

through. A small amount is reflected and a portion is absorbed by the glass. The amount absorbed depends upon the character and thickness of the glass and the angle between it and the sun's rays. The temperature of the glass is raised by the absorbed heat and this heat is then delivered to the air on each side in proportion to the difference between the glass and air temperatures⁷.

The A.S.H.V.E. tests⁸ indicate that a single pane of double strength glass 0.127 in. thick absorbs approximately 11 per cent of the solar radiation passing through it when the impingement is normal. For smaller angles of impingement, the glass retards percentages of the total radiant energy approximately in proportion to the sine of the angle.

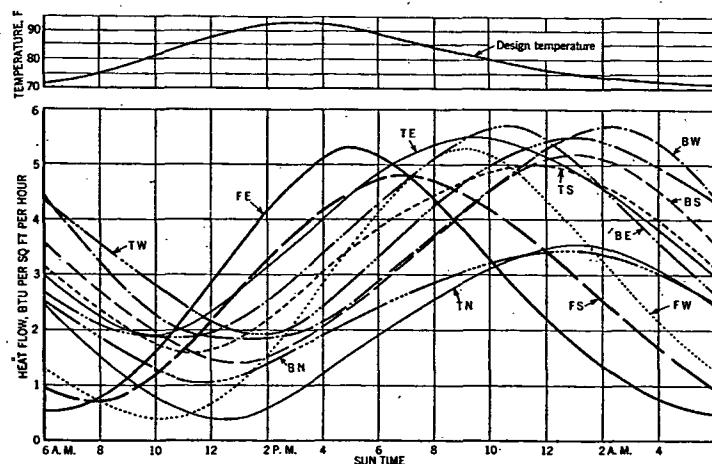


FIG. 3. RELATION BETWEEN TIME AND HEAT FLOW THROUGH THE INSIDE SURFACE OF WALLS OF DIFFERENT CONSTRUCTION AND ORIENTATION ON A 93 F DESIGN DAY WITH 90 PER CENT OF DESIGN SOLAR RADIATION

Walls BE, BS, BW and BN—12 in. solid brick and plaster facing east, south, west and north respectively.
Walls TE, TS, TW and TN—4 in. brick veneer, 8 in. tile and plaster facing east, south, west and north respectively.
Walls FE, FS and FW—4 in. brick veneer, building paper, 7/8 in., matched sheathing, 2 x 4 in. studs, metal lath and plaster facing east, south and west respectively.

The amount of solar radiation delivered to an unshaded glass surface may be obtained from Tables 2, 3, 4 or 5. These values must be used only for the net glass area on which the sun shines and not the entire glass area. Tests at the A.S.H.V.E. Research Laboratory⁹ have determined the percentage of heat from solar radiation actually delivered to a room with various types of outdoor and indoor shading. The data in Table 7 are taken from these tests.

The percentage values in this table were obtained by dividing the total amount of heat actually entering through the shaded window by the total amount of heat calculated to enter through a bare window (solar

⁷Heat Absorbing Glass Windows, by W. W. Shaver (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 287).

⁸A.S.H.V.E. RESEARCH REPORT No. 974—Radiation of Energy Through Glass, by J. L. Blackshaw and F. C. Houghten (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 93). A.S.H.V.E. RESEARCH REPORT No. 975—Studies of Solar Radiation Through Bare and Shaded Windows, by F. C. Houghten, Carl Gutberlet, and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 101). A.S.H.V.E. RESEARCH REPORT No. 1180—Heat Gain Through Western Windows With and Without Shading, by F. C. Houghten and David Shore (A.S.H.V.E. TRANSACTIONS, Vol. 47, 1941, p. 251).

⁹Loc. Cit. Note 8.

TABLE 6. TIME LAG IN TRANSMISSION OF SOLAR RADIATION THROUGH WALLS AND ROOFS

TYPE AND THICKNESS OF WALL OR ROOF	TIME LAG, HOURS
1-in. yellow pine horizontal roof, water proofing, smooth black finish.....	1
2-in. yellow pine horizontal roof, water proofing, smooth black finish.....	1 3/4
4-in. reinforced clay tile horizontal roof, water proofing, slag finish.....	2 1/4
2-in. gypsum horizontal roof, water proofing, slag finish.....	2 1/4
Slate and slaters felt on 2 1/4 in. tongue and grooved yellow pine, sloped roof	2 1/2
4-in. gypsum horizontal roof, water proofing, slag finish.....	4 1/2
6-in. concrete horizontal roof, water proofing, slag finish.....	5
1-in. concrete, 4-in. cinders, 1 1/2-in. concrete, water proofing, smooth black finish.....	8
Wood siding, 1-in. sheathing, 2 x 4 studs, lath and plaster.....	2
Wood siding, 1-in. sheathing, 2 x 4 studs (studding space filled with insulation) lath and plaster.....	5
4-in. brick, 1-in. sheathing, 2 x 4 studs, lath and plaster.....	7
4-in. brick, 8-in. tile and plaster.....	10 1/2
13-in. brick, plastered.....	12
9-in. brick, 3 3/4-in. tile, 5 1/4-in. air space, 3 3/4-in. tile and 1 1/4-in. plaster....	16

radiation plus glass transmission, based on observed outside glass temperature). For bare windows on which the sun shines, the transmission of heat from outside air to glass may be small or negative as the glass temperature is raised by the solar radiation absorbed.

In calculating the total heat gain through windows on the sunny side of buildings, it is sufficiently accurate to proceed as outlined herewith:

Consider the total heat gain as that resulting from solar radiation and neglect the heat transmission through the glass caused by the difference between the temperatures of the inside and outside air. This method should be used except at times when the calculated heat gain per square foot due to normal transmission exceeds the solar intensity. At such times, solar radiation may be neglected and the total heat gain considered as resulting from normal transmission.

The solar heat transmission through windows or skylights may be expressed by the formula:

$$H_G = A_G f I \quad (2)$$

where

H_G = solar radiation transmitted through a window, Btu per hour.

A_G = net area of glass exposed to sun's rays, square feet.

f = percentage of solar radiation (expressed as a decimal) transmitted to the inside (Table 7). For bare windows, $f = 1$.

I = intensity of solar radiation striking surface, Btu per hour per square foot (Tables 2, 3, 4 and 5).

TABLE 7. SOLAR RADIATION TRANSMITTED THROUGH SHADED WINDOWS

TYPE OF APERTURE	FINISH FACING SUN	PER CENT DELIVERED TO ROOM
Canvas awning.....	Plain	28
Canvas awning.....	Aluminum	22
Inside shade, fully drawn.....	Aluminum	45
Inside shade, one-half drawn.....	Buff	68
Inside Venetian blind, fully covering window, slats at 45 deg.....	Aluminum	58
Outside Venetian blind, fully covering window, slats at 45 deg.....	Aluminum	22