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TABLES OF EMISSIVITY OF SURFACES

THE information given in these Tables of Emissivity of Surfaces was compiled by Dr. Margaret Fishenden before her retirement from the staff of the Department of Mechanical Engineering at the Imperial College of Science and Technology, London, in 1954. The tables and references were compiled for private use but are now reproduced, largely in their original form, with Dr. Fishenden's permission. The emissivities are total hemispherical, for the most part, but some exceptions may exist. For this reason, and because of the incomplete definition of the state of the surfaces, the tables should be used with caution, the original references or other data being consulted before acceptance. The tables are published here, with the above reservations, as a preliminary guide to emissivity values and as an aid to further literature surveys.

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Table 1. *Metals*

Surface	Temperature °F								Ref.
	100	200	300	400	500	1000	2000	5000	
	Emissivity, per cent								
Aluminium									
Polished, 98% pure	—	—	—	4	4	6	—	—	40
Polished, 98% pure	4	4	4	5	5	8	17	26	9
Polished, 98% pure	5	5	5	5	4	6	—	—	38
Polished, 98% pure	—	5	5	6	7	11	—	—	5
Polished, 98% pure	—	—	5	—	—	—	—	—	39
Polished, 98% pure	—	3	—	—	—	—	—	—	31
Lacquered foil	—	8	—	—	—	—	—	—	31
Sheet	—	9	—	—	—	—	—	—	47
Rough plate	7	—	—	—	—	—	—	—	38
Polished, lightly oxidized	5	—	—	—	—	—	—	—	44
Oxidized	8	9	10	11	12	18	—	—	36
Oxidized	20	20	21	22	23	33	—	—	5
Corroded black	—	—	83	—	—	—	—	—	14
Antimony									
Polished	28	28	29	30	31	33	40	45	9
Bismuth	—	37	—	—	—	—	—	—	39
Copper									
Polished electrolytic	—	2	—	—	—	—	—	—	27
Polished	—	2	—	—	—	—	—	—	48
Polished	4	—	—	—	—	—	—	—	38
Polished	—	—	—	—	—	—	—	—	2
Polished	—	—	—	—	2	4	6	—	34
Buffed	—	12	—	—	—	—	—	—	31
Etched or scratched	9	—	—	—	—	—	—	—	38
Matt	22	22	—	—	—	—	—	—	44
Rolled	64	—	—	—	—	—	—	—	44
Rough	74	—	—	—	—	—	—	—	44
Slightly tarnished	5	—	—	—	—	—	—	—	38
Tarnished by exposure	—	—	—	—	—	—	—	—	2

