

TABLE 3. COEFFICIENTS A, B, C APPEARING IN EQUATIONS 4a, 5a, 6a, MAXIMUM VALUES OF CORRECTIONS DEFINED BY EQUATIONS 4a, 5a, 6a. DEGREE OF SATURATION AT WHICH THESE MAXIMA OCCUR, μ_m . MAXIMUM VALUE OF CORRECTION DEFINED BY EQUATION 6b. DEGREE OF SATURATION AT WHICH THIS MAXIMUM OCCURS, μ_m .

(Standard Atmospheric Pressure)

t (F)	A (ft ² /lba)	B (Btu/lba)	C (Btu/F/lba)	$\bar{v}_{max}$ (ft ³ /lba)	$\bar{h}_{max}$ (Btu/lba)	$\bar{s}_{max}$ (Btu/F/lba)	$\bar{\mu}_m$	$\bar{s}_{max}$ (Btu/F/lba)	$\bar{\mu}_m$
96	0.0018	0.0286	0.00004	0.0004	0.0069	0.00001	0.4925	0.0015	0.3650
112	0.0042	0.0650	0.00009	0.0010	0.0155	0.00002	0.4878	0.0025	0.3632
128	0.0096	0.1439	0.00020	0.0022	0.0332	0.00005	0.4805	0.0040	0.3602
144	0.0215	0.3149	0.00042	0.0047	0.0693	0.00009	0.4691	0.0065	0.3557
160	0.0487	0.6969	0.00091	0.0099	0.1418	0.00019	0.4511	0.0106	0.3485
176	0.1169	1.636	0.00207	0.0207	0.2903	0.00037	0.4213	0.0179	0.3363
192	0.3363	4.608	0.00567	0.0451	0.6180	0.00076	0.3662	0.0333	0.3129

values of the specific enthalpy of dry air h_a at one-degree intervals of temperature. Values of humidity ratio at saturation W_s plotted against values of reduced enthalpy at saturation ($h_s - 1000W_s$) determine the saturation curve ($\mu = 100$ per cent). Lines of constant temperature connect points on the saturation curve with corresponding points on the dry-air axis and are inclined upward to the right. They are drawn straight in accordance with Equations 3 and 5 because the curvature contributed by the correction term 5a is inappreciable at all temperatures within the range of the chart. The portion of each isotherm lying between the dry-air axis and the saturation curve is divided into 10 equal parts by curves of constant per cent saturation. The per cent saturation of any point below the saturation curve is readily determined by linear interpolation along the isotherm through that point.

Each isotherm breaks at the saturation curve to incline upward to the left into the two-phase region above the saturation curve. The ordinate of a point in this region is the total weight of water in both the vapor phase (moist air) and the condensed phase (liquid or solid) per pound of dry air in both phases. Neglecting the very small amount of dissolved air in the condensed phase, it is the weight of water in both phases per pound of dry air in the vapor phase. The ordinate at the break in the isotherm through the point in question is the weight of water per pound of dry air in the vapor phase. Consequently, the difference between the two ordinates is the weight of condensed phase per pound of dry air in the vapor phase.

It has been stated that the region above the saturation curve is the two-phase region. This is so except in the wedge with apex on the saturation curve at 32 F where three distinct phases, namely, solid, liquid, and vapor coexist. In fact, this wedge separates the liquid-vapor region above the wedge from the solid-vapor region below it. A point inside the wedge divides the horizontal line extending through it from one boundary to the other into two segments which are in the same ratio as are the weights of solid and liquid. The temperature is 32 F throughout the wedge.

The isotherms in the two-phase regions above the saturation curve have been extended downward to the right into the vapor-phase region

below the saturation curve as lines of constant *thermodynamic wet-bulb temperature*. The definition of thermodynamic wet-bulb temperature will be given later.

On the Mollier Diagram provided with THE 1946 GUIDE there has been drawn a *protractor* from which can be determined the direction in which the state point of a mixture of water and dry air will be moved by *simultaneous addition of energy and water without addition of dry air*. A particular direction is specified by the numerical value of the *ratio of energy to water added* which ratio is designated as q and called the *specific enthalpy of water added, Btu per pound*. The protractor is especially useful in locating the *condition line* of a cooling load or heating load problem.

DERIVED PROPERTIES

Thermodynamic Wet-bulb Temperature. For any state of moist air there exists a temperature t^* at which liquid (or solid) water may be evaporated into the air to bring it to saturation at exactly this same temperature. The humidity ratio of the air is increased from a given initial value W to the value W_s^* corresponding to saturation at the temperature t^* ; the enthalpy of the air is increased from a given initial value h to the value h_s^* corresponding to saturation at the temperature t^* ; the weight of water added per pound of dry air is $W_s^* - W$ and this adds energy of amount $(W_s^* - W)h_w^*$, where h_w^* denotes the specific enthalpy of the water as added at the temperature t^* ; therefore, if the process is strictly adiabatic,

$$h + (W_s^* - W)h_w^* = h_s^* \quad (7)$$

The solution of Equation 7 for given values of h and W is called *thermodynamic wet-bulb temperature*.

Example 1. Find the thermodynamic wet-bulb temperature of moist air at 80 F, 50 per cent saturation, atmospheric pressure.

Solution. The answer is obtained directly from the Mollier Diagram. From the data of Table 1, the enthalpy of the air is $h = 19.221 + 0.50 \times 24.47 = 31.46$ Btu/lb_a (Equation 5). To a first approximation this is the enthalpy at saturation at the thermodynamic wet-bulb temperature which is therefore approximately 67 F.

At 67 F the humidity ratio at saturation is 0.01424 lb_w/lb_a and the specific enthalpy of liquid water is 35.11 Btu/lb_w. The humidity ratio of the air is $W = 0.50 \times 0.02233 = 0.01117$ lb_w/lb_a (Equation 3). Therefore, to a second approximation, the enthalpy at saturation at the thermodynamic wet-bulb temperature is $h_s^* = 31.46 + (0.01424 - 0.01117) \times 35.11 = 31.57$ Btu/lb_a, Equation 7. Interpolation in Table 1 gives as final answer,

$$t^* = 66.94 \text{ F}$$

The psychrometer is an instrument consisting of two thermometers one of which has the bulb covered with a suitable wick that has been dipped in liquid water and thoroughly wetted by it. On placing the wet-bulb of the instrument in an air stream, the liquid begins to evaporate from the wick and it is usually assumed that such evaporation brings the air immediately adjacent to the wick to saturation. At first this air may reach saturation at a higher or lower temperature than that of the liquid on the wick; but in a relatively short time the temperature of the liquid will have changed to approach equality with that of the air touching the wick, even if this requires the liquid to freeze on the wick. Then the liquid (or solid) will continue for a time to evaporate into the air stream at such temperature as will bring a portion of the air stream to saturation