APPLICATION OF COMFORT CHARTS TO AIR COOLING

From a study of the comfort charts it will be evident that there are four fundamental ways of producing effective cooling:

1. The dry-bulb temperature may be lowered by direct cooling or removal of heat.
2. The moisture content of the air may be reduced.
3. Air motion may produce effective cooling except for extremely severe conditions.
4. Evaporation of water without addition or subtraction of heat is accompanied by an increase in moisture content and a fall in dry-bulb temperature along the wet-bulb line resulting in effective cooling.

Take as an example a condition of 92 F dry-bulb and 40 per cent relative humidity having a wet-bulb temperature of 72.8 F and an effective temperature of 81.1 deg. This condition can be made equivalent to 78 deg ET or it can be made to feel 3.1 deg ET cooler by any one of the four fundamental changes mentioned, as follows:

1. By the removal of heat the dry-bulb temperature may be made to fall to 85.5 F (see Fig. 2) along the *90 grain moisture per pound of dry air line or 64.2 F dew-point* line, when the effective temperature will be 78 deg.
2. Without removal of sensible heat or lowering of the dry-bulb temperature, the moisture content may be reduced from 90 to 46 grains per pound of dry air, when the effective temperature will be 78 deg.
3. A 460-ft velocity (see Fig. 1) will change the still-air condition of 81.1 deg ET to 78 deg ET or will give 3.1 deg ET cooling.
4. Evaporation of water at room temperature without addition or removal of heat will cause the point on the chart, Fig. 2, indicated by the condition under consideration to move along the wet-bulb temperature line to the left thereby lowering the dry-bulb temperature and increasing the moisture content. The wet-bulb temperature will remain the same but the effective temperature will be lowered. By adding 14 grains of moisture without heat, the dry-bulb temperature will fall to 83.8 F and the effective temperature will fall to 78 deg.

The best method of producing effective cooling to be employed in any particular case will depend upon accompanying circumstances and should be determined by a competent engineer. Generally, the removal of heat or water vapor or both, by direct cooling or dehumidifying is most effective. Effective cooling by air motion or evaporation of water is relatively much less expensive, but these methods of cooling are limited to certain conditions of temperature and humidity. Cooling by evaporation of water is effective when the air is dry or when there is considerable difference between the wet- and dry-bulb temperature. Cooling by air motion is most effective at low temperatures. When the effective temperature approaches that of the body little or no cooling results and for certain higher temperatures air motion will make an uncomfortable condition even less bearable.

For moderately high temperatures greater effective cooling results from adiabatic saturation and air movement. Take, for example, a condition of 96 F dry-bulb and 80 F wet-bulb having an effective temperature of 85.7 deg. A 300-fpm air velocity will improve this condition by only 2.0 deg ET. Saturation with water vapor will give a condition of 80 F dry-bulb, 80 F wet-bulb and 80 deg ET or 5.7 deg ET improvement. A 300-ft air velocity with this new wet- and dry-bulb temperature will give an effective temperature of 75.6 deg or a total improvement of 10.0 deg.

A good air washer may reduce the temperature of the air passing through it about 70 per cent of the difference between the wet- and dry-bulb temperatures. Its operation would hardly be justified without a water supply having a temperature of 50 F or cooler because of increasing relative humidity with a decreasing temperature. The effectiveness of an air washer will increase in proportion to the dryness of the outside air and the coldness of the water. For additional information on air washers, see Chapter 30.

RECIRCULATION AND THE USE OF OZONE

Recirculation of air to the extent of 50 per cent or more effects a considerable saving in both heating and refrigeration, but as a general rule it impairs the quality of the air by excessive humidity, excessive odors or both. Moreover, recirculation has a tendency to deprive the air of its ionic content[17], but the influence of this factor on comfort and health is at present questionable.

The value of ozone in recirculated air is debatable and not well founded. Numerous researches[18], [19], [20] have shown that ozone in concentrations permissible in air conditioning work (0.1 to 0.5 parts per million parts of air) exerts practically no effect on pathogenic air-borne organisms and it does not destroy odors but it merely masks them by olfactory compensation. It requires at least 13 parts of ozone per million parts of air to influence bacteria[21]. Human beings are injuriously affected by ozone in concentrations of one part or more per million parts of air. This amount will not destroy odors, kill bacteria, nor purify organic matter.

ULTRA-VIOLET RADIATION AND IONIZATION

In spite of rapid advances in air conditioning during the past few years, the secrets of reproducing indoors the natural climatic elements as they exist in open country under ideal weather conditions have not as yet been fully ascertained. Extensive studies have failed to discover the stimulating quality in open country air which is lost when the air is brought indoors, and particularly when it is treated mechanically. Ultra violet light and ionization have been suggested but have not yet been identified.

It is generally recognized that total solar radiation in open air is the greatest curative and a powerful germicidal agent. A critical review of the literature, however, discloses that artificial ultra-violet radiation has little importance in air conditioning, at least for the time being, because it is not known which of the solar rays brings about the cure, and what physiologic processes are involved in their action. With the exception of rickets and certain skin diseases, artificial radiation was found to have no effect on susceptibility, incidence, and resistance to respiratory infections[22],

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[17] *Changes in Ionic Content in Occupied Rooms, Ventilated by Natural and Mechanical Methods*, by C. P. Yaglou, L. C. Benjamin and S. P. Choate (*Heating, Piping and Air Conditioning*, October, 1931).

[18] *Proceedings, Royal Society of London*, by L. Hill and M. Flack (1911, B, Vol. 84, p. 404).

[19] *Jordan and Carlson* (*Journal American Medical Association*, 1931, Vol. 61, p. 1607).

[20] *Konrich* (Ztschr. f. Hyg., 1913, Vol. 73, p. 443).

[21] *Preventive Medicine and Hygiene*, by Milton J. Rosenau.

[22] *Light—Its Photodynamic Activity and Use as a Therapeutic Agent*, by F. W. Schultz, K. W. Stenstrom and E. M. Clausen (Report to the White House Conference on Child Health and Protection, Washington, February, 1931).