Table 1. *Metals—continued*

Surface	Temperature °F								Ref.
	100	200	300	400	500	1000	2000	5000	
	Emissivity, per cent								
Copper—continued									
Calorized	18	18	18	18	19	19	—	—	36
Calorized	34	29	27	26	25	23	—	—	28
Oxidized	50	50	50	50	50	50	—	—	36
Oxidized	56	56	56	57	61	88	—	—	5
Oxidized	75	74	73	73	73	73	—	—	28
Thick blue-black oxide	—	72	—	—	—	—	—	—	39
Black oxidized	78	—	—	—	—	—	—	—	38
Black oxide	92	91	90	89	83	77	—	—	10
Copper oxide	—	—	73	—	—	—	—	—	14
Cuprous oxide	—	—	—	—	—	78	54	—	6
Molten copper	—	—	—	—	—	—	16	—	6
Molten copper	—	—	—	—	—	—	14	—	45
Chromium									
Clean	—	—	7	—	—	—	—	—	39
Polished sheet	8	11	14	15	17	27	37	43	9
Polished sheet	—	8	—	—	—	—	—	—	31
Gold									
Vaporized in vacuum	—	—	2	—	—	—	—	—	14
Electrolytic, polished	2	2	2	2	2	3	62	—	19
Pure, highly polished	—	—	—	2	2	3	—	—	40
Deposited, not polished	47	—	—	—	—	—	—	—	44
Iron and Steel									
Electrolytic iron, highly polished	—	—	—	6	8	—	—	—	40
Pure polished iron	6	6	6	7	8	12	22	35	9
Cast iron, polished	21	21	21	21	21	—	—	—	36
Polished iron wire	—	—	—	—	8	22	49	—	43
Wrought iron polished	28	28	28	28	27	—	—	—	46
Iron, pickled,	—	—	16	—	—	—	—	—	39
Iron	—	—	—	—	—	23	26	34	34
Polished steel casting	—	—	—	—	—	49	56	—	35
Polished steel	7	7	8	9	10	14	23	37	36
Cold rolled steel	—	8	—	—	—	—	—	—	31
Rolled sheet steel	56	—	—	—	—	—	—	—	38
Ground sheet steel	—	—	—	—	—	41	61	—	35
Smooth wrought iron	35	—	—	—	—	—	—	—	46
Smooth sheet iron	—	—	—	—	—	48	60	—	35
Iron rubbed with emery	24	—	—	—	—	—	—	—	38
Cast iron bright	16	21	24	—	—	—	—	—	28
Cast iron, freshly drawn	44	—	—	—	—	—	—	—	38
Cast plate iron, smooth	80	—	—	—	—	—	—	—	38
Cast plate iron, rough	82	—	—	—	—	—	—	—	38
Cast iron, with skin	81	—	—	—	—	—	—	—	14
Cast iron, with skin due to rolling	—	—	60	—	—	—	—	—	38
Cast iron, lathe turned	—	—	—	—	—	—	70	—	35
Rough ingot iron	—	—	—	—	—	—	95	—	35
Ground sheet steel	—	—	—	—	—	—	61	—	35

Table 1. *Metals—continued*

Surface	Temperature °F								Ref.
	100	200	300	400	500	1000	2000	5000	
	Emissivity, per cent								
Iron and Steel—continued									
Rough steel plate	94	95	95	96	97	98	—	—	21
Rolled sheet steel	66	—	—	—	—	—	—	—	38
Cast iron, oxidized	58	61	62	64	66	75	—	—	36
Cast iron, oxidized	63	63	63	63	63	52	—	—	28
Oxidized iron	—	74	—	—	—	—	—	—	42
Smoothly oxidized electrolytic iron	78	78	79	79	80	83	—	—	40
Matt wrought iron, oxidized	95	95	95	95	95	—	—	—	46
Rough cast iron, oxidized	98	—	—	—	—	—	—	—	46
Iron with rough oxide layer	81	—	—	—	—	—	—	—	38
Red rusted iron	69	—	—	—	—	—	—	—	38
Corroded sheet iron	—	74	—	—	—	—	—	—	47
Completely rusted iron	61	—	—	—	—	—	—	—	38
Sheet steel with rough oxide	80	—	—	—	—	—	—	—	38
Sheet steel with dense shining oxide	82	—	—	—	—	—	—	—	38
Oxidized steel, after long heating at dull red	85	88	90	92	93	96	—	—	5
Oxidized steel	79	79	79	79	79	79	—	—	36
Calorized steel	50	51	52	52	53	56	—	—	36
Iron oxide	—	—	—	—	—	85	89	—	35
Iron oxide	—	—	—	—	—	85	88	—	8
Red iron oxide	96	—	—	—	—	67	—	59	10
Black iron oxide	—	56	—	—	—	—	—	—	31
Molten cast iron	—	—	—	—	—	—	29 (at 2400°F)	—	45
Molten mild steel	—	—	—	—	—	—	28 (at 3000°F)	—	45
Lead									
Pure, polished	5	5	6	7	8	—	—	—	40
Rough	43	—	—	—	—	—	—	—	44
Grey oxidized	28	—	—	—	—	—	—	—	38
Oxidized at 390°F	—	—	—	63	—	—	—	—	36
Magnesium, Polished	7	7	10	12	13	18	23	26	9
Manganin, Smooth rolled	—	6	6	—	—	—	—	—	39
Mercury, Pure clean	10	12	—	—	—	—	—	—	Calculated
Molybdenum									
Polished	6	6	6	7	8	11	18	43	9
Polished	—	—	—	—	—	7	14	—	40
Polished	—	—	—	—	—	13	19	36	34
Filament	—	—	—	—	—	8	14	29	50
Nickel									
Electrolytic	4	4	5	5	6	10	16	28	19
Pure, polished	5	5	6	7	7	10	—	—	40
Polished	—	—	—	—	13	17	22	29	34
Polished iron, nickel plated	6	—	—	—	—	—	—	—	38
Polished iron, nickel plated	—	5	—	—	—	—	—	—	39
Matt iron, nickel plated	—	5	—	—	—	—	—	—	39

