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## DEFINITIONS

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- 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<sub>v</sub>:** Flow capability indication commonly accepted by the valve industry. The literal definition is that a component with a C<sub>v</sub> of one (1) can flow one (1) gallon of water with a ΔP of one (1) PSI. The calculated results from C<sub>v</sub> 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  $\Delta P$  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 x 10<sup>-4</sup> scc / sec

0.25 bubbles / min

4 minutes / bubble



## LIQUID FLOW C<sub>v</sub> EQUATION

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

This equation applied to all liquids including cryogenic liquids.

### LEGEND

- C<sub>v</sub> - 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<sub>v</sub> 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<sub>v</sub> EQUATION SUBSONIC FLOW

### DEFINITION

Flow is subsonic when the  $\Delta P$  (differential pressure) is less than 1/2 of the inlet pressure.

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

### LEGEND

- C<sub>v</sub> - Flow coefficient
- Q - Flow in SCFM
- $\Delta P$  - Differential Pressure (Difference between inlet and outlet pressure) in PSI.
- G - Specific gravity of Media (Taken from Properties of Gases)
- P<sub>1</sub> - Inlet pressure in PSIA (PSIG + 14.7)
- P<sub>2</sub> - Outlet pressure in PSIA (PSIG + 14.7)

### EXAMPLE

GIVEN: Flow - 100 SCFM of N<sub>2</sub>  
Inlet Pressure - 100 PSIG  
Outlet Pressure - 75 PSIG

FIND THE C<sub>v</sub> REQUIRED.

### SOLUTION

Q = 100 SCFM N<sub>2</sub>  
Inlet Pressure = 100 PSIG  
P<sub>1</sub> = 100 PSIG + 14.7 = 114.7 PSIA  
Outlet Pressure = 75 PSIG  
P<sub>2</sub> = 75 PSIG + 14.7 = 89.7 PSIA  
 $\Delta P = P_1 - P_2 = 114.7 \text{ PSIA} - 89.7 \text{ PSIA}$   
 $\Delta P = 25 \text{ PSI}$   
Media = N<sub>2</sub>  
Specific Gravity of N<sub>2</sub> = 0.067

