to 99.5 F. A decrease in the optimum temperature became apparent only when the prevailing outdoor temperature fell to 66 F, which is below the customary room temperature in the United States for summer and winter.

The optimum effective temperature for summer (Fig. 3) applies primarily to cases in which the human body has reached thermal equilibrium with the surrounding air. When one enters a room at 71 deg ET on a hot day, one is likely to experience an intense chill or shock. However, after about two hours exposure, this optimum condition will be quite satisfactory for the average person. On account of this acclimatization, a higher plane of summer temperature conditions is required in places of public assembly where the period of occupancy is short, than is required for offices or industrial plants where the period of occupancy is of longer duration. Both summer and winter comfort zones shown in Fig. 3 make proper allowance for adaptation, and they apply to homes, offices, schools and other similar places where people of sedentary habits spend from three to eight or more hours daily.

In theaters and department stores, which are cooled artificially in warm weather, the contrast between outdoor and indoor air conditions becomes the deciding factor in regard to the temperature and humidity to be maintained. The object of cooling theaters in summer is not to reduce the temperature to the optimum degree, but to maintain therein a reasonably comfortable temperature, and at the same time to avoid sensations of chill or of intense heat in entering and leaving the building.

A satisfactory rule of thumb is to add to 72 F one-third of the difference between the outside dry-bulb temperature and 70 F. This will give a moderate difference and eliminate the shock caused by passing from a hot to a cool atmosphere or the reverse. It is also advantageous to keep the theater entrances and lobbies at a temperature between that prevailing out of doors and that in the auditorium. Desirable indoor conditions in summer corresponding to various outdoor temperatures are given in Table 2, Chapter 2. The relative humidity must be lowered so as to give a sense of comfort without chill. For economical reasons the relative humidity in air-conditioned buildings is, as a general rule, maintained too high in summer and too low in winter, whereas for comfort it should be just the opposite. Entirely aside from this requirement, the relative humidity must induce a rate of evaporation which will keep clothing and skin dry. The lower limit in winter is 30 per cent and the upper limit in summer is 60 per cent.

Optimum Humidity

Dry air produces an excessive loss of moisture from the skin and respiratory tract. Owing to the cooling effect of evaporation, higher temperatures are necessary, and this condition leads to discomfort and lassitude. Moist air, on the other hand, interferes with the normal evaporation of moisture from the skin, and again may cause a feeling of oppression and lassitude, especially when the temperature is also high.

Just what the optimum range of humidity is, is a matter of conjecture. There seems to exist a general opinion, supported by some experimental and statistical data, that warm, dry air is less pleasant than air of a

moderate humidity, and that it dries up the mucous membranes in such a way as to increase susceptibility to colds and other respiratory disorders[11], [12], [13].

For the premature infant, a high relative humidity of about 65 per cent is demonstrably beneficial to health and growth[14], and according to Huntington[15], this seems to be the case for adults also. All of these studies indicate that the optimum humidity must always be considered in combination with temperature.

The chief drawback to high indoor humidities is condensation and frosting on the window glass. With an outdoor temperature of 25 F, condensation will occur on a single glass when the relative humidity reaches 30 per cent, and on double glass when the humidity reaches 63 per cent. In zero weather double glazing will allow an indoor humidity of 48 per cent before condensation begins.

Comfort Zone for Men Working

Satisfactory comfort conditions are found to vary from 40 deg to 70 deg ET, depending upon the rate of work and amount of clothing worn. The effective temperatures giving maximum comfort for persons working have been determined by the A.S.H.V.E. Research Laboratory for a rate of work which is considered hard labor. For this degree of work, 50 per cent were fairly comfortable for temperatures ranging from 46 to 64 deg ET, while the greatest percentage found maximum comfort at 53 deg ET. In hot industries, 80 deg ET is considered the upper limit compatible with efficiency, and, whenever possible, this should be reduced to 70 deg ET or less.

Optimum Air Conditions for Infants and Children

The comfort charts (Figs. 2 and 3) apply to adults between 20 and 70 years of age living in the northeastern parts of the United States. For prematurely born infants, the optimum temperature varies from 100 F to 75 F, depending upon the stage of development. The optimum relative humidity for these infants is placed at 65 per cent. No data are yet available on the optimum air conditions for full term infants and young children up to school age. Satisfactory air conditions for these age groups are assumed to vary from 75 F to 68 F with natural indoor humidities. For school children, the studies of the *New York State Commission on Ventilation* place the optimum air conditions at 66 F to 68 F temperature with a moderate humidity (not specified) and a moderate but not excessive amount of air movement (not specified)[16].

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[11] *Reactions of the Nasal Cavity and Post-Nasal Space to Chilling of the Body Surface*, by Mudd, Stuart, et al (*Journal Experimental Medicine*, 1921, Vol. 34, p. 11).

[12] *Reactions of the Nasal Cavity and Post-Nasal Space to Chilling of the Body Surfaces*, by A. Goldman, et al. II Concurrent Study of Bacteriology of Nose and Throat (*Journal Infectious Diseases*, 1921, Vol. 29, p. 151).

[13] *The Etiology of Acute Inflammations of the Nose, Pharynx and Tonsils*, by Mudd, Stuart, et al (Am. Otol., Rinol., and Laryngol, 1921).

[14] *Application of Air Conditioning to Premature Nurseries in Hospitals*, by C. P. Yaglou, Philip Drinker and K. D. Blackfan (A.S.H.V.E. TRANSACTIONS, Vol. 36, 1930).

[15] *Weather and Health*, by Ellsworth Huntington (*Bulletin* of the National Research Council No. 75. The National Academy of Science, Washington, D. C., 1930).

[16] *Ventilation*, Report of the New York State Commission on Ventilation, 1923.