

# Emissivity Table

When using infrared pyrometers such as the Calex Pyropen, a knowledge of emissivity setting for various materials will permit optimisation of the measurement.

Emissivity is a function of temperature, and is also subject to variations due to the surface condition of the material, and these tables should therefore be used as a guide.

Where accuracy or measurement is critical it is recommended that the notes on "Understanding and using the Infrared Thermometer" be read.

## FERROUS AND NON FERROUS METALS

Material	Temp (°C)	Temp (°F)	ε -Emissivity
<b>Alloys</b>			
20-Ni, 24-CR, 55-FE, Oxidized.....	200	392	0.90
20-Ni, 24-CR, 55-FE, Oxidized.....	500	932	0.97
60-Ni, 12-CR, 28-FE, Oxidized.....	270	518	0.89
60-Ni, 12-CR, 28-FE, Oxidized.....	560	1040	0.82
80-Ni, 20-CR, Oxidized.....	100	212	0.87
80-Ni, 20-CR, Oxidized.....	600	1112	0.87
80-Ni, 20-CR, Oxidized.....	1300	2372	0.89
<b>Aluminium</b>			
Unoxidized.....	25	77	0.02
Unoxidized.....	100	212	0.03
Unoxidized.....	500	932	0.06
Oxidized.....	199	390	0.11
Oxidized.....	599	1110	0.19
Oxidized at 599°C.....	199	390	0.11
Oxidized at 599°C.....	599	1110	0.19
Heavily Oxidized.....	93	200	0.20
Heavily Oxidized.....	504	940	0.31
Highly Polished.....	100	212	0.09
Roughly Polished.....	100	212	0.18
Commercial Sheet.....	100	212	0.09
Highly Polished Plate.....	227	440	0.04
Highly Polished Plate.....	577	1070	0.06
Bright Rolled Plate.....	170	338	0.04
Bright Rolled Plate.....	500	932	0.05
Alloy A3003, Oxidized.....	316	600	0.40
Alloy A3003, Oxidized.....	482	900	0.40
Alloy 1100-0.....	93-427	200-800	0.05
Alloy 24ST.....	24	75	0.09
Alloy 24ST Polished.....	24	75	0.09
Alloy 75ST.....	24	75	0.11
Alloy 75ST Polished.....	24	75	0.08
<b>Bismuth, Bright.....</b>			
Bismuth, Unoxidized.....	80	176	0.34
Bismuth, Unoxidized.....	25	77	0.05
Bismuth, Unoxidized.....	100	212	0.06
<b>Brass</b>			
73%Cu.27%Zn. Polished.....	247	476	0.03
73%Cu.27%Zn. Polished.....	357	674	0.03
62%Cu.37%Zn. Polished.....	257	494	0.03
62%Cu.37%Zn. Polished.....	377	710	0.04
83%Cu.17%Zn. Polished.....	277	530	0.03
Matte.....	20	68	0.07
Burnished to Brown Colour.....	20	68	0.40

Material	Temp (°C)	Temp (°F)	ε -Emissivity
Cu-Zn, Brass Oxidized.....	200	392	0.61
Cu-Zn, Brass Oxidized.....	400	752	0.60
Cu-Zn, Brass Oxidized.....	600	1112	0.61
Unoxidized.....	25	77	0.04
Unoxidized.....	100	212	0.04
<b>Cadmium.....</b>			
Cadmium.....	25	77	0.02
<b>Carbon</b>			
Lampblack.....	25	77	0.95
Unoxidized.....	25	77	0.81
Unoxidized.....	100	212	0.81
Unoxidized.....	500	932	0.79
Candle Soot.....	121	250	0.95
Filament.....	260	500	0.95
Graphitized.....	100	212	0.76
Graphitized.....	300	572	0.75
Graphitized.....	500	932	0.71
<b>Chromium.....</b>			
Chromium.....	38	100	0.08
Chromium.....	538	1000	0.26
Chromium Polished.....	150	302	0.06
<b>Cobalt, Unoxidized.....</b>			
Cobalt, Unoxidized.....	500	932	0.13
Cobalt, Unoxidized.....	1000	1832	0.23
<b>Columbium,Unoxidized.....</b>			
Columbium,Unoxidized.....	816	1500	0.19
Columbium,Unoxidized.....	1093	2000	0.24
<b>Copper</b>			
Cuprous Oxide.....	38	100	0.87
Cuprous Oxide.....	260	500	0.83
Cuprous Oxide.....	538	1000	0.77
Black, Oxidized.....	38	100	0.78
Etched.....	38	100	0.09
Matte.....	38	100	0.22
Roughly Polished.....	38	100	0.07
Polished.....	38	100	0.03
Highly Polished.....	38	100	0.02
Rolled.....	38	100	0.64
Rough.....	38	100	0.74
Molten.....	538	1000	0.15
Molten.....	1077	1970	0.16
Molten.....	1221	2230	0.13
Nickel Plated.....	38-260	100-500	0.37
Dow Metal.....	(18)-316	0-600	0.15

