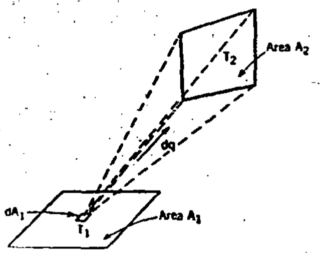


Fig. 3. Radiation Between Surfaces

radiation which exists. Emissivities or absorptivities (ϵ) for many common surfaces, are given in Table 3. The value of F_E for large parallel planes, long concentric cylinders, or large enclosed bodies is $1 \div (1/\epsilon_1 + 1/\epsilon_2 - 1)$.

The radiation under black-body conditions, or for an emissivity of 1.0, is given in Table 4[7] for cold surfaces as low as −39 F to warmer surfaces as high as 139 F. Some net radiation exchange solutions for several common radiation systems are given in Table 5.

There are several methods by which the geometrical factors F_A can be determined. One method involves the use of a mechanical geometrical integrator (Reference 8). Photographic and other methods are given in References 9 and 10.

Equivalent Conductance for Radiation

Although Equation 3 is a suitable equation for describing radiant exchange, it is not convenient for computations where other modes of energy transfer are operative. For such cases, it is convenient to define an *equivalent conductance for radiation* by the equation:

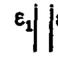
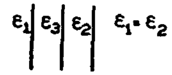
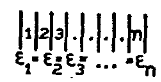
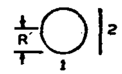
$$q_r = h_r A (t_1 - t_2) \tag{4}$$

Table 4. Heat Transmission by Radiation for Black-Body Conditions[a]
Expressed in Btu per (square foot) (hour)

Temp F Deg	0	−1	−2	−3	−4	−5	−6	−7	−8	−9
−30	59.3	58.7	58.2	57.7	57.2	56.7	56.2	55.7	55.2	54.7
−20	65.2	64.7	64.1	63.5	62.9	62.3	61.7	61.1	60.5	59.9
−10	71.4	70.8	70.1	69.5	68.9	68.3	67.7	67.1	66.4	65.8
0	78.0	77.4	76.7	76.0	75.4	74.7	74.0	73.4	72.7	72.1
	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0	78.0	78.7	79.4	80.1	80.8	81.5	82.2	82.9	83.6	84.3
10	85.0	85.7	86.5	87.2	88.0	88.7	89.4	90.2	90.9	91.7
20	92.4	93.3	94.0	94.8	95.6	96.4	97.2	98.0	98.8	99.6
30	100	101	102	103	104	105	105	106	107	108
40	109	110	111	112	112	113	114	115	116	117
50	118	119	120	121	122	123	123	124	125	126
60	127	128	129	130	131	132	133	134	135	136
70	137	138	139	140	142	143	144	145	146	147
80	148	149	150	151	152	153	154	155	156	157
90	159	160	161	162	163	164	166	167	168	169
100	170	171	173	174	175	176	178	179	180	182
110	183	184	185	187	188	189	191	192	193	195
120	196	197	199	200	201	203	204	206	207	209
130	211	212	214	215	217	218	220	221	222	224

[a] *Example:* Radiation from walls of room at 32 F to surface at −25 F for effective emissivity of 0.95 = (102 − 62.3) 0.95 = 37.7 Btu per (square foot) (hour).

Table 5. Net Radiation Solutions

System	Solution	Remarks
 Two infinite parallel planes.	$\frac{q_r}{A} = \frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} \sigma(T_1^4 - T_2^4)$	Considering interreflections. (Reference 5)
 One radiation shield between two infinite parallel planes.	$\frac{q_r}{A} = \left(\frac{1}{2}\right) \frac{1}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} \sigma(T_1^4 - T_2^4)$	Considering interreflections. (Reference 5)
 *n* radiation shields between two infinite parallel planes.	$\frac{q_r}{A} = \frac{1}{n+1} \left(\frac{q_r}{A}\right)_0$ where $\left(\frac{q_r}{A}\right)_0$ is the net radiation exchange without the shields.	Considering interreflections. (Reference 5)
 Two concentric spheres or two infinitely long cylinders.	$\frac{q_r}{A_1} = \frac{1}{\frac{1}{\epsilon_1} + \frac{A_1}{A_2}\left(\frac{1}{\epsilon_2} - 1\right)} \sigma(T_1^4 - T_2^4)$	Considering interreflections and diffuse surfaces. (Reference 5)
 Two areas dA_1 and dA_2	$\frac{dq_r}{dA_1} = \epsilon_1 \epsilon_2 \sigma F_A (T_1^4 - T_2^4)$	Surface diffuse, neglecting interreflection. (Reference 5)
 Tube of infinite length parallel to an infinite wall.	$\frac{q_r}{2\pi R N} = \left(\frac{1}{2}\right) \epsilon_1 \epsilon_2 \sigma (T_1^4 - T_2^4)$ where N is the length of cylinder from which q_r is exchanged	Neglecting interreflections. (Reference 5)
 Surfaces are perfect radiators. Surface element dA and rectangle above and parallel to it, with one corner of rectangle contained in normal to dA.	See Fig. 4	(Reference 4)
 Surfaces are perfect radiators. Adjacent rectangles in perpendicular planes.	See Fig. 5	(Reference 4)
 Surfaces are perfect radiators. Opposed parallel rectangles and disks of equal size.	See Fig. 6	(Reference 4)