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

$$C_v = \frac{100 \sqrt{0.067}}{\sqrt{89.7 \times 25}}$$

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

$$C_v = 2.07$$



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## GAS FLOW $C_v$ EQUATION

### SONIC FLOW

#### DEFINITION

Flow is sonic when the  $\Delta P$  (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.
- $\Delta P$  - 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  
 $P_1 = 100 \text{ PSIG} + 14.7 = 114.7 \text{ PSIA}$   
Outlet Pressure = 25 PSIG  
 $P_2 = 25 \text{ PSIG} + 14.7 = 39.7 \text{ PSIA}$   
 $\Delta P = P_1 - P_2 = 114.7 - 39.7 = 75 \text{ PSI}$   
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		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	A	B	Amyl Acetate	A	A	A	A	D	C	A	A	D	A	D	D	C	A	
Acetamide	A	A	A	A	A	A	A	A	B	D	A	A	A	A	A	A	Amyl Alcohol	A	A	A	A	A	A	A	A	D	A	A	D	C	A	
Acetate Solvent	A	A	A	A	D	B	A	B	D	D	D	D	B	B	B	B	Amyl Chloride	A	A	A	A	A	A	A	D	D	D	C	D	C	A	
Acetic Acid, Glacial	A	A	B	A	A	A	A	A	**	B	B	C	D	C	C	Aniline	A	A	A	A	A	A	A	A	D	D	D	D	D	C	A	
Acetic Acid	A	A	A	A	C	A	D	A	A	A	C	B	C	C	C	Anti-Freeze	A	A	A	A	A	A	A	A	D	D	D	D	D	C	A	
Acetic Anhydride	A	A	A	A	A	A	D	A	A	A	C	B	D	C	C	Aqua Regia	A	A	A	A	A	A	A	A	D	D	D	D	D	C	A	
Acetone	A	A	A	A	A	A	A	A	A	A	C	B	D	C	C	(80% HCl, 20% HNO <sub>3</sub> )	D	D	A	A	B		D	D	D	D	D	B	A	A		
Acetylene	A	A	A	A	A	*	A	A	A	A	A	D	D	D	D	Arochlor 1248	A	A	A	A	A		D	D	D	D	D	D	D	D	C	
Acrylonitrile	A	A	A	A	A						D	D	D	C	C	Aromatic Hydrocarbons	A	A	A	A	A		A	B	A	D	D	D	D	D	C	
Alcohols	A	A	A	A		B	A	B		C			C	B	B	Arsenic Acid	A	A	A	A	A		B	A	A	D	D	D	D	D	A	
Amyl																Asphalt	A	A	A	A	A	B	A	A	A	D	D	D	D	D	A	
Benzyl																Barium Carbonate	A	A	A	A		A	B	A	A	A	A	A	A	A	A	
Butyl		A	A	A	A	B										Barium Chloride	A	A	A	A		D	A	B	D	A	A	A	A	A	A	
Diacetone			A	A	A	*					D	A	D	D	D	Barium Cyanide	A	A	A	A		A	B	D	A	A	A	A	A	A	A	
Ethyl			A	A	A	A					A	A	A	A	A	Barium Hydroxide	A	A	A	A		A	B	D	A	A	A	A	A	A	A	
Hexyl			A	A	A	A					A	A	A	A	A	Barium Nitrate	A	A	A	A		A	A	D	A	A	A	A	A	A	A	A
Isobutyl			A	A	A	A					B	A	A	A	A	Barium Sulfate	A	A	B	A	A	C	D	A	A	A	A	A	A	A	A	A
Isopropyl			A	A	A	A					B	A	A	A	A	Barium Sulfide	A	A	B	A	A	A	A	A	A	A	A	A	A	A	A	A
Methyl			A	A	A	A					A	A	A	A	A	Beer	A	A	A	A	A		B	A	A	A	A	A	A	A	A	A
Octyl			A	A	A	A					B	A	A	A	A	Beet Sugar Liquids	A	A	A	A	A	A	C	A	A	A	A	A	A	A	A	B
