In Tables 7, 8, 9 and 10 the unit of concentration is the *mol*. A *M* molal solution is defined as a solution containing $M \times 42.37$ grains of anhydrous lithium chloride per 1000 grains of water. The formula connecting concentration in mols with weight in per cent is equivalent to: $[100 \times M \times 42.37] \div [1000 + (M \times 42.37)]$.

Example 4. Calculate the dew-point, wet-bulb, relative humidity and absolute humidity of air in equilibrium at 100 F with pure lithium chloride solution of density 1.270.

Solution. From Table 8 the concentration of a solution of density 1.270 at 100 F is 18.0 *M*. From Table 7 the dew-point of 18 *M* lithium chloride at 100 F is 43.7 F. From Table 6, Chapter 1, the partial pressure of water over the solution is 0.2858 in. of Hg,, the absolute humidity is 42.00 grains per pound dry air, and the wet-bulb is 65.8 F. The relative humidity is 14.0 per cent.

Example 5. Calculate the boiling point, and freezing point of 18 *M* lithium chloride solutions.

Solution. From Table 10, boiling point (standard) is 285.8 F, freezing point is 58.1 F. The salt precipitated on cooling to this temperature has the composition $LiCl\text{-}2H_2O$.

Example 6. Calculate the heat of vaporization of 1 lb of water from a large amount of lithium chloride solution at the boiling point.

Solution. The heat of boiling is equal to the heat of mixing plus the heat of boiling pure water at the same temperature. The heat of mixing from Table 10 at 18 *M* and 285.8 F is $(145 - 0.186 \times 285.8) = 92$ Btu per pound. The heat of vaporization of water from steam tables at 285.8 F is 920 Btu per pound. Therefore the heat of vaporization of water from the solution is $920 + 92 = 1012$ Btu per pound.

Example 7. One thousand pounds of air per minute at 100 F dry-bulb with a dew-point of 70 F and a relative humidity of 39 per cent is passed over 18 *M* lithium chloride solution. The rate of flow of the solution is 200 gpm and the entering temperature is 80 F. The air leaves the absorber at 85 F dry-bulb and dew-point of 35 F. Calculate (*a*) the heat to be removed from the lithium chloride solution to maintain these conditions, and (*b*) the temperature rise of the solution in passing through the absorber.

Solution. (*a*) The heat content of the entering air: From Table 6, Chapter 1, weight of vapor at 70 F dew-point is 0.01574 lb times heat content of steam at 100 F dry-bulb is 1104.2 (Table 8, Chapter 1) equals 17.41 Btu per pound plus heat content of dry air at 100 F is 24.0 (Table 6, Chapter 1) resulting in heat content of mixture as 41.41 Btu per pound.

Similarly, the heat content of the leaving air: Weight of vapor at 35 F dew-point is $0.004262 \times 1097.5 = 4.68$ Btu per pound plus heat content of dry air at 85 F is 20.39 resulting in heat content of mixture as 25.07 Btu per pound.

Heat to be extracted from air is $1000 \times (41.41 - 25.07) = 16.340$ Btu per minute. Add to this the heat of mixing of *18M lithium chloride* at 80 F equals $145 - (0.186 \times 80) = 130$ Btu per pound (Table 10) or for 1000 lb of air $\times (0.01574 - 0.00426) \times 130 = 1494$ Btu per minute. Heat to be removed from solution is $16.340 + 1494 = 17,834$ Btu per minute.

(*b*) The weight of solution circulated is 200×1.275 (Table 8) $\times 8.33 = 2124$ lb per minute. Its heat capacity is 2124×0.631 (Table 10) = 1340 Btu per minute per degree Fahrenheit. The temperature rise is $17,834 \div 1340 = 13.31$ F.

Chapter 3

PHYSICAL AND PHYSIOLOGICAL PRINCIPLES

Chemical Vitiation of Air, Physical Impurities in Air, Thermal Changes Between the Body and Its Environment, Adaptation to Hot Conditions, Adaptation to Cold Conditions, Relation of Air Conditioning Needs to Metabolism, Acclimatization, Effective Temperature Index, Physiological Objectives of Heating and Ventilation, Relation of Air and Wall Temperatures, Influence of Humidity, Influence of Air Movement, The Four Vital Factors

VENTILATION is defined in part as *the process of supplying or removing air by natural or mechanical means to or from any space.* (see Chapter 46). The word in itself implies quantity but not necessarily quality. From the standpoint of comfort and health, however, the problem is now considered to be one of securing air of the proper quality rather than of supplying a given quantity.

The term *air conditioning* in its broadest sense implies control of any or all of the physical or chemical qualities of the air. More particularly, it is often used to include the simultaneous control of temperature, humidity, movement and quality of air. The term is broad enough to embrace whatever factors may be found desirable, in a given case, for maintaining the atmosphere of occupied spaces at a condition best suited to the physiological requirements of the human body.

CHEMICAL VITIATION OF AIR

Under the artificial conditions of indoor life, the air undergoes certain physical and chemical changes which are brought about by the occupants themselves. The oxygen content is somewhat reduced, and the carbon dioxide slightly increased by the respiratory processes. Organic matter, which is usually perceived as odors, comes from the nose, mouth, skin and clothing. The temperature of the air is increased by the metabolic processes, and the humidity raised by the moisture emitted from the skin and lungs.

Contrary to old theories, the usual changes in oxygen and carbon dioxide are of no physiological concern because they are too small to produce appreciable effects even under the worst conditions of normal human occupancy. The amount of carbon dioxide in air is often used in ventilation work as an index of odors of human origin, but the information it affords rarely justifies the labor involved in making the observation[1,2].

[1] A.S.H.V.E. RESEARCH REPORT No. 959—Indices of Air Change and Air Distribution, by F. C. Houghten and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 261).

[2] A.S.H.V.E. RESEARCH REPORT No. 1031—Ventilation Requirements, by C. P. Yaglou, E. C. Riley and D. J. Coggins (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 133).