TFE-O-SIL®

Teflon Encapsulated Silicone and Fluorocarbon O-rings

TECHNICAL BULLETIN

Acts as an ordinary o-ring but is impervious to most solvents and chemicals and has an extremely low coefficient of friction

ROW INCORPORATED

TFE-O-SIL ® O-rings have a silicone core, solid or hollow, 70 ± 5 durometer. Solid core is used primarily for static applications but may also be used for dynamic applications. Hollow core can be used in static applications where more compression is required and dynamic applications under certain conditions determined by testing. All sizes are also available with solid fluorocarbon elastomer core. Encapsulation is made from Teflon FEP resin which exceeds the requirements of L-P-389A and ASTM-D-2116.

Encapsulation thicknesses for different cross section sizes of solid core are shown in the following table.

Size		Teflon	Size		Teflon	Size		Teflon
IN	MM	Wall	IN	MM	Wall	IN	MM	Wall
.059	1.50	.010	.157	4.00	.012	.312	8.00	.020
.063	1.60	.010	.170	4.30	.015	.350	9.00	.020
.070	1.78	.010	.177	4.50	.015	.375	9.50	.020
.079	2.00	.010	.187	4.75	.015	.393	10.0	.020
.094	2.40	.010	.196	5.00	.015	.437	11.0	.030
.103	2.62	.010	.210	5.33	.015	.472	12.0	.030
.118	3.00	.010	.225	5.70	.015	.500	12.5	.030
.125	3.15	.010	.236	6.00	.015	.625	16.0	.030
.139	3.53	.012	.250	6.30	.020	.708	18.0	.030
.150	3.80	.010	.275	6.99	.020	.750	19.0	.030

Teflon wall for all hollow core cross-section sizes is .010
Note: Additional cross sections are available in inches and mm

Teflon FEP is resistant to most solvents and chemicals. *See Table I for a partial list.*

TABLE I
TYPICAL CHEMICALS WITH WHICH TEFLON RESINS ARE COMPATIBLE[1]

Abietic acid
Acetic acid
Acetic anhydride
Acetone
Acetophenone
Acrylic anhydride
Allyl methacrylate
Aluminum chloride
Ammonia liquid
Ammonium chloride
Aniline
Benzoyl chloride
Benzyl alcohol
Borax
Boric acid
Bromine
n-Butyl amine
Butyl acetate
Butyl methacrylate
Calcium chloride
Carbon disulfide
Cetane
Chlorine
Chloroform
Chlorosulfonic acid
Chromic acid
Cyclohexane
Cyclohexanone
Dibutyl phthalate
Dibutyl sebacate
Diethyl carbonate
Diethyl ether
Dimethyl formamide
Di-isobutyl adipate
Dimethylformamide
Dimethyl hydrazine, Unsymmetrical
Dioxane
Ethyl acetate
Ethyl alcohol
Ethyl ether
Ethyl hexoate
Ethylene bromide
Ethylene glycol
Ferric chloride
Ferric phosphate
Fluoronitrobenzene
Formaldehyde
Formic acid
Furane
Gasoline
Hexachloroethane
Hexane
Hydrazine
Hydrochloric acid
Hydrogen peroxide
Lead
Magnesium chloride
Mercury
Methyl ethyl ketone
Methacrylic acid
Methanol
Methyl methacrylate
Napthalene
Napthols
Nitric acid
Nitrobenzene
2-Nitro-butanol
Nitromethane
Nitrogen tetroxide
2-nitro-2-methyl propanol
n-octadecyl alcohol
Oils, animal and vegetable
Ozone
Perchlorethylene
Pentachlorobenzamide
Perfluoroxylene
Phenol
Phosphoric acid
Phosphorus pentachloride
Phthalic acid
Pinene
Piperidene
Polyacrylonitrile
Potassium acetate
Potassium hydroxide
Potassium permanganate
Pyridine
Soap and detergents
Sodium hydroxide
Sodium hypochlorite
Sodium peroxide
Solvents, aliphatic and aromatic [2]
Stannous chloride
Sulfur
Sulfuric acid
Tetrabromoethane
Tetrachloroethylene
Trichloroacetic acid
Trichloroethylene
Tricresyl phosphate
Triethanolanime
Vinyl methacrylate
Water
Xylene
Zinc chloride

[1]Based on experiments conducted up to the boiling points of the liquids listed 'Teflon' resins have normal service temperatures up to 500 °F (260 °C) for TFE 400 °F (205 °C) for FEP resins

[2]Some hologenated solvents may cause moderate swelling
Note: Values are averages only and not for specification purposes

Under some strenuous conditions Teflon fluorocarbon resins are not compatible with certain materials. It is widely known that Teflon will react with molten alkali metals (such as metallic sodium), fluorine and strong fluorinating agents (such as chlorinetrifluoride). Also, Teflon will react with molten sodium hydroxide at temperatures above 200 °C.