Material	Temp (°C)	Temp (°F)	ε-Emissivity
<b>Gold</b>			
Enamel	100	212	0.37
Plate (.0001)			
on .0005 Silver	93-399	200-750	.11-.14
on .0005 Nickel	93-399	200-750	.07-.09
Polished	38-260	100-500	0.02
Polished	538-1093	1000-2000	0.03
<b>Haynes Alloy C, Oxidized</b>			
	316-1093	600-2000	.90-.96
Haynes Alloy 25, Oxidized	316-1093	600-2000	.86-.89
Haynes Alloy X, Oxidized	316-1093	600-2000	.85-.88
<b>Inconel Sheet</b>			
	538	1000	0.28
Inconel Sheet	649	1200	0.42
Inconel Sheet	760	1400	0.58
Inconel X, Polished	24	75	0.19
Inconel B, Polished	24	75	0.21
<b>Iron</b>			
Oxidized	100	212	0.74
Oxidized	499	930	0.84
Oxidized	1199	2190	0.89
Unoxidized	100	212	0.05
Red Rust	25	77	0.70
Rusted	25	77	0.65
Liquid	1516-1771	2760-3220	.42-.45
<b>Cast Iron</b>			
Oxidized	199	390	0.64
Oxidized	599	1110	0.78
Unoxidized	100	212	0.21
Stong Oxidation	40	104	0.95
Strong Oxidation	250	482	0.95
Liquid	1535	2795	0.29
<b>Wrought Iron</b>			
Dull	25	77	0.94
Dull	349	660	0.94
Smooth	38	100	0.35
Polished	38	100	0.28
<b>Lead</b>			
Polished	38-260	100-500	.06-.08
Rough	38	100	0.43
Oxidized	38	100	0.43
Oxidized at 593°C	38	100	0.63
Gray Oxidized	38	100	0.28
<b>Magnesium</b>			
	38-260	100-500	.07-.13
Magnesium Oxide	1027-1727	1880-3140	.16-.20
<b>Mercury</b>			
	0	32	0.09
Mercury	25	77	0.10
Mercury	38	100	0.10
Mercury	100	212	0.12
<b>Molybdenum</b>			
	38	100	0.06
Molybdenum	260	500	0.08
Molybdenum	538	1000	0.11
Molybdenum	1093	2000	0.18
Molybdenum Oxidized at 538°C	316	600	0.80
Molybdenum Oxidized at 538°C	371	700	0.84
Molybdenum Oxidized at 538°C	427	800	0.84
Molybdenum Oxidized at 538°C	482	900	0.83
Molybdenum Oxidized at 538°C	538	1000	0.82
<b>Monel, Ni-Cu</b>			
	200	392	0.41
Monel, Ni-Cu	400	752	0.44