Propyl			A	A	A	A					A	A	A	A	A	Benzaldehyde	A	A	A	A	*	B	C	A	A	A	A	A	A	A	A	B
Aluminum Chloride 20%	A	A	A	A	A	D	D	C	D	A	A	A	B	A	C	Benzene	D	B	A	A	A	*	A	A	B	A	D	D	D	D	B	
Aluminum Fluoride			A	A	A	A	C	C								Benzoic Acid	A	A	A	A	A	*	B	B	B	D	D	D	D	D	C	
Aluminum Hydroxide			A	A	A	A	A	A								Benzol	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Aluminum Potassium Sulfate (Aluminum)	A	A	A	A	A	A	C	A	C	A	A	B	A	A	C	Borax (Sodium Borate)	A	A	A	A	A	A	C	A	A	C	B	A	A	A	A	A
Aluminum Sulfate			A	A	A	A	D	A	C	A	A	B	A	A	C	Boric Acid	A	A	A	A	A	A	D	A	B	A	A	A	A	A	A	C
Amines			B	A	A	A	B	A	A	D	B	D	D	D	D	Brewery Slop	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Ammonia, Anhydrous			A	A	A	A	A	A	A	C	A	A	D	D	D	Bromine	A	D	C	A	A	*	C	D	D	D	D	D	D	D	D	D
Ammonia, Liquids			A	A	A	A	A	A	A	C	A	B	D	X	X	Butadiene	A	A	A	A	A		A	A	A	A	A	A	A	A	A	D
Ammonia, Nitrate			A	A	A	A	A	A	A	C	A	B	D	X	X	Butane	A	A	A	A	*		A	A	A	A	A	A	A	A	A	D
Ammonium Bifluoride			A	A	A	A	A	A	A	A	A	A	A	A	A	Butter	A	A	A	A			A	A	A	A	A	A	A	A	A	B
Ammonium Carbonate			A	A	A	A	B	B	A	B	A	B				Buttermilk	A	A	A	A		D	C	A	A	A	A	A	A	A	A	A
Ammonium Casenite			A	A	A	A	A	A	A	A	B	A	B			Butylene	A	A	A	A			A	A	A	A	A	A	A	A	A	A
Ammonium Chloride			A	A	A	A	D	D	B	C	B	A	C	B	B	Butyl Acetate	A	A	A	A	*	D	C	B	A	A	D	B	D	D	C	
Ammonium Hydroxide	A	A	A	A	A	A	D	A	A	A	A	C	B	B	B	Butyric Acid	A	A	A	A		D	C	B	A	D	B	B	C	D	C	
Ammonium Nitrate	A	A	A	A	A	A	D	A	A	C	A	A	A	B	B	Calcium Bisulfide	A	A	A	A		D	B	B	C	A	D	A	A	A	A	
Ammonium Oxalate			A	A	A	A	A	A	A	A	A	A	A	A	A	Calcium Carbonate	A	A	A	A		A	A	A	A	A	A	A	A	A	A	A
Ammonium Persulfate	A	A	A	A	A	A	D	A	A	D	A	A	A	A	A	Calcium Chloride	A	A	A	A		A	C	A	A	B	C	B	A	A	A	A
Ammonium Phosphate, Dibasic	A	A	A	A	A	D	A	C	A	A	A	A	B	A	A	Calcium Hydroxide	A	A	A	A		C	D	A	A	A	C	B	A	A	A	A
Ammonium Phosphate, Monobasic			A	A	A		C	A	A	A	A	A	A	A	A	Calcium Hypochlorite	A	A	A	A		A	D	A	D	D	B	A	A	A	A	A
Ammonium Phosphate, Tribasic			A	A	A		A	A	A	A	A	A	A	A	A	Calcium Sulfate	A	A	A	A		C	A	B	A	A	A	A	A	A	A	A
Ammonium Sulfate	A	A	A	A	A	D	B	C	A	A	A	A	A	A	A	Calgon®	A	A	A	A		*	A	A	A	A	A	A	A	A	A	A
Ammonium Thio-Sulfate	A	A	A	A	A		B	C	A	A	A	A	A	A	A	Cane Juice	A	A	A	A			C	A	A	A	A	A	A	A	A	A
			A	A	A											Carbolic Acid (See Phenol)	A	A	A	A												
			A	A	A											Carbon Bisulfide	A	A	A	A	*			B	A	D	A	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 Seal & O-Rings

	KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINIUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE		KEL-F	RYTON® (PPS)	EPOXY	TFL	NYLON	POLYPROPYLENE	BRASS	303 S.S.	316 S.S.	ALUMINIUM	BUNA N	ETHYLENE/PROPYLENE	TYGON	VITON	SILICONE				
Carbon Dioxide	A		A	A	A	A	A	A	A	A	A	B	A	A		Formic Acid	A		A	A	A	A	D	B	B	D	D	C	B	C					
Carbon Disulfide			A	A	A	*	A	A	A	A	D	D	A	A		Freon 11		A	A	A	A	A	A	A	A	D	D	B	B	A					
Carbon Monoxide			A	A	A	A	A	A	A	A	A	A	A	A		Freon 12 (wet)	C		A	A	A	A	B	C	A	A	D	D	A	C					
Carbon Tetrachloride	B		A	A	A	D	B	A	A	C	D	D	C	A		Freon 22		A	A	A	A	A	A	A	A	B	C	A	D	C					
Carbonated Water			A	A	A	A	A	A	A	A	A	A	A	A		Freon 113		A	A	A	A	A	A	A	A	A	C	C	D	B					
Carbonic Acid			A	A	A	A	A	A	B	A	B	A	A	A		Freon T. F.		A	A	A	A	A	A	A	A	A	C	C	D	B					
Catsup			A	A	A	A	A	A	A	A	A	A	A	A		Fruit Juice		A	A	A	A	A	A	C	A	A	A	C	D	B					
Chloracetic Acid	A		C	A	A		D	D	D	D	D	B	D	D	A	Fuel Oils	A		A	A	A	A	B	A	A	A	A	A	D	A					
Chlorinated Glue			A	A	A				A	A	C	B	B	C	A	Furan Resin		A	A	A	A	A		A	A	A	A	D	B	D					
Chlorine, Anhydrous Liquid	B		B	A			D	D	D	D	D	D	C	A	C	Furfural	B		A	A	*	C	A	A	A	A	D	B	D	D					
Chlorobenzene (Mono)		A	A	A	A	D	D	A	A	D	D	D	D	C	A																				
Chloroform			A	A	A	D	D	A	A	D	D	D	D	C	A	Gasoline	A	A	A	A	D	A	A	A	A	A	**	D	D	A	D				
Chlorosulfonic Acid			C	A	A	D	D	A	D	D	D	D	C	D	C	Gelatin		A	A	A	A	A	A	C	A	A	A	A	A	A	A				
Chlorox (Bleach)	D		A	A	A	D			A	A	B	B	A	A		Glucose		A	A	A	A	A	A	A	A	A	A	A	A	A	B				
Chocolate Syrup			A	A	A				A	A	A	A	A	A		Glue P. V. A.		A	A	A	A	*	A	C	A	A	A	A	A	A	A				
Chromic Acid 5%	A		B	A			D		A	A	A	A	B	A	C	Glycerine	A		A	A	A	A	B	A	A	A	A	A	A	A	B				
Chromic Acid 50%	A		B	A			D		D	A	A	A	B	A	C	Glycolic Acid																			
Cider			A	A	A	A			A	A	A	A	A	A		Gold Monocyanide																			
Citric Acid	A		A	A	A	A	D	B	A	A	A	A	B	A		Grape Juice																			
Citric Oils			A	A	A	A			A	A	A	A	A	A		Grease																			
Coffee			A	A	A	A			A	A	A	A	A	A	B	Heptane																			
Copper Chloride			A	A	A	A		D	B	A	A	A	A	A		Hexane																			
Copper Cyanide			A	A	A	A			A	A	A	A	A	A		Honey																			
Copper Fluoborate			A	A	A	A			D	D	B	B	A	A		Hydraulic Oils (Petroleum)																			
Copper Nitrate	A		A	A	A	A	D	A	A	D	A	A	A	A		Hydraulic Oils (Synthetic)																			
Copper Sulfate	A		A	A	A	A	D	C	A	D	A	A	A	A		Hydrazine																			
Cream			A	A	A	A			A	A	A	A	A	A		Hydrobromic Acid																			