ABSORPTION OF COMMON ACIDS AND BASES IN TEFLON RESINS

Teflon fluorocarbon resins have unusually low absorption when compared with other thermoplastics.
They absorb practically no common acids and bases at temperatures as high as 399 °F. (200 °C) and exposures at up to one year. *See Table II.*

TABLE II - ABSORPTION OF COMMON ACIDS AND BASES IN TEFLON RESINS

Reagent	Exposure Temp. °C (°F)	Exposure Time	Weight increase* %
Hydrochloric acid			
10%	25 (77)	12 mo.	0
	50 (122)	12 mo.	0
	70 (158)	12 mo.	0
20%	100 (212)	8 hr.	0
	200 (392)	8 hr.	0
Nitric acid 10%	25 (77)	12 mo.	0
	70 (158)	12 mo.	0.1
Sulfuric acid 30%	25 (77)	12 mo.	0
	70 (158)	12 mo.	0
	100 (212)	8 hr.	0
	200 (392)	8 hr.	0.1
Sodium hydroxide			
10%	25 (77)	12 mo.	0
	70 (158)	12 mo.	0.1
50%	100 (212)	8 hr.	0
Ammonium hydroxide 10%	25 (77)	12 mo.	0
	70 (158)	12 mo.	0.1

*Weight changes less than 0.1% are not considered experimentally significant.
Note: Values are averages only and not for specification purposes.

ABSORPTION OF SOLVENTS

Absorption of solvents is also very small, even at elevated temperatures and considerable exposure time. That is due to the low degree of wettability. *See Table III.*

TABLE III - ABSORPTION OF COMMON SOLVENTS IN TEFLON RESINS

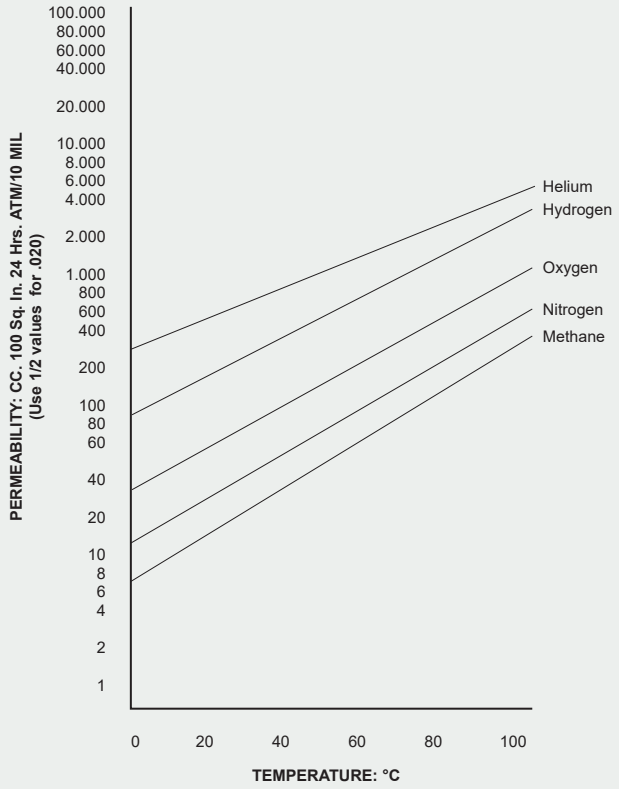
Solvent	Exposure Temp. °C (°F)	Exposure Time	Weight increase* %
Acetone	25 (77)	12 mo.	0.30
	50 (122)	12 mo.	0.4
	70 (158)	2 wk.	0
Benzene	78 (172)	96 hr.	0.5
	100 (212)	8 hr.	0.6
	200 (392)	8 hr.	1.0
Carbon tetrachloride	25 (77)	12 mo.	0.6
	50 (122)	12 mo.	1.6
	70 (158)	2 wk.	1.9
	100 (212)	8 hr.	2.5
	200 (392)	8 hr.	3.7
Ethyl alcohol (95%)	25 (77)	12 mo.	0
	50 (122)	12 mo.	0
	70 (158)	2 wk.	0
	100 (212)	8 hr.	0.1
	200 (392)	8 hr.	0.3
Ethyl acetate	25 (77)	12 mo.	0.5
	50 (122)	12 mo.	0.70
	70 (158)	2 wk.	0.7
Toluene	25 (77)	12 mo.	0.3
	50 (122)	12 mo.	0.6
	70 (158)	2 wk.	0.6

*Weight changes less than 0.1% are not considered experimentally significant
Note: Values are averages only and not for specification purposes.