Material	Temp (°C)	Temp (°F)	ε-Emissivity
Monel, Ni-Cu	600	1112	0.46
Monel, Ni-Cu Oxidized	20	68	0.43
Monel, Ni-Cu Oxidized at 599°C	599	1110	0.46
<b>Nickel</b>			
Polished	38	100	0.05
Oxidized	38-260	100-500	.31-.46
Unoxidized	25	77	0.05
Unoxidized	100	212	0.06
Unoxidized	500	932	0.12
Unoxidized	1000	1832	0.19
Electrolytic	38	100	0.04
Electrolytic	260	500	0.06
Electrolytic	538	1000	0.10
Electrolytic	1093	2000	0.16
<b>Nickel Oxide</b>			
	538-1093	1000-2000	.59-.86
<b>Palladium Plate</b>			
(.00005 on .0005 silver)	93-399	200-750	.16-.17
<b>Platinum</b>			
	38	100	0.05
Platinum	260	500	0.05
Platinum	538	1000	0.10
Platinum Black	38	100	0.93
Platinum Black	260	500	0.96
Platinum Black	1093	2000	0.97
Platinum Black Oxidized at 593°C	260	500	0.07
Platinum Black Oxidized at 593°C	538	1000	0.11
<b>Rhodium Flash</b>			
(.0002 on .0005 Ni)	93-371	200-700	.10-.18
<b>Silver</b>			
Plate (.0005 on Ni)	93-371	200-700	.06-.07
Polished	38	100	0.01
Polished	260	500	0.02
Polished	538	1000	0.03
Polished	1093	2000	0.03
<b>Steel</b>			
Cold Rolled	93	200	.75-.85
Ground Sheet	938-1099	1720-2010	.55-.61
Polished Sheet	38	100	0.07
Polished Sheet	260	500	0.10
Polished Sheet	538	1000	0.14
Mild Steel, Polished	24	75	0.10
Mild Steel, Polished Smooth	24	75	0.12
Mild Steel, Liquid	1599-1799	2910-3270	0.28
Steel, Unoxidized	100	212	0.08
Steel Oxidized	25	77	0.80
<b>Steel Alloys</b>			
Type 301, Polished	24	75	0.27
Type 301, Polished	232	450	0.57
Type 301, Polished	949	1740	0.55
Type 303, Oxidized	316-1093	600-2000	.74-.87
Type 310, Rolled	816-1149	1500-2100	.56-.81
Type 316, Polished	24	75	0.28
Type 316, Polished	232	450	0.57
Type 316, Polished	949	1740	0.66
Type 321	93-427	200-800	.27-.32
Type 321 Polished	149-816	300-1500	.18-.49
Type 321 w/BK Oxide	93-427	200-800	.66-.76
Type 347, Oxidized	316-1093	600-2000	.87-.91
Type 350	93-427	200-800	.18-.27
Type 350, Polished	149-982	300-1800	.11-.35
Type 446, Polished	149-816	300-1500	.15-.37
Type 17-7PH	93-316	200-600	.44-.51

