{G}}{P_1/2}$$

LEGEND

- C_v - Flow coefficient.
- Q - Flow in SCFM.
- ΔP - Differential Pressure (Difference between inlet and outlet pressure) in PSI.
- G - Specific Gravity of Media. (Taken from Properties of Gases)
- P_1 - Inlet Pressure in PSIA. (PSIG + 14.7)
- P_2 - Outlet Pressure in PSIA. (PSIG + 14.7)

EXAMPLE

GIVEN: Flow = 100 SCFM of N_2
Inlet Pressure = 100 PSIG
Outlet Pressure = 25 PSIG

FIND THE C_v REQUIRED.

SOLUTION

Q = 100 SCFM of N_2
Inlet Pressure = 100 PSIG
P_1 = 100 PSIG + 14.7 = 114.7 PSIA
Outlet Pressure = 25 PSIG
P_2 = 25 PSIG + 14.7 = 39.7 PSIA
$\Delta P = P_1 - P_2 = 114.7 - 39.7 = 75$ PSI
Media - N_2
Specific Gravity of N_2 = 0.967

$$C_v = \frac{Q\sqrt{G}}{P_1/2} = \frac{100\sqrt{0.967}}{114.7/2} = \frac{100 \times 0.9533}{57.35}$$

C_v = 1.7

CIRCLE SEAL CONTROLS, INC.

CHEMICAL RESISTANCE CHART

Material Guide for Valve Selection

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE
Acetaldehyde	A		A	A	A	A	D	A	A	B	D	B	D	A	B
Acetamide			A						A			A		A	
Acetate Solvent	A		A		A	D	B		A	B	D		D		B
Acetic Acid, Glacial		A	B		A	A			A		**	B		D	
Acetic Acid	A		A	A	C	A	D	A	A	A	C	B	C	C	
Acetic Anhydride	A		A	A	A		D	A	A	A	C	B	D	C	C
Acetone	A		A	A	A	A	A	A	A	A	D	A	D	D	B
Acetylene			A		A	*			A		A	D		A	
Acrylonitrile			A								D	D		C	
Alcohols	A	A		A			B	A		B			C		B
Amyl			A		A	A			A		A	A		A	
Benzyl			A		A	A			A		A	B			
Butyl		A	A		A	B			A		A	A		A	
Diacetone			A		A	*			A		D	A		D	
Ethyl			A		A	A			A		A	B			
Hexyl			A		A				A		A	A		C	
Isobutyl			A		A				A		A	A		A	
Isopropyl			A		A	A			A		B	A		A	
Methyl			A		A	A			A		A	A		A	
Octyl			A		A				A		B	A		A	
Propyl			A		A	A			A		A	A		A	
Aluminum Chloride 20%	A		A	A	A	A	D	D	C	D	A	A	B	A	C
Aluminum Fluoride			A	A	A	A		C	C						
Aluminum Hydroxide			A	A	A	A		A	A		A				
Aluminum Potassium Sulfate (Aluminum)	A		A	A	A	A		C	A	C	A	A	B	A	
Aluminum Sulfate			A	A	A	A	D	-	A	C	A	B	B	A	C
Amines		B	A	A	A		B	A	A		D	B		D	
Ammonia, Anhydrous			A	A	A		D	A	A		C	A		D	
Ammonia, Liquids			A		A	A			A		C	A	B	D	X
Ammonia, Nitrate			A						A		C				
Ammonium Bifluoride			A						A		A			A	
Ammonium Carbonate			A		A	A			B		B	A	B		
Ammonium Casenite			A						A						
Ammonium Chloride			A	A	A	A	D	D	B	C	B	A			
Ammonium Hydroxide	A	A	A	A	A	A	D	D	A		A	A	C	B	B
Ammonium Nitrate	A		A		A	A	D	A	A	C	A	A	B	B	
Ammonium Oxalate			A						A		A				
Ammonium Persulfate	A		A			A	D		A		D	A		A	
Ammonium Phosphate, Dibasic	A		A	A	A	A	D	A	C	A	A	A	B	A	
Ammonium Phosphate, Monobasic			A		A	A			C		A	A		A	
Ammonium Phosphate, Tribasic			A		A	A			A		A	A		A	
Ammonium Sulfate	A		A		A	A	D		B	C	A	A		A	
Ammonium Thio-Sulfate			A								A				
Amyl Acetate		A	A	A	A	D		C	A	A	D	A	D	D	C
Amyl Alcohol			A	A	A	A			A			A	D	C	A
Amyl Chloride			A	A					A		D	D	C	A	
Aniline	A		A	A	A	A		A	A	D	D	D	D	D	C
Anti-Freeze			A						A		A				
Aqua Regia (80%, HCl, 20%, HNO_3)		D	D		A	B			D		D	D	D	B	
Arochlor 1248			A								D	B		A	
Aromatic Hydrocarbons			A						A		D	D	D	A	C
Arsenic Acid			A	A	A				B		A	A		A	
Asphalt	A		A	A	A	A	B		A	A	B	D		A	
Barium Carbonate			A	A	A			A	B		A			A	
Barium Chloride	A		A	A	A		D	A	B	D	A	A		A	
Barium Cyanide			A						A		C	A		A	
Barium Hydroxide	A		A	A	A	A	C	A	A	D	A	A		A	
Barium Nitrate	A		B	A			D		A		A			A	
Barium Sulfate			B	A	A			A	A		A			A	
Barium Sulfide			A	A	A				A		A	A		A	
Beer	A		A	A	A	A	B	A	A	A	A	A	C	A	B
Beet Sugar Liquids	A		A	A	A		C	A	A	A	A	A		A	
Benzaldehyde		B	A			*			A		D	A	D	D	B
Benzene	D		A	A	A	*	A	A	B	A	D	A	C	A	B
Benzoic Acid	A		A	A		*	B		B	B	D	D		A	
Benzol			A	A	A	A		A		A	D	D		A	
Borax (Sodium Borate)	A		A	A	A	A	C	A	A	C	B	A		A	
Boric Acid	A		A	A	A	A	D	A	B	A	A	A	B	A	C
Brewery Slop			A						A		A			A	
Bromine	A	D	C	A		*	C	D	D	D	D	D	B	A	D
Butadiene		A	A	A	A			A	A		A	A		A	
Butane			A	A		*			A	A	A	D	C	A	D
Butter			A						A		A	A	B	A	B
Buttermilk	A			A	A		D	C	A	A	A				
Butylene			A								A	D		A	
Butyl Acetate			A	A		*			C	A	D	B	D	D	C
Butyric Acid	A		A	A			D	C	B	A	D	B	C	D	
Calcium Bisulfide	A		A	A	A		D	B	B	C	A	D		A	
Calcium Carbonate			A	A	A			A	A	C	A			A	
Calcium Chloride	A		A	A		A	C	A	B	C	B	A		A	
Calcium Hydroxide	A		A	A	A	A	D	A	A	D	B	A		A	
Calcium Hypochlorite	A		A	A		A	D		D	A	B	A		A	
Calcium Sulfate			A	A	A	A			B	A	A			A	
Calgon®			A		A				A		A				
Cane Juice			A			*			A		A				
Carbolic Acid (See Phenol)	A			A	A	*	C	A		A					
Carbon Bisulfide			A			*			B		A	D	A		

