are also given. Normal incidence transmittance values for some commonly-used types and combinations are given in Table 18. Some variation in these values can be expected in practice due to variations in manufacture and in solar energy distribution. However, a change in transmissivity causes an approximately equal and opposite change in absorptivity. Hence, the *total heat flow* is not greatly altered. Transmittance data for other types of glass and various patterns of 8-in. glass block are given in A.S.H.V.E. research papers.[16, 17, 18, 19]

As stated earlier in this chapter, present data as to the value of R_s are inadequate, so for the present it is suggested that f_{co} be increased to include radiation, and the term $\epsilon_{go}R_s - \epsilon_{go}R_{go}$ be disregarded. It is not practicable to give values of S in this chapter. However, for ordinary glass, the value of S is small.

Fig. 4 is a graphical solution, for single glass, of Equation 7b. Only

TABLE 15. TRANSMITTANCES AND ABSORPTANCES OF COMMON WINDOW GLASS FOR DIRECT AND DIFFUSE SOLAR RADIATION

ANGLE OF INCIDENCE, θ, DEG	SINGLE SHEETS		TWO AIR-SPACED SHEETS		
	τ_D	α_D	τ_D	α_D Outdoor Sheet	α_D Indoor Sheet
	FOR DIRECT RADIATION				
0	0.87	0.05	0.76	0.06	0.04
20	0.87	0.05	0.76	0.06	0.04
40	0.86	0.06	0.74	0.06	0.04
50	0.84	0.06	0.72	0.07	0.05
60	0.79	0.06	0.66	0.07	0.05
70	0.67	0.06	0.52	0.07	0.05
80	0.42	0.06	0.25	0.07	0.05
90	0.0	0.0	0.0	0.0	0.05
	FOR DIFFUSE OR SKY SOLAR RADIATION				
	0.79	0.06	0.68	0.07	0.05

absorbed solar radiation is considered, although low temperature radiation exchange and heat storage can be added algebraically to $\alpha_t I_t$ if such data are available. The small thermal resistance of the glass has been neglected. The heat flow rates are for a 75 F indoor temperature, an indoor surface conductance for convection f_{ci} as given by Equation 8, and an equivalent surface conductance for radiation f_{ri} as given by Equation 9. Indoor surfaces seen by the glass are assumed to radiate as a black body at room air temperature.

$$f_{ci} = 0.27\ (t_{gi} - t_i)^{0.25} \tag{8}$$

$$f_{ri} = 0.162 \left[\left(\frac{t_{gi} + 460}{100}\right)^4 - \left(\frac{t_i + 460}{100}\right)^4\right] \Big/ (t_{gi} - t_i) \tag{9}$$

where

t_{gi} = temperature of indoor surface of glass, Fahrenheit degrees.
t_i = temperature of indoor air, Fahrenheit degrees.

A more complete treatment of the problem is given in an A.S.H.V.E. research paper.[19]

Example 13. Find the total heat gain at 10 a.m. sun time for a single unshaded sheet of common window glass in a wall facing 18 deg east of south on August 1 at

50 deg north latitude. The indoor temperature is 75 F, the outdoor temperature is 83 F. Use clear atmosphere radiation values and f_{co} = 4.0.

Solution. From Example 2, K is 0.557; hence, the angle of incidence, θ, is 56 deg 9 min. From Example 4, I_D = 152.0, I_d = 26.6. By interpolation in Table 15, τ_D is found to be 0.81, α_D is 0.06; τ_d and α_d are 0.79 and 0.06, respectively.

The heat gain due to transmitted solar radiation is:

$$(q/A)_r = 152.0 \times 0.81 + 26.6 \times 0.79 = 144.1 \text{ Btu per (hr)(sq ft).}$$

The heat gain by convection and radiation from the indoor surface is found from Fig. 4:

$$t_o + \frac{\alpha_t I_t}{f_{co}} = 83 + \frac{0.06\ (152.0 + 26.6)}{4} = 85.7 \text{ F}$$

from which

$$(q/A)_{cr} = 11.5 \text{ Btu per (hr)(sq ft).}$$

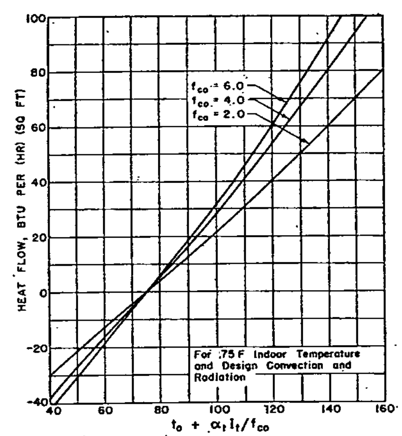

FIG. 4. CONVECTION AND RADIATION HEAT FLOW FOR VERTICAL SINGLE GLASS

From equation (7a) the total heat flow is

$$(q/A) = 144.1 + 11.5 = 155.6 \text{ Btu per (hr)(sq ft).}$$

Design Tables for Flat Glass

Tables 16 and 17 give design values of instantaneous rates of heat gain for *single unshaded common window glass* for a solar declination of 18 deg. This corresponds to a nominal August 1 day. The tables are based upon the solar intensity values for a clear atmosphere as given in Table 5. Table 16 represents the first bracketed term of Equation 7a; therefore, the values are dependent only upon values of I and τ. Table 17 is the second term of Equation 7a, and is based upon a 75 F indoor temperature and a dry-bulb temperature cycle, with a 95 F maximum as tabulated. *The total heat gain is the sum* of the Table 16 and Table 17 values. In preparing Table 17, convection and radiation heat exchange were combined; and a combined surface conductance of 4.0 used. Corrections to be applied for