Cresols		A	A	A	A	*			A	A	A	D	D	D	A	Hydrochloric Acid (20%)																			
Cresylic Acid			A	A	A	D			A	A	A	D	D	D		Hydrochloric Acid (37%)																			
Cyclohexane		A	A	A		D			A	A	B	D	D	D		Hydrocyanic Acid																			
Cyanic Acid			A	A					A	A	C					Hydrofluoric Acid (20%)	A	A	A	A	A	A	D	D	D	D	D	C	C	B	B	C			
Detergents			A	A	A	A			A	**	A	A	A	A		Hydrofluoric Acid (50%)	A	A	A	A	A	A	D	D	D	D	D	C	C	C	B	C			
Diesel Fuel			A	A	A	A			A	A	**	D	D	B		Hydrofluoric Acid (75%)	A	A	B	A	A	A	D	D	D	D	D	C	C	C	A	D			
Diethylamine			A	A	A	A			A	A	A	A	A	A		Hydrofluosilicic Acid (20%)	A	A	C		*	D	D	D	D	D	D	C	C	C	A	D			
Diethylene Glycol			A	A	A			A	A	A	A	A	A	A		Hydrogen Peroxide	A		A	A	A	A	D	C	A	A	A	A	C	A	A	B			
Diphenyl Oxide			A						A	A	D	D	A	A		Hydrogen Sulfide, Aqueous Solution	A		A	A	A	A	D	B	A	A	B	A	B	A	A	A			
Dyes			A						A	A	D	D	A	A		Hydroxyacetic Acid (70%)	A		A	A	A	A	D	B	A	A	B	A	B	A	A	A			
Epsom Salts (Magnesium Sulfate)			A						A	A	A	A	A	A		Ink																			
Ethane			A						A	A	D	D	C	C	D	Iodine	A		A	A	C	A	D	C	D	D	D	A	B	B	A	A			
Ethanolamine			A	A	A	A			A	A	A	D	C	C		Isotane			A	A	A	A													
Ether		B	A	A	A	††			A	A	A	D	C	C		Isopropyl Acetate			A	A	A	A													
Ethyl Acetate		A	A	A	A	A			A	A	A	D	B	D	C	Isopropyl Ether			A	A	A	A													
Ethyl Chloride	B		A	A	A	D	B	C	A	A	A	A	A	A	C	Jet Fuel (JP3, JP4, JP5)			A																
Ethyl Sulfate			A	A	A				A	A	D	A	A	A		Kerosene	A		A	A	A	A	A												
Ethylene Chloride			A	A	A	D			A	A	A	D	C	A		Ketones			B																
Ethylene Dichloride			A	A	A	A			A	A	A	D	C	D	A	Lacquers			A	A	A	A													
Ethylene Glycol	A		A	A	A	A	B	A	A	A	A	A	A	C		Lactic Acid			A	A	A	A	D	C	A	A	D	D	A	B	D	D	D		
Ethylene Oxide			A	A	A				A	A	D	C	A	D		Lard			A	A	A	A													
Fatty Acids	A		A	A	A	C	A	A	A	A	B	C	B	A	C	Latex			A	A	A	A													
Ferric Chloride	A		A	A	A	A	D	D	D	D	A	A	A	B	A	Lead Acetate			A	A	A	A	D												
Ferric Nitrate	A		A	A	A	A	D	A	D	B	D	A	A	A		Lead Sulfamate			A	A	A	A													
Ferric Sulfate	A		A	A	A	A	D	D	A	D	B	B	A	A	C	Ligroin			A	A	A	A													
Ferrous Chloride			A	A	A	A	D	D	D	B	B	A	A	A		Lime			A	A	A	A	††												
Ferrous Sulfate	A		A	A	A	A	D	A	B	A	B	B	A	A																					
Fluoboric Acid			A	A	A				A	B	A	B	B	A																					
Fluosilicic Acid			A	A	A				A	B	A	B	B	A																					
Formaldehyde	A		A	A	A	C	A	A	A	C	A	B	C	A	B																				