Table 1. *Metals—continued*

Surface	Temperature °F								Ref.
	100	200	300	400	500	1000	2000	5000	
	Emissivity, per cent								
Nickel—continued									
Matt iron, nickel plated	11	—	—	—	—	—	—	—	38
Nickel wire	—	—	9	10	11	13	20	—	43
Nickel, strongly oxidized	48	—	—	—	—	—	—	—	44
Nickel, strongly oxidized	—	—	—	—	—	—	28	—	36
Nickel, oxidized	—	—	—	—	—	46	81	—	7
Platinum									
Pure polished	4	5	5	6	6	10	19	27	9
Pure polished	4	5	5	5	6	10	18	—	40
Pure polished	3	4	5	5	6	8	13	—	15
Pure polished	5	—	—	—	—	—	—	—	19
Polished	—	—	—	6	7	10	18	—	36
Polished	—	—	—	—	—	18	24	29	34
Foil	—	—	—	—	—	12	8	—	33
Filament	4	5	6	6	7	10	17	—	13
Wire	5	6	6	7	8	10	16	—	14
Wire	—	—	—	—	23	55	—	—	43
Platinum black	93	93	94	95	96	97	97	97	10
Rhodium, Polished	5	6	7	7	7	8	9	16	9
Silicon, Polished	72	72	72	72	72	72	72	72	9
Silver									
Pure polished	—	—	2	2	2	3	—	—	40
Polished or deposited	1	1	2	2	2	3	3	4	9
Polished	—	—	—	2	2	3	—	—	36
Polished	2	2	3	3	3	3	—	—	21
Wire	—	—	—	—	10	11	—	—	43
Lacquered silver mirror	—	—	—	—	—	—	5	13	9
Tantalum									
Polished	6	6	7	7	7	7	9	25	12
Filament	—	—	—	—	—	—	17	33	50
Tellurium, Polished	22	28	33	37	39	45	48	51	9
Tin									
Bright tinned iron sheet	8	—	—	—	—	—	—	—	38
Polished sheet	—	5	—	—	—	—	—	—	31
Tungsten									
Polished	4	4	5	5	6	8	15	39	9
Polished	2	2	2·5	3	3·5	7·5	15	35	27
Filament	—	—	—	—	—	—	—	39	53
Filament, aged	32	32	32	32	32	32	33	35	16
Vanadium, Polished	8	10	12	13	17	23	31	39	9
Wolfram, Polished	3	4	4	5	6	9	17	—	40

