Physical Properties

Shown above (l to r): part-to-part quality repeatability; inspecting face condition on a mechanical seal primary ring; precision lapping of thrust washers; and, dimensional inspection and serialization with a DCC/CMM.

Physical Characteristics – Test Methods

On pages 7 to 9 of this brochure is a list of typical physical characteristics of the most popular Metcar grades. The following are definitions of terms and descriptions of methods used to obtain the physical characteristics of Metcar.

Physical characteristics of carbon/graphite materials are sensitive to part size, shape and grain direction. To obtain the data presented here, specimens were tested with the length dimension oriented parallel to the grain direction.

Apparent Density (ANSI/ASTM C 559) is the mass per unit volume including permeable and impermeable voids and pores. Values are calculated in grams per cubic centimeter at 25°C.

Hardness (ANSI/NEMA CB1) is a material's resistance to permanent deformation, particularly indentation or scratching. Shore Scleroscope hardness is determined by dropping a diamond pointed weight on a specimen from a standard height. The rebound up a graduated scale indicates hardness. Six readings taken on opposite sides of the specimen are averaged to obtain an accurate value.

Compressive Strength (ANSI/ASTM C 695) is a material's ability to withstand a uniaxial crushing load. Values are obtained from the ultimate crushing force per unit of cross section. Ultimate strength and yield strength are identical.

Transverse Strength (ANSI/NEMA CB1) is a material's ability to withstand a transverse or flexural load. Values are obtained by loading to failure a rectangular beam suspended on two knife edges.

Tensile Strength (ASTM C 749) is a material's ability to resist being pulled apart. Values are obtained from the uniaxial force at rupture per unit of cross section.

Modulus of Elasticity (ASTM C 747) is a constant which expresses the ratio of stress per unit area to corresponding strain per unit length, the distortion or strain being within the elastic limit. Specimens are vibrated in the transverse mode, and values are calculated from the resonance frequency.

Temperature Limit is the highest temperature that a material can tolerate without significant thermal decomposition or loss in strength; this varies with the amount of oxygen present. Metcar demonstrates an unusual ability to increase in strength with increase in temperature.

Coefficient of Thermal Expansion (ASTM E 228) is the change in unit length per change in degree of temperature. Linear expansion is measured using a vitreous silica dilatometer which indicates dimensional changes of a specimen when subjected to heat. Metcar's CTE increases as temperature increases; values listed represent an average from 50°C to the respective temperature limit.

Thermal Conductivity is a material's ability to transmit heat. Values are obtained from the cooling characteristics of a heated probe brought into contact with a specimen.

Pressure Tight (a function of permeability) is a specification indicating the suitability of a given grade for use in seal ring applications. The internal cavity of a standard ring is pressurized with air. Its outside diameter is coated with a leak detecting fluid. An absence of bubbles (after 2 minutes at 100psi) defines acceptability.