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		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					Diesel Fuel (2D, 3D, 4D, 5D)		A			A			A		**	D		A			
Magnesium Carbonate			A		A			A	A		A					Fuel (1, 2, 3, 5A, 5B, 6)		A			A			A		B	D		A			
Magnesium Chloride	A		A	A	A	D	D	A	D	A	A	B	A			Ginger		A			A			A		A						
Magnesium Hydroxide	A		A	A	A	B	A	A	D	A	A					Hydraulic (See Hydraulic)		A			A			A		A						
Magnesium Nitrate			A		A			A	A	A	A					Lemon		A			A			A		A						
Magnesium Oxide			A		A			A	A	A	A					Linseed		A	A	A	A			A		A		D		A		
Magnesium Sulfate	A		A	A	A	C	A	A	D	A	A	B	A			Mineral		A	A	A	A			A		A		D		B		
Maleic Acid			A	A	A			A	A	D	D	A				Olive		A	A	A	A			A		A						
Maleic Anhydride			A		A			A	D	D	A					Orange		A			A			A		A					D	
Mash			A		A			A	D	D	A					Palm		A			A			A		A						
Mayonnaise			A	A	A		C	A	A	A	A		B	A		Peanut		A			A			A		A						
Melamine			A	A	A		D	D	D	C						Peppermint		A			A			A		A		D				
Mercuric Chloride (Dilute Solution)	A		A	A		D		D	D	D	A					Pine		A	A		A			A		A		D				
Mercuric Cyanide	A		A	A		D		D	A	A	A					Rape Seed		A			A			A		A		D				
Mercury	A		A	A		D		D	A	D	A					Rosin		A			A			A		A		D				
Methanol (See Alcohol Methyl)																Sesame Seed		A			A			A		A						
Methyl Acetate									A		D	B		D		Silicone		A			A			A		A						
Methyl Acetone			C						A		D	D		D		Soybean		A	A	A	A			A		A						
Methyl Acrylate			A								D	B		D		Sperm		A			A			A		A						
Methyl Bromide			B								D	D		D		Tanning		A			A			A		A						
Methyl Butyl Ketone			B						A		D	D		D		Turbine		A			A			A		A						
Methyl Cellosolve			C	A	A						D	B		D		Oleic Acid		A	A	A	A			A		A		D	C			
Methyl Chloride	A		A	A		B	A	A	D	C	C	C		A	C	Oleum		A	A	A	A		D	C	A	A		D	A		B	
Methyl Dichloride			A							D	D	D		A		Oxalic Acid (cold)	A				A			A		A						
Methyl Ethyl Ketone			A	A	A				A	D	D	D		D		Paraffin			A	A	A			A		A						
Methyl Isobutyl Ketone			A	A		D			A	A	D	C		D		Pentane			A	A				A		A		D				
Methyl Isopropyl Ketone			A	A					A		D	B		D		Perchloroethylene								A		A		D	D			
Methyl Methacrylate			A						A		D	D		D		Petrolatum								A		A						
Methylamine			A						A		D	D		D		Phenol (Carbolic Acid)		A	A	A	D	A		A		A		D				
Methylene Chloride			A			D			A		B	D		B		Phosphoric Acid (to 40% Solution)		A	A	A		A	D	C	A	D	C	B	B		A	
Milk	A		A	A	A	D	A	A	A	A	A	A		B	A	Phosphoric Acid (40%-100% Solution)		A	A	A		A	D	C	B	D	C	B	B		A	
Molasses	A		A	A	A	B	A	A	A	A	A			B	A	Phosphoric Acid (Crude)		A	A	A		A	D	C	B	D	C	B	B		A	
Mustard			A		A				A		B			A		Photographic Developer		A						A		A						
Naptha	B		A	A	A	B	A	A	A	A	D	C		C	C	Plating Solutions																
Napthalene			A	A	A	A	B	A	B	D	D			A		Antimony									A							
Nickel Chloride	A		A	A	A	D	C	C	D	B	A	A		A		Arsenic									A							
Nickel Sulfate	A		A	A	A	A	D	B	B	A	A			A		Brass									A							
Nitric Acid (5-10% Solution)	A	A	A	A	A	D	A	D	D	D	B	B	A	B	B	Bronze									A							
Nitric Acid (20% Solution)	A		B	A	A	D		A	D	D	D	B	A	B	B	Cadmium									A							
Nitric Acid (50% Solution)	A		C	A	*	D		A	D	D	D	B	A	B	B	Chrome									A							
Nitric Acid (Concentrated Solution)	A		D	A	D	D		A	D	D	D	C	A	C	C	Copper									A							
Nitrobenzene	B		A	A	††	A		A	B	C	D	D		A		Gold									A							
Oils																Indium									A							
Aniline			A	A	A			A	D	D	B			A		Iron									A							
Anise			A		A									A		Lead									A							
Bay			A		A									A		Nickel									A							
Bone			A		A									A		Silver									A							
Castor			A	A	A									A		Tin									A							
Cinnamon			A		A									A		Zinc									A							
Citric			A		A									A		Potash								A		A						
Clove			A		A									A		Potassium Bicarbonate								A	B	A						
Coconut			A		A									A		Potassium Bromide								A	C	D						
Cod Liver			A		A									A		Potassium Carbonate								A	C	D						
Corn			A		A									A		Potassium Chlorate								A	B							
Cotton Seed			A		A									A		Potassium Chloride								A	B							
Creosote			A	A	D									A		Potassium Chromate								A	B							
			A		A									A		Potassium Cyanide Solutions								A	D							
			A		A									A		Potassium Dichromate								A	D							