Table 1. *Metals—continued*

Surface	Temperature °F								Ref.
	100	200	300	400	500	1000	2000	5000	
	Emissivity, per cent								
Zinc									
Pure polished	2	2	2	2	3	4	6	50	9
Pure polished	—	—	—	4	5	—	—	—	40
Galvanized sheet iron, bright	23	—	—	—	—	—	—	—	41
Galvanized sheet iron, bright	—	7	—	—	—	—	—	—	31
Galvanized iron, grey	28	—	—	—	—	—	—	—	38
Matt zinc	21	21	21	21	21	—	—	—	46
Oxidized zinc	—	—	—	—	11	—	—	—	36
Alloys									
Alloy steel, rough	—	—	—	44	43	35	—	—	37
Alloy 60% Ni, 12% Cu, black oxidized	—	—	—	—	89	82	—	—	37
Brass, highly polished (73% Cu, 27% Zn)	—	—	—	3	3	3	—	—	40
Brass, highly polished (62·4% Cu, 36·8% Zn, 0·4% Pb, 0·3% Al)	—	—	—	—	4	4	—	—	40
Brass, highly polished (83% Cu, 17% Zn)	—	—	—	—	3	—	—	—	40
Brass, polished	10	10	10	10	10	—	—	—	24
Brass, polished	5	—	—	—	—	—	—	—	38
Brass, polished, slightly corroded	5	—	—	—	—	—	—	—	38
Brass, burnished sheet	—	43	—	—	—	—	—	—	47
Brass, rough rolled	7	—	—	—	—	—	—	—	38
Brass, freshly rubbed with emery	21	—	—	—	—	—	—	—	38
Brass, matt	21	—	—	—	—	—	—	—	36
Brass, dull plate	22	22	23	23	23	—	—	—	46
Brass, oxidized	—	61	61	61	60	60	—	—	36
Brass, oxidized	46	48	50	53	56	75	—	—	5
German Silver	—	—	—	—	7	9	1?	26	35
Manganin, rolled	—	—	57	—	—	—	—	—	38
Nichrome wire, bright	65	65	66	66	67	71	79	—	43
Nichrome wire, oxidized	95	95	96	96	97	98	—	—	5
Ni, Cu, Zn alloy, oxidized	26	—	—	—	—	—	—	—	38
Stellite (Cr, Mo, Co)	12	12	13	13	14	18	24	28	11, 12

Table 2. Pigments

Surface	Temperature °F							Ref.
	−250	125	750	1500	2000	2500	5000	
			Emissivity, per cent					
Acetylene soot	97	99	99	—	—	—	99	10
Camphor soot	94	98	99	—	—	—	99	10
Lampblack	—	94·5	94	—	—	—	—	21
Candle soot	—	95	95	—	—	—	—	48
Lampblack, waterglass coating	—	96	93	—	—	—	—	26
Lampblack, waterglass coating	—	96	94	—	—	—	—	40
Lampblack, waterglass coating, thin layer	—	93	—	—	—	—	—	40
Lampblack, waterglass coating, thick layer	—	97	—	—	—	—	—	38
Platinum black	92	91	95	—	—	—	97	10
Black (CuO)	96	—	85	—	—	—	76	10
Burnt Sienna	—	—	—	—	—	—	—	41
Blue (Co_2O_3)	94	87	86	—	—	—	97	10
Red (Fe_2O_3)	91	96	70	—	—	—	59	10
Red (Fe_2O_3), very fine	—	—	—	57	74	85	—	25
Vermilion	—	—	—	—	—	—	—	41
Green (Cr_2O_3)	92	95	67	—	—	—	55	10
Green (Cr_2O_3)	—	—	—	80	83	85	—	25
Yellow (PbO)	90	74	49	—	—	—	—	10
Yellow ($PbCrO_4$)	93	95	59	—	—	—	—	41
Yellow ($PbCrO_4$)	—	—	—	—	—	—	—	6
White (Al_2O_3)	94	98	79	—	—	—	12	10
White (Al_2O_3)	—	—	—	38	46	46	—	25
White (CaO)	94	96	78	—	—	—	—	10
White (CaO)	—	—	—	27	27	27	—	25
White ($MgCO_3$)	91	96	89	—	—	—	11	10
White (MgO)	91	97	84	—	—	—	—	10
White (MgO)	—	—	—	33	37	40	—	25
White ($PbCO_3$)	93	89	71	—	—	—	7	10
White (SiO_2)	—	—	—	38	39	43	—	25
White (ThO_2)	90	93	53	—	—	—	—	10
White (Y_2O_3)	90	89	66	—	—	—	—	10
White (ZnO)	95	97	91	—	—	—	14	10
White (ZnO)	—	—	—	—	57	69	—	25
White (ZrO_2)	95	95	77	—	—	—	16	10