Material	Temp (°C)	Temp (°F)	ε -Emissivity	Material	Temp (°C)	Temp (°F)	ε -Emissivity
Type 17-7PH Polished	149-816	300-1500	.09-.16	Light Buff	538	1000	0.80
Type C1020, Oxidised	316-1093	600-2000	.87-.91	Lime Clay	1371	2500	0.43
Type PH-15-7 MO	149-649	300-1200	.07-.19	Fire Brick	1000	1832	.75-.80
<b>Stellite, Polished</b>	20	68	0.18	Magnesite, Refractory	1000	1832	0.38
<b>Tantalum</b>				Gray Brick	1100	2012	0.75
Unoxidized	727	1340	0.14	Silica, Glazed	1093	2000	0.88
Unoxidized	1093	2000	0.19	Silica, Unglazed	1093	2000	0.80
Unoxidized	1982	3600	0.26	Sandlime	1371-2760	2500-5000	.59-.63
Unoxidized	2930	5306	0.30	<b>Carborundum</b>	1010	1850	0.92
<b>Tin, Unoxidized</b>	25	77	0.04	<b>Ceramic</b>			
Tin, Unoxidized	100	212	0.05	Alumina on Inconel	427-1093	800-2000	.69-.45
<b>Tinned Iron, Bright</b>	24	76	0.05	Earthenware, Glazed	21	70	0.90
Tinned Iron Bright	100	212	0.08	Earthenware, Matte	21	70	0.93
<b>Titanium</b>				Greens No. 5210-2C	93-399	200-750	.89-.82
Alloy C110M, Polished	149-649	300-1200	.08-.19	Coating No. C20A	93-399	200-750	.73-.87
Alloy C110M, Oxidised at 538°	93-427	200-800	.51-.61	Porcelain	22	72	0.92
Alloy T1-95A Oxidised at 538°	93-427	200-800	.35-.48	White Aluminium Oxide	93	200	0.90
Anodized onto SS	93-316	200-600	.96-.82	Zirconia on Inconel	427-1093	800-2000	.62-.45
<b>Tungsten</b>				<b>Clay</b>	20	68	0.39
Unoxidized	25	77	0.02	Clay Fired	70	158	0.91
Unoxidized	100	212	0.03	Clay Shale	20	68	0.69
Unoxidized	500	932	0.07	Clay Tiles, Light Red	1371-2760	2500-5000	.32-.34
Unoxidized	1000	1832	0.15	Clay Tiles, Red	1371-2760	2500-5000	.40-.51
Unoxidized	1500	2732	0.23	Clay Tiles, Dark Purple	1371-2760	2500-5000	0.78
Unoxidized	2000	3632	0.28	<b>Concrete</b>			
Filament (Aged)	38	100	0.03	Rough	0-1093	32-2000	0.94
Filament (Aged)	538	1000	0.11	Tiles, Natural	1371-2760	2500-5000	.63-.62
Filament (Aged)	2760	5000	0.35	Tiles, Brown	1371-2760	2500-5000	.87-.83
<b>Uranium Oxide</b>	1027	1880	0.79	Tiles Black	1371-2760	2500-5000	.94-.91
<b>Zinc</b>				<b>Cotton Cloth</b>	20	68	0.77
Bright Galvanized	38	100	0.23	<b>Dolomite Lime</b>	20	68	0.41
Commercial 99.1%	260	500	0.05	<b>Emery Corundum</b>	80	176	0.86
Galvanized	38	100	0.28	<b>Glass</b>			
Oxidized	260-538	500-1000	0.11	Convex D	100	212	0.80
Polished	38	100	0.02	Convex D	316	600	0.80
Polished	260	500	0.03	Convex D	500	932	0.76
Polished	538	1000	0.04	Nonex	100	212	0.82
Polished	1093	2000	0.06	Nonex	316	600	0.82
				Nonex	500	932	0.78
				Smooth	0-93	32-200	.92-.94
<b>OTHER MATERIALS</b>				<b>Granite</b>	21	70	0.45
<b>Adobe</b>	20	68	0.90	<b>Gravel</b>	38	100	0.28
<b>Asbestos</b>				<b>Gypsum</b>	20	68	.80-.90
Board	38	100	0.96	<b>Ice, Smooth</b>	0	32	0.97
Cement	0-200	32-392	0.96	Ice Rough	0	32	0.96
Cement Red	1371	2500	0.67	<b>Lacquer</b>			
Cement White	1371	2500	0.65	Black	93	200	0.96
Cloth	93	199	0.90	Blue, on Aluminum Foil	38	100	0.78
Paper	38-371	100-700	0.93	Clear, on Aluminum Foil (2 coat)	93	200	.08(.09)
Slate	20	68	0.97	Clear, on Bright Copper	93	200	0.66
<b>Asphalt, pavement</b>	38	100	0.93	Clear, on Tarnished Copper	93	200	0.64
Asphalt, tar paper	20	68	0.93	Red, on Aluminum Foil (2 coat)	38	100	.61(.74)
<b>Basalt</b>	20	68	0.72	White	93	200	0.95
<b>Brick</b>				White, on Aluminum Foil (2 coat)	38	100	.69(.88)
Red, rough	21	70	0.93	Yellow, on Aluminum Foil (2 coat)	38	100	.57(.79)
Gault Cream	1371-2760	2500-5000	.26-.30				
Fire Clay	1371	2500	0.75				

