

Example 4. Find the dew-point temperature of moist air at 80 F, 50 per cent saturation, atmospheric pressure.

Solution. On the Mollier Diagram follow a horizontal line from a given state point (80 F, 50 per cent) to the saturation curve and read the temperature at the intersection.

To solve from Table 1:

From the data in Table 1, the humidity ratio of the air is $W = 0.50 \times 0.02233 = 0.01117 \text{ lb}_w/\text{lb}_a$. By interpolation this is found to be the humidity ratio at saturation at 60.22 F which is therefore the required answer.

Example 5. Find the degree of saturation of moist air at 90 F dry-bulb, 40 F (dew-point), atmospheric pressure.

Solution. On the Mollier Diagram follow a horizontal line from 40 F on the saturation curve to the 90 F isotherm (dry-bulb) and read the degree of saturation directly.

To solve from Table 1:

From the data in Table 1, the humidity ratio of the air must be $W = 0.005213$. But the humidity ratio at saturation at 90 F is 0.03118; hence the degree of saturation is

$$\mu = 0.005213/0.03118 = 16.72 \text{ per cent}$$

TYPICAL AIR CONDITIONING PROCESSES

The use of Table 1 and the Mollier Diagram in analyzing typical air conditioning processes is best explained by means of illustrative examples. In each of the following, it is to be understood that the process in question takes place at a constant pressure of 29.921 in. Hg, or standard atmospheric pressure.

Heating

The process of adding heat to moist air is represented by a horizontal line on the Mollier Diagram. The length of the line between the initial and final state points is the increase of reduced enthalpy; but, since the humidity ratio is constant, it is also the increase of enthalpy itself and therefore the quantity of heat added per pound of dry air.

Example 6. Air initially at 20 F, 80 per cent saturation is heated to 120 F. Find the quantity of heat required to process 20,000 cfm of heated air.

Solution. From the data in Table 1: the initial humidity ratio is $0.80 \times 0.002152 = 0.001722 \text{ lb}_w/\text{lb}_a$; the initial enthalpy is $4.804 + 0.80 \times 2.302 = 6.646 \text{ Btu}/\text{lb}_a$; the final degree of saturation is $0.001722/0.08149 = 2.113 \text{ per cent}$; the final enthalpy is $28.841 + 0.02113 \times 90.70 = 30.757 \text{ Btu}/\text{lb}_a$.

It may be supposed that the air is heated between two sections of a duct. The quantities of energy convected across the two sections per pound of dry air crossing them are the two enthalpies calculated. Conservation of energy requires that the difference between these two enthalpies be the quantity of heat added; thus,

$$\Delta Q_B = 30.757 - 6.646 = 24.111 \text{ Btu}/\text{lb}_a.$$

The final volume is $14.611 + 0.02113 \times 1.905 = 14.651 \text{ cu ft}/\text{lb}_a$. Since 20,000 cfm of heated air is to be processed, the total quantity of heat required is

$$\Delta Q_B = 24.111 \times 20,000/14.651 = 32,914 \text{ Btu per minute.}$$

On the Mollier Diagram the process is represented by the horizontal line AB, Fig. 2, whose length is the quantity of heat added per pound of dry air. The reduced enthalpy at A is 4.92 while that at B is 29.03, both being read directly from the chart. Since humidity ratio is constant the difference between these reduced enthalpies is also the difference between the enthalpies themselves, namely, 24.11 Btu/lb_a.

Cooling

The process of cooling moist air is also represented by a horizontal line on the Mollier Diagram. The line may extend across the saturation curve into the two-phase region, nevertheless, the length of the line between

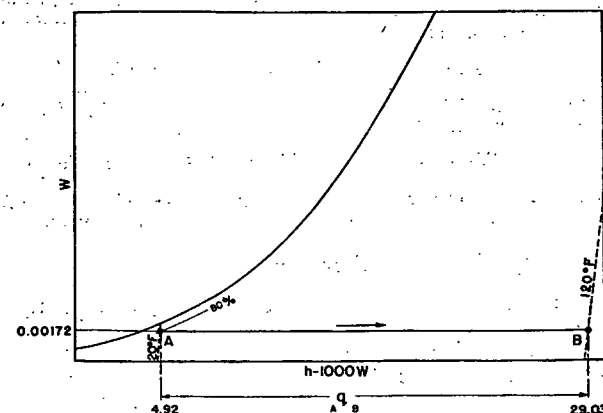


FIG. 2. ILLUSTRATION OF USE OF MOLLIER DIAGRAM IN SOLUTION OF EXAMPLE 6

the initial and final states is the quantity of heat removed, or refrigeration supplied, per pound of dry air. By following the final isotherm downward to the right to the saturation curve and reading the ordinate there, the weight of water vapor per pound of dry air in the vapor phase is determined. The difference between the initial humidity ratio and this ordinate is the weight of condensed phase per pound of dry air in the final state.

Example 7. Air at 95 F and 50 per cent saturation is cooled to 70 F. Find the refrigeration required to process 20,000 cfm of uncooled air.

Solution. From the data in Table 1: the initial humidity ratio is $0.50 \times 0.03673 = 0.01837 \text{ lb}_w/\text{lb}_a$; the initial enthalpy is $22.827 + 0.50 \times 40.49 = 43.072 \text{ Btu}/\text{lb}_a$; the humidity ratio at saturation at the final temperature is 0.01582 lb_w/lb_a; the quantity of liquid formed is $0.01837 - 0.01582 = 0.00255 \text{ lb}_w/\text{lb}_a$; the enthalpy of the final two-phase mixture is $34.09 + 0.00255 \times 38.11 = 34.187 \text{ Btu}/\text{lb}_a$.

It may be supposed that the air is cooled between two sections of a duct. The quantities of energy convected across the two sections per pound of dry air crossing them

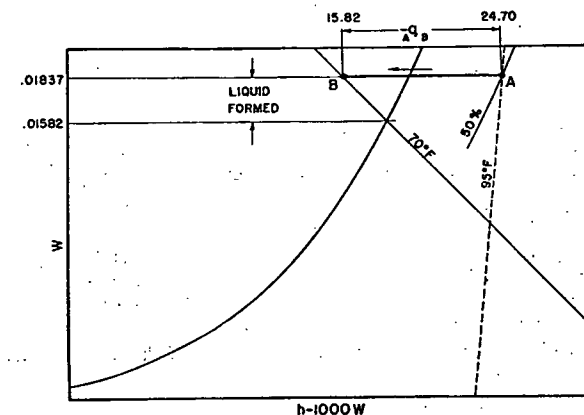


FIG. 3. ILLUSTRATION OF USE OF MOLLIER DIAGRAM IN SOLUTION OF EXAMPLE 7