

$h_2 - h_1$  = the increase in the heat content of the air-water vapor mixture in passing through the apparatus, Btu per pound of dry air

$$= 0.24 (t_2 - t_1) + W_2 (1059.2 + 0.45 t_2) - W_1 (1059.2 + 0.45 t_1)$$

The net quantity of heat added to or removed from air-water vapor mixtures in air conditioning work is frequently *approximated* by taking the differences in total heat at exit and entrance.

For example, in Fig. 1, an *approximate* result is

$$E_h - R_c = \Sigma_2 - \Sigma_1 \quad (16)$$

where

$\Sigma_2$  = the total heat of the air-vapor mixture at exit, Btu per pound of dry air.

$\Sigma_1$  = the total heat of the air-vapor mixture at entrance, Btu per pound of dry air.

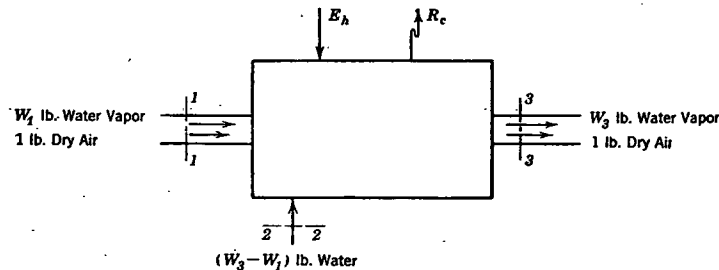


FIG. 1. DIAGRAM ILLUSTRATING ENERGY EQUATION 15

From the definitions of *total heat* and *heat content*, it may be demonstrated that Equation 16 is exactly equivalent to Equation 15, when, and only when,  $t_2 = t_1 = t_2$ ; i.e., when the initial and final wet-bulb temperatures and the temperature of the water supplied are equal. The one process that meets these conditions is adiabatic saturation, and either equation will give a result of zero; for other conditions, Equation 16 is approximate but satisfactory for many calculations.

The following problems illustrate the application of these principles:

**Example 6. Heating** (data from Example 2). Assuming the water to be supplied at 50 F, the net quantity of heat supplied is, from Equation 15,

$$E_h - R_c = 0.24 (70 - 0) + 0.000548 \times 0.45 (70 - 0) + 0.005632 [1059.2 + 0.45 \times 70 - (50 - 32)] = 22.90 \text{ Btu per pound of dry air.}$$

**Example 7. Cooling** (data from Example 3). If the condensate is removed at 54 F the quantity of heat removed is found from Equation 15, by proper regard to the arrow direction in Fig. 1,

$$E_h + R_c = 0.24 (84 - 54) + 0.00887 \times 0.45 (84 - 54) + 0.00361 [1059.2 + 0.45 \times 84 - (54 - 32)] = 11.24 \text{ Btu per pound of dry air.}$$

Using Table 6, the initial total heat of the air-vapor mixture, since the wet-bulb temperature is 70 F, is 33.96 Btu per pound of dry air.

The final total heat is, from Table 6, since the exit air is saturated, 22.55 Btu per pound. Hence, using Equation 16, the quantity of heat removed is, approximately, (33.96 - 22.55) or 11.41 Btu per pound of dry air. The degree of approximation to the correct result is evident in this example.

## PSYCHROMETRIC CHART

The revised Bulkeley Psychrometric Chart<sup>4</sup>, will be found attached to the inside back cover. It shows graphically the relationships expressed in Equations 9a and 9b. It also gives the grains of moisture per pound of dry air for saturation, the grains of moisture per cubic foot of saturated air, the total heat in Btu per pound of dry air saturated with moisture, and the weight of the dry air in pounds per cubic foot. Fig. 2 shows the procedure to follow in using the Bulkeley Chart. The directrix curves above the saturation line are as follows:

A is the total heat in Btu contained in the mixture above 0 F, and is to be referred to the column of figures at the left side of the chart. Heat of the liquid is not included.

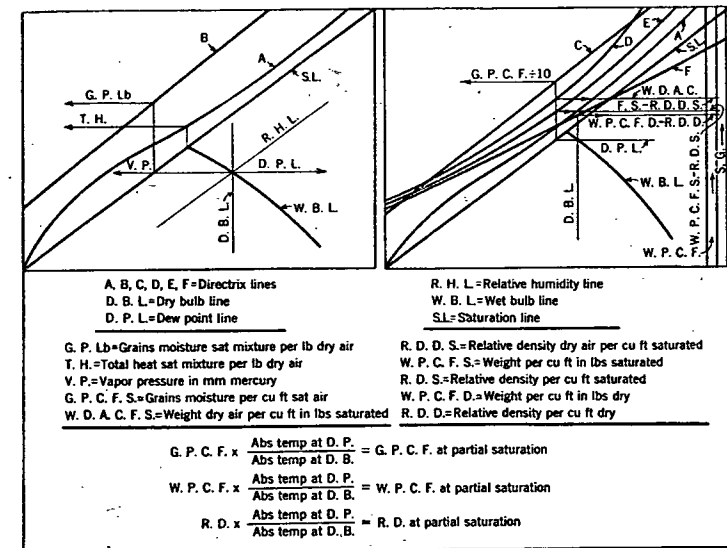


FIG. 2. DIAGRAMS SHOWING PROCEDURE TO FOLLOW IN USING BULKELEY CHART

B is the grains of moisture of water vapor contained in each pound of the saturated mixture and is to be referred to the figures at the left side of the chart.

C is the grains of moisture of water vapor per cubic foot of saturated mixture, and is to be referred to the figures at the left side of the chart which are to be divided by 10.

D is the weight in decimal fractions of a pound of dry air in one cubic foot of the saturated mixture, and is referred to the first column of figures to the right of the saturation line between the vertical dry-bulb temperature lines 170 and 180 F. The relative density of the mixture is read in a similar manner from the same curve by the column of figures between the vertical dry-bulb temperature lines 180 and 190 F.

E is similar to D but is for one cubic foot of the saturated mixture.

<sup>4</sup>The Bulkeley Psychrometric Chart was presented to the Society in 1926. (See A.S.H.V.E. TRANSACTIONS, Vol. 32, 1926, p. 163.) Single copy of the chart can be furnished at a cost of \$ .25.