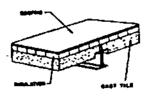
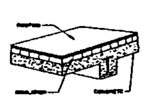
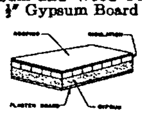
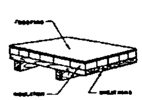
TABLE 11. SUMMER COEFFICIENTS OF HEAT TRANSMISSION U OF FLAT ROOFS COVERED WITH BUILT-UP ROOFING[a]

Btu per (hour) (square foot) (F deg difference between the air on the two sides)

Type of Roof Deck Ceiling not shown	Thickness of Roof Deck (Inches)	Insulation on Top of Deck (Covered With Built-Up Roofing)									
		No Ceiling—Underside of Roof Exposed					Furred Ceiling with Air Space, Metal Lath and Plaster				
		No Insulation	Insulating Board[d] Thickness, In. ½	1	1½	2	No Insulation	Insulating Board[d] Thickness, In. ½	1	1½	2
Flat Metal Roof Deck	4 Ply Felt Roof	0.73	0.35	0.23	0.17	0.13	0.40	0.25	0.18	0.14	0.12
	Ditto + ½ in. Slag	0.54	0.30	0.20	0.16	0.13	0.34	0.22	0.16	0.13	0.11
Precast Cement Tile	4 Ply Felt Roof 1½	0.67	0.33	0.22	0.17	0.13	0.38	0.24	0.18	0.14	0.12
	Ditto + ½ in. Slag 1½	0.50	0.28	0.20	0.15	0.12	0.32	0.21	0.17	0.13	0.11
Concrete	4 Ply Felt Roof 2	0.65	0.33	0.22	0.16	0.13	0.37	0.24	0.18	0.14	0.12
	4	0.59	0.31	0.21	0.16	0.13	0.36	0.23	0.17	0.13	0.12
	6	0.54	0.30	0.20	0.16	0.13	0.33	0.22	0.17	0.13	0.11
	Ditto + ½ in. Slag 2	0.49	0.28	0.20	0.15	0.12	0.31	0.21	0.16	0.13	0.11
	4	0.46	0.27	0.19	0.15	0.12	0.30	0.21	0.16	0.13	0.11
	6	0.42	0.26	0.19	0.14	0.12	0.29	0.20	0.16	0.13	0.10
Gypsum and Wood Fiber[b] on ½″ Gypsum Board	4 Ply Felt Roof 2½	0.34	0.23	0.17	0.13	0.12	0.25	0.18	0.14	0.12	0.097
	3½	0.28	0.20	0.15	0.12	0.11	0.21	0.16	0.13	0.11	0.094
	Ditto + ½ in. Slag 2½	0.29	0.20	0.16	0.13	0.11	0.22	0.16	0.13	0.11	0.093
	3½	0.25	0.18	0.14	0.12	0.10	0.19	0.15	0.13	0.10	0.090
Wood[c]	4 Ply Felt Roof 1	0.43	0.26	0.19	0.15	0.12	0.29	0.20	0.15	0.13	0.11
	1½	0.33	0.22	0.17	0.13	0.11	0.24	0.18	0.14	0.12	0.097
	2	0.29	0.20	0.16	0.13	0.11	0.22	0.16	0.13	0.11	0.094
	3	0.22	0.16	0.13	0.11	0.09	0.17	0.13	0.12	0.10	0.085
	Ditto + ½ in. Slag 1	0.35	0.23	0.17	0.14	0.11	0.25	0.18	0.14	0.12	0.10
	1½	0.29	0.20	0.15	0.12	0.10	0.21	0.17	0.13	0.11	0.093
	2	0.26	0.19	0.14	0.12	0.10	0.20	0.15	0.13	0.10	0.090
	3	0.20	0.15	0.12	0.10	0.09	0.16	0.13	0.11	0.09	0.081

[a] The summer coefficients are considered temporary, and have been calculated with an outdoor wind velocity of 8 mph. For summer an inside surface conductance of 1.2 has been used instead of the regular 1.65 value. In all of these roofs a 4 ply felt roof has been assumed ⅜ in. thick, thermal conductivity = 1.33. Pitch and slag have been assumed as an additional thickness of ½ in. which has been assigned thermal conductivity = 1.0. In both cases thermal conductivity refers to one *inch* thickness.

