TABLE OF EMISSIVITY OF VARIOUS SURFACES

Introduction:

Emissivity is a modifying factor used in single color thermometry to achieve a correct temperature reading. Emissivity, or radiating efficiency, of most materials is function of surface condition, temperature and wavelength of measurement.

In the following table, values for the total emissivity of various surfaces, as well as spectral emissivity at a given temperature, have been tabulated. Total emissivity is defined as the resultant value when the individual emissivity factors are averaged over the total radiation spectrum being utilized.

The user may find that for the application a different emissivity setting is required than the one tabulated. This table, however, will provide the best initial setting. A more refined value should be determined experimentally.

References:

1) Handbook of Chemistry and Physics, Chemical Rubber Publishing Co., Cleveland, Ohio

2) DMIC Report 177, Battelle Memorial Institute

3) Thermal Radiation Properties Survey, Honeywell Research Center

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TOTAL EMISSIVITY OF VARIOUS SURFACES

MATERIAL	TEMPERATURE °C	*EMISSIVITY
Alloys		
20Ni-25Cr-55Fe, oxidized	200	0.90
	500	0.97
60Ni-12Cr-28Fe, oxidized	270	0.89
	560	0.82
80Ni-20Cr, oxidized	100	0.87
	600	0.87
	1300	0.89
Aluminum		
Polished	100	0.095
Highly Polished	50-500	0.04-0.06
Unoxidized	25	0.022
	100	0.028
	500	0.060
Oxidized	200	0.11
	600	0.19
Commercial Sheet	100	0.090
Anodized Sheet, Chromic Acid Proc	100	0.55
Heavily Oxidized	93-504	0.2-0.31
Aluminum Oxide	500-827	0.42-0.26
Asbestos		
Board	20	0.96
Cement	0-200	0.96
Cloth	93	0.90
Paper	0-100	0.95
Asphalt	Ambient	0.90-0.98
Oil, on polished metal		
.001” Thick	Ambient	0.27
.002” Thick	Ambient	0.46
.005” Thick	Ambient	0.72
Bismuth, Unoxidized	25	0.048
	100	0.061
Brass		
Polished	200	0.03
Unoxidized	25	0.035
	100	0.035
Oxidized	200	0.61
	600	0.59
Rolled Sheet	20	0.06
Brick		
Building	1000	0.450
Red, rough, no gross irregularities	20	0.930
Grog, Brick, glazed	1100	0.750
Silica Brick	1000	0.80
	1100	0.85
Fire Brick	1000	0.750

*When range of values for temperature and emissivity are given, end points correspond and linear interpolation of emissivity is acceptable.

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Bronze, Polished	50	0.10
Carbon		
Filament	1000-1400	0.53
Graphite	0-3600	0.70-0.80
Lamp, Black, water glass coating	20-400	0.96
Soot applied to solid	50-1000	0.96
Soot with water glass	20-200	0.96
Candle Soot	97-271	0.952
Graphite, pressed, filed surface	250-510	0.980
Unoxidized	25	0.81
	100	0.81
	500	0.81
Carborundum 87SiC; 2.3 density	1010-1400	0.920-0.820
Ceramic		
Earthenware	20	0.90
Porcelain, Glazed	20	0.92
Refractory Black	93	0.94
Refractory White	93	0.90
Chromium		
Polished	50	0.10
	500-1000	0.28-0.38
Unoxidized	100	0.08
Oxidized	316	0.08
	482	0.18
	650	0.27
	816	0.36
	982	0.66
Cobalt, Unoxidized	500	0.13
	1000	0.23
Columbium		
Polished	1500	0.19
	2000	0.24
Oxidized	816	0.73
	927	0.70
Concrete	0-100	0.94
Concrete Tiles	1000	0.630
Copper		
Commercial, Scoured to a shine	20	0.07
Calorized	100	0.26
Calorized, oxidized	200	0.18
	600	0.19