A —No effect—Excellent
B —Minor effect—Good
C —Moderate effect—Fair, contact Angar
D —Severe effect—Not recommended
X —Carbon/Ceramic Seal

† —P.V.C.—Satisfactory to 72° F
° —Polypropylene—Satisfactory to 72° F
†† —Polypropylene—Satisfactory to 120° F
** —BUNA N—Satisfactory for Seal & O-Rings

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE
Carbon Dioxide	A		A	A		A	A		A	A	A	B		A	
Carbon Disulfide			A	A	A	*		A	A	A	D	D		A	
Carbon Monoxide			A			A			A			A		A	
Carbon Tetrachloride	B		A	A	A	D	B	A	A	C	D	D	C	A	C
Carbonated Water			A	A	A	A		A	A		A			A	
Carbonic Acid			A			A			B		B	A		A	
Catsup			A			A			A		A			A	
Chloracetic Acid	A		C	A	A		D	D	D	D	D	B	D	D	A
Chlorinated Glue			A						C		B				
Chlorine, Anhydrous Liquid	B		B	A			D		D	D	B	C	D	A	C
Chlorobenzene (Mono)		A	A			D			A		D	D	C	A	C
Chloroform			A	A	A	D		A	A	D	D	D	C	A	C
Chlorosulfonic Acid			C			D			D		D	D	C	D	
Chlorox (Bleach)	D		A	A	A	D			A		B	B		A	
Chocolate Syrup			A						A		A			A	
Chromic Acid 5%	A		B	A			D		A	A		A	B	A	C
Chromic Acid 50%	A		B	A			D		D	A		A	B	A	C
Cider			A			A			A		A			A	
Citric Acid	A		A	A	A	A	D	B	A	A	A	A	B	A	
Citric Oils			A						A		A			A	
Coffee			A	A	A	A			A		A			A	B
Copper Chloride			A	A	A	A		D	B		A	A		A	
Copper Cyanide			A			A			A		A	A		A	
Copper Fluoborate			A						D		B			A	
Copper Nitrate	A		A	A	A		D	A	A	D	A			A	
Copper Sulfate	A		A	A	A	A	D	C	A	D	A	A		A	
Cream			A			A			A		A			A	
Cresols		A	A			*			A		D	D	D	A	A
Cresylic Acid			A	A	D			A	A	A	D	D		A	
Cyclohexane		A	A			D			A		B	D		A	
Cyanic Acid			A								C				
Detergents			A			A			A		**	A		A	
Diesel Fuel			A	A	A				A		**	D		A	
Diethylamine			A	A	A				A		B	B		B	
Diethylene Glycol			A	A	A			A	A		A	A		B	
Diphenyl Oxide			A						A		D	D		A	
Dyes															
Epsom Salts (Magnesium Sulfate)			A						A		A	A		A	
Ethane			A						A		A	D		A	
Ethanolamine			A	A	A				A		B			D	
Ether		B	A	A		††		A	A	A	D	C	C	C	D
Ethyl Acetate		A	A	A	A	A			A	C	A	B	D	C	C
Ethyl Chloride	B		A	A	A	D	B	C	A	A	A	A	D	A	C
Ethyl Sulfate			A	A	A				D		A			A	
Ethylene Chloride			A			D			A		D	C		A	
Ethylene Dichloride			A	A	A	A			A		D	C	D	A	C
Ethylene Glycol	A		A	A	A	A	B	A	A	A	A	C	C	A	B
Ethylene Oxide			A	A	A						D	C		D	C
Fatty Acids	A		A	A	A		C	A	A	A	B	C	B	A	C
Ferric Chloride	A		A	A	A	A	D	D	D	D	A	A	B	A	C
Ferric Nitrate	A		A	A		A	D	A	B	A	A	A		A	
Ferric Sulfate	A		A	A	A	A	D	D	D	D	B		B	A	C
Ferrous Chloride			A	A	A	A		D	D		B			A	
Ferrous Sulfate	A		A	A	A	A	D	A	B	A	B			A	
Fluoboric Acid			A	A					B	A	B		B	A	
Fluosilicic Acid			A	A					B		A				
Formaldehyde	A		A	A	A	A	C	A	A	A	C	B	C	A	B
Formic Acid	A					A	A		B	A	A			A	
Freon 11						A					A				
Freon 12 (wet)	C					A					A				
Freon 22						A					A				
Freon 113						A					A				
Freon T.F.						A					A				
Fruit Juice						A					A				
Fuel Oils	A					A					A				
Furan Resin						A					A				
Furfural	B					A					A				
Gasoline	A		A			A					A				
Gelatin						A					A				
Glucose						A					A				
Glue P.V.A.						A					A				
Glycerine	A					A					A				
Glycolic Acid						A					A				
Gold Monocyanide						A					A				
Grape Juice						A					A				
Grease						A					A				
Heptane						A					A				
Hexane						A					A				
Honey						A					A				
Hydraulic Oils (Petroleum)						A					A				
Hydraulic Oils (Synthetic)						A					A				
Hydrazine						A					A				
Hydrobromic Acid						A					A				
Hydrochloric Acid (20%)	A	A	A	A		A	D		D	D	C	A	B	A	B
Hydrochloric Acid (37%)	A	A	A	A		A	D		D	D	C	C	C	A	C
Hydrocyanic Acid			A	A	A	A		A	A	A	B	A	B	A	
Hydrofluoric Acid (20%)	A	A	B			A	D	D	A	D	C	A	C	A	D
Hydrofluoric Acid (50%)	A	A	C			*	D	D	B	D	C	A	C	A	D
Hydrofluoric Acid (75%)	A	A	C			*	D	D	B	D		C	C	A	D
Hydrofluosilicic Acid (20%)	A		A	A	A		D		D		A	A		A	
Hydrogen Peroxide	A		A	A	A	A	D	C	A	A	A	C	C	A	B
Hyrodgen Sulfide, Aqueous Solution	A		A	A		A	D	B	A	A	B	A	B	A	
Hydroxyacetic Acid (70%)											A	A		A	
Ink			A	A	C			C	A		A				
Iodine	A		A	A	A	A	D	D	D	D	A	B	B	A	
Isotane			A								A				
Isopropyl Acetate			A	A					B		D	B		D	
Isopropyl Ether				A		A			A		A	D		D	
Jet Fuel (JP3, JP4, JP5)			A						A		B	D		A	
Kerosene	A		A	A	A	A	A		A		A	D	D	A	D
Ketones		B	B	A	A	A			A		D	A	D	D	C
Lacquers			A	A	A			C	A	A	D	D	D	D	D
Lactic Acid	A		A	A	A	A	D	A	A		A	B	B	A	
Lard			A						B		A	B		A	B
Latex			A								A			A	
Lead Acetate	A		A			A	D				B	A	B	D	
Lead Sulfamate			A			A			B		B	A		A	
Ligroin			A			††			A		A	D		A	
Lime			A	A	A				A		A	A		A	
Mercury	A		A	A	A	A	C	A	A	A	C	B	C	A	B
Methane			A			A			A		A			A	
