

SECTION NINE

TECHNICAL REFERENCE

- Unit Conversions
 - Temperature Conversions
 - Measurement Unit Factors
 - Conversion Tables
- Common Abbreviations
- Glossary of O-Ring Related Terms



REFERENCE—UNITS CONVERSION

TEMPERATURE CONVERSIONS

Temperature conversions are not accomplished with simple multipliers, since the Celsius and Fahrenheit scales are shifted 32 degrees with respect to one another. The formulas for converting from Celsius to Fahrenheit and Fahrenheit to Celsius are given below. A table of conversions for temperatures common on material data sheets are given at right.

Absolute temperatures are not typically used in the elastomeric seal industry, but they may be encountered. The metric and non-metric absolute temperature scales are the Kelvin and Rankin scales respectively. To convert from Celsius to Kelvin, add +273.15 to the Celsius temperature. To convert from Fahrenheit to Rankin, add +459.67 to the Fahrenheit temperature.

Temperature Conversion Calculation

$$^{\circ}\text{F} = (^{\circ}\text{C} \times \frac{9}{5}) + 32$$

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times \frac{5}{9}$$

TEMPERATURE		
°C	°F	
300	572	
275	527	
250	482	
225	437	
200	392	
175	347	
150	302	
125	257	
100	212	◀ BOILING POINT OF WATER
70	158	
38	100	
23	73	◀ ROOM TEMPERATURE
0	32	◀ FREEZING POINT OF WATER
-10	14	
-18	0	
-25	-13	
-35	-31	
-40	-40	
-50	-58	
-55	-67	
-65	-85	
-75	-103	
-80	-112	

CONVERSION TABLE USE

The **MEASUREMENT UNIT FACTORS** in the table (on page 207) can be used to convert your unit measure. Multiply the units you have by the factor of the unit measurement from the table that you want, and divide by the factor of the units that the value is currently in.

EXAMPLE: To convert 1000 square meters to acres, multiply acre unit measure (0.0002471) by 1000 and divide by the square meter unit measurement (1); thus, $[1000 \times 0.0002471] \div 1 = .2471$.

Therefore, 1000 square meters is the same as .2471 acres.

As an alternative, the conversion tables on the following six pages can be used. To use the tables, find the **units that you have** in the left column. Look across the table to find the units you wish to convert to. The value that is contained in that row and column is the multiplier that converts from the units that you have to the units that you want.

EXAMPLE: To convert 100 knots to m/s, find the row labeled “knots” and look across to the column labeled “m/s” and find the multiplier 0.514444.

$$100 \times 0.514444 = 51.4444$$

Therefore, 100 knots is the same as 51.4444 meters per second.

NOTE: Some of the conversion tables have been split into two tables to accommodate the page width.



MEASUREMENT UNIT FACTORS

Unit	Abbreviation	Factor
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LENGTH

meter	m	1
centimeter	cm	100
millimeter	mm	1,000
yard	yd	1.0936
foot	ft	3.2808
inch	in	39.37
kilometer	km	0.001
mile	mi	0.000621
mil	mil	39,370
micron	mm	1,000,000
angstrom	Å	10,000,000,000

AREA

square meter	m ²	1
square centimeter	cm ²	10,000
square yard	yd ²	1.196
square foot	ft ²	10.7639
square inch	in ²	1550
square kilometer	km ²	0.000001
square mile	mi ²	3.861E-07
acre	acre	0.0002471

VOLUME

cubic meter	m ³	1
cubic centimeter	cm ³	1,000,000
cubic yard	yd ³	1.30795
cubic foot	ft ³	35.315
cubic inch	in ³	61023.74
liter	l	1000
gallon	gal	264.172
quart	qt	1056.688
pint	pt	2113.376
milliliter	ml	1,000,000
fluid ounce	ozfl	33,814
tablespoon	tbsp	67,628
teaspoon	tsp	202,884

TIME

years	yr	1
days	day	365.24
hours	hr	8765.81
minutes	min	525,949
seconds	sec	31,556,926

Unit	Abbreviation	Factor
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VELOCITY

meters per second	m/s	1
centimeters per second	cs/s	100
feet per second	ft/s	3.28
kilometers per hour	kph	3.6
miles per hours	mph	2.237
knots	knots	1.944

MASS

kilogram	kg	1
gram	g	1000
pound	lb	2.205
ounce	oz	35.274
ton	ton	0.001102
metric ton	t	0.001
slug	slug	0.06852

FORCE

Newton	N	1
dyne	dyne	100000
gram force	gf	101.97
pound force	lbf	0.2248

ENERGY

Joule	J	1
erg	erg	10000000
kilocalorie	kcal	0.0002388
calorie	cal	0.2388
British Thermal Unit	BTU	0.0009478
foot pound	ftlbf	0.73756

POWER

watt	watt	1
horsepower	hp	0.001341

PRESSURE

megapascal	mPa	1
pascal	Pa	1000
atmosphere	atm	0.009869
bar	bar	0.01
psi	psi	0.145
torr	torr	7.5
millimeters of mercury	mmHg	7.5
inches of mercury	inHg	0.2953
inches of water	inH ₂ O	4.0186

REFERENCE—CONVERSION TABLES

CONVERSION TABLES

LENGTH— METRIC	m	cm	mm	km	µm	Å
m	1	100	1000	0.001	1000000	10000000000
cm	0.01	1	10	0.00001	10000	100000000
mm	0.001	0.1	1	0.000001	1000	10000000
yd	0.9144	91.44	914.1	0.0009144	914400	9144000000
ft	0.3048	30.48	304.8	0.0003048	304800	3048000000
in	0.0254	2.54	25.4	0.0000254	25400	254000000
km	1000	100000	1000000	1	1000000000	1E+13
mi	1609.344	160934.4	1609344	1.609344	1609344000	1.60934E+13
mil	0.0000254	0.00254	0.0254	2.54E-08	25.4	254000
µm	0.000001	0.0001	0.001	0.000000001	1	10000
Å	1E-10	0.00000001	0.0000001	1E-13	0.0001	1

