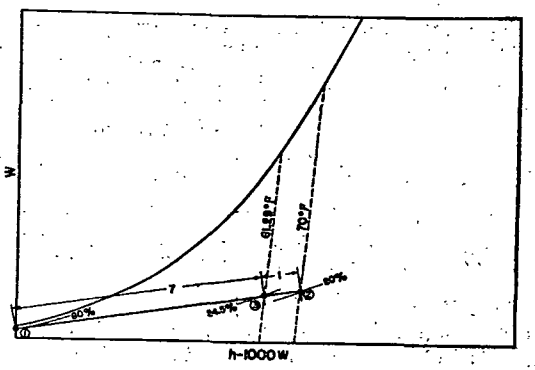


FIG. 5. ILLUSTRATION OF USE OF GOFF DIAGRAM IN SOLUTION OF EXAMPLE 8

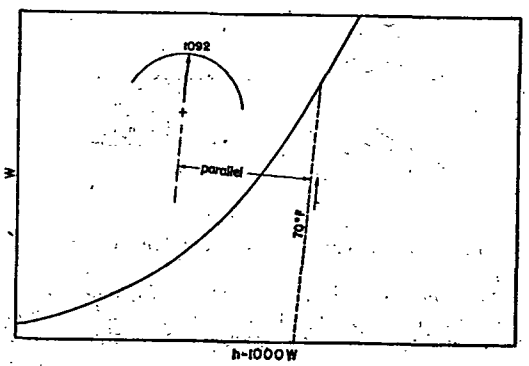


FIG. 6. ILLUSTRATION OF USE OF GOFF DIAGRAM IN SOLUTION OF EXAMPLE 9

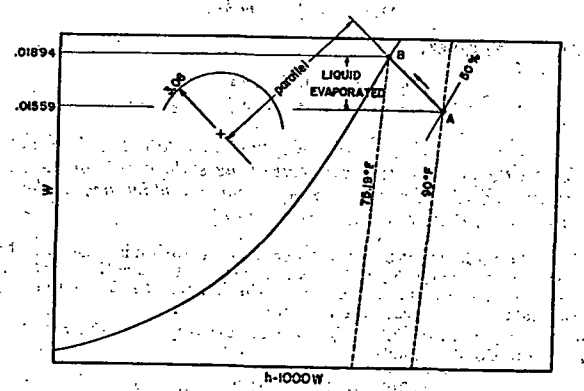


FIG. 7. ILLUSTRATION OF USE OF GOFF DIAGRAM IN SOLUTION OF EXAMPLE 10

from which: $W_3 = 0.002847$, $h_3 = 17.820$. At the temperature of the resulting mixture, therefore,

$$h_a + 0.002847\, h_{aa}/W_a = 17.820$$

At 61 F the left-hand member of this equation has the value 17.750; at 62 F its value is 17.991; by interpolation the temperature of the resulting mixture is 61.29 F where the humidity ratio at saturation, also by interpolation, is 0.01161; hence the degree of saturation of the resulting mixture is

$$\mu = 0.002847 \div 0.01161 = 24.52 \text{ per cent}$$

On the Goff Diagram, Fig. 5, a straight line is drawn between point 1 (0 F, 80 per cent) and point 2 (70 F, 20 per cent); then point 3 is located on the line one-eighth of the distance from point 2 to point 1. The temperature and degree of saturation at point 3 are read directly.

Adiabatic Mixing with Injected Water

Another typical air conditioning process is that of injecting water into an air stream to mix with it adiabatically. Let $W_2 - W_1$ denote the increase in humidity ratio of the air; this is obviously the quantity of water injected per pound of dry air; it follows that the quantity of energy injected per pound of dry air is $(W_2 - W_1)h_w$, where h_w denotes the specific enthalpy of the water as injected; if the process is adiabatic this produces an equal increase in the enthalpy of the air, namely, $h_2 - h_1$; therefore,

$$h_2 - h_1 = h_w(W_2 - W_1) \qquad (10)$$

according to which: *the process of injecting water into an air stream to mix adiabatically with it is represented by a straight line on the Goff Diagram whose direction is fixed by the specific enthalpy of the water as injected.* The protractor drawn on the Goff Diagram provided with this book provides a convenient means for determining this direction.

Example 9. It is desired to increase the humidity ratio of air at 70 F dry-bulb, without changing its temperature. Under what conditions may water be injected in order to accomplish the desired result?

Solution. At 70 F the increase of enthalpy per unit increase of humidity ratio is $h_{aa}/W_a = 17.27 \div 0.01582 = 1092$ Btu per pound of water. This must be the specific enthalpy of the water added if the state point of the air is to be moved along the 70 F isotherm. Saturated steam at 668 F has this specific enthalpy[3].

On the Goff Diagram, Fig. 6, it is seen that the 70 F isotherm is parallel to the line on the protractor for a specific enthalpy of 1092 Btu per pound.

Adiabatic Saturation

Any process by which the state point of moist air is moved to the saturation curve adiabatically may properly be called adiabatic saturation.

Example 10. Liquid water chilled to 35 F is evaporated into an air stream initially at 90 F and 50 per cent saturation. How much water must be evaporated to bring the air to saturation at what temperature?

Solution. The initial enthalpy of the air is $21.625 + 0.50 \times 34.31 = 38.780$ Btu/lb$_a$; the initial humidity ratio is $0.50 \times 0.03118 = 0.01559$ lb$_w$/lb$_a$; the specific enthalpy of the chilled water is 3.06 Btu/lb$_w$; therefore, the temperature at which the air reaches the saturation curve must be such that the enthalpy h_s and humidity ratio W_s at saturation satisfy the equation,

$$h_s - (W_s - 0.01559) \times 3.06 = 38.780$$

The solution is 75.19 F where the humidity ratio at saturation is 0.01894; consequently, the weight of water evaporated is $0.01894 - 0.01559 = 0.00335$ lb per pound of dry air.

On the Goff Diagram, Fig. 7, a line is drawn through the initial state point (90 F,