(U). This applies to *pitched roofs*. In the case of *flat roofs* it is not necessary to calculate the attic temperatures, as the ceiling-roof heat loss can be determined as suggested in paragraph 1a.

INFILTRATION HEAT LOSS

The infiltration heat loss includes (1) the *sensible heat loss* or the heat required to warm the outside air entering by infiltration and (2) the *latent heat loss* or the heat equivalent of any moisture which must be added.

Sensible Heat Loss

The formula for the heat required to warm the outside air which enters a room by infiltration to the temperature of the room, is given in Equation 5:

$$H_s = 0.240\ Qd\ (t - t_o) \tag{5}$$

where

H_s = heat required to raise temperature of air leaking into building from t_o to t, Btu per hour.

0.240 = specific heat of air.

Q = volume of outside air entering building, cubic feet per hour (see Chapter 10).

d = density of air at temperature t_o, pounds per cubic foot.

It is sufficiently accurate to use $d = 0.075$ in which case Equation 5 reduces to

$$H_s = 0.018\ Q\ (t - t_o) \tag{5a}$$

The volume of outside air entering per hour (Q) depends on the wind velocity and direction, the width of crack or size of openings, the type of openings and other factors, as explained in Chapter 10. Where the crack method is used for estimating leakage, it is more convenient to express the air leakage heat loss in terms of the crack length:

$$H_s = B\ L\ (t - t_o) \tag{5b}$$

where

B = air leakage per (hour) (foot of crack) (Chapter 10) for the wind velocity and type of windows or door crack involved, multiplied by 0.018.

L = length of window or door crack to be taken into consideration, feet.

Example 4. What is the infiltration heat loss per hour through the crack of a 3 x 5 ft average, double-hung, non-weatherstripped, wood window, based on a wind velocity of 15 mph? Assume inside and outside temperatures to be 70 F and zero, respectively.

Solution. According to Table 2, Chapter 10, the air leakage through a window of this type (based on $\frac{1}{16}$ in. crack and $\frac{3}{32}$ in. clearance) is 39 cu ft per (ft of crack) (hour). Therefore, $B = 39 \times 0.018 = 0.70$. The length of crack ($L$) is $(2 \times 5) + (3 \times 3)$, or 19 ft; $t = 70$ and $t_o = 0$. Substituting in Equation 5b,

$$H_s = 0.70 \times 19 \times (70 - 0) = 931 \text{ Btu per hour.}$$

Number of Air Changes to be Used for Computations

Since a certain amount of judgment regarding quality of construction, weather conditions, use of room and other factors is required in estimating infiltration by any method, some designers base infiltration upon an estimated number of air changes rather than upon the length of window cracks.

Table 4 of Chapter 10 indicates air changes commonly used but should be taken only as a guide. For further discussion of the method see section on Air Change Method in Chapter 10.

Crack Length to be Used for Computations

For designers who prefer to use the crack method the basis of calculation is as follows: The amount of crack used for computing the infiltration heat loss should be not less than half of the total length of crack in the outside walls of the room. For a building having no partitions, air entering through the cracks on the windward side must leave through the cracks on the leeward side. Therefore, take one-half the total crack for computing each side and end of the building. In a room with one exposed wall, take all the crack; with two exposed walls, take the wall having the most crack; and with three or four exposed walls, take the wall having the most crack; but in no case take less than half the total crack.

The total infiltration loss of a building having partitions will not be equal to the sum of the infiltration losses of the various rooms, since at any given time infiltration will take place only on the windward side or sides and not on the leeward side. Therefore, if a building has more than one room which is divided by interior walls or partitions, it is sufficiently accurate to use half of the total infiltration losses for determining the total heat requirements.

Latent Heat Loss

When it is intended to add moisture to air leaking into a room in order to maintain proper winter comfort conditions, it is necessary to determine the heat required to evaporate the water vapor added, which may be calculated by the equation:

$$H_l = Qd\left(\frac{m_i - m_o}{7000}\right) h_{tg} \tag{6}$$

where

H_l = heat required to increase moisture content of air leaking into building from m_o to m_i, Btu per hour.

Q = volume of outside air entering building, cubic feet per hour.

d = density of air at temperature t_i, pounds per cubic foot.

m_i = vapor density of inside air, grains per pound of dry air.

m_o = vapor density of outside air, grains per pound of dry air.

h_{tg} = latent heat of vapor at m_i, Btu per pound.

If the latent heat of vapor (h_{fg}) is assumed to be 1060 Btu per lb, Equation 6 reduces to:

$$H_l = 0.0114\ Q\ (m_i - m_o) \tag{6a}$$

Equations 5a, 5b and 6a may also be used for determining the sensible and latent heat gains due to infiltration in cooling load computations.

SELECTION OF WIND VELOCITIES

The effect of wind on the heating requirements of any building should be given consideration under two heads:

1. Wind movement increases the heat transmission of walls, glass, and roof, affecting poor walls to a much greater extent than good walls.