LENGTH— AMERICAN	yd	ft	in	mi	mil
m	1.0936	3.2808	39.37	0.000621	39370
cm	0.010936	0.032808	0.3937	0.00000621	393.7
mm	0.0010936	0.0032808	0.03937	0.000000621	39.37
yd	1	3	36	0.000568182	36000
ft	0.333333333	1	12	0.000189394	12000
in	0.027777778	0.083333333	1	1.57828E-05	
1000km	1093.6	3280.8	39370	0.621	39370079
mi	1760	5280	63360	1	63360000
mil	2.77778E-05	8.33333E-05	0.001	1.58E-08	1
µm	1.0936E-06	3.2808E-06	0.00003937	6.21E-10	3.94E-02
Å	1.0936E-10	3.2808E-10	3.937E-09	6.21E-14	3.94E-06



DICHTOMATIK
NORTH AMERICA



CONVERSION TABLES

AREA— METRIC	m ²	cm ²	mm ²	km ²
m ²	1	10000	1000000	0.000001
cm ²	0.0001	1	100	1E-10
mm ²	0.000001	0.01	1	1E-12
yd ²	0.83612736	8361.2736	836127.36	8.36127E-07
ft ²	0.09290304	929.0304	92903.04	9.2903E-08
in ²	0.00064516	6.4516	645.16	6.4516E-10
km ²	1000000	10000000000	1E+12	1
mi ²	2589988	25899880000	2.58999E+12	2.589988
acre	4046.8726	40468726	4046872600	0.004046873

AREA— AMERICAN	yd ²	ft ²	in ²	mi ²	acre
m ²	1.19599	10.76391	1550	3.861E-07	0.0002471
cm ²	0.000119599	0.001076391	0.155	3.861E-11	2.471E-08
mm ²	1.19599E-06	1.07639E-05	0.00155	3.861E-13	2.471E-10
yd ²	1	9	1296	3.23E-07	0.00020661
ft ²	0.111111111	1	144	3.59E-08	2.29568E-05
in ²	0.000771605	0.006944444	1	2.49E-10	1.59E-07
km ²	1195990	10763910	1550000000	0.3861	247.1
mi ²	3097600	27878400	4014489600	1	639.99744
acre	4840	43560	6272665	0.0015625	1



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REFERENCE—CONVERSION TABLES

CONVERSION TABLES

VOLUME— METRIC	m ³	cm ³	l	ml
m ³	1	1000000	1000	1000000
cm ³	0.000001	1	0.001	1
yd ³	0.764555	764555	764.555	764555
ft ³	0.028316852	28316.85185	28.31685185	28316.85185
in ³	1.63871E-05	16.387064	0.016387064	16.387064
l	0.001	1000	1	1000
gal	0.003785412	3785.411784	3.785411784	3785.411784
qt	0.000946353	946.352946	0.946352946	946.352946
pt	0.000473176	473.176473	0.473176473	473.176473
ml	0.000001	1	0.001	1
ozfl	2.95735E-05	29.57352956	0.02957353	29.57352956
tbsp	1.47868E-05	14.78676478	0.014786765	14.78676478
tsp	4.92892E-06	4.928921594	0.004928922	4.928921594

VOLUME— AMERICAN	yd ³	ft ³	in ³
m ³	1.30795	35.315	61023.744
cm ³	1.30795E-06	0.000035315	0.06102374
yd ³	1	27	46656
ft ³	1728	28.31685185	7.480518519
in ³	2.14335E-05	0.000578704	1
l	0.00130795	0.035315	61.02374
gal	0.004951132	0.133680556	231
qt	0.001237783	0.033420139	57.75
pt	0.000618892	0.016710069	28.875
ml	1.30795E-06	0.000035315	0.06102374
ozfl	3.86807E-05	0.001044379	1.8046875
tbsp	1.93404E-05	0.00052219	0.90234375
tsp	6.44679E-06	0.000174063	0.30078125



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NORTH AMERICA



CONVERSION TABLES

VOLUME— AMERICAN	gal	qt	pt	ozfl	tbsp	tsp
m ³	264.172	1056.688	2113.376	33814	67628	202884
cm ³	0.000264172	0.001056688	0.002113376	0.033814	0.067628	0.202884
yd ³	201.974	807.896	1615.792	25852.672	51705.35	155116.05
ft ³	7.480518519	29.92207407	59.84414815	957.5063704	1915.012963	5745.038889
in ³	0.004329	0.01731602	0.034632035	0.55411255	1.108225	3.324675
l	0.264172	1.056688	2.113376	33.814	67.628	202.884
gal	1	4	8	128	256	768
qt	0.25	1	2	32	64	192
pt	0.125	0.5	1	16	32	96
ml	0.000264172	0.001056688	0.002113376	0.033814	0.067628	0.202884
ozfl	0.0078125	0.03125	0.0625	1	2	6
tbsp	0.00390625	0.015625	0.03125	0.5	1	3
tsp	0.001302083	0.005208333	0.010416667	0.166666667	0.333333333	1

TIME	yr	day	hr	min	sec
yr	1	365.24	8765.81	525949	31556925
day	0.002737926	1	24	1440	86400
hr	0.00011408	0.041666667	1	60	3600
min	1.90133E-06	0.000694444	0.016666667	1	60
sec	3.16888E-08	1.15741E-05	0.000277778	0.016666667	1

