

SUMMER COMFORT

The problem of keeping cool in summer is physiologically as important as keeping warm in winter. In summer the relative humidity of the atmosphere is of great importance, along with air temperature, air movement, and wall temperature. There is no very practical method of cooling walls, but summer comfort can be promoted by modifying any one of the other three factors involved.

Increase of comfort by air movement may be had by the promotion of natural circulation by cross or through ventilation; and here the architect is responsible for providing fenestration which will make such natural ventilation possible. In the lowest cost housing this should be considered as essential.

The direct control of air temperature and humidity is, of course, the ideal solution where the cost of a complete air conditioning equipment can be met. Where this objective is attained, there are two schools of thought concerning the relation between temperature and humidity to be maintained. For a given effective temperature some engineers favor comparatively low temperature with a high humidity as this results in a reduction of refrigeration requirements. Preliminary experiments at the A.S.H.V.E. Laboratory⁴⁷ would seem to indicate not much impairment of comfort with relative humidities of 70 per cent and somewhat higher, provided the effective temperature is between 70 and 73 deg. Until this subject is fully investigated it is desirable not to exceed 70 per cent and in general relative humidities of 60 per cent or less give more satisfactory results⁴⁸.

The second school favors a higher dry-bulb temperature, according to the prevailing outdoor dry-bulb, with a comparatively low humidity (well below 50 per cent), the main purpose being an assumed reduction in temperature contrasts upon entering and leaving the cooled space and to keep the clothing and skin dry. This second scheme requires more refrigeration with the present conventional type of apparatus.

INFLUENCE OF HUMIDITY

The limitation of the comfort zones in Fig. 6 with respect to humidity is not final. Relative humidities below 30 per cent may prove satisfactory from the standpoint of comfort. In mild weather comparatively high relative humidities seem to be entirely feasible, but in cold weather they are objectionable on account of condensation and frosting on the windows. Information on this subject is given in Chapter 4.

As to the effects of dryness of the air, *per se*, and irrespective of thermal effects, there is a common belief that dry air in itself exerts a harmful effect upon the skin and mucous membranes; but there is no convincing evidence that the increase of atmospheric moisture which can practically be introduced by humidification into the air of cool occupied rooms has any effect upon health and comfort. All controlled experiments on this point have yielded negative results; and the respiratory membranes of industrial workers exposed to hot moist air are distinctly abnormal compared with those of workers exposed to hot dry air⁴⁹.

⁴⁷A.S.H.V.E. RESEARCH REPORT No. 1035—Comfort Standards for Summer Air Conditioning, by F. C. Houghten and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 215). A.S.H.V.E. RESEARCH REPORT No. 1055—Cooling Requirements for Summer Air Conditioning, by F. C. Houghten, F. E. Giesecke, C. Tasker and Carl Gutberlet (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 145).

⁴⁸Loc. Cit. Note 35.

⁴⁹Loc. Cit. Note 39.

For the premature infant, a high relative humidity of about 65 per cent is demonstrably beneficial to health and growth⁵⁰ until the infants reach a weight of about 5 lb. No such clear-cut evidence exists in the case of adults. In the comfort zone experiments of the A.S.H.V.E. Research Laboratory, the relative humidity was varied between the limits of 30 and 70 per cent approximately, but the most comfortable range has not been determined. In similar experiments at the *Harvard School of Public Health*, the majority of the subjects were unable to detect sensations of humidity (*i.e.*, too high, too low, or medium) when the relative humidity was between 30 per cent and 60 per cent with ordinary room temperatures which is in accord with other studies^{51,52}.

INFLUENCE OF AIR MOVEMENT

Air movement has a powerful influence on the factors involved in thermal equilibrium of the body. An understanding of the phenomena involved is best obtained through a consideration of the purely physical factors involved in the effect of air movement on heat dissipation from inanimate surfaces by radiation, convection and evaporation. Thermal equilibrium of the human body is more complex because of the physiological control exercised in permitting the body surface temperature to drop when factors influencing heat loss are unavoidably increased without additional clothing and by the making available of perspiration for evaporation.

Air movement does not affect radiation loss, provided there is no change in the skin temperature. However, if there is excessive cooling and lowering of the skin temperature due to increased convection loss, then radiation loss (which varies as the differences of the fourth power of the absolute temperatures of the radiator and receiver) decreases. It has been shown by the work at the *John B. Pierce Laboratory of Hygiene*⁵³ and by the A.S.H.V.E. Research Laboratory⁵⁴ that radiation may thus actually decrease due to air movement in relatively cool atmospheres.

Convection loss from any surface, including that of the clothed body, is greatly increased by air movement, provided the surface temperature remains the same. In cool atmospheres, unless increased clothing is worn, heat loss due to air movement may be accompanied by a drop in body surface temperature.

Heat loss by evaporation is greatly increased by air movement, provided surface temperature and moisture available for evaporation (or the wetness of the surface) are constant. However, since in the human body perspiration is only made available when there is need for increased evaporative heat loss due to reduction in convection loss, increased air movement is accompanied by decreased perspiration and evaporative cooling in moderately cool atmospheres. In very hot atmospheres, particularly with low vapor pressure, evaporative cooling may be increased by air movement so as to increase the maximum temperature level at which thermal equilibrium may be maintained. Results of studies at

⁵⁰Loc. Cit. Note 42.

⁵¹Humidity and Comfort, by W. H. Howell (*The Science Press*, April, 1931).

⁵²Effect of Variation in Relative Humidity upon Skin Temperature and Sense of Comfort, by U. Miura (*American Journal of Hygiene*, Vol. 13, 1931, p. 432).

⁵³Loc. Cit. Note 15.

⁵⁴Loc. Cit. Note 13.