Methanol			A	A	A	A			A		A	A		A	
Methyl Acetate			A						A		A			A	
Methyl Alcohol			A	A	A	A			A		A	A		A	
Methyl Bromide			A						A		A			A	
Methyl Chloride			A	A	A				A		A			A	
Methyl Ethyl Ketone			A						A		A			A	
Methylene Chloride			A						A		A			A	
Milk			A			A			A		A	A		A	
Mineral Oil			A	A	A	A			A		A			A	
Molasses			A			A			A		A	A		A	
Monochlorobenzene			A						A		A			A	
Monoethanolamine			A						A		A			A	
Naphtha			A	A	A	A			A		A			A	
Naphthalene			A						A		A			A	
Natural Gas			A			A			A		A			A	
Nickel Chloride			A						A		A	A		A	
Nickel Nitrate			A						A		A	A		A	
Nickel Sulfate			A						A		A	A		A	
Nitric Acid (20%)	A		A	A			D		A	D	C	A	B	A	B
Nitric Acid (50%)	A		A	A			D		A	D	C	A	B	A	B
Nitric Acid (70%)	A		A	A			D		A	D	C	A	B	A	B
Nitrobenzene			A						A		A			A	
Nitrogen			A	A	A	A			A		A	A		A	
Nitrogen Tetroxide			A						A		A			A	
Nitromethane			A						A		A			A	
Nitropropane			A						A		A			A	
Oleic Acid			A						A		A			A	
Oleum															
Oxalic Acid			A			A			A		A	A		A	
Oxygen			A	A	A	A			A		A	A		A	
Ozone			A						A		A			A	
Palmitic Acid			A						A		A			A	
Paraffin			A						A		A			A	
Perchloric Acid (10%)	A		A	A			D		A	D	C	A	B	A	B
Perchloric Acid (70%)	A		A	A			D		A	D	C	A	B	A	B
Perchloroethylene			A						A		A			A	
Petroleum Ether			A						A		A			A	
Phenol			A						A		A			A	
Phosphoric Acid (20%)	A		A	A			D		A	D	C	A	B	A	B
Phosphoric Acid (50%)	A		A	A			D		A	D	C	A	B	A	B
Phosphoric Acid (70%)	A		A	A			D		A	D	C	A	B	A	B
Phosphoric Acid (85%)	A		A	A			D		A	D	C	A	B	A	B
Phosphorus Trichloride			A						A		A			A	
Photographic Solutions			A						A		A			A	
Picric Acid			A						A		A			A	
Potassium Bromide			A						A		A			A	
Potassium Carbonate			A						A		A			A	
Potassium Chloride			A						A		A			A	
Potassium Cyanide			A						A		A			A	
Potassium Dichromate			A						A		A			A	
Potassium Hydroxide (20%)	A		A	A			D		A	D	C	A	B	A	B
Potassium Hydroxide (50%)	A		A	A			D		A	D	C	A	B	A	B
Potassium Hydroxide (70%)	A		A	A			D		A	D	C	A	B	A	B
Potassium Nitrate			A						A		A			A	
Potassium Permanganate			A						A		A			A	
Potassium Sulfate			A						A		A			A	
Propane			A						A		A			A	
Propyl Alcohol			A						A		A			A	
Propylene Glycol			A						A		A			A	
Pyridine			A						A		A			A	
Rosin			A						A		A			A	
Salicylic Acid			A						A		A			A	
Salt Water			A			A			A		A	A		A	
Sea Water			A			A			A		A	A		A	
Silicone Oil			A						A		A			A	
Silver Nitrate			A						A		A			A	
Soap Solutions			A						A		A			A	
Sodium Bicarbonate			A						A		A			A	
Sodium Bisulfate			A						A		A			A	
Sodium Carbonate			A						A		A			A	
Sodium Chloride			A						A		A			A	
Sodium Cyanide			A						A		A			A	
Sodium Hydroxide (20%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Hydroxide (50%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Hydroxide (70%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Hypochlorite (20%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Hypochlorite (50%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Hypochlorite (70%)	A		A	A			D		A	D	C	A	B	A	B
Sodium Nitrate			A						A		A			A	
Sodium Peroxide			A						A		A			A	
Sodium Phosphate			A						A		A			A	
Sodium Silicate			A						A		A			A	
Sodium Sulfate			A						A		A			A	
Sodium Sulfide			A						A		A			A	
Sodium Sulfite			A						A		A			A	
Soybean Oil			A						A		A			A	
Stannic Chloride			A						A		A			A	
Stannous Chloride			A						A		A			A	
Starch			A						A		A			A	
Stearic Acid			A						A		A			A	
Styrene			A						A		A			A	
Sugar Solutions			A						A		A			A	
Sulfite Liquors			A						A		A			A	
Sulfur			A						A		A			A	
Sulfur Dioxide			A						A		A			A	
Sulfur Trioxide			A						A		A			A	
Sulfuric Acid (20%)	A		A	A			D		A	D	C	A	B	A	B
Sulfuric Acid (50%)	A		A	A			D		A	D	C	A	B	A	B
Sulfuric Acid (70%)	A		A	A			D		A	D	C	A	B	A	B
Sulfuric Acid (85%)	A		A	A			D		A	D	C	A	B	A	B
Sulfuric Acid (Fuming)	A		A	A			D		A	D	C	A	B	A	B
Sulfurous Acid			A						A		A			A	
Tannic Acid			A						A		A			A	
Tartaric Acid			A						A		A			A	
Tetrachloroethylene			A						A		A			A	
Tetrahydrofuran			A						A		A			A	
Toluene			A						A		A			A	
Transformer Oil			A						A		A			A	
Trichloroethylene			A						A		A			A	
Turpentine			A						A		A			A	
Urea			A						A		A			A	
Varnish			A						A		A			A	
Vegetable Oil			A						A		A			A	
Vinegar			A						A		A			A	
Water			A			A			A		A	A		A	
Whiskey			A						A		A			A	
Xylene			A						A		A			A	
Yeast			A						A		A			A	
Zinc Chloride			A						A		A			A	
Zinc Sulfate			A						A		A			A	