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

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**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.



FLUID	O-RING DESIGNATION		BODY MATERIALS		FLUID	O-RING DESIGNATION		BODY MATERIALS	
	EXCELLENT	GOOD	EXCELLENT	GOOD		EXCELLENT	GOOD	EXCELLENT	GOOD
Acetaldehyde		24,62	T, T1	A	Hydraulic Oil (MIL-H-5606)	20, 32, 77, 99		A, B, S, T, T1	
Acetate	20, 62		A, S, T, T1	B	Lubricating Oil (MIL-L-7808)	16, 20, 32		A, T, T1	
Acetic Acid		62	T1	A, T	Hydraulic Oil (MIL-O-6083)	20, 69, 77, 99		A, B, S, T, T1	
Acetic Anhydride		62	T1, A	T	Hydraulic Oil (Mineral Base)	32, 49, 59, 77, 99		A, B, S, T, T1	
Acetone	20, 62		A, B, T, T1	B	Hydrazine	20, 62		T2	A1, T, T1
Acetylene	20, 32, 62	49, 59	A, S, T, T1	A1, T	Hydrochloric Acid	20, 32	62	A1, T, T1, T2	T3
Aerozene	20, 62		T2, T6	S	Hydrogen Peroxide	20, 32	62	T1, T3	A
Air	20, 32, 49, 59		A, B, T, T1		IRFNA	20			A, A1, T
Alcohol	20, 32, 49, 59, 69, 77, 99		A, B, T, T1		Isopropyl Acetate	20	62		
Amines Mixed		62	A, T, T1						
Ammonia					Kerosene	20, 32, 69, 77, 99		A, B, S, T, T1	
Anhydrous	20, 62, 73	77, 79	T, T1	S	Ketone	20	62	T	
Ammonium Hydroxide	20, 62, 73	59	T, T1	A, S	Lead Sulfamate	62, 73	32	T, T1	
Ammonia, Aqueous	20, 62	73	T, T1		Methyl Acetone	20	62	T, T1	
Ammonium Persulfate	62		T, T1		Methyl Alcohol	49, 59, 73	62	A, B, S, T, T1	
Argon	20, 32, 62	24, 64	A, B, T		Methyl Bromide	20, 32		T, T1	
Aromatic Fuels	20, 32, 69, 72	77, 99	A, B, T, T1		Methyl Chloride	32	62		B, T, T1
Beer	32, 59, 62, 73		A, T, T1	S	Methyl Ethyl Ketone	20, 62		T1	
					Mono Methyl Hydrazine	20, 32	62, 73	T2	T, T1
Benzene	20, 32, 64		A, B, T, T1		Natural Gas	32, 49, 59, 73	20	A, B, S, T, T1	
Benzyl Alcohol	20, 32	62, 73	A, B, T, T1		Nitromethane	62	73	A, B, S, T, T1	
Benzyl Chloride	20, 32		T, T1		Nitrogen Gas	32, 59, 77, 99	73	A, B, S, T, T1	
Brake Fluid					Nitrogen Liquid	20		A, B, T, T1	
Automotive	62	73	A, B, S, T, T1		Nitrogen Tetroxide	20		T2	
Butane	32, 59, 73		A, B, S, T, T1		Nitrogen Tetroxide Fumes	20		T2	
Calcium Nitrate	32, 59, 62		A		Nitrous Oxide	20, 59		A, B, S, T, T1	
Carbon Dioxide	20, 59	32, 62	A, S, T, T1	B	Oxalic Acid	32, 62		T1	T
Carbon					Oxygen Gas	20, 33, 53	24, 32, 62	A, B, T, T1	S
Tetrachloride	20, 32	64	T, T1	A, B					
Chlorine (dry)	20, 32, 64		T, T1	T3	Oxygen Liquid	20		A, T, T1	
Chromic Acid		32	T1	T	Perchloroethylene	20, 32	59	T, T1	A, B
Coke Oven Gas	32	24, 64	T, T1	A	Phenol	32		A, T, T1	
Di-isopropyl Ketone	62		A, B, T, T1, T2		Phosphate Esters	20, 62		A, B, S, T	
Ethylene Glycol	20, 32, 49, 59	62, 99, 77	T, T1	A, B, S	Phosphoric Acid	32, 49	62		T1
Ethylene Oxide	20	62	T, T1	A	Propane	20, 32, 59, 99		B, S, T, T1	
Ethyl Mercaptan	20	32	A, T, T1	S	Pydraul	20, 32	62	A, T, T1	
Freon 11	20	32, 49, 59	A, B, T, T1	S	RP-1	20, 64, 69, 99	32	A, T, T1	
Freon 12	20, 32, 49, 59, 73	62	A, B, T, T1	S	Silver Nitrate	24, 32, 59, 62, 64		T, T1	
					Skydrol	62	20	A, T, T1	
Freon 13	20, 32, 59, 73		A, B, T, T1, S	S	Sodium Chloride	49, 59, 62, 73		M, T, T1	A
Freon 21	20	73	A, B, T, T1	S	Sodium Hydroxide	62	32, 59, 73	T, T1	
Freon 22	20, 62, 73		A, B, T, T1	S	Steam (250°F)	20, 62		B, T, T1	
Freon 114	49, 59, 62, 73		A, B, T, T1		Steam (300°F)	20, 62		A, B, T, T1	
Freon TF	59, 73	32	A, B, T, T1, S	S	Steam (400°F)	20	62	B, T, T1	
Fuels Aircraft	32, 69, 77	20	A, B, T, T1		Sulfur Dioxide (Tri)	62		T, T1	
Fuels Automotive	32, 69, 77, 99	20	A, B, T, T1	S	Sulfur Hexafluoride	62, 73	24	T1	
Fuels Diesel	32, 69, 77, 99	20	A, B, S, T, T1		Sulfuric Acid	20, 32			T3
Fuels Jet	32, 69	20	A, B, T, T1		Toluene	20, 32		A, B, T, T1	
Fuels Oil	20, 32, 59	49, 64	A, B, S, T, T1		Trichloroethylene	20, 32	64	T, T1	A, B, S
Furfural		62	A, T, T1	B	UDMH	20, 62	73, 77	T2	A1, T
Gasoline Solvents	32, 49, 59, 77, 99		A, B, T, T1	S	Vacuum	62, 32	49	A, B, S, T, T1	
Helium	32, 62, 73, 99	59	A, B, S, T, T1		Water, Fresh	20, 49, 59, 69, 99	62	T, T1	B
Hydraulic Fluids, High Temp.					Water, Salt	20, 59, 73, 77	49, 59, 99	M	T, T1
Silicate Base	32, 73	77	T, T1, T2		Xylene	32	64	A, B, T, T1	



