

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

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.....		
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.



TOTAL EMISSIVITY OF VARIOUS SURFACES

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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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.....	0.370-0.480
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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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		
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		
Thinipasted on Tinned or Blackened Plate	19.....	0.920-0.940
Plaster.....		
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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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 O ₂ , 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 (8Cr 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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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

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



TOTAL EMISSIVITY OF VARIOUS SURFACES

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

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