VELOCITY	m/s	cs/s	ft/s	kph	mph	knots
m/s	1	100	3.28	3.6	2.237	1.944
cs/s	0.01	1	0.0328	0.036	0.02237	0.01944
ft/s	0.3048	30.48	1	1.09728	0.681818182	0.5924838
kph	0.277777778	27.77777778	0.911344415	1	0.621	0.54
mph	0.44704	44.704	1.466666667	1.609344	1	0.868976
knots	0.514444444	51.44444444	1.6878	1.852	1.150779	1



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REFERENCE—CONVERSION TABLES

CONVERSION TABLES

MASS	kg	g	lb	oz	ton	t	slug
kg	1	1000	2.205	35.274	0.001102	0.001	0.06852
g	0.001	1	0.002205	0.035274	0.000001102	0.000001	0.00006852
lb	0.45359237	453.59237	1	16	0.0005	0.000453592	0.03108095
oz	0.028349523	28.34952313	0.0625	1	0.00003125	2.83495E-05	0.001942559
ton	907.18474	907184.74	2000	32000	1	0.90718474	62.1619
t	1000	1000000	2205	35274	1.102	1	68.52
slug	14.5939	14593.9	32.174	514.785	0.016087	0.0145939	1

FORCE	N	dyne	gf	lbf
N	1	100000	101.97	0.2248
dyne	0.00001	1	0.0010197	0.00002248
gf	0.00980665	980.665	1	0.0022046
lbf	4.44822	444822	453.59237	1

ENERGY	J	erg	kcal	cal	BTU	ft-lbf
J	1	10000000	0.00023885	0.23885	0.0009478	0.737562
erg	0.0000001	1	2.3885E-11	2.3885E-08	9.478E-11	7.37562E-08
kcal	4186.8	41868000000	1	1000	3.96832	3088.0252
cal	4.1868	41868000	0.001	1	0.00396832	3.0880252
BTU	1055.0559	10550558526	0.25199576	251.99576	1	778.16296
ft-lbf	1.35582	13558179	0.000323832	0.323832	0.001285068	1

POWER	W	kW	hp	ft-lbf/s
W	1	0.001	0.001341	0.73756
kW	1000	1	1.341	737.56
hp	745.7	0.7457	1	550
ft-lbf/s	1.35582	0.00135582	0.001818182	1



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NORTH AMERICA



CONVERSION TABLES

PRESSURE- METRIC	Mpa	Pa	bar	torr	mmHg
MPa	1	1,000,000	10	7500.6	7500.6
Pa	1E-06	1	1E-05	0.0075	0.0075
atm	0.101325	101,325	1.01325	760	760
bar	0.1	100,000	1	750.06	750.06
psi	0.00689476	6894.76	0.0689476	51.715	51.715
torr	0.000133322	133.322	0.00133322	1	1
mmHg	0.000133322	133.322	0.00133322	1	1
inHg	0.003386388	3386.388	0.03386388	25.4	25.4
inH ₂ O	0.00024884	248.84	0.0024884	1.86645	1.86645

PRESSURE- AMERICAN	atm	psi	inhg	inH₂O
MPa	9.869	145.04	295.3	4018.65
Pa	9.869E-06	0.000145	0.0002953	0.00401865
atm	1	14.6959	29.921	407.189
bar	0.9869	14.504	29.53	401.865
psi	0.068046	1	2.036	27.7076
torr	0.00131579	0.019337	0.03937	0.535775
mmHg	0.00131579	0.019337	0.03937	0.535775
inHg	0.033421	0.491154	1	13.6087
inH ₂ O	0.00245586	0.03609119	0.0734824	1



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REFERENCE—ABBREVIATIONS

COMMON ABBREVIATIONS

ACM	polyacrylate rubber	IRHD	International Rubber Hardness degrees
ACN	acrylonitrile; component in nitrile rubber	IRM	Industry Reference Material—e.g. IRM 903 oil
AEM	ethylene-acrylic rubber; copolymer of ethylene and methyl acrylate; Vamac®	ISO	International Organization for Standardization
AMS	Aerospace Material Specification	JIC	Joint Industrial Conference on Hydraulic Standards for Industrial Equipment
ANSI	American National Standards Institute	JIS	Japanese Industrial Standard
AQL	Acceptable Quality Level	K	degrees Kelvin; absolute temperature scale
ARP	Aerospace Recommended Practice	Max.	maximum
AS	Aerospace Standard	Mil	Military (specification)
ASTM	American Society for Testing and Materials	Mil Std	Military Standard
atm	atmosphere—a unit of pressure	Min	minimum
AU	polyester-based polyurethane rubber	MPa	megaPascal; SI unit of pressure
BR	polybutadiene rubber	MQ	methyl silicone rubber
C or °C	degrees Celsius	MS	Military Standard
cc	cubic centimeter	NAS	National Aerospace Standard
CIIR	chlorobutyl rubber	NBR	nitrile butadiene rubber; Buna N; copolymer of acrylonitrile and butadiene
CO	homopolymer of epichlorohydrin	NBS	National Bureau of Standards
CR	polychloroprene rubber; Neoprene	NR	natural rubber; polyisoprene
CS	cross-section	NSF	National Sanitation Foundation
CSM	chlorosulfonated polyethylene rubber; Hypalon®	OD	outside diameter
Dia	diameter	OSHA	Occupational Safety and Health Administration
DIN	German standardization organization	PLI	pounds per linear inch
ECO	copolymer of epichlorohydrin and ethylene oxide	PMQ	phenyl methyl silicone rubber
EPA	Environmental Protection Agency	PSI	pounds per square inch
EPM, EPDM	ethylene-propylene rubber	PTFE	polytetrafluoroethylene
EU	polyether-based polyurethane rubber	PVMQ	phenyl vinyl methyl silicone rubber
F or °F	degrees Fahrenheit	QPL	qualified products list
FDA	Food and Drug Administration	RMA	Rubber Manufacturers Association
FEPM	tetrafluoroethylene-propylene rubber; Aflas®	rpm	revolutions per minute
FFKM	perfluoroelastomer	SAE	Society of Automotive Engineers
FKM	fluorocarbon elastomer	SBR	styrene butadiene rubber; copolymer of styrene and butadiene
FMQ	fluoromethyl silicone rubber; fluorosilicone	SG	specific gravity
FPM	feet per minute	SI	denotes The International System of Units or metric system
FSA	Fluid Sealing Association	Spec.	specification
FVMQ	fluoro vinyl methyl silicone rubber; fluorosilicone	TC	critical temperature
GRS	Government Rubber Styrene; now SBR	TFE	tetrafluoroethylene; a fluoroplastic
HNBR	hydrogenated nitrile rubber	TIR	Total Indicator Reading
HSN	highly saturated nitrile; alternative name for HNBR	UL	Underwriters Laboratories
ID	inside diameter	UV	ultraviolet light
IIR	butyl rubber; copolymer of isobutylene and isoprene	VMQ	vinyl methyl silicone rubber
in.	inch	W	width
IR	isoprene rubber	XNBR	carboxylated nitrile rubber



