Leaving Air: Humidity, $H = 0.0355$ lb water vapor per pound dry air.
Per Cent Humidity, $\% H = 32$

Water pick up $= 0.0355 - 0.01 = 0.0255$ lb per pound bone dry air.

Bone dry air circulated per hour $= 250 \div 0.0255 = 9800$ lb.

Volume of air circulated at 80 F dry-bulb, and 46 per cent humidity
$14.1 - 13.6 = 0.5$ cu ft vapor (Fig. 4).

Volume $= 13.6 + (0.46 \times 0.5) = 13.87$ cu ft $= 1$ lb dry air + vapor.

Volume handled by fan at 80 F $= \dfrac{9800 \times 13.87}{60} = 2260$ cfm.

Btu received by water $= (130 - 70) \times 1.0 = 60$

Latent heat of steam at 130 F (Fig. 4) $=$ 1019

Total $=$ 1079 Btu per pound.

Heat used for evaporation per pound dry air $= 1079 \times 0.0255 = 27.43$ Btu.

For entering air: Humidity, $H = 0.01$, Humid Heat $= 0.2425$ Btu per pound (Fig. 4)

$$(t_1 - t_2) \times S = \text{Btu for evaporation}$$
$$(t_1 - 130) \times 0.2425 = 27.43$$
$$t_1 = 247 \text{ F}$$

6 ● Given the following conditions, air 160 F dry-bulb, 49.6 per cent relative humidity (Φ), 29.92 in. Hg, barometric pressure, find the per cent H, absolute humidity.

For 160 F, $p_s = 9.65$ in. Hg (From Table 6, Chapter 1)

$$p = \Phi p_s = 0.496 \times 9.65 = 4.78$$

$$\frac{29.92 - 9.65}{29.92 - 4.78} \times 0.496 = 0.40 \text{ or } 40 \text{ per cent absolute humidity.}$$

Chapter 36

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 cooperatively 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:

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

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 $\times$ 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.)