GAS PERMEABILITY OF FEP RESINS

All plastics have a certain amount of permeability to gases but with FEP resins it is considerably lower. Absorption generally increases with temperature and surface contact area. It also decreases with the thickness of film. *See Table IV.*

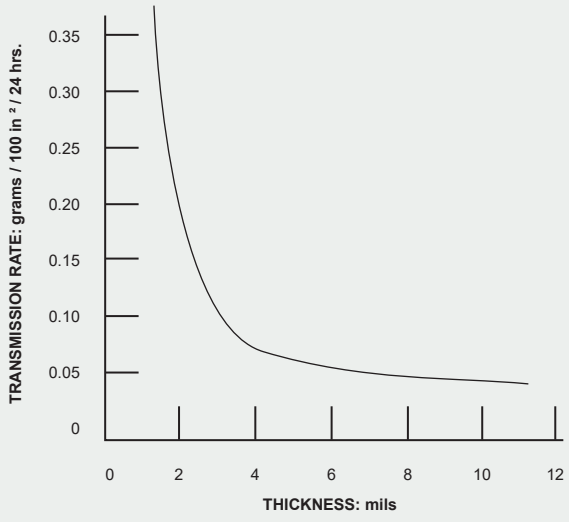
TABLE IV - PERMEABILITY OF TEFLON FEP RESINS TO GASES AT VARIOUS TEMPERATURES



VAPOR TRANSMISSION

Vapor transmission is the same as for gases. *See Table V and Table VI.*

TABLE V - WATER VAPOR TRANSMISSION RATE OF TEFLON FEP RESINS AT 40 °C (104 °F)



Notes: Values are averages only and not for specification purposes.
To convert the permeation values for 100 sq. in. to those for 1 sq cm, multiply by 0.00155.

TABLE VI - PERMEABILITY OF TEFLON FLUOROCARBON RESINS TO VAPORS (gm. / 100 in2 / 24 hrs.*)

	23 °C (73 °F)	30 °C (86 °F)	23 °C (73 °F)	35 °C (95 °F)	50 °C (122 °F)
Acetic acid	-	-	-	0.42	-
Acetone	-	-	0.13	0.95	3.29
Acetophenone	0.56	-	0.47	-	-
Benzene	0.36	0.80	0.15	0.64	-
n-Butyl ether	-	-	0.08	-	0.65
Carbon tetrachloride	0.06	-	0.11	0.31	-
Decane	-	-	0.72	-	1.03
Dipentene	-	-	0.17	-	0.35
Ethyl acetate	-	-	0.06	0.77	2.9
Ethyl alcohol	0.13	-	0.11	0.69	-
Hexane	-	-	-	0.57	-
HCl. 20%	< 0.01	-	< 0.01	-	-
Methanol	-	-	-	-	5.61
Peperidine	0.07	-	0.04	-	-
"Skydrol" hydraulic fluid	0.06	-	0.05	-	-
NaOH, 50%	$5x10^{-5}$	-	$4x10^{-5}$	-	-
H_2SO_4, 98%	$1.8x10^{-5}$	-	$8x10^{-6}$	-	-
Toluene	-	-	0.37	-	2.93
Water	-	0.35	0.09	0.45	0.89

*Test Method: ASTM E-96-53T (at vapor pressure: for 0.001 in film thickness).

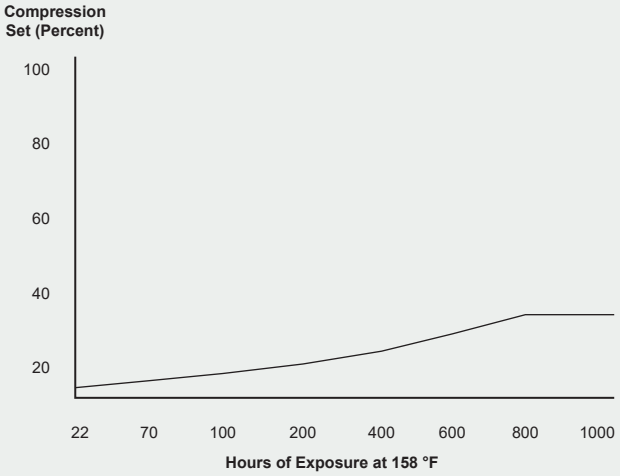
Notes: Values are averages only and not for specification purposes.

To convert the permeation values for 100 sq. in. to those for 1 sq. cm. multiply by 0.00155

COMPRESSION SET

Compression set is generally determined by compressing an O-ring to ASTM Spec. No. D395 Method B which is 75% of its original thickness and then releasing it. The percentage of original thickness lost from being under load is recorded in relation to it being compressed to 75% of its original thickness. See Table VII.