REFERENCE—TERMS AND DEFINITIONS

GLOSSARY

Abrasion the surface loss of a material due to frictional forces.

Absorption the penetration of matter in bulk into other matter, as in dissolving of a gas by a liquid.

Accelerator a compounding material used in small amounts with a vulcanizing agent to increase the speed of vulcanization.

Accelerator, delayed action an accelerator that, in conjunction with other curing agent(s), produces, at vulcanizing temperatures, a period of no significant cross-linking, followed by a period of rapid cross-link formation.

Accuracy a concept of exactness. When applied to a test method, it denotes the extent to which bias is absent; when applied to a measured value, it denotes the extent to which both bias and random error are absent.

Activator compounding material used in small proportions to increase the effectiveness of an accelerator.

Adhesion failure the loss of structural integrity due to the separation of two bonded surfaces at the bond interface.

Adsorption the surface retention of matter by other matter.

Agglomerates clusters of particles of compounding materials contained in a continuous rubber phase.

Aging (act of) exposure of materials to a deteriorating environment for a specified time interval.

Aging the irreversible change of material properties during exposure to a deteriorating environment for a specified time interval.

Aliphatic straight-chain hydrocarbons. Three sub-groups are alkanes, alkenes, and alkynes.

Alloy a unique composition of two or more polymers that has one or more of the polymers treated or processed in a special way to confer enhanced performance characteristics on the resulting material.

Amorphous materials with no definite arrangement of atoms.

Angstrom (Å) a unit of length, an angstrom is one ten-thousandth of a micron (10⁻⁴ μm) or 100,000,000 Å=1 cm.

Anticoagulant a substance added to field latex to retard bacterial action which would otherwise cause rapid coagulation of the latex.

Antidegradant a compounding material used to retard deterioration caused by oxidation, ozone, light and combinations of these.

Anti-extrusion ring a thin ring installed on the low-pressure side of a seal to prevent elastomer extrusion into the clearance gap.

Antiflex cracking agent a compounding material used to retard cracking caused by cyclic deformations.

Antioxidant compounding material used to retard deterioration caused by oxidation.

Antiozonant compounding material used to retard deterioration caused by ozone.

Antistatic agent a material which reduces the tendency for accumulation of electric charge on the surface of an article.

Aromatic oil a hydrocarbon process oil containing at least 35%, by mass, of aromatic hydrocarbons.

Ash the residue from incineration of a material under specified conditions.

Autoclave a vessel used for vulcanizing rubber compounds by means of steam pressure.

Backrinding a molding defect in which the rubber adjacent to the flash line shrinks below the surface of the molded product, with the flash line often being ragged and torn.

Bake-out secondary post-curing operation designed to remove residual volatile materials.

Batch the product of one mixing operation.

Blank a portion of a rubber compound of suitable volume to fill the cavity of a mold.

Bleeding the exuding of a liquid compounding material from the surface of a vulcanized or unvulcanized rubber.

Blister a cavity or sack that deforms the surface of a material.

Bloom a liquid or solid material that has migrated to the surface of a rubber and generally changes the surface appearance.

Bound monomer a monomer that is combined or reacted with itself or other types of monomers in a polymerization reaction to form a polymer.

Breakaway friction the force required to overcome friction to start a body in motion over a surface.

Brittle point the temperature at which elastomers break when subjected to an impact.

Bulk modulus of elasticity also known as compression modulus, the ratio of compressive force applied to a surface per unit surface area to the change in volume of the substance per unit volume.

Bumping, molding process the application, release, and reapplication of pressure prior to the start of vulcanization to vent entrapped gases, thereby facilitating complete filling of the mold.

REFERENCE—TERMS AND DEFINITIONS

GLOSSARY

Butt joint a connection made with two ends cut at right angles.

Calender a machine with two or more parallel, counter-rotating rolls with a controllable, roll-to-roll spacing, rotating at selected surface speeds and controlled temperatures, used for sheeting, laminating, skim coating (topping) and friction coating, to a controlled thickness and/or surface condition.

Chalking the formation of a powdery residue on the surface of a rubber, commonly resulting from surface degradation.

Chemisorption a chemical adsorption process in which weak chemical bonds are formed between gas or liquid molecules and a solid surface.

Coagent a compounding ingredient used in small amounts to increase the cross-linking efficiency of certain no-sulfur vulcanizing systems or to modify the properties given by such systems.