Table 3. *Paints*

Surface	Temperature °F					Ref.
	100	200	500	1000	5000	
	Emissivity, per cent					
Lacs and oils						
Dark glossy varnish	89	—	—	—	—	38
Spirit varnish	83	—	—	—	—	38
Gum lac	67	—	—	—	—	44
Gum, soft, colourless	86	—	—	—	—	44
Gum, hard, black	95	—	—	—	—	44
Oil on polished iron						
Very thin	6	—	—	—	—	38
0·0008 in. thick	22	—	—	—	—	38
0·0020 in. thick	45	—	—	—	—	38
0·0040 in. thick	65	—	—	—	—	38
0·0080 in. thick	81	—	—	—	—	38
Very thick	83	—	—	—	—	38
Linseed oil and Al foil						
Zero thickness	—	9	—	—	—	42
One coat oil	—	56	—	—	—	42
Two coats oil	—	57	—	—	—	42
Linseed oil varnish on Al sheet	—	56	—	—	—	47
Clear lac on bright copper						
Bright Copper	7	7	8	10·5	20	22
Bright copper with one thin coat	37	37	35	—	—	22
Bright copper with two thin coats	65	62	58	—	—	22
Clear lac on tarnished copper						
Tarnished copper	43	44	48	—	—	22
Tarnished copper with one thin coat	64	64	53	—	—	22
Tarnished copper with two thin coats	73	72	63	—	—	22
White lac on bright copper						
Thin coat	85	83	—	—	—	22
Heavy coat	92	92	—	—	—	22
White paint	—	95	91	71	—	23
White enamel	92	—	—	—	—	38
Red	97	96	91	84	—	24
Various colours of cellulose	—	—	—	—	—	2
Green	96	94	89	78	—	24
16 different colours	—	92–96	—	—	—	42
Lampblack paint	96	96	97	97	97	10
Matt black shellac	91	91	—	—	—	48
Black lacquer	80	95	—	—	—	21
Black lacquer	—	96	—	—	—	31
Flat black lacquer	96	98	—	—	—	21
Shiny black lacquer	82–87	—	—	—	—	38
Gold enamel	—	37	—	—	—	28
Enamelled steel						
Blue	—	—	—	—	73	3
Red	—	—	—	—	74	3
Green	—	—	—	—	81	3

Table 3. Paints—continued

Surface	Temperature °F					Ref.
	100	200	500	1000	5000	
	Emissivity, per cent					
Aluminium paints						
10% Al, 22% lac	—	52	—	—	—	42
26% Al, 27% lac	—	30	—	—	—	42
Al lac	—	29	—	—	—	39
Al lac one coat unpolished on bright copper	33	33	33	31	—	—
Al lac two coats polished on bright copper	26	26	26	25	—	—
Al paint, after heating to 620°F	—	35	35	—	—	—
Al bronze on iron	—	26	—	—	—	14
Al paint	—	27	—	—	—	31
Al paint	40	—	—	—	—	38
Al paint	69	55	39	—	—	28
Al paint	65	—	—	—	—	4
Al paint	—	39–62	—	—	—	47

