The factor 1076 is defined in list of symbols at Equation 14. (Sensible cooling of the water vapor is included in the factor 1076.)

The only means of preventing moisture transfer is to use a vapor proof wall, or to apply a special lining, which is vapor proof. All openings in moisture proof construction must be equipped with special gaskets to prevent entrance of moisture.

When moisture transfer contributes an appreciable part of the latent-heat load, it is recommended that estimates should be made intentionally liberal in order to avoid later difficulties with insufficient dehumidifying capacity. Storage spaces, for example, would require sufficient dehumidifying capacity to handle the moisture brought in with goods to be stored, in addition to moisture leaking in subsequently.

MISCELLANEOUS HEAT LOADS

This designation is intended to cover the various small heat gains from exposed piping, ducts, work done by circulating fan, and unforeseen contingencies. Where sufficient data are available, these various heat gains may be estimated individually. In the majority of cases, however, common practice is to lump these factors together and combine them with a *safety factor* according to the experience and judgment of the estimator. On this basis, a small safety factor is added to the calculated cooling load to compensate for miscellaneous effects. No rules can be given for this procedure, as experience in air conditioning is indispensable for application of suitable safety factors.

REQUIRED AIR QUANTITY THROUGH CONDITIONING EQUIPMENT

The procedure for determining the required air quantity is based upon the thermodynamic principles of Chapter 3 and the use of the A.S.H.V.E. psychrometric chart. Readers are advised to review these principles, paying particular attention to the illustrative examples of cooling load calculations, and to refer to the section on Apparatus Dew-Point in Chapter 29.

Calculation of the cooling load for a conditioned space is equivalent to making, for the space, a heat balance in which all heat, moisture, and infiltration are treated as directly entering the space. As explained in the section, *Load from Outside Air, Ventilation, and Infiltration*, the outside air load normally does not become a part of the space load, because heat and moisture are removed in the air conditioner before this air gets into the conditioned space. The desired conditions are maintained by considering a certain quantity of air to be withdrawn from the space, passed through the conditioning equipment, and returned to the space with such a temperature and humidity ratio that its net effect will be to counterbalance or *remove* the given entering amounts of heat and water vapor. This quantity of *indoor air*, which is considered to be circulated in this manner, is called the *required air quantity* and its determination is normally part of every cooling-load estimate. The procedure is as follows:

1. Determine the total sensible and latent heat loads in Btu per hour for the space.

2. Compute the quantity called the enthalpy-humidity difference ratio (also referred to as heat-moisture ratio) of the room load, $\frac{h - h_s}{W_i - W_s}$. Use the equation:

$$\frac{h_i - h_s}{W_i - W_s} = \frac{\text{(Space sensible load + space latent load)}}{\text{Space latent load/1076}} \tag{18}$$

where

h_s = enthalpy of moist air supplied to the space, Btu per pound of dry air.

h_i = enthalpy of moist air at room design conditions, Btu per pound of dry air.

W_s = humidity ratio of moist air supplied to the space, pounds of vapor per pound of dry air.)

W_i = humidity ratio of moist air at room design conditions, pounds of vapor per pound of dry air.

Note that the ratio (space latent load/1076) is the equivalent of the required rate of water vapor removal in pounds per hour. If the rate of water removed is known, it may be used directly in Equation 18.

3. Draw a line through the reference point on the A.S.H.V.E. psychrometric chart and the value of $(h_i - h_s)/(W_i - W_s)$ determined above. Draw a second line through the state point of the room air (design wet-bulb and dry-bulb temperatures) parallel to this line. This is the *condition line* for the process.

4. Read the temperature where the condition line from step 3 intersects the saturation line. This is called the *apparatus dew-point*.

5. Compute the *required air quantity* from the relation

$$Q_{ra} = \frac{\text{(Space sensible load)}}{1.08\left[\left(\begin{matrix}\text{Space}\\ \text{dry-bulb}\end{matrix}\right) - \left(\begin{matrix}\text{Apparatus}\\ \text{dew-point}\end{matrix}\right)\right] \times \left(\begin{matrix}\text{Coil}\\ \text{efficiency}\end{matrix}\right)} \tag{19}$$

The magnitude of Q_{ra} is substantially the quantity, cfm, of cooled and dehumidified air for which the distribution system must be designed.

The numerical factor 1.08 is derived from the product 1 cfm × 60 min × 0.244 × 0.075 $\left(1 - \frac{0.00923}{0.62}\right)$ = 1.08, assuming an average supply air dew-point of 55 F. Since standard air density (0.075) includes the weight of the water vapor, it is desirable to reduce it to the basis of dry air by the last factor where 0.00923 = humidity ratio of air at 55 F dew-point, and 0.62 = ratio of density of water vapor to dry air at same temperature and pressure. Refer to Chapter 35 for coil selection.

Note that the product [(space dry-bulb) − (apparatus dew-point)] × (coil efficiency) is equal to the dry-bulb range through which the conditioned air is cooled. Hence, in rare instances when the *condition line* of the process may not intersect the saturation line, any other convenient reference temperature on the *condition line* may be used instead, provided that the coil efficiency is specified accordingly on the proper basis.

MINIMUM ENTERING AIR TEMPERATURE

Due consideration must be given to the temperature of the air entering the conditioned space in order to prevent objectionable drafts. With ceiling type diffusers or wall grilles with a high aspect ratio (see Chapter 30), many engineers consider 20 deg as the maximum difference for good design under average conditions. This difference can only be exceeded with extremely high ceiling outlets or wall grilles. Thus, if 80 F dry-bulb is to be maintained in a space with average ceiling height, the minimum delivered air temperature would be limited to about 60 F dry-bulb temperature. If the latent heat load is relatively high, it is often necessary to circulate more air with a higher delivered dry-bulb temperature in order to produce a thermodynamic balance. If the dry-bulb temperature of the air supplied to the space is known, the required air quantity can be calcuated from the formula,

$$Q_{ra} = \frac{q_s}{1.08\,(t_i - t_s)} \tag{20}$$