PROBLEMS IN PRACTICE

1 ● What are the most comfortable air conditions?

Comfort standards are not absolute, but they are greatly affected by the physical condition of the individual, and the climate, season, age, sex, clothing, and physical activity. For the northeastern climate of the United States, the conditions which meet the requirements of the majority of people consist of temperatures between 68 and 72 F in winter and between 70 and 85 F in summer, the latter depending largely upon the prevailing outdoor temperature. The most desirable relative humidity range seems to be between 30 and 60 per cent.

2 ● Are the optimum conditions for comfort identical with those for health?

There are no absolute criteria of the prolonged effects of various air conditions on health. For the present it can be only inferred that bodily discomfort may be an indication of adverse conditions leading to poor health.

3 ● Given dry-bulb and wet-bulb temperatures of 76 F and 62 F, respectively, and an air velocity of 100 fpm, determine: (1) effective temperature of the condition; (2) effective temperature with calm air; (3) cooling produced by the movement of the air.

(1) In Fig. 1 draw line *AB* through given dry- and wet-bulb temperatures. Its intersection with the 100 ft velocity curve gives 69 deg for the effective temperature of the condition. (2) Follow line *AB* to the right to its intersection with the 20 fpm velocity line, and read 70.4 deg for the effective temperature for this velocity or so-called still air. (3) The cooling produced by the movement of the air is 70.4 − 69 = 1.4 deg ET.

4 ● Assume that the design of an air conditioning system for a theater is to be based on an outdoor dry-bulb temperature of 95 F and a wet-bulb temperature of 78 F with an indoor relative humidity of 50 per cent. According to Table 2, the dry-bulb temperature in the auditorium should be 80 F. Estimate the sensible and latent heat given up per person.

The sensible heat given up per person per hour may be obtained from Fig. 9. With an abscissa value of 80 F, Curve *D* for men seated at rest gives a value (on the ordinate scale) of 220 Btu per person per hour as the sensible heat loss. The latent heat given up by a person seated at rest may be obtained from Fig. 10. With an abscissa value of 80 F, Curve *D* indicates a latent heat loss of 175 Btu per hour (left hand scale) or a moisture loss of 1190 grains per hour (right hand scale).

5 ● Neglecting the gain or loss of heat by transmission or infiltration through walls, windows and doors, how many cubic feet of outside air, 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 temperature shall not exceed 75 F dry-bulb and 65 F wet-bulb?

Figs. 9 and 10 give 265 Btu sensible heat and 905 grains of moisture 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 absorbed in raising the dry-bulb temperature from 65 to 75 F, and 265,000 ÷ 2.4 = 110,400 lb of air or 110,400 × 13.4 = 1,479,000 cfh of air will be required. This is equivalent to 1,479,000 ÷ (1000 × 60) = 24.7 cfm per person.

The moisture content of the inside air is 76 grains per pound of dry air and that of the outside condition is 65 grains. From a psychrometric chart the increase in moisture content will therefore be 11 grains per pound of dry air. Hence 905,000 ÷ 11.0 = 82,300 lb of air at the specified condition will be required. This is equivalent to 82,300 × 13.4 = 1,103,000 cfh of air or 1,103,000 ÷ (1000 × 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.

Chapter 4

AIR POLLUTION

Classification of Air Impurities, Dust Concentrations, Air Pollution and Health, Occlusion of Solar Radiation, Smoke and Air Pollution Abatement, Dust and Cinders, Nature's Dust Catcher

THE particulate impurities which contribute to atmospheric pollution include carbon from the combustion of fuels, particles of earth, sand, ash, rubber tires, leather, animal excretion, stone, wood, rust, paper, threads of cotton, wool, and silks, bits of animal and vegetable matter, and pollen. Microscopic examination of the impurities in city air shows that a large percentage of the particles are carbon.

CLASSIFICATION OF AIR IMPURITIES

The most conspicuous sources of atmospheric pollution may be classified arbitrarily according to the size of the particles as dusts, fumes, and smoke. *Dusts* consist of particles of solid matter varying from 1.0 to 150 microns in size. (micron = 0.001 millimeter or 1/25,000 in.) *Fumes* include particles resulting from chemical processing, combustion, explosion, and distillation, ranging from 0.1 to 1.0 micron in size. The word fumes may be applied also to mixtures of mists (liquid droplets) and gases as *acid mists*. *Smoke* is composed of fine soot or carbon particles, usually less than 0.1 micron in size, which result from incomplete combustion of carbonaceous materials, such as coal, oil, tar, and tobacco. In addition to carbon and soot, smoke contains unconsumed hydrocarbon gases, sulphur dioxide, carbon monoxide, and other industrial gases capable of injuring property, vegetation, and health.

The lines of demarcation in these three classifications are neither sharp nor positive, but the distinction is descriptive of the nature and origin of the particles, and their physical action. Dusts settle without appreciable agglomeration, fumes tend to aggregate, smoke to diffuse. Particles which approach the common bacteria in size—about 1 micron—are difficult to remove from air and are apt to remain in suspension unless they can be agglomerated by artificial means. The term *fly-ash* is usually applied to the microscopic glassy spheres which form the principal solid constituent of the effluent gases from powdered-coal fired furnaces. *Cinders* denote the larger solid constituents which may be entrained by furnace gases.

It is well established that particles larger than about 1 micron are unlikely to remain suspended in air currents of moderate strength. Only