Table 4. Miscellaneous substances

Surface	Temperature °F							Ref.
	100	500	1000	1500	2000	2500	5000	
	Emissivity, per cent							
White paper	—	89	—	—	—	—	—	39
White paper	95	85	69	—	51	—	25	10
Paper	93	—	—	—	—	—	—	38
Asbestos paper	93	94	94	—	—	—	—	21
Asbestos paper	93	—	—	—	—	—	—	31
Asbestos cloth	90	—	—	—	—	—	—	31
Asbestos board	96	—	—	—	—	—	—	38
Black velvet	97	96	96	—	—	—	—	10
Ordinary refractory brick	—	—	—	—	59	—	—	49
Sillimanite refractory brick	—	—	—	—	—	29	—	49
Silica refractory brick	—	—	—	—	66	—	—	49
Magnesite refractory brick	—	—	—	—	—	39	—	49
White refractory brick	—	89	63	—	29	—	—	23
Light buff refractory brick	—	—	80	—	53	—	—	23
Dark chrome refractory brick	—	—	94	—	98	—	—	23
Red brick refractory brick	88	—	—	—	—	—	—	10
Rough red brick	93	—	—	—	—	—	—	38
Glazed grey brick	—	—	—	—	75	—	—	35
Rough unglazed silica	—	—	—	—	80	—	—	35
Rough glazed silica	—	—	—	—	85	—	—	35
40 different refractories	—	—	63–84	—	77–91	—	—	52
Sandstone	83	90	90	—	—	—	—	10
Sandstones, various	—	—	—	—	—	—	—	2
Limestone	95	83	75	—	—	—	—	10
Limestones, various	—	—	—	—	—	—	—	2
Polished serpentine	90	—	—	—	—	—	—	38

Table 4. Miscellaneous substances—continued

Surface	Temperature °F							Ref.
	100	500	1000	1500	2000	2500	5000	
	Emissivity, per cent							
Granolith, pavement	—	—	—	—	—	—	—	10
Asphalt, pavement	—	—	—	—	—	—	—	10
Slate	—	—	—	—	—	—	—	10
White marble	95	94	93	—	—	—	—	10
White marble	—	—	—	—	—	—	—	2
Polished grey marble	93	—	—	—	—	—	—	38
Rough lime plaster	92	92	—	—	—	—	—	38
Plaster of Paris ($\frac{1}{2}$ mm)	91	—	—	—	—	—	—	38
Quartz powder	90	65	50	—	—	—	19	10
Fused quartz, rough	93	—	—	—	—	—	—	38
Opaque quartz (vitreosil)	—	93	80	68	—	—	—	33
Glazed porcelain	92	99	—	—	—	—	—	46
Glazed porcelain	93	—	—	—	—	—	—	38
Ball clay 60/40	—	93	67	44	—	—	—	33
Alumina ceramic	—	64	40	24	—	—	—	33
Thoria ceramic	—	58	33	19	—	—	—	33
Magnesia ceramic	—	55	36	18	—	—	—	33
White earthenware	86	—	—	—	—	—	—	39
Glass	88	—	—	—	—	—	—	39
Polished glass	95	—	—	—	—	—	—	38
Quartz glass (2 mm)	—	92	66	42	—	—	—	33
Pyrex glass	—	94	75	—	—	—	—	33
Mica	75	—	—	—	—	—	—	44
Planed oak	90	—	—	—	—	—	—	38
Beechwood	94	—	—	—	—	—	—	11
Sanded spruce	82	—	—	—	—	—	—	31
Sanded walnut	83	—	—	—	—	—	—	31
Water (0·1 mm or more thick)	96	—	—	—	—	—	—	38
Hoar frost (0·1–0·2 mm thick)	98	—	—	—	—	—	—	38
Ice	92–96 (at 32°F)	—	—	—	—	—	—	39
Rough emery	84	—	—	—	—	—	—	39
Polished graphite	42	97	97	—	—	—	—	33
Pressed graphite	—	49	44	—	64	—	73	9
Carbon filament	—	—	—	—	53	—	—	26
SiC_2 + 25% ball clay	—	100	97	73 (at 1800°F)	—	—	—	33
Hard, glossy rubber	94	—	—	—	—	—	—	38
Soft, rough, grey rubber	86	—	—	—	—	—	—	38

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