Coefficient of friction the force in the direction of motion required to move one surface with respect to another, divided by the force normal to the two surfaces.

Coefficient of thermal expansion the increment in volume of a unit volume of material for a rise of one degree temperature at constant pressure.

Cohesive failure a rupture occurring entirely within any single uniform layer of the assembly.

Cold flow slow deformation, under gravitational force, at or below room temperature.

Comonomer one of the two or more monomer species that polymerize to form a copolymer.

Composite seal a seal composed of two or more dissimilar materials.

Compound an intimate admixture of a polymer(s) with all the materials necessary for the finished article.

Compression the amount of deformation on a seal, often calculated by dividing the deformation by the original seal cross-sectional diameter.

Compression molding molding process in which the material is placed directly in the mold cavity and compressed to shape by closure of the mold.

Compression set the residual deformation of a material after removal of the compressive stress.

Conditioning (environmental) the storage of a rubber, under specified conditions (time, temperature, humidity) prior to testing.

Conditioning (mechanical) the prescribed program of deformation of a specimen prior to testing.

Conductive rubber an elastomer having high conductivity.

Copolymer a polymer formed from two different monomers.

Covalent bonding chemical bonding whereby each atom of a bound pair contributes one electron to form a pair of electrons.

Crack(s), atmospheric fissure(s) originating in the surface of a rubber vulcanizate or product as a result of natural weathering.

Crack(s), ozone fissure(s) originating in the surface of a rubber vulcanizate, caused by exposure to an ozone-containing environment; the fissure(s) are perpendicular to the direction of strain.

Crack(s), flex fissure(s) originating in the surface of a rubber vulcanizate, resulting from cyclic deformation (usually bending).

Creep the time-dependent part of a strain resulting from stress.

Cross-link chemical bond bridging one polymer chain to another.

Cross-linking agent compounding material that produces cross-linking in rubber.

Crystallization, polymer arrangement of previously disordered polymer segments of repeating patterns into geometric symmetry.

Cure see **vulcanization**, the preferred term.

Density the mass-per-unit volume of a material.

Desiccant compounding material used to irreversibly absorb moisture present (in a rubber mix) particularly for the purpose of minimizing risk of porosity during vulcanization.

Die swell difference between the dimensions of the cross-section of an extrudate and the corresponding dimensions of the die orifice by which the extrudate is formed.

Diene polymer a polymer formed from one or more monomer species, at least one of which is a diolefin.

Diffusion the spontaneous mixing of one substance with another when in contact with, or separated by, a permeable membrane or microporous barrier.

Dispersing agent (latex) a surface-active substance used to facilitate the suspension of solid compounding materials in a liquid medium and to stabilize the dispersion thereby produced.



GLOSSARY

Dispersion (the act of) application of shearing forces to distribute one or more compounding materials uniformly throughout the mass of a continuum material.

Dumbbell specimen a flat specimen having a narrow, straight central portion of essentially uniform cross section.

Durometer an instrument for measuring the indentation hardness of rubber.

Dynamic seal a seal designed to prevent leakage between surfaces which move relative to each other.

Elastic limit the greatest stress that a material is capable of sustaining without any permanent strain remaining upon complete release of the stress.

Elastomer a viscoelastic macromolecular material that can respond to large deformations.

Elongation the extension of a uniform section of a specimen expressed as percentage of the original length.

Elongation, ultimate the elongation at the time of rupture.

Emulsifying agent (latex) a surface-active substance used to facilitate the dispersion of an immiscible liquid compounding material in another liquid and to stabilize the emulsion thereby produced.

Esters a compound formed by the elimination of water and the bonding of an alcohol and an organic acid. Characterized by “-C=C-O-” bonding.

Ethers a compound characterized by “-O-” bonding.

Extender an organic material used to augment the polymer in a compound.

Extensometer a device for determining elongation of a specimen as it is strained.

Extrudate the material that issues from an extruder.

Extruder machine designed to force a rubber or rubber mix through an orifice, which is often shaped to the geometry of the desired product.

Extrusion 1) the continuous shaping of a material during plastic passage through a die. 2) the displacement of a part of the seal into the clearance gap under action of fluid pressure or thermal expansion.

Face seal, flange seal an axial contact seal.

Fatigue life (dynamic) the number of deformations required to produce a specified state of fatigue breakdown in a test piece or product that is deformed under a prescribed set of conditions.

Filler a solid compounding material, usually in finely divided form, which may be added in relatively large proportions to a polymer for technical or economic reasons.

Fissure a surface split or crack.

Flash the excess material protruding from the surface of a molded article at the mold junctions.

Flex life the number of cycles required to produce a specified state of failure in a specimen that is flexed in a prescribed method.

Flow marks marks or lines on a molded product, caused by imperfect fusion or “knitting” of material.

Fluorocarbon elastomer also known as fluoroelastomer.

Fluorosilicone a fluorinated silicone elastomer.

Foam stabilizer (latex) a substance used in the preparation of latex foam to help stabilize the foam latex before gelation, drying and vulcanization.

Formula a list of the materials and their amounts used in the preparation of a compound.

Frequency the number of periodic oscillations, vibrations or waves per unit of time.

Furnace carbon black type of carbon black produced by the decomposition reaction of hydrocarbons when injected into a high-velocity stream of combustion gases under controlled conditions.

Gasket a deformable material clamped between essentially stationary faces to prevent the passage of matter through an opening or joint.

Gel, dry rubber the portion of unvulcanized rubber insoluble in a chosen solvent.

Gland a cavity into which a seal is installed.

Grain anisotropy introduced into rubber during processing operations.

Gum compound a rubber compound containing only those ingredients necessary for vulcanization and small amounts of other ingredients for processing, coloring and improving the resistance to aging.

