

In spite of the rapid advances in the field of air conditioning during the past few years, the secret of reproducing indoor atmospheres of as stimulating qualities as those existing outdoors under ideal weather conditions, has not as yet been found. Extensive studies have failed to elucidate the cause of the stimulating qualities of country air, qualities which are lost when such air is brought indoors and particularly when it is handled by mechanical means. Ultra-violet light and ionization have been suggested but the evidence so far is inconclusive or negative⁴.

Ozone has been used with success for the destruction of micro-organisms (molds) in meat packing establishments and the like; and where considerable amounts of organic effluvia are present this substance may be useful as a deodorant. For ordinary ventilation practice, however, neither of these purposes can be usefully attained, since the concentration of ozone necessary for effectiveness would be likely to transcend the limit of comfort in ordinary occupied rooms. While ozone has been used in the treatment of certain diseases, there is no evidence that it has a tendency to increase comfort or to benefit health under conditions of normal human occupancy. The allowable concentrations in the breathing zone are very small, between 0.01 to 0.05 ppm parts of air. These are much too small to influence bacteria. Higher concentrations are associated with a pungent unpleasant odor and considerable discomfort to the occupants. One part per million causes respiratory discomfort in man, headaches and depression, lowers the metabolism, and may even lead to coma⁵.

PHYSICAL IMPURITIES IN AIR

Dust particles of various types, when present in considerable concentrations, produce an irritant effect upon the mucous membranes of nose and throat and may be associated with high prevalence of acute respiratory diseases such as bronchitis and pneumonia. Dust which contains free silica has special harmful effects, causing a primary disease of the lungs (silicosis) and predisposing the victim in a high degree to tuberculosis. These, however, are special problems of industrial hygiene which will not be discussed in detail in this chapter.

A certain part of the dissemination of disease in confined spaces is caused by the emission of pathogenic organisms from infected persons. Droplets sprayed into the air in talking, coughing, sneezing, etc., do not all fall immediately to the ground within a few feet from the source, as was formerly believed. The large droplets do, of course, but minute droplets less than 0.1 mm in diameter evaporate to dryness before they fall the height of a man. Nuclear residues from such sources, which may contain

⁴A.S.H.V.E. RESEARCH REPORT No. 921—Changes in Ionic Content in Occupied Rooms, Ventilated by Natural and Mechanical Methods, by C. P. Yaglou, L. C. Benjamin and S. P. Choate (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 191). A.S.H.V.E. RESEARCH REPORT No. 965—Physiologic Changes During Exposure to Ionized Air, by C. P. Yaglou, A. D. Brandt and L. C. Benjamin (A.S.H.V.E. TRANSACTIONS, Vol. 39, 1933, p. 357). A.S.H.V.E. RESEARCH REPORT No. 985—Diurnal and Seasonal Variations in the Small Ion Content of Outdoor and Indoor Air, by C. P. Yaglou and L. C. Benjamin (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 271). The Nature of Ions in Air and Their Possible Physiological Effects, by L. B. Loeb (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 101). The Influence of Ionized Air upon Normal Subjects, by L. P. Herrington (Journal Clinical Investigation, 14, January, 1935). The Effect of High Concentrations of Light Negative Atmospheric Ions on the Growth and Activity of the Albino Rat, by L. P. Herrington and Karl L. Smith (Journal Ind. Hygiene, 17, November, 1935). Subjective Reactions of Human Beings to Certain Outdoor Atmospheric Conditions, by C.-E. A. Winslow and L. P. Herrington (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 119).

⁵The British Medical Journal, Editorial, June 25, 1932, p. 1182. See also Loc. Cit. Note 4.

infective organisms drift long distances with the air currents and the virus may remain alive long enough to be transmitted to other persons in the same room or building. Droplet nuclei have been recovered from cultures of resistant micro-organisms a week after inoculation into a tight chamber of 3000 cu ft capacity, although the majority of disease germs died out within a few hours⁶. Practical epidemiological evidence indicates that the danger of such atmospheric transmission is slight with the bacterial diseases but may be appreciable with the diseases caused by the much smaller and lighter viruses. Avoidance of overcrowding is a major factor in avoiding such dangers. The microbic content of the atmosphere may also be reduced by air change but local drafts carrying minute droplets from person to person will increase the hazard. Practical possibilities in sterilizing air supplies by the use of ultra-violet light are now being studied⁷.

THERMAL INTERCHANGES BETWEEN THE BODY AND ITS ENVIRONMENT

The importance of the thermal factors arises from the profound influence which they exert upon body temperature, comfort and health. Body temperature depends upon the balance between heat production and heat loss. The heat resulting from the combustion of food within the body (metabolism) maintains the body temperature well above that of the surrounding air. At the same time, heat is constantly lost from the body by radiation, convection and evaporation. Since, under ordinary conditions, the body temperature is maintained at its normal level of about 98.6 F, the heat production must be balanced by the heat loss.

In conditioning air for comfort and health it is necessary to know the rate of sensible and latent heat liberation from the human body, which in conjunction with other heat loads (see Chapters 3, 5 and 6) determine the capacity required for proper conditioning. The data in common use are those of the A.S.H.V.E. Research Laboratory⁸.

The fundamental thermodynamic processes concerned in heat interchanges between the body and its environment may be described by the equation:

$$M \pm S = E \pm R \pm C \quad (1)$$

where

M = rate of metabolism.

S = rate of storage.

E = rate of evaporative heat loss.

R = rate of radiative heat loss or gain.

C = rate of convective heat loss or gain.

Units may be expressed in kilogram-calories or Btu per hour, and storage is considered positive when the body cools; negative, when the

⁶Air-Borne Infection and Sanitary Air Control, by W. F. Wells (Journal Industrial Hygiene, November, 1935).

⁷Sanitary Ventilation in Wards, by W. F. Wells (Heating and Ventilating, April, 1939, p. 26). Measurement of Sanitary Ventilation, by W. F. Wells (American Journal of Public Health, Vol. 28, 1938, p. 343).

⁸Thermal Exchanges Between the Bodies of Men Working and the Atmospheric Environment, by F. C. Houghten, W. W. Teague, W. E. Miller, and W. P. Yant (American Journal of Hygiene, Vol. XIII No. 2, March, 1931, p. 415).