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 4.

$$H_s = 0.24\,Qd\,(t - t_o) \tag{4}$$

where

H_s = heat required to raise temperature of air leaking into building from t_o to t, Btu per hour.
0.24 = specific heat of air.
Q = volume of outside air entering building, cubic feet per hour (see Chapter 5).
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 4 reduces to

$$H_s = 0.018\,Q\,(t - t_o) \tag{4a}$$

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 5. Where the crack method is used for estimating the amount of air leakage, it is more convenient to express the heat loss due to air leakage in terms of the crack length, as follows:

$$H_s = 0.018\,Q\,L\,(t - t_o) = B\,L\,(t - t_o) \tag{4b}$$

where

B = air leakage per foot of crack (Chapter 5) 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 double-hung wood window, based on an average non-weatherstripped window and a wind velocity of 15 mph? Assume inside and outside temperatures to be 70 F and zero respectively.

Solution. According to Table 2, Chapter 5, the air leakage through a window of this type (based on 1/16 in. crack and 3/64 in. clearance) is 39 cu ft per foot of crack per 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 4b,

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

Crack Length to be Used for Computations

The amount of crack used for computing the infiltration heat loss should not be less than half of the total crack in the outside walls of the room. For a building having no partitions, whatever wind enters 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 for the maintenance of proper winter comfort conditions, it is necessary to determine the heat equivalent to evaporate the required amount of water vapor, which may be calculated by the equation:

$$H_l = Q\,d\left(\frac{m_i - m_o}{7000}\right) h_{fg} \tag{5}$$

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_{fg} = 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 pound, Equation 5 reduces to

$$H_l = 0.0114\,Q\,(m_i - m_o) \tag{5a}$$

Equations 4a, 4b and 5a 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.
2. Wind movement materially increases the infiltration (inleakage) of cold air through the cracks around doors and windows, and even through the building materials themselves, if such materials are at all porous.

Theoretically as a basis for design, the most unfavorable combination of temperature and wind velocity should be chosen. It is entirely possible that a building might require more heat on a windy day with a moderately low outside temperature than on a quiet day with a much lower outside temperature. However, the combination of wind and temperature which is the worst would differ with different buildings, because wind velocity has a greater effect on buildings which have relatively high infiltration losses. It would be possible to work out the heating load for a building for several different combinations of temperature and wind velocity which records show to have occurred and to select the worst combination; but designers generally do not feel that such a degree of refinement is justified.

It has been the practice for many years in estimating air leakage by the crack method to use the *average* wind velocity during the months of December, January and February. This *average* wind velocity may not necessarily correspond with that occurring during periods when the