Hardness a material's ability to resist a distorting force (indenter point).

Heat buildup the accumulation of thermal energy generated within a material as a result of hysteresis, evidenced by an increase in temperature.

Hertz (Hz) an international unit for frequency—the number of cycles per second.

Homogeneous having uniform composition or structure.

Homogenization repeated passage of raw rubber through a mill or other mixing device, under specified conditions, to ensure uniformity.

REFERENCE—TERMS AND DEFINITIONS

GLOSSARY

Homopolymer a polymer formed from a single monomer species.

Hydrogen bonding unusually strong dipole-dipole attractions that occur among molecules in which hydrogen is bonded to a highly electronegative atom.

Hydrophilic affinity toward water (water-loving); a hydrophilic surface is one that will allow water to spread across it in large puddles.

Hydrophobic aversion to water; a hydrophobic surface will not allow large puddles of water, but rather will form droplets. These surfaces are often termed “de-wetted.”

Hydroscopic attracts and absorbs water.

Hysteresis the lagging of strain behind stress during deformation.

Impact resistance resistance to fracture under shock force.

Inhibitor a material used to suppress a chemical reaction.

Ion an atom that has either gained or lost electrons, making it a charged particle.

Ionic bonding the electrostatic attraction between oppositely charged ions—characterized by electron transfer.

Isotactic a polymeric molecular structure containing a sequence of regularly spaced asymmetric atoms arranged in like configuration in the polymer chain.

Ketone an organic compound containing the carbonyl group “C=O.”

Kinetic friction the minimum force required to maintain a body in motion over a surface.

Latex colloidal aqueous dispersion of rubber.

Lip seal a custom seal, static or dynamic, that seals on a flexible extension.

Lot a mass of material or collection of articles of similar composition and characteristics.

Masterbatch a homogeneous mixture of rubber and one or more materials in known proportions for use as a raw material in the preparation of the final compounds.

Mastication a breakdown or softening of raw rubber, or a mix, by the combined action of mechanical work (shear) and atmospheric oxygen, sometimes accelerated by the use of a peptizer and frequently at elevated temperatures.

Microhardness hardness measured with an instrument having a smaller indenter and applying a lower force than the standard instrument, permitting measurements on smaller specimens or thinner sheets that are not amenable to measurement by normal instruments.

Micron (μm) a unit of length, one millionth of a meter.

Mill a machine used for rubber mastication, mixing or sheeting, having two counter-rotating rolls with adjustable longitudinal axis separation that usually rotate at different speeds.

Mismatch a defect resulting from differing cross-section dimensions in adjacent mold halves.

Mixer a machine that incorporates and disperses compounding ingredients into rubber to form a mix or a compound through the action of mechanical work (shear).

Mixer, internal a machine with a closed cavity in which a specially shaped rotor (or rotors) masticates the rubber or incorporates and disperses compounding materials into the rubber, or both.

Modulus, tensile See tensile stress, at given elongation the preferred term.

Modulus, Young's the ratio of normal stress to corresponding strain for tensile or compressive stresses below the proportional limit of the material.

Mold cavity hollow space in the mold designed to impart the desired form to the product being made.

Mold marks surface imperfection transferred to a molded product from corresponding marks on a mold.

Mold release see **release agent** (mold).

Molding shrinkage the difference in dimensions between a molded product and the mold cavity in which it was molded, both the mold and product being at normal room temperature when measured.

Molding, compression the process of forming a material to a desired shape by flow induced by a force applied after a material is placed in the mold cavity.

Molding, injection the process of forming a material by forcing it from an external heated chamber through a sprue (runner, gate) into the cavity of a closed mold by means of a pressure gradient that is independent of the mold-clamping force.

Molding, transfer the process of forming a material by forcing it from an auxiliary heated chamber through a sprue (runner, gate) into the cavity of a closed mold by means of a pressure gradient that is dependent on the mold-clamping force.

Molecule smallest quantity of a substance that retains the properties of that substance.

Monomer a low-molecular-weight substance consisting of molecules capable of reacting with like or unlike molecules to form a polymer.

Mooney viscosity the measurement of the plasticity of compounded or uncompounded elastomeric seal material.

GLOSSARY

Necking the localized reduction in cross section that may occur in a material under tensile stress.

Network a three-dimensional structure formed by interchain or intrachain bonding of polymer molecules in combination with chain entanglements.

Nip the radial clearance between rolls of a mill or calender on a line of centers.

Nitrile (Buna-N) a common hydrocarbon elastomer.

Non-fill defect resulting from the failure of the rubber to fill out all the mold pattern detail.

Non-polar pertaining to an element or compound which has no permanent dipole moment.

Occlusion process by which materials are entrapped within the folds of a given substance during manufacture.

Off-register misalignment of mold halves causing out-of-round O-ring cross section.

Olefins a family of hydrocarbons with one carbon-carbon double bond.

Oligomer a polymer consisting of only a few monomer units, such as a dimer, trimer, tetramer, etc., or their mixtures.

O-ring see *seal, O-ring*.

Outgassing the release of adsorbed or occluded gases or water vapor, usually by heating.

Oxidation a chemical reaction in which a compound loses electrons.

Paraffins saturated straight-chain hydrocarbons of the methane series.

Perfluoroelastomer a fully fluorinated fluoroelastomer.

Permanent set the permanent distortion of an elastomer after being strained.

Permeability the permeation rate divided by the pressure gradient of the gas or vapor. For a homogeneous material that obeys Fick's law, the permeability is equal to the product of the diffusion coefficient and the solubility coefficient of the gas or vapor.

Permeance the permeation rate divided by the pressure differential of a gas or vapor between opposite faces of a solid body.