A —No effect—Excellent
B —Minor effect—Good
C —Moderate effect—Fair, contact Angar
D —Severe effect—Not recommended
X —Carbon/Ceramic Seal

† —P.V.C.—Satisfactory to 72° F
* —Polypropylene—Satisfactory to 72° F
†† —Polypropylene—Satisfactory to 120° F
** —BUNA N—Satisfactory for Seal & O-Rings

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE
Lubricants			A			A			A		A	D		A	
Magnesium Carbonate			A			A			A		A				
Magnesium Chloride	A		A	A	A	A	D	D	A	D	A	A	B	A	
Magnesium Hydroxide	A		A	A	A	A	B	A	A	D	A	A		A	
Magnesium Nitrate			A			A			A		A				
Magnesium Oxide			A						A		A				
Magnesium Sulfate	A		A	A	A	A	C	A	A	B	A	A	B	A	
Maleic Acid			A	A	A			A	A		D	D		A	
Maleic Anhydride			A						D	D		A			
Mash			A						A		A				
Mayonnaise			A	A	A			C	A		A		B	A	
Melamine			A	A	A			D	D		C				
Mercuric Chloride	A						D			D					
(Dilute Solution)			A	A		A		D	D		A	A		A	
Mercuric Cyanide	A		A			A	D		A		A				
Mercury	A		A	A	A	A	D	A	A	D	A	A		A	
Methanol (See Alcohol Methyl)															
Methyl Acetate									A		D	B		D	
Methyl Acetone			C						A		D				
Methyl Acrylate			A								D	B		D	
Methyl Bromide			B								D	D		A	
Methyl Butyl Ketone			B						A			A		D	
Methyl Cellosolve			C	A	A						D	B		D	
Methyl Chloride	A		A	A	A		B	A	A	D	C	C		A	C
Methyl Dichloride			A								D	D		A	
Methyl Ethyl Ketone			A	A	A	A			A		D	A		D	
Methyl Isobutyl Ketone			A	A		D			A		D	C		D	
Methyl Isopropyl Ketone			A						A		D	B		D	
Methyl Methacrylate			A								D	D		D	
Methylamine			A						A		B				
Methylene Chloride			A			D			A		D	D		B	
Milk	A		A	A	A	A	D	A	A	A	A	A	B	A	
Molasses	A		A	A	A	A	B	A	A		A		B	A	
Mustard			A			A			A		B			A	
Naptha	B		A	A	A	A	B	A	A		A	D	C	A	C
Napthalene			A	A	A			A	B		D	D		A	
Nickel Chloride	A		A	A	A	A	D	C	C	D	A	A		A	
Nickel Sulfate	A		A	A		A	D		B	B	A	A		A	
Nitric Acid (5-10% Solution)	A	A	A	A		A	D		A	D	D	B	B	A	B
Nitric Acid (20% Solution)	A		B	A		A	D		A	D	D	D	B	A	B
Nitric Acid (50% Solution)	A		C	A		*	D		A	D	D	D	B	A	B
Nitric Acid															
(Concentrated Solution)	A		D	A	D		D		A	D	D	D	C	A	C
Nitrobenzene		B	A	A		††		A	B		C	D	D	A	
Oils															
Aniline			A	A	A			A	A	D	D	B		A	
Anise			A						A						
Bay			A						A					A	
Bone			A						A		A				
Castor			A	A	A			A	A	A	A	B		A	
Cinnamon			A						A						
Citric			A						A					A	
Clove			A						A		A				
Coconut			A						A		A	A		A	
Cod Liver			A						A		A	A			
Corn			A			A			A		A	C		A	
Cotton Seed			A			A			A		A	C		A	
Creosote			A	A	D	*			A	A	B	D		A	

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE
Diesel Fuel (2D, 3D, 4D, 5D)			A			A			A		A	D		A	
Fuel (1, 2, 3, 5A, 5B, 6)			A								A	**	D	A	
Ginger			A								A	D		A	
Hydraulic (See Hydraulic)															
Lemon			A								A			A	
Linseed			A	A	A	A		A	A	A	A	D		A	
Mineral			A	A	A	A		A	A			D	B		C
Olive			A						A		A			A	
Orange			A						A		A			A	D
Palm			A						A		A			A	
Peanut			A						A		A			A	
Peppermint			A						A		D			A	
Pine			A	A	A				A		D			A	
Rape Seed			A						A		D			A	
Rosin			A						A		A			A	
Sesame Seed			A						A		A			A	
Silicone			A			A			A		A			A	
Soybean			A	A	A				A		A			A	
Sperm			A						A		A			A	
Tanning			A						A		A			A	
Turbine			A						A		A			A	
Oleic Acid			A	A	A	A		A	A		A	D	C	A	
Oleum			A	A		D		C	A		A	D		A	
Oxalic Acid (cold)	A		A	A	A	A	D	A	A	A	A	A	B	A	
Parafin			A	A	A				A		A			A	
Pentane			A	A								D		A	
Perchloroethylene			A						A		D	D		A	
Petrolatum			A						A		A	A		A	
Phenol (Carbolic Acid)		A	A	A	D	A		A	A	A	D	D	C	A	
Phosphoric Acid															
(to 40% Solution)	A	A	A	A		A	D	C	A	D	C	B	B	A	
Phosphoric Acid															
(40%-100% Solution)	A	A	A	A		A	D	C	B	D	C	B	B	A	
Phosphoric Acid (Crude)	A		A	A			D	C	C	D	C	B	B	A	
Photographic Developer			A			A			A		A			A	
Plating Solutions													B		
Antimony			A			A			A		A			A	
Arsenic			A			A			A		A			A	
Brass			A			A			A		A			A	
Bronze			A			A			A		A			A	
Cadmium			A			A					A			A	
Chrome			B			A								A	
Copper			A			A					A			A	
Gold			A			A			A		A			A	
Indium			A			A			A		A			A	
Iron			A			A			A		A			A	
Lead			A			A					A			A	
Nickel			A			A					A			A	
Silver			A			A			A		A			A	
Tin			A			A					A			A	
Zinc			A			A					A			A	
Potash			A						A		A			A	
Potassium Bicarbonate			A					A	B	A	A			A	
Potassium Bromide	A		A	A			C	C	B	C	A	A		A	
Potassium Carbonate	A		A	A	A	A	B	A	A	D	A		B	A	
Potassium Chlorate	A		A	A	A	A	B	A	A	B	A		B	A	
Potassium Chloride	A		A	A	A	A	D	C	A	A	A	A		A	
Potassium Chromate			C	A	A				B		A			A	
Potassium Cyanide Solutions	A		A	A	A		D	A	A	D	A	A		A	
Potassium Dichromate	A		C	A		A	D		A	A	A	A		A	

