Solution b: From the A.S.H.V.E. Chart. Solution of Equation 35 for the ratio $(h_2 - h_1)/(W_2 - W_1)$ yields

$$\frac{h_2 - h_1}{W_2 - W_1} = h_w \tag{36}$$

The slope of the condition line is therefore determined by the enthalpy of the water which is supplied. This slope is established on the chart by connecting the center of the protractor on the psychrometric chart with the value of h_w on the protractor. Draw a line parallel to this reference line through the initial point 1 (Fig. 13). The second line is the condition line for the process. Since the conditions of the problem require the final point to lie on the saturation line, the intersection of the condition line with the saturation line gives the desired solution.

Adiabatic Saturation

Adiabatic saturation is the designation given any process in which the state of moist air is changed from some initial unsaturated condition to a saturated one with-

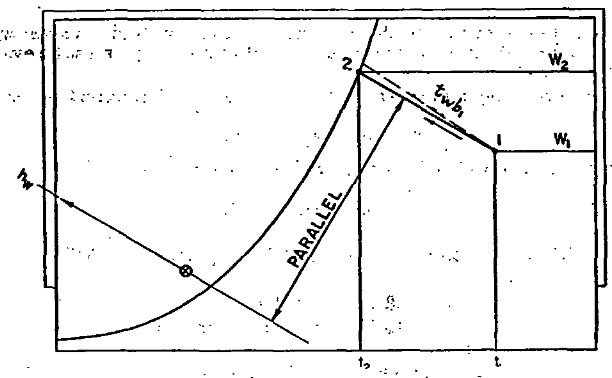

Fig. 13. Solution of Example 6 on A.S.H.V.E. Psychrometric Chart

out the addition or removal of heat. According to this definition, the addition of moisture to an adiabatic stream may become an adiabatic saturation process. *Example 6* is an illustration.

A type of adiabatic saturation of further practical interest is the use of continually recirculated spray water in a saturating air washer. Here the spray water will ultimately come to the same temperature as the saturated leaving air; this temperature is, by definition, the thermodynamic wet-bulb temperature. Hence, adiabatic saturation in this manner will have the final state point on the saturation curve, with the same thermodynamic wet-bulb temperature as the original state point.

In a process such as this, the moist air enthalpy changes very slightly. The moisture added and temperature change may be obtained from the psychrometric chart as sketched in Fig. 14.

Example 7: Moist air at 75 F dry-bulb temperature and 0.60 degree of saturation, is saturated adiabatically with recirculating spray water. Find the amount of water added and the change in enthalpy.

Solution a: From the data of Table 2. As previously stated, the final temperature of the mixture will be the thermodynamic wet-bulb temperature at the initial state. This must first be determined by the method of *Example 2*, and is 65.51 F. At this temperature the humidity ratio at saturation and enthalpy at saturation are 0.01350 and 30.45, respectively. The humidity ratio at the initial state is 0.60(0.01882) = 0.01129; the initial enthalpy is 0.60(20.59) + 18.018 = 30.372. The weight of water

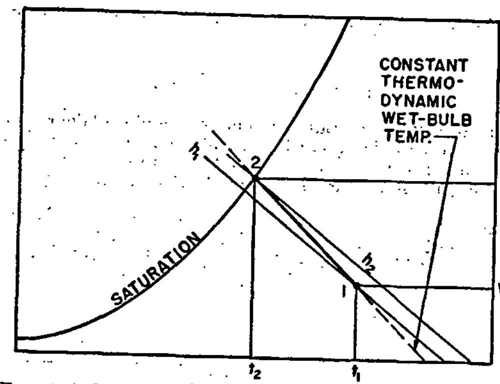

Fig. 14. Moisture Added and Temperature Change

added is therefore 0.01350 − 0.01129 = 0.00221 lb per lb of dry air; the enthalpy change is 30.45 − 30.372 = 0.078 Btu per lb of dry air.

Solution b: From the A.S.H.V.E. Chart. Since the initial and final states have the same thermodynamic wet-bulb temperature, the results may be read directly from the chart.

Addition of Heat and Water Vapor to an Air Stream in Steady Flow

Fig. 15 is a schematic representation of a system operating at constant pressure, where

G_1 is the rate of flow of dry air, pounds per minute.
G_w is the rate of evaporation of the water, pounds per minute.
h_w is the enthalpy of the liquid water entering, Btu per pound.
Q is the rate of heat addition, Btu per minute.

An energy balance for the system gives

$$G_1h_1 + Q + G_wh_w = G_1h_2 \tag{37}$$

A mass balance gives

$$G_1 + G_1W_1 + G_w = G_1 + G_1W_2$$

or

$$G_1W_1 + G_w = G_1W_2 \tag{38}$$

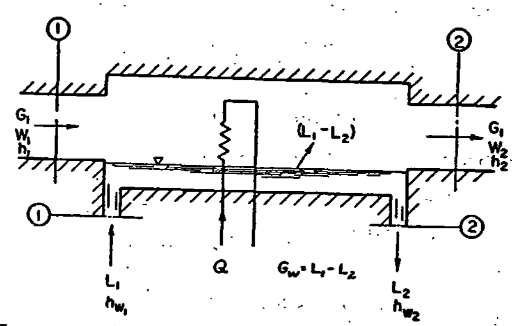

Fig. 15. Illustration of Addition of Heat and Water Vapor to an Air Stream in Steady Flow