Permeation rate the flow rate of a gas or vapor, under specified conditions, through a prescribed area of a solid body, divided by that area.

Physiosorption a physical adsorption process in which there are van der Waals forces of interaction between gas or liquid molecules and a solid surface.

Pigment an insoluble compounding material used to impart color.

Plasticizer a compounding material used to enhance the deformability of a polymeric compound.

Polar describing a molecule or radical that has, or is capable of developing, electrical charges. Polar molecules ionize in solution and impart conductivity.

Polymer a substance consisting of macromolecules characterized by the repetition (neglecting ends, branch junctions and other minor irregularities) of one or more types of monomeric units.

Polymer network a three-dimensional reticulate structure formed by chemical or physical linking of polymer chains.

Porosity the presence of numerous small cavities.

Post-cure heat or radiation treatment, or both, to which a cured or partially cured thermosetting plastic or rubber composition is subjected to enhance the level of one or more properties.

Pot life the period of time during which a reacting thermosetting plastic or rubber composition remains suitable for its intended use after mixing with a reaction-initiating agent.

Precision a concept of uniformity based on the magnitude of the random errors. The smaller the random errors, the higher the precision.

Primary accelerator the principal, highest concentration accelerator used in a vulcanizing system.

Processability the relative ease with which raw or compounded rubber can be handled in rubber machinery.

Processing aid a compounding material that improves the processability of a polymeric compound.

Radial clearance the difference in the radial dimensions between the sealing surfaces of a radial seal.

Recipe a formula, mixing procedure and any other instructions needed for the preparation of a product.

Recovery the degree to which a rubber product returns to its normal dimensions after being distorted.

Reinforcement the act of increasing the mechanical performance capability of a rubber by the incorporation of materials that do not participate significantly in the vulcanization process.

Release agent (mold) a substance applied to the inside surfaces of a mold or added to a material to be molded, to facilitate removal of the product from the mold.

Resilience the ratio of energy output to energy input in a rapid (or instantaneous) full recovery of a deformed specimen.

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GLOSSARY

Resilience, impact the ratio of output to input mechanical energy in a rapid deformation and recovery cycle of a rubber specimen.

Retarder a material used to reduce the tendency of a rubber compound to vulcanize prematurely.

Reversion (vulcanization) deterioration of vulcanizate properties that may occur when vulcanization time is extended beyond the optimum.

Rubber a material that is capable of recovering from large deformations quickly and forcibly, and can be, or already is, modified to a state in which it is essentially insoluble (but can swell) in a boiling solvent such as benzene, methyl ethyl ketone or ethanol toluene azeotrope.

Rubber hardness degree, international (IRHD) a measure of hardness, the magnitude of which is derived from the depth of penetration of a specified indenter into a specimen under specified conditions. The scale is so chosen that zero would represent a material showing no measurable resistance to indentation, and 100 would represent a material showing no measurable indentation.

Runner the secondary feed channel for transferring material under pressure from the inner end of the sprue to the cavity gate.

Scarf joint a connection made with two ends cut at an angle and overlapping.

Scorch premature vulcanization of a rubber compound.

Scorch, Mooney the time to incipient cure of a compound when tested in the Mooney shearing disk viscometer under specific conditions.

Seal any material or device that prevents or controls the passage of matter across the separable members of a mechanical assembly.

Seal, O-ring a product of precise dimensions molded in one piece to the configuration of a torus with circular cross-section, suitable for use in a machined groove for static or dynamic service.

Secondary accelerator accelerator used in smaller concentrations, compared to the primary accelerator, to achieve a faster rate of vulcanization.

Set strain remaining after complete release of the force producing the deformation.

Shelf life see *storage life, shelf*.

Shock load the sudden application of an external force.

Shrinkage 1) decrease in volume of a seal in service due to extraction of fillers. 2) decrease in volume of an elastomeric compound during molding.

Silicone rubber poly dimethyl siloxane elastomer.

Solubility the ability or tendency of one substance to blend uniformly with another.

Sorption the term used to denote the combination of absorption and adsorption processes in the same substance.

Specific gravity the ratio of the weight of a given substance to the weight of an equal volume of water at a specified temperature.

Spew line line on the surface of a molded product at the junction of the mold parts.

Squeeze the compression of a seal, usually expressed as a percentage calculated by dividing the deformation by the original seal cross-sectional diameter.

Static seal a seal in which the sealing surfaces do not move relative to each other.

Stiction the increase in static friction resulting from prolonged seal compression.

Stiffness, bending the force required to produce a bent configuration under specified conditions.

Stock see *compound*.

Storage life, shelf the period of time after production during which a material or product that is stored under specified conditions retains its intended performance capabilities.

Strain the unit change, due to force, in the size or shape of a body referred to its original size or shape.

Stress the intensity, at a point in a body, of the internal forces (or components of force) that act on a given plane through the point.

Stress relaxation the decrease in stress after a given time at constant strain.

Swelling the increase in volume of a specimen immersed in a liquid or exposed to a vapor.

Tear mechanical rupture initiated and propagated at a site of high stress concentration caused by a cut, defect or localized deformation.

Tear strength the maximum force required to tear a specified specimen, the force acting substantially parallel to the major axis of the test specimen.

Tensile set the extension remaining after a specimen has been stretched and allowed to retract in a specified manner expressed as a percentage of the original length.

Tensile strength the maximum tensile stress applied during stretching a specimen to rupture.

Tensile stress a stress applied to stretch a test piece (specimen).

GLOSSARY

Tension fatigue fracture, through crack growth, of a component or test specimen subjected to a repeated tensile deformation.

Tension set the strain remaining after a test piece or product has been stretched and allowed to retract.