A —No effect—Excellent
B —Minor effect—Good
C —Moderate effect—Fair, contact Angar
D —Severe effect—Not recommended
X —Carbon/Ceramic Seal

† —P.V.C.—Satisfactory to 72° F
* —Polypropylene—Satisfactory to 72° F
†† —Polypropylene—Satisfactory to 120° F
** —BUNA N—Satisfactory for Seals & O-Rings

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE
Potassium Hydroxide	A		A	A	A	A	D	A	B	D	A	A	B	D	B
Potassium Nitrate			A						B		A	A		A	
Potassium Permanganate	A		A	A	A	A	B	A	B	A				A	
Potassium Sulfate	A		A	A	A	A	B	A	B	A	A	A		A	
Propane (Liquified)	A		A	A		*	A	A	A	A	A	D		A	
Propylene Glycol			A						A		A			A	
Pyridine		B	A	A				D	B		D	B	D	D	
Pyrogallic Acid	A		A	A			B	C	A	B				A	
Rosins	A		A	A	A		C		A	A	A				
Rum			A						A		A			A	
Rust Inhibitors			A			A			A		A			A	
Salad Dressing			A						A		A				
Sea Water			A	A	A	A			A		A	A		A	
Shellac (Bleached)			A		A				A						
Shellac (Orange)			A		A				A						
Silicone			A			A			A		A	A		A	
Silver Bromide	A		A				D	A	B						
Silver Nitrate	A		A	A	A	A	D	A	A		A	C		A	
Soap Solutions			A	A	A	A		A	A		A		B	A	B
Soda Ash (See Sodium Carbonate)															
Sodium Acetate	A		A	A	A		B	A	B	A	A			A	
Sodium Aluminate			A	A	A			A	A		A	A		A	
Sodium Bicarbonate			A	A	A	A		A	A	A	A	A	B	A	
Sodium Bisulfate	A		A	A	A	A	D	A	A	B	B		B	A	
Sodium Bisulfite			A	A	A	A		C	A	A			B	A	
Sodium Carbonate	A		A	A	A	A	D	A	A	D	A	A	B	A	B
Sodium Chlorate			A			A		A	B	B	A		B	A	
Sodium Chloride	A		A	A	A	A	D	A	B	B	A	A	B	A	B
Sodium Chromate			C	A	A	A					A			A	
Sodium Cyanide	A		A	A	A	A	D	A	A	D	A	A		A	
Sodium Hydroxide (20%)		A	A			A			A		A	A	B	A	B
Sodium Hydroxide (50% Solution)	C		A			A	C		B		D		B	A	B
Sodium Hydroxide (80% Solution)	C		A			A	D				D		C	B	C
Sodium Hypochlorite (to 20%)	B		A	A	A	A	D	C	C		**	B	C	A	
Sodium Metaphosphate			A	A	A	*		C	A	A	A	A		A	
Sodium Metasilicate			A						A		A			A	
Sodium Nitrate	A		A	A	A	A	C	A	B	A	C	A	B	A	
Sodium Perborate	A		A	A	A	A	D		C	A	**	A		A	
Sodium Peroxide	A		A	A	A		D	A	A	A	C	A		A	
Sodium Polyphosphate (Mono, Di, Tribasic)	A		A	A	A			A	B		B	A		A	
Sodium Silicate	A		A	A	A	A	B	A	B	D	A	A	B	A	
Sodium Sulphate	A		A	A	A	A	B	A	B	A	A	A		A	
Sodium Sulfide	A		A	A	A	A	D	C	B	D	A	A	B	A	
Sodium Tetraborate			A	A	A			A	A		A			A	
Sodium Thiosulphate ("Hypo")	A		A	A	A	A	B	A	A	D	B	A		A	
Sorghum			A						A		A			A	
Soy Sauce			A						A		A			A	
Stannic Chloride	A		A					D			A	A		A	
Stannic Fluoborate			A								A			A	
Starch			A	A	A			A	A		A			A	
Steric Acid			A	A	A	*		B	B	A	B	B	B	A	C
Stoddard Solvent			A			A			A		B	D		A	
Styrene			A						A		D	D		B	
Sugar (Liquids)			A	A	A			A	A		A		B	A	
Sulfate Liquors			A						C						
Sulfur Chloride	A		C	A	A	*	D		D	D	D	D	C	A	
Sulfur Dioxide	C		A	A	A	*	C		B	A	D	A	C	A	B
Sulfur Trioxide			A		A				C	A	D	B	B	A	
Sulfuric Acid (to 10%)	A	A	A	A	C	A	D	D	C	B	A	D	B	A	B
Sulfuric Acid 10%-75%)	A	A	A			A	D		D		C	D	C	A	C
Sulfuric Acid 75%-95%)	A		A			A	D		D		C	D	D	A	D
Sulfuric Acid (95%-100%)	A		A	A	D		D	B	A	D	D	D	D	A	D
Sulfurous Acid	A		A	A	B	A	D	C	B	B	C	B	B	A	C
Syrup			A			A			A		A			A	
Tallow			A	A	A				A		A			A	
Tannic Acid	A		A	A	A	A	B	A	C	D	**	A	B	A	C
Tanning Liquors			A						A		C				
Tartaric Acid			A	A	A			C	B	A	A			A	
Tetrachlorethane			A			A			A		C	D		A	
Tetrahydrofuran		C	A			D			A		D	B		B	
Toluene, Toluol	B		A	A	A	††	A	A	A	A	D	D	D	A	D
Tomato Juice			A						A		A		B	A	
Trichlorethane			A						A		D	D		A	
Trichlorethylene	D		A	A		D	B	A	A	A	C	D		A	
Trichloropropane			A						A		A			A	
Tricresylphosphate			A						A		D	A		A	
Triethylamine			A								A			A	
Turpentine	A		A	A	A	††	B	A	A	A	A	D	C	A	D
Urine			A			A			A		A	A		A	
Vegetable Juice			A						A		A			A	
Vinegar	A		A	A	A	A	D	C	A	C	B	A	B	A	B
Water, Acid, Mine	A		A	A		A	D		A		A		B	A	B
Water, Distilled, Lab Grade 7	A		A			A	D		A		A	A		A	
Water, Fresh	A		A			A			A		A	A	B	A	B
Water, Salt	A		A			A	C	C	A	C	A	A		A	
Weed Killers			A						A		B			A	
Whey			A						A		A			A	
Whiskey and Wines	A		A	A	A	A	B	A	A	B	A	A	C	A	B
White Liquor (Pulp Mill)			A			A			A					A	
White Water (Paper Mill)			A			A			A					A	
Xylene	D	A	A	A	A	°	A	A	A	A	D	D	D	A	D
Zinc Chloride	A		A	A	A	A	D	D	C	D	A	A	B	A	
Zinc Hydrosulphite			A	A	A			A	A		A	A			
Zinc Sulfate	A		A	A	A		D	B	A	A	A	A		A	