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Plate, heated long time, covered with thick oxide layer	25	0.78
Plate, heated at 600°C	200-600	0.570
Cuprous Oxide	800-1100	0.66-0.54
Polished	50-100	0.02-.05
Oxidized	50	0.6-0.7
	200	0.60
	500	0.88
Unoxidized	100	0.02
	Liquid	0.15
Dow Metal	232-400	0.24-0.20
Enamel, White, fused on Iron	19	0.900
Glass		
Smooth	0-200	0.95
	250-1000	0.87-0.72
	1100-1500	0.70-0.67
Fused Quartz	320	0.75
Covex D Glass	320	0.76
Nonex Glass	320	0.82
Pyrex	0-300	0.90
Gold		
Pure, highly polished	100	0.02
Carefully Polished	200-600	0.02-0.03
Unoxidized	100	0.02
	500	0.03
Enamel	100	0.37
Graphite	0-3600	0.70-0.80
Gypsum 0.02” thick on smooth or blackened plate	20	0.93
Human Skin	36-7-37.2	0.985
Inconel		
Type X		0.550-0.780
Type B	450-1620	0.350-0.550
Iron		
Cast		
Oxidized	200-600	0.64-0.78
Strongly Oxidized	40	0.95
	250	0.95
Unoxidized	100	0.21
Polished	200	0.210
Newly Turned	22	0.440
Turned and Heated	882-990	0.600-0.700

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Liquid Unoxidized	--	0.29
Rusted	25	0.65
Wrought, Dull	100	0.50
Wrought Iron, dull oxidized	21-360	0.940
Wrought, highly polished	38-250	0.280
Oxidized	100	0.74
	500	0.84
Unoxidized	1200	0.89
Plate, pickled, then rusted red	20	0.610
Plate, completely rusted	19	0.690
Smooth oxidized electrolytic iron	127-527	0.780-0.820
Iron Oxide	500-1200	0.85-0.89
Rough-ingot iron	927-1116	0.870-0.950
Cast Plate, oxidized, smooth	23	0.8
Cast Plate, oxidized, rough	23	0.82
Molten Pure Iron	1516-1771	0.420-0.450
Molten Armco Iron	1521-1689	0.400-0.410
Lead		
Pure (99.96%) Unoxidized	127-227	0.057-0.075
Oxidized	200	0.63
Oxidized, Gray	24	0.280
Magnesium		
Magnesium Oxide	227-826	0.550-0.200
Magnesium Oxide	900-1704	0.200
Magnesite		
Refractory Brick	1000	0.380
Marble, Light Grey Polished	0-100	0.903
Mercury, Unoxidized	0	0.09
	25	0.10
	100	0.12
Molybdenum		
Polished	538	0.05
	1482	0.17
Oxidized	538	0.82
Unoxidized	1000	0.13
	1500	0.19
	2000	0.24
Filament	827-2593	0.096-0.202

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Monel Metal, Oxidized	200	0.43
	600	0.43
Nichrome Wire		
Clean	50	0.65
	500-1000	0.71-0.79
Oxidized	50-500	0.95-0.98
Nickel		
Polished	low	0.12
	1204	0.32
Oxidized	200	0.37
	871	0.85
	1200	0.85
Unoxidized	25	0.045
	100	0.06
	500	0.12
	1000	0.19
Electroplated, Polished	23	0.045
Electroplated, not Polished	20	0.110
Wire	187-1007	0.096-0.186
Plate, oxidized by heating at 600°C	200-600	0370-0.480
Nickel Oxide	650-1254	0.590-0.860
Chromnickel	52-1034	0.640-0.760
Nickel-Silver Polished	100	0.135
Oak, Planed	21	0.900
Oil Layers on Aluminum Foil		
(Linseed Oil)		
Aluminum Foil	100	0.087
+1, 2 coats oil	100	0.561-0.574
Paint, Lacquers, Varnishes		
Alum. Paint	0-100	0.55
Bronze Paint	0-100	0.80
Black Glass Paint	0-100	0.90
White Lacquer	0-100	0.95
Green Paint	0-100	0.95
Gray Paint	0-100	0.95
Lamp Black	0-100	0.95
Gold Enamel	0-100	0.37
Snow White Enamel varnish on rough iron plate	23	0.906
Black Shiny Lacquer, sprayed on iron	24	0.875
Black Shiny shellac on tinned iron sheet	21	0.821
Black Matte shellac	77-146	0.910
Black on White Lacquer	38-93	0.800-0.950
Flat Black Lacquer	38-93	0.960-0.980
Oil Paints, 16 diff. (all colors)	100	0.920-0.960