[b] 87½ percent gypsum, 12½ percent wood fiber. Thickness indicated includes ½ in. gypsum board. This is a poured roof.

[c] Nominal thickness of wood is specified, but actual thickness was used in calculations.

[d] If corkboard insulation is used, the coefficient U may be decreased 10 percent.

A method of determining *heat flow rates,* when structure is not given in Tables 9 or 10, is illustrated in *Example 7.*

Example 7: A 4 in. stone concrete roof covered with an average depth of 4 in. cinder concrete (k = 4.9) on which is placed a ⅜ in. thick felt roof with ½ in. pitch and slag surface, is exposed to the sun. The location is the central part of the United States.

Design temperatures are: outdoor 95 F; daily range 20 deg; indoor temperature 80 F. Find the heat flow rate at 2:00 p.m. for a day in July.

Solution: For the purpose of selecting the *equivalent temperature differential,* this construction is assumed to be equal approximately to an uninsulated 6 in. concrete roof, for which the equivalent temperature is found to be 38 deg in the 2:00 p.m. column of Table 9. Calculate the overall heat transmission coefficient U (see Equation 3 of Chapter 9) of the roof as follows:

$$U = \frac{1}{\frac{1}{1.2} + \frac{4}{12} + \frac{4}{4.9} + \frac{0.375}{1.33} + \frac{0.50}{1.00} + \frac{1}{4.0}} = 0.33.$$

The heat flow rate is then 38 × 0.33 equals 12.5 Btu per (hr) (sq ft).

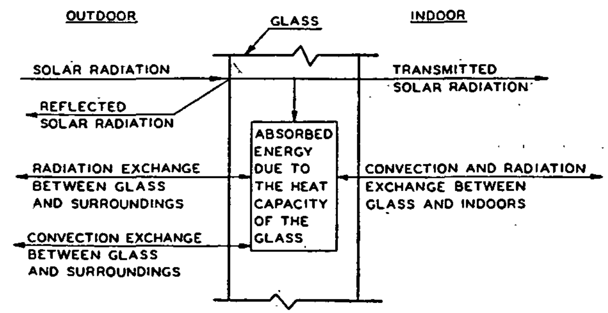


FIG. 2. INSTANTANEOUS HEAT-BALANCE FOR A GLASS OR GLASS BLOCK SECTION

TABLES FOR CALCULATING SOLAR HEAT GAIN THROUGH GLASS AREAS

Basic Principles

In order to set forth the principles involved in calculating heat flow through glass areas, the general instantaneous heat-balance relation will be presented. It will be shown schematically in Fig. 2. The net heat gain for the indoor space is the result of several contributing factors.

The following observations concerning the behavior of glass with respect to radiant energy will lead to a better understanding of the heat-balance relation.

1. Glass transmits, in varying degrees, radiation having wave lengths between 0.29 and 4.75 microns. The percentage of each wave length transmitted is dependent upon the chemical and physical characteristics of the glass, and upon the angle of incidence of the radiant energy. Of the energy not transmitted, part is absorbed and part reflected.
2. Glass is opaque to radiant energy emitted from sources below 450 F.
3. Because of the above principles, it is convenient to group radiant energy into two classifications, solar radiant energy and low-temperature radiant energy.

The complete heat-balance for a glass section can be expressed for a unit time interval as follows:

$$\begin{bmatrix}\text{Total heat flow,} \\ \text{through glass section}\end{bmatrix} = \begin{bmatrix}\text{Transmitted,} \\ \text{solar radiation}\end{bmatrix} \pm \begin{bmatrix}\text{Heat flow by convective} \\ \text{and radiative exchanges at} \\ \text{the indoor surface}\end{bmatrix} \quad (2a)$$

The second term of the right side of Equation 2a can also be expressed by a heat balance equation as follows: