

time lag⁴ in the transmission of heat through them as shown by the curves. For the types of construction covered in Figs. 2 and 3 and for the conditions indicated, the heat flow through the inside surface at any given time can be read directly. For other types of construction, the curves may be used as a guide in estimating the heat flow. The time lag for other types of construction is included in Table 6 which was prepared by the A.S.H.V.E. Laboratory from data collected by it and by other authorities.

Solar Radiation Transmitted Through Glass

Windows present a problem somewhat different from that of opaque walls, because they permit a large percentage of the solar energy to pass

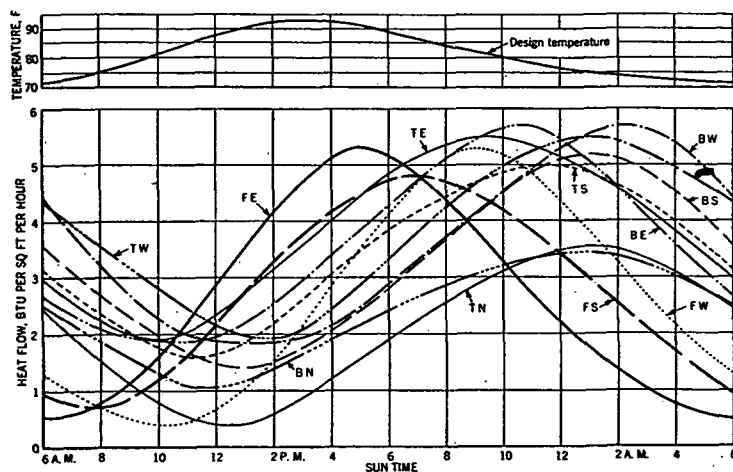


FIG. 3. RELATION BETWEEN TIME AND HEAT FLOW THROUGH THE INSIDE SURFACE OF WALLS OF DIFFERENT CONSTRUCTION AND ORIENTATION ON A 93 F DESIGN DAY WITH 90 PER CENT OF DESIGN SOLAR RADIATION

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, $\frac{3}{8}$ in., matched sheathing, 2 x 4 in. studs, metal lath and plaster facing east, south and west respectively.

through. A small amount is reflected and the balance 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 temperatures⁵.

The A.S.H.V.E. tests⁶ indicate that a single pane of double strength glass 0.127 in. thick absorbs approximately 11 per cent of the solar

⁴Loc. Cit. Note 2.

⁵Heat Absorbing Glass Windows, by W. W. Shaver (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 287).

⁶A.S.H.V.E. RESEARCH REPORT No. 974—Radiation of Energy Through Glass, by J. L. Blackshaw and F. C. Houghton (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. Houghton, Carl Gutberlet, and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 101).

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 $\frac{3}{4}$
4-in. reinforced clay tile horizontal roof, water proofing, slag finish.....	2 $\frac{1}{4}$
2-in. gypsum horizontal roof, water proofing, slag finish.....	2 $\frac{1}{4}$
Slate and slaters felt on 2 $\frac{1}{4}$ in. tongue and grooved yellow pine, sloped roof.....	2 $\frac{1}{2}$
4-in. gypsum horizontal roof, water proofing, slag finish.....	4 $\frac{1}{2}$
6-in. concrete horizontal roof, water proofing, slag finish.....	5
1-in. concrete, 4-in. cinders, 1 $\frac{1}{2}$ -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 $\frac{1}{2}$
13-in. brick, plastered.....	12
9-in. brick, 3 $\frac{3}{4}$ -in. tile, 5 $\frac{1}{4}$ -in. air space, 3 $\frac{3}{4}$ -in. tile and 1 $\frac{1}{4}$ -in. plaster....	16

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.

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 Laboratory⁷ 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 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:

TABLE 7. SOLAR RADIATION TRANSMITTED THROUGH SHADED WINDOWS

TYPE OF APERTURANCE	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

*Loc. Cit. Note 6.