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Aluminum Paints & Lacquers		
10% A1 22% lacquer body, on rough or smooth surface	100	0.520
Other A1 paints, varying age and Al content	100	0.270-0.670
A1 Lacquer, Varnish binder on rough plate	21	0.390
A1 Paint after heating to 326°C	150-316	0.350
Radiator Paint: White, Cream, Bleach	100	0.790, 0.770, 0.840
Radiator Paint, bronze	100	0.510
Lacquer coatings, 0.001-0.015" thick on Alum. alloys	38-150	0.870-0.970
3M Nextel101-C10	0-300	.98
Mikron High Temp Test Paint (Spirex SP102)	Ambient-650	0.999
Clear Silicone Vehicle Coating 0.001-0.150" thick:		
On mild steels	260	0.660
On stainless steels 316, 301, 347	260	0.680, 0.750, 0.750
On Dow Metal	260	0.740
On Al Alloys, 24ST, 75ST	260	0.770, 0.820
Aluminum Paint with silicone vehicle paint on Inconel	260	0.290
Dull Black Varnish	40-100	0.80-0.95
Glossy Black Varnish sprayed on iron	20	0.87
	40	0.96-0.98
Paper, Any Color	0-100	0.94
Thinipasted on Tinned or Blackened Plate	19	0.920-0.940
Plaster	0-200	0.91
Plastics, Opaque any color	25	0.950
Platinum		
Cleaned Polished	200-600	0.05-0.10
Filament	27-1227	0.036-0.192
Unoxidized	25	0.037
	100	0.047
	500	0.096
	1000	0.152
	1500	0.191
Wire	50-200	0.06-0.07
	500-1000	0.10-0.16

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
	1400	0.18
Propellant:		
Liquid rocket engine	600-4500	0.900
Quartz		
Rough, fused	21	0.930
Glass, 1.98mm Thick	282-838	0.900-0.410
Glass, 6.88mm Thick	300-838	0.930-0.470
Opaque	300-838	0.920-0.680
Roofing Paper	21	0.910
Silica (98 Si O2, Fe-free) effect of grain size, microns		
10 microns	1010-1566	0.420-0.330
70-600 microns	1010-1566	0.620-0.460
Silver		
Polished	100	0.052
Cleaned Polished	200-600	0.02-0.03
Unoxidized	100	0.02
	500	0.035
Stainless Steel 18-8		
Buffed	20	0.160
Polished	93	0.16
	371	0.19
Oxidized	93-371	0.83
Stainless Steel 303	316	0.74
Oxidized	1093	0.87
Stainless Steel 304 (8Cri 18Ni) light silvery, rough brown, after heating	216-490	0.440-0.360
After 42 hours of heating at 527°C	216-527	0.620-0.730
Stainless Steel 310 (25Cr, 20Ni) Brown, splotched, oxidized from furnace service	216-527	0.900-0.970
Stainless Steel		
Allegheny metal No. 4, polished	100	0.130
Allegheny metal No. 66, polished	100	0.110
Steel		
Alloyed (8%Ni, 18%Cr)	500	0.35
Aluminized	50-500	0.79

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Dull Nickel Plated	20	0.11
Flat, Rough Surface	50	0.95-0.98
Cast, Polished	750-1050	0.52-0.56
Calorized, Oxidized	200	0.52
	600	0.57
Sheet Steel, Ground	938-1100	0.550-0.610
Sheet Steel, Rolled	21	0.660
Sheet Steel, Strong, Rough Oxide Layer	24	0.800
Sheet with Shiny layer of oxide	20	0.82
Oxidized	25	0.80
	200	0.79
	600	0.79
Unoxidized	100	0.08
Molten Steel	1500-1650	0.420-0.530
	1520-1650	0.430-0.40
Molten Mild Steel	1600-1800	0.280
Molten Steel, various with 0.25-1.2% (slightly oxidized surfaces.)	1560-1710	0.270-0.390
Molten Steel, unoxidized	Liquid	0.280
Steel Plate, Rough	40	0.94
	400	0.97
	600	0.57
Tantalum		
Unoxidized	1500	0.21
	2000	0.26
Filament	1327-3000	0.190-0.310
Thorium Oxide	277-500	0.580-0.360
Tin		
Unoxidized	25	0.05
Commercial tin-plated sheet iron	100	0.070-0.080
Tungsten		
Filament, aged	27-3316	0.320-0.350
Filament	3316	0.390
Unoxidized	25	0.024
	100	0.032
	500	0.071
	1000	0.15
	1500	0.23
	2000	0.28
Turbojet Engine Operating	350-600	0.900
Water	Ambient	0.96
Wood		
Spruce, sanded	93	0.82
Oak, planed	0-200	0.89

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MATERIAL	TEMPERATURE °C	*EMISSIVITY
Zinc		
Highly Polished	200-300	0.04-0.05
Unoxidized	300	0.05
Oxidized by heating at 399°C	399	0.110
Galvanized Sheet Iron, fairly bright	28	0.230
Galvanized Sheet Iron, gray oxidized	24	0.280
Zinc, galvanized Sheet	100	0.210
Zirconium Silicate	238-500	0.920-0.800
	500-832	0.800-0.520

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