Metcar Average Physical Characteristics

Of Interest	Metcar Grade #	Apparent Density (gm/cc)	Hardness-Shore Scleroscope C2	Strength: Compressive (psi)	Strength: Transverse (psi)	Strength: Tensile (psi)	Elasticity: Modulus of (psi x 10^6)	Temp. Limit: Neutral Atmosphere (°F)	Temp. Limit: Oxidizing Atmosphere (°F)	Coefficiant of Thermal Expansion (in/in/°F x 10^{-5})	Thermal Conductivity (Btu/hr/ft2/°F/ft)	Pressure Tight	Modable to Size	Corrosion Resistance Classification	Composition
❑	M-10	1.70	85	30000	9000	6000	2.5	1700	700	2.1	6	No	Yes	C1	CG
❑	M-11	1.75	65	20000	7500	4500	2.3	1700	700	2.0	8	No	Yes	C1	CG
❑	M-19	1.80	75	20000	8000	5500	1.6	6000	900	1.9	40	No	No	C1	G
❑	M-45	2.10	85	30000	12000	9000	2.7	1500	900	2.4	45	Yes	No	C4	GF
❑	M-100	1.85	80	27000	9000	6000	3.1	500	500	2.9	8	No	Yes	C2	CGR
❑	M-105	1.85	85	22000	8500	6000	2	500	500	1.9	40	Yes	No	C2	GR
❑	M-106	1.85	95	41000	12500	8500	3.3	500	500	3.2	6	Yes	Yes	C2	CGR
❑	M-110	1.85	90	28000	9000	6500	2.2	500	500	2.6	40	Yes	No	C3	GR
❑	M-130	1.85	95	42000	12000	9000	3.0	500	500	2.6	6	Yes	No	C3	CGR
❑	M-133	1.85	95	42000	12000	9000	3.6	500	500	2.8	6	Yes	No	C3	CGR
❑	M-161	2.55	50	20000	7000	5500	2.9	400	400	1.9	15	No	No	C5	CGB
❑	M-162	2.40	65	26000	10000	7500	3.7	400	400	3.0	9	No	Yes	C5	CGB
❑	M-199	2.35	75	35000	13000	8000	3.8	1700	700	2.9	10	No	No	C6	CGCU
❑	M-201	2.50	55	24000	8500	6500	2.8	1700	700	1.8	20	No	No	C6	CGCU
❑	M-234	2.50	95	45000	14000	10500	4.1	1500	700	3.1	9	No	No	C7	CGAG
❑	M-271	2.45	90	50000	15000	9500	4.2	1700	700	3.8	8	No	No	C8	CGBR
❑	M-272	2.55	55	25000	8500	6500	3.1	1700	700	2.1	19	No	No	C8	CGBR
❑	M-310	2.40	55	23000	7500	5500	2.8	1700	700	1.4	18	No	No	C9	CGNICR
❑	M-312	2.40	95	55000	16000	10000	4.4	1700	700	2.5	8	No	No	C9	CGNICR
❑	M-400	1.85	85	30000	9500	6500	3.2	500	500	2.9	8	Yes	No	C2	CGR
❑	M-444	2.30	90	40000	12000	9000	4.2	1100	700	2.3	8	Yes	Yes	C10	CGSB
❑	M-444B	2.30	90	40000	12000	9000	3.8	1100	700	2.3	8	No	No	C10	CGSB
❑	M-595	1.85	70	20000	10000	7500	2.2	1500	1000	2.4	40	No	No	C9	GH
❑	M-712	1.85	95	42000	12000	9000	3.6	500	500	2.8	6	Yes	No	C3	CGR

Composition Key

CG = Carbon Graphite
G = Graphite
R = Resin Impregnation
F = Proprietary Impregnation
B = Babbitt Impregnation
BR = Bronze Impregnation
Cu= Copper Impregnation
Sb= Antimony Impregnation
Ag = Silver Impregnation
N = Nickel Impregnation
H = Oxidation Inhibitor Impregnation

Chemical Properties

Corrosion Resistance Classifications

Resistant ●
Not Resistant ○
Conditionally Resistant* ◐

**Conditionally Resistant rating indicates that factors such as temperature, concentration, and exposure time prohibit unconditionable approval of certain grades in a particular chemical group. Consult Metcar engineering.*

Metcar Corrosion Resistance by Chemical Category

Refer to the Physical Properties Table for the Corrosion Resistance Classification of each Metcar Grade.

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Inorganic										
Neutral Salts	●	●	●	○	●	●	●	●	●	●
Acid Forming Salts	◐	◐	◐	○	◐	◐	◐	◐	◐	◐
Alkali Forming Salts	●	●	●	○	◐	◐	◐	◐	◐	◐
Non-Oxodizing Mineral Acids	◐	◐	◐	○	◐	◐	◐	◐	◐	◐
Oxidizing Mineral Acids	◐	◐	●	◐	◐	◐	◐	◐	◐	◐
Non-Oxodizing Mineral Alkalis	◐	◐	◐	○	◐	◐	◐	◐	◐	◐
Oxidizing Mineral Alkalis	◐	●	●	○	◐	◐	◐	◐	◐	◐

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Organic										
Neutral (Solvents,Oils,etc.)	●	●	●	◐	●	●	●	●	●	●
Acid Forming Salts	●	●	●	○	◐	◐	◐	◐	◐	◐
Weak Acids	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Strong Acids	●	◐	●	○	◐	◐	◐	◐	◐	◐
Weak Alkalis	●	●	●	○	●	◐	●	◐	●	●
Strong Alkalis	●	●	●	○	◐	◐	◐	◐	◐	◐

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Melts										
Neutral Salts	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Acid Salts	●	◐	●	◐	◐	◐	◐	◐	◐	◐
Alkaline Salts	●	◐	●	○	○	◐	◐	◐	◐	◐
Oxidizing Salts	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Metals (Listed)	◐	◐	◐	◐	○	◐	◐	◐	◐	◐

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Gases										
Inert	●	●	●	●	●	●	●	●	●	●
Acid	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Alkaline	●	●	●	○	◐	◐	◐	◐	◐	◐
Oxidizing	◐	◐	◐	◐	◐	◐	◐	◐	◐	◐
Reducing	●	●	●	●	●	●	●	●	●	●