

with dry- and wet-bulb temperatures of 65 F and 59 F, respectively, (63.1 deg ET) must be supplied per hour to an auditorium containing 1000 people in order that the inside shall not exceed 75 F (dry-bulb) and 65 F (wet-bulb), respectively?

Solution. Figs. 5 and 6 give 265 Btu sensible heat and 905 grains of moisture as the additions per person with a dry-bulb temperature of 75 F in the auditorium. Therefore 265,000 Btu of sensible heat and 905,000 grains of moisture will be added to the air in the auditorium per hour.

Taking 0.24 as the specific heat of air, 2.4 Btu per pound of air will be required to raise the dry-bulb temperature from 65 to 75 F and $\frac{265,000}{2.4} = 110,400$ lb of air or $110,400 \times 13.4 = 1,479,000$ cfh of air will be required. This is equivalent to $\frac{1,479,000}{1000 \times 60} = 24.7$ cfm per person.

The moisture content of the inside air as taken from a psychrometric chart is 76 grains per pound of dry air and that of the outside condition is 65 grains. The increase in moisture content will therefore be 11 grains per pound of dry air. Hence $\frac{905,000}{11.0} = 82,300$ lb of air at the specified condition will be required. This is equivalent to $82,300 \times 13.4 = 1,103,000$ cfh of air or $\frac{1,103,000}{1000 \times 60} = 18.4$ cfm of air per person.

The higher volume of 24.7 cfm per person will be required to keep the dry-bulb temperature from rising above the 75 F specified. The wet-bulb temperature will therefore not rise to the maximum of 65 F.

Example 8. Assume that a man performs work at a rate equivalent to 50,000 ft-lb per hour, in an atmosphere having a dry-bulb temperature of 70 F. Estimate the sensible and latent heat given off per hour.

Solution. Since the net mechanical efficiency of the human body is about 20 per cent, the increase in metabolism due to work, over the resting metabolism, will be $\frac{50,000}{778} \times 0.20 = 320$ Btu per hour. Assuming a resting metabolism of 400 Btu per hour (see Fig. 4), the total metabolism during work will be $400 + 320 = 720$ Btu per hour, and the total heat loss $720 - \frac{50,000}{778} = 656$ Btu per hour approximately. In Fig. 7, follow a vertical line from a dry-bulb temperature of 70 F to a point midway between Curves A and B. The sensible heat loss is about 46 per cent of the total loss, or $0.46 \times 656 = 302$ Btu per hour, and the latent heat 54 per cent of the total or $0.54 \times 656 = 354$ Btu per hour.

In cases in which the external work is not appreciable, as for instance in sewing, walking on a level road, and the like, the rate of heat loss will be approximately equal to the total metabolism.

*Heat equivalent of mechanical work in foot-pounds per Btu.

Chapter 3

INDUSTRIAL AIR CONDITIONING

Moisture Content and Regain, Hygroscopic Materials, Atmospheric Conditions Required, Air Conditioning of Libraries, Banana Ripening, Greenhouse Heating, Apparatus for Industrial Conditioning, Industrial Humidifying Systems, Direct Humidifiers, Combined Direct and Indirect Humidifiers, Dehumidifiers

IN many industries, the temperature and relative humidity of the air have a marked influence upon the rate of production and the weight, strength, appearance, and general quality of the product. These results are due to the fact that most materials of animal or vegetable origin, and to a lesser extent minerals in certain forms, either take up or give moisture to the surrounding air. Air conditioning is applicable to industrial or process conditioning for the improvement of products during manufacture, or for making the process independent of climatic conditions.

MOISTURE CONTENT AND REGAIN

The terms *moisture content* and *regain* refer to the amount of moisture in hygroscopic materials. *Moisture content* is the more general term and refers either to free moisture (as in a sponge) or to hygroscopic moisture (which varies with atmospheric conditions). It is usually expressed as a percentage of the total weight of material. *Regain* is more specific and refers only to hygroscopic moisture. It is expressed as a percentage of the bone-dry weight of material. For example, if a sample of cloth weighing 100.0 grains, is dried to a constant weight of 93.0 grains, the loss in weight, or 7.0 grains, represents the weight of moisture originally contained. This expressed as a percentage of the total weight (100.0 grains) gives the moisture content or 7 per cent. The regain, which is expressed as a percentage of the bone-dry weight, is $\frac{7.0}{93.0}$ or 7.5 per cent.

The use of the term *regain* does not necessarily imply that the material as a whole has been completely dried out and has re-absorbed moisture. In the case of certain textiles; for instance, complete drying during manufacturing is avoided as it might appreciably reduce the ability of the material to re-absorb moisture. In measuring moisture it is necessary to dry out a sample so that the loss in weight may be used as a basis for calculating the regain of the whole lot.

HYGROSCOPIC MATERIALS

Air conditioning is extensively used in the manufacture or processing of hygroscopic materials such as textiles, paper, wood, leather, tobacco and