Material	Temp (°C)	Temp (°F)	ε-Emissivity
<b>Lime Mortar</b>	38-260	100-500	.90-.92
<b>Limestone</b>	38	100	0.95
<b>Marble, White</b>	38	100	0.95
Marble, Smooth, White	38	100	0.56
Marble, Polished Gray	38	100	0.75
<b>Oil on Nickel</b>			
.001 Film	22	72	0.27
.002 Film	22	72	0.46
.005 Film	22	72	0.72
Thick Film	22	72	0.82
<b>Oil, Linseed</b>			
On Aluminum Foil, uncoated	121	250	0.09
On Aluminum Foil, 1 coat	121	250	0.56
On Aluminum Foil, 2 coats	121	250	0.51
On Polished Iron, .001 Film	38	100	0.22
On Polished Iron, .002 Film	38	100	0.45
On Polished Iron, .004 Film	38	100	0.65
On Polished Iron, Thick Film	38	100	0.83
<b>Paints</b>			
Blue, Cu <sub>2</sub> O <sub>3</sub>	24	75	0.94
Black, CuO	24	75	0.96
Green, Cu <sub>2</sub> O <sub>3</sub>	24	75	0.92
Red, Fe <sub>2</sub> O <sub>3</sub>	24	75	0.91
White Al <sub>2</sub> O <sub>3</sub>	24	75	0.94
White Y <sub>2</sub> O <sub>3</sub>	24	75	0.90
White ZnO	24	75	0.95
White MgCO <sub>3</sub>	24	75	0.91
White, ZrO <sub>2</sub>	24	75	0.95
White ThO <sub>2</sub>	24	75	0.90
White MgO <sub>2</sub>	4	75	0.91
White PbCO <sub>3</sub>	24	75	0.93
Yellow, PbO	24	75	0.90
Yellow PbCrO <sub>4</sub>	24	75	0.93
<b>Paints, Aluminum</b>	38	100	.27-.67
10% Al	38	100	0.52
20% Al	38	100	0.30
Dow XP-310	93	200	0.22
<b>Paints, Bronze</b>	Low	Low	.34-.80
<b>Gum Varnish (2 coats)</b>	21	70	0.53
Gum Varnish (3 coats)	21	70	0.50
Cellulose Binder (2 coats)	21	70	0.34
<b>Paints, Oil</b>			
All colours	93	200	.92-.96
Black	93	200	0.92
Black Gloss	21	70	0.30
Camouflage Green	52	125	0.85
Flat Black	27	80	0.88
Flat White	27	80	0.91
Gray-Green	21	70	0.95
Green	93	200	0.95
Lamp Black	98	209	0.96
Red	93	200	0.95
White	93	200	0.94
<b>Quartz, Rough, Fused</b>	21	70	0.93
Glass, 1.96 mm	282	540	0.90
Glass, 1.96 mm	838	1540	0.41
Glass, 6.88 mm	282	540	0.93
Glass, 6.88 mm	838	1540	0.47
Opaque	299	570	0.92
Opaque	838	1540	0.68

Material	Temp (°C)	Temp (°F)	ε-Emissivity
<b>Red Lead</b>	100	212	0.93
<b>Rubber, Hard</b>	23	74	0.94
Rubber, Soft, Gray	24	76	0.86
<b>Sand</b>	20	68	0.76
Sandstone	38	100	0.67
Sandstone Red	38	100	.60-.83
<b>Sawdust</b>	20	68	0.75
<b>Shale</b>	20	68	0.69
Silica Glazed	1000	1832	0.85
Silica Unglazed	1100	2012	0.75
<b>Silicon Carbide</b>	149-649	.300-1200	.83-.96
<b>Silk Cloth</b>	20	68	0.78
<b>Slate</b>	38	100	.67-.80
<b>Snow, Fine Particles</b>	-7	20	0.82
Snow Granular	-8	18	0.89
<b>Soil</b>			
Surface	38	100	0.38
Black Loam	20	68	0.66
Plowed Field	20	68	0.38
<b>Soot</b>			
Acetylene	24	75	0.97
Camphor	24	75	0.94
Candle	121	250	0.95
Coal	20	68	0.95
<b>Stonework</b>	38	100	0.93
<b>Water</b>	38	100	0.67
<b>Waterglass</b>	20	68	0.96
<b>Wood</b>	Low	Low	.80-.90
Beech, Planed	70	158	0.94
Oak, Planed	38	100	0.91
Spruce, Sanded	38	100	0.89