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° —Polypropylene—Satisfactory to 72° F
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** —BUNA N—Satisfactory for Seal & O-Rings

CIRCLE SEAL CONTROLS, INC.

2302 WARDLOW CIRCLE • POST OFFFICE BOX 3300 • CORONA, CALIFORNIA 92878
Telephone (909) 270-6200 • FAX (909) 270-6201

CSP-418-L • 4/91

INDUSTRIAL, AEROSPACE AND MILITARY FLUIDS

Service recommendations are based upon the best information available to us assuming normal service with the fluids listed, but are in no way guaranteed. Unusual service conditions may effect the suitability of materials recommended. O-ring recommendations are subject to change as new compounds are developed.

Recommendation Code:
Excellent—Considered most suitable material for service.
Good—Generally satisfactory and recommended for service.

O-rings listed below are standard for at least one valve series. To determine standard O-rings for any particular series, please consult the appropriate catalog sheet. For specifications covering O-ring numbers and material letters see reverse side.

CIRCLE SEAL CONTROLS TECHNICAL DATA

FLUID	O-RING DESIGNATION		BODY MATERIALS	
	EXCELLENT	GOOD	EXCELLENT	GOOD
Acetaldehyde		24,62	T, T1	A
Acetate	20, 62		A, S, T, T1	B
Acetic Acid		62	T1	A, T
Acetic Anhydride		62	T1, A	T
Acetone	20, 62		A, B, T, T1	
Acetylene	20, 32, 62	49, 59	A, S, T, T1	B
Aerozene	20, 62		T2, T6	A1, T
Air	20, 32, 49, 59 69,77,79,99		A, B, T, T1	S
Alcohol	20, 32, 49, 59, 69 77, 99		A, B, T, T1	
Amines Mixed		62	A, T, T1	
Ammonia Anhydrous	20, 62, 73	77, 79	T, T1	S
Ammonium Hydroxide	20, 62, 73	59	T, T1	A, S
Ammonia, Aqueous	20, 62	73	T, T1	
Ammonium Persulfate	62		T, T1	
Argon	20, 32, 62	24, 64	A, B, T	
Aromatic Fuels	20, 32, 69, 72	77, 99	A, B, T, T1	
Beer	32, 59, 62, 73		A, T, T1	S
Benzene	20, 32, 64		A, B, T, T1	
Benzyl Alcohol	20, 32	62, 73	A, B, T, T1	
Benzyl Chloride	20, 32		T, T1	
Brake Fluid Automotive	62	73	A, B, S, T, T1	
Butane	32, 59, 73		A, B, S, T, T1	
Calcium Nitrate	32, 59, 62		A	
Carbon Dioxide	20, 59	32, 62	A, S, T, T1	B
Carbon Tetrachloride	20, 32	64	T, T1	A, B
Chlorine (dry)	20, 32, 64		T, T1	T3
Chromic Acid		32	T1	T
Coke Oven Gas	32	24, 64	T, T1	A
Di-isopropyl Ketone	62		A, B, T, T1,T2	
Ethylene Glycol	20, 32, 49, 59	62, 99, 77	T, T1	A, B, S
Ethylene Oxide	20	62	T, T1	A
Ethyl Mercaptan	20	32	A, T, T1	S
Freon 11	20	32, 49, 59	A, B, T, T1	S
Freon 12	20, 32, 49, 59, 73	62	A, B, T, T1	S
Freon 13	20, 32, 59, 73		A, B, T, T1, S	S
Freon 21	20	73	A, B, T, T1	S
Freon 22	20, 62, 73		A, B, T, T1	S
Freon 114	49, 59, 62, 73		A, B, T, T1	
Freon TF	59, 73	32	A, B, T, T1, S	S
Fuels Aircraft	32, 69, 77	20	A, B, T, T1	
Fuels Automotive	32, 69, 77, 99	20	A, B, T, T1	S
Fuels Diesel	32, 69, 77, 99	20	A, B, S, T, T1	
Fuels Jet	32, 69	20	A, B, T, T1	
Fuels Oil	20, 32, 59	49, 64	A, B, S, T, T1	
Furfural		62	A, T, T1	B
Gasoline Solvents	32, 49, 59, 77, 99		A, B, T, T1	S
Helium	32, 62, 73, 99	59	A, B, S, T, T1	
Hydraulic Fluids, High Temp. Silicate Base	32, 73	77	T, T1, T2	

