

# 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..... 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.

## 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

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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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## 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
<b>Lead</b>		
Pure (99.96%) Unoxidized.....	127-227.....	0.057-0.075
Oxidized.....	200.....	0.63
Oxidized, Gray.....	24.....	0.280
<b>Magnesium</b>		
Magnesium Oxide.....	227-826.....	0.550-0.200
Magnesium Oxide.....	900-1704.....	0.200
<b>Magnesite</b>		
Refractory Brick.....	1000.....	0.380
Marble, Light Grey Polished.....	0-100.....	0.903
Mercury, Unoxidized.....	0.....	0.09
.....	25.....	0.10
.....	100.....	0.12
<b>Molybdenum</b>		
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.....	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

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<b>MATERIAL</b>	<b>TEMPERATURE °C</b>	<b>*EMISSIVITY</b>
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: .....	100.....	0.790, 0.770, 0.840
White, Cream, Bleach		
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 O <sub>2</sub> , 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

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## 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

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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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