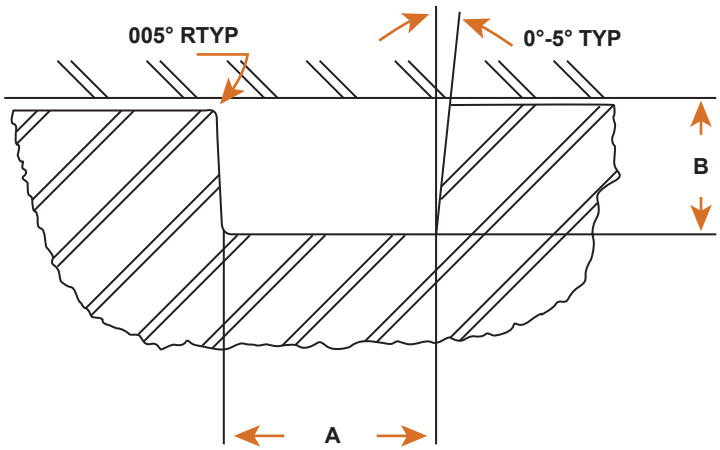
TABLE VII - COMPRESSION SET PERCENTAGE OF AN FEP TEFLON ENCAPSULATED O-RING OVER TIME



Compression test made with a 0.210" cross section, solid core O-ring.

GENERAL SPECS

Temperature Range: -75 °F (60 °C) to 400 °F (205 °C). Special applications up to 500 °F (260 °C).
Hardness: Overall hardness 85 ± 5 durometer
Pressure over 28 ” vacuum to 10,000 PSI: Ultimate pressure depends on temperature, time, clearance and use of back up rings.
Thermal expansion: 1.0 x 10^{-4} in/in/deg F. average in free state.
Coefficient of friction: .1 to .2.



Recommended Groove Dimensions for Common Cross Sections

NOMINAL CROSS SECTION	A (INCHES)	B (INCHES)	
		STATIC	DYNAMIC
.070	.093/.098	.050/.052	.055/.057
.103	.140/.145	.081/.083	.088/.090
.139	.192/.187	.111/.113	.121/.123
.210	.281/.286	.170/.173	.185/.188
.275	.375/.380	.226/.229	.240/.247

Additional cross sections in inches and mm can be found on our website at www.row-inc.com

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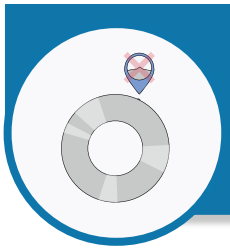
*Teflon is a registered trademark of Chemours Company. Testing was conducted on materials chemically similar to Teflon.

INSTRUCTIONS FOR INSTALLING TFE-O-SIL® O-RINGS



Ensure Smooth Surfaces

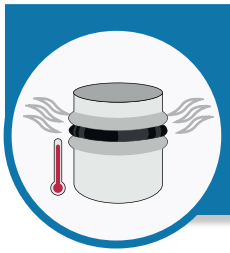
All surfaces that the O-Ring will contact in operation should be smooth and free from sharp edges, burrs and deep scratches. A 20 microinch finish is recommended.

Using Boiling Water

If it is difficult to install the O-Ring over a shaft or cone, it may be "stretched" by first immersing the O-Ring in boiling water for 3 minutes (there is no upper time limit). This softens and enlarges the O-Ring without the risk of deforming if extra installation pressure is applied

Avoid Rolling the O-Ring

Do not attempt to roll the O-ring as this could result in failure. ROW's TFE-O-SIL O-Rings have lower friction which should assist with installation.



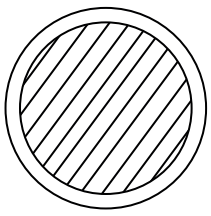
Apply Heat *Post-Installation*

After installation, it may be necessary to apply heat to the O-Ring once again so it will shrink back to a tight fit. Allow to cool under load for at least a few hours so the Teflon encapsulation will flow and form to imperfections.

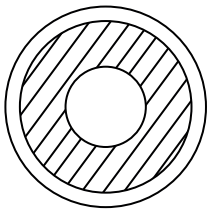
ENGINEERING ASSISTANCE

It is impossible to test o-rings under all the conditions to which they might be exposed in the field, therefore, it is important that o-rings be tested under conditions that duplicate the service conditions before a seal design is finalized.

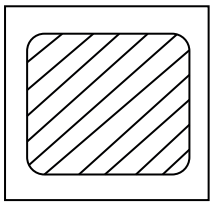
CROSS SECTION PROFILES



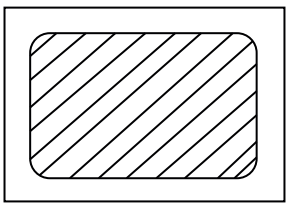
Solid Core



Hollow Core



Square



Rectangular