FLUID	O-RING DESIGNATION		BODY MATERIALS	
	EXCELLENT	GOOD	EXCELLENT	GOOD
Hydraulic Oil (MIL-H-5606)	20, 32, 77, 99		A, B, S, T, T1	
Lubricating Oil (MIL-L-7808)	16, 20, 32		A, T, T1	
Hydraulic Oil (MIL-O-6083)	20, 69, 77, 99		A, B, S, T, T1	
Hydraulic Oil (Mineral Base)	32, 49, 59, 77, 99		A, B, S, T, T1	
Hydrazine	20, 62		T2	A1, T, T1
Hydrochloric Acid	20, 32	62		T3
Hydrogen Peroxide	20, 32	62	A1, T, T1, T2	A
IRFNA	20	32	T1, T3	A, A1, T
Isopropyl Acetate	20	62		
Kerosene	20, 32, 69, 77, 99		A, B, S, T, T1	
Ketone	20	62	T	
Lead Sulfamate	62, 73	32	T, T1	
Methyl Acetone	20	62	T, T1	
Methyl Alcohol	49, 59, 73	62	A, B, S, T, T1	
Methyl Bromide	20, 32		T, T1	
Methyl Chloride	32	62		B, T, T1
Methyl Ethyl Ketone	20, 62		T1	
Mono Methyl Hydrazine	20, 32	62, 73	T2	T, T1
Natural Gas	32, 49, 59, 73	20	A, B, S, T, T1	
Nitromethane	62	73	A, B, S, T, T1	
Nitrogen Gas	32, 59, 77, 99	73	A, B, S, T, T1	
Nitrogen Liquid	20		A, B, T, T1	
Nitrogen Tetroxide	20		T2	
Nitrogen Tetroxide Fumes	20		T2	
Nitrous Oxide	20, 59		A, B, S, T, T1	
Oxalic Acid	32, 62		T1	T
Oxygen Gas	20, 33, 53	24, 32, 62	A, B, T, T1	S
Oxygen Liquid	20		A, T, T1	
Perchlorethylene	20, 32	59	T, T1	A, B
Phenol	32		A, T, T1	
Phosphate Esters	20, 62		A, B, S, T	
Phosphoric Acid	32, 49	62		T1
Propane	20, 32, 59, 99		B, S, T, T1	
Pydraul	20, 32	62	A, T, T1	
RP-1	20, 64, 69, 99	32	A, T, T1	
Silver Nitrate	24, 32, 59, 62, 64		T, T1	
Skydrol	62	20	A, T, T1	
Sodium Chloride	49, 59, 62, 73		M, T, T1	A
Sodium Hydroxide	62	32, 59, 73	T, T1	
Steam (250°F)	20 62		B, T, T1	
Steam (300°F)	20 62		A, B, T, T1	
Steam (400°F)	20	62	B, T, T1	
Sulfur Dioxide (Tri)	62		T, T1	
Sulfur Hexafluoride	62, 73	24	T1	
Sulfuric Acid	20, 32			T3
Toluene	20, 32		A, B, T, T1	
Trichlorethylene	20, 32	64	T, T1	A, B, S
UDMH	20, 62	73, 77	T2	A1, T
Vacuum	62, 32	49	A, B, S, T, T1	
Water, Fresh	20, 49, 59, 69, 99	62	T, T1	B
Water, Salt	20, 59, 73, 77	49, 59, 99	M	T, T1
Xylene	32	64	A, B, T, T1	

CIRCLE SEAL CONTROLS, INC.
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Material Letter	Material Description	Specifications	Finish
A	Aluminum 2024-T4 or T351	QQ-A-225/6	Chromic Anodize MIL-A-8625 Type I
A1	Aluminum 6061-T6 or T651	QQ-A-225/8	Sulfuric Anodize MIL-A-8625 Type II
A2	Aluminum, Die Cast	Alcoa #380	
B	Brass Commercial Bar Stock	QQ-B-626	
	Brass Sand Casting	SAE 40 Red Brass	
	Brass Forging	QQ-B-626 Comp. 377 (Comp. 21)	
M	Monel R	QQ-N-281 CL B	
N	Naval Brass	QQ-B-637 Comp. 1, 2 or 3	
S	Steel Cold Rolled	QQ-S-637 12L14	Black Oxide, MIL-C-13924 Class I
S1	Steel Cold Rolled	AISI 1018, or 1020	Black Oxide, MIL-C-13924 Class I
T	Steel, Cor. Res. Type 303Se or S	ASTM A582	
T1	Type 316	ASTM A479	
T14	Type 17-4PH H1150	AMS 5643 COND. H1150	

TECHNICAL CHARACTERISTICS AND SPECIAL PROPERTIES OF COMMONLY USED "O" RINGS

"O" Ring Number	Basic Compound	Hardness Shore (1)	Military or Mat'l Spec.	Material Operating Temperature °F (2)	Special Properties and Uses
02	Ethylene Propylene	60		−65 to +300	Phosphate Esters, Skydrol, Air and Steam
10	CTFE "Kel-F"	80	AMS 3650	−320 to +350	Chemically Inert (see note 3)
16	Buna N	70	MIL-R-7362	−65 to +275	MIL-L-7808
19 *	Buna N	50	MIL-G-1149	−40 to +250	Air, Oil, Water, Alcohol
20 *	TFE "Teflon"	55-70	MIL-R-8791	−320 to +400	Chemically Inert (see note 3)
24 *	Silicone	70-75	AMS 3304	−70 to +450	Air, Water, Oxygen (FDA Approved)
32 *	Viton	75	MIL-R-83248 TP.I.CL.I (AMS 7280)	−20 to +400	Aromatic Fuels, Toluene, MIL-L-7808,RFNA, Oxygen
14	Silicone	50	AMS 3302	−80 to +500	See Number 24
33 *	Neoprene	80	AMS3242	−40 to +300	General Purpose Oxygen
34	Silicone	80	AMS3305	−70 to +450	Air, Water, Oxygen (FDA Approved)
35	Disogrin	90	Polyurethane	−40 to +212	Oils, Air, Nitrogen, Gasoline, Kerosene Alcohol, Glycols, Water (General Purpose)
45	Disogrin	70	Polyurethane	−40 to +212	See Number 35
49 *	Buna N	90		−65 to +250	See Number 77
52	Viton	90	MIL-R-83248 TP.I.CL2	−20 to +400	See Number 32
53	Neoprene (W)	70	AMS 3209	−40 to +300	General purpose, Oxygen Compatible
59 *	Buna N	70	MIL-P-25732	−65 to +275	See Number 77
62 *	Ethylene Propylene	80		−65 to +300	Phosphate Esters (skydrol) Air, Steam
64	Fluoro-silicone	70	MIL-R-25988	−80 to +350	Oil, Water, Air, Aircraft & Jet Fuel Silicate Ester Hydraulic Oil
65	Kalrez (Dupont)	80	Perfluoroelastomer	+40 to +550	Chemically Inert
69	Buna N	65	MIL-P-5315	−65 to +180	Aromatic Fuels, Oil, Water, Gasoline, Alcohol
72	Viton	60		−20 to +400	See Number 32
73	Neoprene (W)	70	AMS 3209	−40 to +300	Silicate Ester Base Hydraulic Fluid, Freon 12, 22
74	Fluoro-silicone	50	MIL-P-25988	−80 to +350	Oil, Air, Water, Aircraft & Jet Fuel, Silicate Ester Base Hydraulic Oil
75	Kalrez (Dupont)	90	Perfluoroelastomer	+40 to +550	Chemically Inert
77 *	Buna N	70	MIL-P-25732 MS28775	−65 to +275	Hydraulic Oil, Air, Water, Solvents, Alcohol, MIL-H-5606 Fuel (General Purpose)
94	Fluoro-silicone	80	MIL-R-25988	−80 to +350	Oil, Water, Air, Aircraft & Jet Fuel Silicate Ester Base Hydraulic Oil
99 *	Buna N	90	MIL-P-5510	−65 to +250	General Purpose (See Number 77)

***"O" rings indicated by "*" are normally stocked in most sizes used.**

Notes:
1. Hardness is Shore "D" for Polyethylene, Teflon & Kel-F, Shore "A" for others. Where required for optimum valve operation, harder or softer "O" rings having identical technical characteristics may be substituted.
2. Exposure to lower temperatures normally will not affect the "O" ring but may reduce the sealing efficiency of the valve. Extended exposure to higher temperatures will damage the "O" ring. These temperatures are for seal material only, not unit operating temperature.
3. For optimum operation at temperatures below—100°F special processing is designated by the prefix letter K in the part number.

