11 ● The characteristics of air supplied to ventilate a room are:

Carbon dioxide concentration	4 parts per 10,000
Wet-bulb temperature	45.2 F
Dry-bulb temperature	55.0 F
Moisture content	29.0 grains per pound of dry air

a. What will be the dry-bulb temperature of the air in the room if it is occupied by five adults, if the air change, including both ventilation and infiltration, is 50 cu ft per minute, and assuming that there is no heat gain or loss to the room from any source other than from the occupants?

b. What will be the carbon dioxide concentration of the air in the room under these conditions?

c. What will be the moisture content of the air in the room under these conditions?

d. What will be the wet-bulb temperature and the relative humidity of the air in the room under these conditions?

e. What would the temperature of the incoming air have to be to give a room a dry-bulb temperature of 70 F?

a. The air change is 10 cu ft per minute per occupant. From the bottom chart of Fig. 6 at the intersection of an incoming air dry-bulb temperature of 55.0 F and a rate of air supply of 10 cu ft per minute per occupant, find by interpolation between the 70 F and 80 F adult curves the dry-bulb temperature of the air in the room to be 78.0 F.

b. From the top chart of Fig. 6 find the increase in CO_2 concentration to be 10 parts of CO_2 per 10,000 parts of air. Therefore, the air in the occupied room will contain 14 parts of CO_2 per 10,000.

c. From the center chart in Fig. 6 find by interpolation between the 70 F and 80 F adult curves the increase in moisture content to be 23 grains per pound of dry air for adults in 78 F air. This gives a resultant moisture content of the air in the room of 52 grains per pound of dry air.

d. From the psychrometric chart, Fig. 5, find the resulting wet-bulb temperature and relative humidity for 78 F dry-bulb and 52 grains of moisture to be 61.0 F and 37 per cent, respectively.

e. From the bottom chart, Fig. 6, find the required incoming air temperature to be 42 F dry-bulb.

12 ● Referring to the A.S.H.V.E. Comfort Chart (Fig. 5), list the conditions (dry-bulb, wet-bulb, effective temperature, and humidity) which will produce comfort at each corner of the average winter comfort zone and of the average summer comfort zone.

Average winter comfort zone:

Wet-Bulb F	Dry-Bulb F	Relative Humidity
58.5	64.5	70 per cent
51.5	67.5	30 per cent
59.0	79.0	30 per cent
67.0	74.0	70 per cent

Average summer comfort zone:

Wet-Bulb F	Dry-Bulb F	Relative Humidity
62.0	68.0	70 per cent
54.0	72.0	30 per cent
63.5	85.0	30 per cent
71.5	78.5	70 per cent

Chapter 4

NATURAL VENTILATION

Wind Forces, Stack Effect, Openings, Windows, Doors, Skylights, Roof Ventilators, Stacks, Principles of Control, General Rules, Measurements, Dairy Barn Ventilation, Garage Ventilation

VENTILATION by natural forces, supplemented in certain cases with mechanical forces, finds extensive application in industrial plants, public buildings, schools, dwellings, garages, and in farm buildings.

The natural forces available for the displacement of air in buildings are the wind and the difference in temperature of the air inside and outside the building. The arrangement and control of ventilating openings should be such that the two forces act coöperatively and not in opposition.

Wind Forces

In considering the use of natural wind forces for the operation of a ventilating system, account must be taken of (1) average and minimum wind velocities, (2) wind direction, (3) seasonal, daily and hourly variations in wind velocity and direction, and (4) local wind interference by buildings and trees.

Table 1, Chapter 8, gives values for the average summer wind velocities and the prevailing wind directions in various localities throughout the United States, while Table 2, Chapter 7, lists similar values for the winter. In almost all localities the summer wind velocities are lower than those in the winter, and in about two-thirds of the localities the prevailing direction is different during the summer and winter. While average wind velocities are seldom below 5 mph, there are many hours in each month during which the wind velocity is from 3 to 5 mph, even in localities where the seasonal average is considerably above 5 mph. There are relatively few places where the hourly wind velocity falls much below 3 mph for more than 10 daylight hours per month. Usually a natural ventilating system should be designed to operate satisfactorily with a wind velocity of 3 to 6 mph, depending on locality.

The following formula may be used for calculating the quantity of air forced through ventilation openings by the wind, or for determining the proper size of such openings:

$$Q = EAV \qquad (1)$$

where

Q = air flow in cubic feet per minute.
A = free area of inlet (or outlet) openings in square feet.
V = wind velocity in feet per minute,
= miles per hour × 88.
E = effectiveness of openings.

(E should be taken at from 50 to 60 per cent if the inlet openings face the wind and from 25 to 35 per cent if the inlet openings receive the wind at an angle.)