Since Table 6 was prepared, the new steam tables, *Thermodynamic Properties of Steam*, by J. H. Keenan and F. G. Keyes, have been published. For the last two years an A.S.H.V.E. Research Technical Advisory Committee on Psychrometry has been formulating standard psychrometric data, on a tentative basis. Included in this Committee's work is a revision of Table 6 to bring it into conformity with the Keenan and Keyes tables. Pending acceptance by the Society of the Committee's report, the tabular data and psychrometric chart published in earlier editions of THE GUIDE have been retained.

ADIABATIC SATURATION OF AIR

The process of adiabatic saturation, or evaporative cooling, is of considerable importance in air conditioning. Suppose that unsaturated air be made to pass at a steady rate through a tunnel which is perfectly insulated against heat transfer to or from its surroundings, and which contains an exposed water surface. Alternatively, let the air pass through an insulated *air washer* whose spray water is recirculated continuously without being heated or cooled externally. In either case, when the apparatus has reached equilibrium temperatures throughout, the *water* will have attained a temperature (the temperature of adiabatic saturation) closely approximating the initial wet-bulb temperature of the air, and the *air* will have become saturated at the temperature of the water (or will have approached saturation at that temperature as a limit, the degree of saturation depending on the time and efficiency of contact of air and water).

Example 5. If air with a dry-bulb of 85 F and a wet-bulb of 70 F be saturated adiabatically by spraying with recirculated water, what will be the final temperature and the vapor content of the air?

Solution. The final temperature will be equal to the initial wet-bulb temperature or 70 F, and since the air is saturated at this temperature, from Table 6, $W = 0.01574$ lb per pound of dry air.

The energy for evaporating moisture into the air comes only from the air and its initially superheated vapor, which led Carrier to formulate the following energy equation for adiabatic saturation:

$$h'_{fg}\,(W_{t'} - W) = c_{p_a}\,(t - t') + c_{p_s} W\,(t - t') \tag{9}$$

and using $c_{p_a} = 0.24$ and $c_{p_s} = 0.45$

$$h'_{fg}\,(W_{t'} - W) = (0.24 + 0.45W)\,(t - t') \tag{9a}$$

where

h'_{fg} = latent heat of vaporization at t', Btu per pound.
$(W_{t'} - W)$ = increase in vapor associated with 1 lb of dry air when it is saturated adiabatically from an initial dry-bulb temperature, t, and an initial vapor content, W, pounds.

Knowing any two of the three primary variables, t, t', or W, the third may be found from this equation for any process of adiabatic saturation.

TOTAL HEAT AND ENTHALPY

The *total heat* of a mixture of dry air and water vapor was originally defined by W. H. Carrier as:

$$\Sigma = c_{p_a}\,(t - 0) + W\,[h'_{fg} + c_{p_s}\,(t - t')] \tag{10}$$

where

Σ = total heat of the mixture, Btu per pound of dry air.
c_{p_a} = mean specific heat at constant pressure of dry air.
c_{p_s} = mean specific heat at constant pressure of water vapor.
t = dry-bulb temperature, degrees Fahrenheit.
t' = wet-bulb temperature, degrees Fahrenheit.
W = weight of water vapor mixed with each pound of dry air, pounds.
h'_{fg} = latent heat of vaporization at t', Btu per pound.

Since this definition holds for any mixture of dry air and water vapor, the *total heat* of a mixture with a relative humidity of 100 per cent and at a temperature equal to the wet-bulb temperature (t') is:

$$\Sigma' = c_{p_a}\,(t' - 0) + W_{t'}\,h'_{fg} \tag{11}$$

By equating Equation 10 to Equation 11, the equation for the adiabatic saturation process, Equation 9a, follows. This demonstrates that the adiabatic saturation process at approximately constant wet-bulb temperature is also approximately a process of constant *total heat*. In short, the *total heat* of a mixture of dry air and water vapor is the same for any two states of the mixture at the same wet-bulb temperature. This fact furnishes a convenient means of finding the *total heat* of an air-vapor mixture in any state.

Enthalpy

This *total heat* of an air-vapor mixture is not equal to the enthalpy of the mixture, since the enthalpy of the liquid is not included in Equation 10. With the meaning of enthalpy in agreement with present practice in other branches of thermodynamics, the true enthalpy of a mixture of dry air and water vapor (with 0 F as the datum for dry air, and the saturated liquid at 32 F as the datum for the water vapor) is:

$$h = c_{p_a}\,(t - 0) + W\,h_s = 0.24\,(t - 0) + W\,h_s \tag{12}$$

where

h = the enthalpy of the mixture, Btu per pound of dry air.
t = the dry-bulb temperature, degrees Fahrenheit.
W = the weight of vapor per pound of dry air, pounds.
h_s = the enthalpy of the vapor in the mixture, Btu per pound.

The enthalpy of the water vapor in the mixture may be found in steam charts or tables when the dry-bulb temperature and the partial pressure of the vapor are known. Or, since the enthalpy of steam at low partial pressures, whether superheated or saturated, depends only upon temperature, the following empirical equation may be used:

$$h_s = 1059.2 + 0.45\,t \tag{13}$$

Substituting this value of h_s in Equation 12, the enthalpy of the mixture is:

$$h = 0.24\,(t - 0) + W\,(1059.2 + 0.45\,t) \tag{14}$$