SEAT & POPPET MATERIALS

MATERIAL DESCRIPTION	SPECIFICATIONS
TFE "TEFLON"	AMS 3652 AMS 3651
CTFE (KEL-F81)	AMS 3650
NYLON	MIL-P-46069 6/6
TFE "TEFLON" (PREMIUM GRADE)	MIL-R-8791
NYLATRON, GS	—
VESPEL (DUPONT SP-1)	(POLYIMIDE)

OXYGEN SERVICE—Any product ordered with "O" rings suitable for and intended for use in oxygen systems must specify "for oxygen service" when ordered in order for the product to be suitably processed and identified.

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CONVERSIONS

LENGTH

1 ft.	=	30.48 cm.	1 micron	=	10^{-6} meter
1 in.	=	2.54 cm.	1 millimicron	=	10^{-9} meter
1 micron	=	3.937 X 10^{-5} in.	1 micromicron	=	10^{-12} meter

VOLUME

1 cc	=	20 drops oil (approx.)	1 cu in.	=	327 drops oil
1 cc	=	16 bubbles from MS33656-4 Fitting		=	16.387 cc
				=	0.5541 oz. fluid
1 ml	=	0.06102 cu in.	1 gal.	=	3785 cc
	=	0.03381 oz fluid		=	231 cu in.
1 cu ft	=	7.481 gal.		=	128 oz fluid
	=	1,728 cu in.		=	0.1337 cu ft.
	=	28,316 cc	1 liter	=	0.03532 cu ft.
	=	28.32 liters	1 oz.	=	29.57 cc
				=	1.8047 cu in.

WEIGHT

1 lb.	=	453.6 gm.
1gm.	=	0.03527 oz.
1 oz.	=	28.35 gm.

PRESSURE

1 atm.	=	14.696 psi	1 ft H_20	=	0.4335 psi
	=	29.92 in Hg	1 psi	=	27.71 in H_20
1 in Hg	=	0.4912 psi		=	0.06805 atm.
1 in Hg	=	13.6 in H_20		=	2.309 ft H_20
1 in H_20	=	0.03609 psi		=	2.042 in Hg

TEMPERATURE

			°F	°C	°R	°K
°F	=	(9/5)°C + 32°	-459.69	-273.16	0	0
°R	=	°F + 460	32	0	492	273
°C	=	5/9 (°F - 32)	70	21	530	294
°K	=	°C + 273	212	100	671	492

COMPARISON OF LEAKAGE RATES IN VARIOUS UNITS

	scc/sec	scc/min	scc/hr	bubbles/min	time/bubble	in^3/sec
	1	60	3600	960	0.06 sec	0.062
	0.0167	1	60	16	3.6 sec	0.001
	10^{-3}	0.06	3.75	1	1 min.	6.25×10^{-5}
*	3×10^{-4}	0.016	1	0.25	4 min.	1.9×10^{-5}
	3×10^{-5}	1.6×10^{-3}	0.1	0.025	40 min.	19×10^{-6}
	10^{-6}	6×10^{-5}	3.6×10^{-3}	9.6×10^{-4}	17.3 hrs.	6.25×10^{-8}
**	10^{-8}	6×10^{-7}	3.6×10^{-5}	9.6×10^{-6}	1730 hrs.	6.25×10^{-10}

* *Standard leakage for "zero leak".*
** *Standard leakage for helium leak test.*

TO CONVERT CFM TO SCFM

$$\frac{Q}{Qstd} = \frac{Pstd}{P} \quad \text{where Pstd = 14.7 PSIA}$$

GIVEN: Q = 20 CFM
P = 294 PSIA
Qstd = (Q P) / Pstd
Pstd = (20 CFM) (294 PSIA) 14.7 PSIA
= 400 SCFM

TO CONVERT PSI TO INCHES H_2O

1 PSI = 27.71 in H_2O (60° F)
1 in H_2O = 0.03609 PSI

TYPICAL SPECIFIC GRAVITIES

Liquids:	Crude Oil	.81 to .97
	Gasoline	.75
	Hydraulic Oil - Mineral Base	.80
	Hydraulic Oil - Phosphate Ester Base	1.10
	Hydraulic Oil - MIL-H-5606	.83
	Hydraulic Oil - Water Glycol Base	1.05
	Kerosene	.82
	Water	1.00

TYPICAL SPECIFIC GRAVITIES (Cont.)

Gases:	Ammonia	.596
	Argon	1.379
	Carbon Dioxide	1.529
	Helium	.138
	Hydrogen	.070
	Hydrogen Chloride	1.268
	Nitrogen	.967
	Oxygen	1.105
	Air	1.0

Qstd (Air) = M (any gas) x 13.36
G (any gas) x _1 / G (any gas)

EXAMPLE: Convert mass flow (lb/min) of any gas to volume flow (SCFM) of air.

GIVEN: M (He) = 1 lb/min, G (He) = .138

Qstd = M x 13.36 = 1 x 13.36
G x _1 / Sg .138 x _1 / .138
= 35.96 SCFM (Air)

OXYGEN SERVICE

CAUTION

Charging an oxygen system presents inherent **hazards** which cannot always be handled with absolute safety, especially with pressures in excess of 2000 PSI.

This product has been cleaned and must be maintained in accordance with Circle Seal Controls CSC/CCD 29.20 or better for oxygen service. Materials used have been determined to be compatible for use with oxygen. Materials (elastomerics, plastic and other soft substances) have been tested in accordance with MIL-V-5027D @ 2175 PSI.
Materials and cleaning are sufficient for oxygen service applications to 3000 PSIG per MIL-V-5027D. For oxygen applications over 3000 PSI the user is responsible for establishing system cleanliness and operational requirements. **Consult with your company's Engineering/Safety or Management personnel before using this product.**

Extreme **CAUTION** should be observed when operating this product for oxygen service. Operate/Turn handle **VERY SLOWLY** when charging a system and when venting a system to prevent **FIRE** and **EXPLOSION.**

System cleanliness must be maintained to prevent ignition causing **FIRE** and **EXPLOSION.**