Terpolymer a polymer formed from three monomer species.

Thermal carbon black type of carbon black produced under controlled conditions by the thermal decomposition of hydrocarbon gases in the absence of air or flames.

Thermal degradation irreversible and undesirable change in the properties of a material due to exposure to heat.

Thermoplastic elastomer (TPE) a diverse family of rubber-like materials that, unlike conventional vulcanized rubbers, can be processed and recycled like thermoplastic materials.

Torr pressure unit; international standard unit replacing the English measure, millimeters of mercury (mm-Hg).

TR-10 a test method for approximating the low-temperature capabilities of an elastomer.

Transition, first order a reversible change in phase of a material; in the case of polymers, usually crystallization or melting.

Transition, glass (T_g) the reversible physical change in a material from a viscous or rubbery state to a brittle, glassy state.

Ultraviolet (UV) electromagnetic radiation in the wavelength 4– 400 nanometers.

UV stabilizer a compounding material that, through its ability to absorb ultraviolet radiation and render it harmless, retards the deterioration caused by sunlight and other UV light sources.

Van der Waals force an attractive force between two atoms due to a fluctuating dipole moment in one molecule inducing a dipole moment in the other molecule which then interact.

Vapor pressure the pressure of the vapor in equilibrium with its liquid or solid phase.

Viscoelasticity a combination of viscous and elastic properties in a material with the relative contribution of each being dependent on time, temperature, stress and strain rate.

Viscosity the resistance of a material to flow under stress.

Viscosity, Mooney a measure of the viscosity of a rubber or rubber compound determined in a Mooney shearing disk viscometer.

Void, cellular material a cavity unintentionally formed in a cellular material and substantially larger than the characteristic individual cells.

Volatilization also known as vaporization, the conversion of a chemical substance from a liquid or solid state to a gaseous or vapor state.

Volt a unit of electromotive force or difference in electric potential.

Volume swell the increase in dimension caused by the absorption of a fluid.

Vulcanizate the product of vulcanization, a cross-linked rubber.

Vulcanization an irreversible process during which a rubber compound, through a change in its chemical structure (for example, cross-linking), becomes less plastic and more resistant to swelling by organic liquids, while elastic properties are conferred, improved, or extended over a greater range of temperature.

Vulcanizing agent compounding material that produces cross-linking in rubber.

Vulcanizing system the combination of a vulcanizing agent and, as required, accelerators, activators and retarders used to produce the desired vulcanization characteristics or vulcanizate characteristics.

Warm-up the reduction in viscosity of a rubber or rubber mix, by mechanical work and heat, to render it suitable for further processing.

Wicking transmission of a gas or liquid, due to a pressure differential or capillary action, along fibers incorporated in a rubber product.

Wiper ring a device designed to keep out foreign material.

Yield point that point on the stress-strain curve, short of ultimate failure, where the rate of stress with respect to strain goes through a zero value and may become negative.

Yield strain the level of strain at the yield point.

Yield stress the level of stress at the yield point.

NOTE: Many definitions are from ASTM D1566. Additional terminology relating to rubber can be found there.

THE O-RING HANDBOOK QUICK INDEX

USING THE QUICK INDEX

To quickly access certain reference sections in the Dichtomatik O-Ring Handbook, locate the section title below, fan the pages of the handbook and turn to the section with edge markings that line up with the section title.

The AS568 Sizes, Master Size List and Chemical Compatibility Guide sections are indicated in red so that they can be found even more easily.

■ O-Ring Gland Design

■ AS568 Sizes

■ ISO 3601 Sizes

■ DIN 3771 Sizes

■ BS 4518 Sizes

■ BS 1806 Sizes

■ JIS B 2401 Sizes

■ NF T47-501 Sizes

■ Master Size List

■ Sealing Elastomers

■ Chemical Compatibility Guide

■ Surface Quality Standards

■ O-Ring Troubleshooting

■ Unit Conversions







DICHTOMATIK
NORTH AMERICA

Dichtomatik North America
47690 East Anchor Court, Plymouth, MI 48170
TEL (734) 354-5555 FAX (734) 254-0934

Transcom-Dichtomatik
3451 West Burnsville Parkway, Burnsville, MN 55337
TEL (952) 894-8400 FAX (952) 894-1588
1-800-328-2840

Dichtomatik Nevada
1111 Mary Crest Road Suite A, Henderson, NV 89074
TEL (702) 312-2828 FAX (702) 312-2841

Dichtomatik Virginia
37307 East Richardson Lane, Purcellville, VA 20132
TEL (540) 338-1862 FAX (540) 338-1867

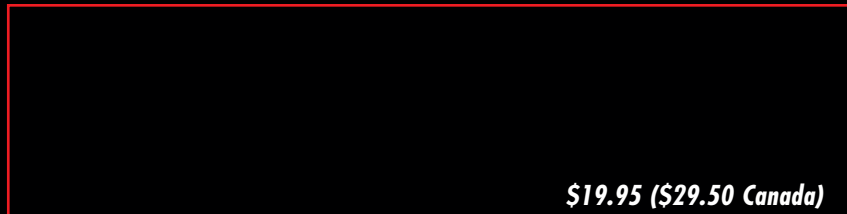
Nu-Seals-Dichtomatik
34 Zaca Lane, San Luis Obispo, CA 93401
TEL (805) 546-9600 FAX (805) 546-0234

Dichtomatik Canada
950 Denison Street #21, Markham, Ontario, Canada L3R3K5
TEL (905) 470-2266 FAX (905) 470-2055

Dichtomatik de Mexico
Privada de los Misterios No. 161, Querétaro, Qro. 7620, México
TEL (442) 2-23-82-37 FAX (442) 2-13-52-24

www.dichtomatik.us

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