**CIRCLE SEAL CONTROLS, INC.**

POST OFFICE BOX 3666  
ANAHEIM, CALIFORNIA 92803  
PHONE (714) 774-6110 • FAX (714) 772-7332

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

## CONVERSIONS

### LENGTH

1 ft.	= 30.48 cm.	1 micron	= $10^{-6}$ meter
1 in.	= 2.54 cm.	1 millimicron	= $10^{-9}$ meter
1 micron	= $3.937 \times 10^{-5}$ 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
1 ml	= 0.06102 cu in.	1 gal.	= 0.5541 oz. fluid
	= 0.03381 oz fluid		= 3785 cc
1 cu ft	= 7.481 gal.		= 231 cu in.
	= 1,728 cu in.	1 liter	= 128 oz fluid
	= 28,316 cc	1 oz.	= 0.1337 cu ft.
	= 28.32 liters		= 0.03532 cu ft.
			= 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 <sub>2</sub> O	= 0.4335 psi
	= 29.92 in Hg	1 psi	= 27.71 in H <sub>2</sub> O
1 in Hg	= 0.4912 psi		= 0.06805 atm.
1 in Hg	= 13.6 in H <sub>2</sub> O		= 2.309 ft H <sub>2</sub> O
1 in H <sub>2</sub> O	= 0.03609 psi		= 2.042 in Hg

### TEMPERATURE

		<u>°F</u>	<u>°C</u>	<u>°R</u>	<u>°K</u>
°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

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

\* Standard leakage for "zero leak".

\*\* Standard leakage for helium leak test.

## TO CONVERT CFM TO SCFM

$$\frac{Q}{Q_{std}} = \frac{P_{std}}{P} \quad \text{where } P_{std} = 14.7 \text{ PSIA}$$

GIVEN: Q = 20 CFM  
P = 294 PSIA  
Q<sub>std</sub> = (Q P) / P<sub>std</sub>  
P<sub>std</sub> = (20 CFM) (294 PSIA) / 14.7 PSIA  
= 400 SCFM

## TO CONVERT PSI TO INCHES H<sub>2</sub>O

$$1 \text{ PSI} = 2.771 \text{ in H}_2\text{O (60° F)}$$

$$1 \text{ in H}_2\text{O} = 0.03609 \text{ PSI}$$

## 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

$$Q_{std} (\text{Air}) = M (\text{any gas}) \times 13.36 \\ G (\text{any gas}) \times \frac{1}{G (\text{any gas})}$$

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

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

$$Q_{std} = M \times 13.36 = 1 \times 13.36 \\ G \times \frac{1}{Sg} = .138 \times \frac{1}{.138} \\ = 35.96 \text{ SCFM (Air)}$$





## **OXYGEN SERVICE**

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## **CAUTION**

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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 (elastomers, 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**.

