

pneumonia death rate is associated with dust, extreme heat, exposure to cold, and to sudden changes in temperature.

ACCLIMATIZATION

Acclimatization and the factor of psychology are two important influences in air conditioning which cannot be ignored. The first is man's ability to adapt himself to changes in air conditions; the second is an intangible matter of habit and suggestion.

Some persons regard the unnecessary endurance of cold as a virtue. They believe that the human organism can adapt itself to a wide range of air conditions with no apparent discomfort or injury to health. In the light of the present knowledge of air conditioning these views are not justified. Acclimatization to extreme conditions involves a strain upon the heat regulating system and it interferes with the normal physiologic functions of the human body. Thousands of years in the heat of Africa do not seem to have acclimatized the Negro to a temperature averaging 80 F. The same holds true of northern races with respect to cold, although the effects are mitigated by artificial control. All this seems to indicate that adaptation to a climate averaging between 60 and 80 F is a very primitive trait¹¹.

Within these limits, however, there does occur a definite adaptation to external temperature level. People and animals raised under conditions of tropical moist heat have a lower rate of heat production than do those who grow up in cooler environments. This causes them to stand chilling poorly as they are unable to quickly increase internal combustion to keep up the body temperature. For this reason they have trouble standing the cold, stormy weather of the temperate zones, and when exposed to it are very susceptible to respiratory infections. Likewise, people living in cool climates suffer greatly in the moist heat of the tropics until their adrenal activity has slowed down. Within a couple of years, however, they find themselves standing the heat much better and disliking cold. They become acclimated by a definite change in the combustion level within the body¹².

In certain individuals the psychological factor is more powerful than acclimatization. A fresh air fiend may suffer in a room with windows closed regardless of the quality of the air. As a matter of fact, instances are known in which paid subjects refused to stay in a windowless but properly conditioned experimental chamber because the atmosphere felt suffocating to them upon entering the room.

WARMTH AND COMFORT

The temperature, humidity, and motion of the air, and the radiation between a person and surrounding hot or cold surfaces, taken together, determine his feeling of warmth and influence his elimination of body heat. In other words, the temperature sensations of the human body depend not only on the temperature of the surrounding air as registered by a dry-bulb thermometer, but also upon the temperature indicated by

¹¹Civilization and Climate, by Ellsworth Huntington, Yale University Press, 1924.

¹²Air Conditioning in its Relation to Human Welfare, by C. A. Mills, M.D. (A.S.H.V.E. Journal Section, Heating, Piping and Air Conditioning, April, 1934).

a wet-bulb thermometer. Dry air at a relatively high temperature may feel cooler than air of considerably lower temperature with a high moisture content. Air motion makes any moderate condition feel cooler.

On the other hand, in cold environments an increase in humidity produces a cooler sensation. The dividing line at which humidity has no effect upon comfort varies with the air velocity and is about 46 F (dry-bulb) for still air and about 51, 56 and 59 F for air velocities of 100, 300 and 500 fpm, respectively.

Thermo-Equivalent Conditions

Combinations of temperature, humidity and air movement which produce the same feeling of warmth are called thermo-equivalent conditions. A series of tests^{13, 14, 15} has been carried out in the psychrometric rooms of the A.S.H.V.E. Research Laboratory, Pittsburgh, in order to determine the equivalent conditions met with in general air conditioning work. These show that this newly-developed scale of thermo-equivalent conditions not only indicates the sensation of warmth, but also determines the physiological effects on the body induced by heat and cold. For this reason, it is called the *effective temperature* scale or index.

Effective temperature is an index of warmth or cold. It is not in itself an index of comfort, as it is often assumed to be, nor are the effective temperature lines necessarily lines of equal comfort. This is true because, in determining this index, the subjects compared not the relative comfort, but rather the relative warmth or cold of various air conditions. Moist air at a comparatively low temperature, and dry air at a higher temperature may each feel as warm as air of an intermediate temperature and humidity, but the *comfort* experienced in the three air conditions would be different, although the effective temperature is the same.

Under extreme humidity conditions there seems to be a difference between sensations of absolute comfort and of the proper degree of warmth. In other words, human beings are not necessarily comfortable when the air is neither *too warm* nor *too cold*. Air of proper warmth may, for instance, contain excessive water vapor, and in this way interfere with the normal physiologic loss of moisture from the skin, leading to damp skin and clothing and producing more or less discomfort; or the air may be excessively dry, producing appreciable discomfort to the mucous membrane of the nose and to the skin which dries up and becomes chapped from too rapid loss of moisture. According to the comfort experiments first conducted at the A.S.H.V.E. Laboratory¹⁶ in the U. S. Bureau of Mines, Pittsburgh, and later studies at the Harvard School of Public Health¹⁷ in Boston, effective temperature appears to be a fair index of comfort also, particularly within a humidity range of 30 to 60 per cent, approximately.

¹³Determining Lines of Equal Comfort, by F. C. Houghten and C. P. Yagloglou (A.S.H.V.E. TRANSACTIONS, Vol. 29, 1923, p. 361).

¹⁴Cooling Effect on Human Beings by Various Air Velocities, by F. C. Houghten and C. P. Yagloglou (A.S.H.V.E. TRANSACTIONS, Vol. 30, 1924, p. 193).

¹⁵Effective Temperature with Clothing, by C. P. Yagloglou and W. E. Miller (A.S.H.V.E. TRANSACTIONS, Vol. 31, 1925, p. 89).

¹⁶Determination of the Comfort Zone With Further Verification of Effective Temperatures Within This Zone, by F. C. Houghten and C. P. Yagloglou (A.S.H.V.E. TRANSACTIONS, Vol. 29, 1923, p. 361).

¹⁷The Summer Comfort Zone; Climate and Clothing, by C. P. Yagloglou and Philip Drinker (A.S.H.V.E. TRANSACTIONS, Vol. 35, 1929).