is installed the opposite situation will take place. The relative humidity will be lower than estimated. This is not generally a disadvantage except that it results in a greater load from outside air than calculated, as well as in increased power consumption. If oversize equipment is furnished, a balance should be made to assure that the ratio of total to sensible capacity is the same as in the estimated load.

Sometimes arbitrary air quantities are specified for ventilation or other reasons independent of the selection of the cooling coil. As shown in Table 3, the coil selection can be altered to take care of various air quantities for the same duty.

Where coil and condensing unit are selected for the peak load condition, and the sensible load partially disappears due to fall of outside temperature or other cause, the condensing unit and coil rebalance. This may result in more sensible capacity than required at the light load condition and less latent in proportion, with an increased relative humidity in the conditioned space. Such a condition, for a typical installation, is shown in Table 4. If approximately 40 per cent of the total air is by-passed, the condition will be improved as indicated. The situation could be entirely avoided by using reheat. With sufficient reheat, it is possible to handle any ratio of sensible and latent loads and maintain the design temperature and humidity.

Care should be taken to avoid freezing at light loads. In general, freezing occurs when the coil surface temperature falls to 32 F. With usual coils for comfort installations, this will not occur unless the evaporating temperature at the coil outlet is about 20 to 25 F. The exact value depends on the design of coil and the amount of loading. Although it is not customary to choose coil and condensing units to balance at low temperatures at peak loads, there is danger of this occurring when the load decreases. This is further aggravated if a by-pass is used so that less air is passed through the coil at light loads. It may be even worse if the control is arranged for decrease of inside temperature with fall of that outside. Freezing can be avoided by making the full load balance a high evaporating temperature and checking the balance at the minimum load condition.

## REFERENCES

A.S.H.V.E. Research Report No. 997—Heat Transfer from Direct and Extended Surfaces with Forced Air Circulation, by G. L. Tuve and C. A. McKeeman (A.S.H.V.E. Transactions, Vol. 40, 1934, p. 427).

A.S.H.V.E. Research Report No. 1029—Performance of Fin-Tube Units for Air Heating, Cooling and Dehumidifying, by G. L. Tuve (A.S.H.V.E. Transactions, Vol. 42, 1936, p. 99).

A.S.H.V.E. Research Report No. 1066—Performance of Fin-Tube Units for Air Cooling and Dehumidifying, by G. L. Tuve and C. A. McKeeman (A.S.H.V.E. Transactions, Vol. 43, 1937, p. 367).

A.S.H.V.E. Research Report No. 1099—Performance of Surface Coil Dehumidifiers for Comfort Air Conditioning, by G. L. Tuve and L. J. Seigel (A.S.H.V.E. Transactions, Vol. 44, 1938, p. 523).

Heat Transmission in Cooling Air with Extended Surfaces, by W. L. Knaus (*Refrigerating Engineering*, January, 1935, p. 23, February, 1935, p. 82).

Dehumidification of Air with Coils, by William Goodman (*Refrigerating Engineering*, October, 1936, p. 225).

Extended Surface Cooling Units, by R. H. Swart (*Refrigerating Engineering*, February, 1938, p. 107).



Chapter 26

# SPRAY EQUIPMENT

*Air Washers, Apparatus for Direct Humidification, Spray Generation and Distribution, Air Dehumidification with Washers, Water Main Temperatures, Atmospheric Water Cooling Equipment, Design Wet-bulb Temperatures for Water Cooling, Cooling Ponds, Winter Freezing*

AIR humidification is effected by the vaporization of water and always requires heat from some source. This heat may be added to the water prior to the time vaporization occurs or it may be secured by a transformation of sensible heat of the air being humidified to latent heat as the vapor is added to the air. The thermodynamics of the process are discussed in Chapter 1. The removal of moisture from air may or may not involve the removal of heat from the air-vapor mixture. With spray equipment dehumidification of air always necessitates the removal of heat.

## AIR WASHERS

Air washers may be used as either humidifiers or dehumidifiers depending upon the method of operation and the temperature of the spray water. The functions of an air washer are to regulate the moisture and heat content of air passing through it and to remove dust and dirt from the air. Air washers are not as effective as air filters in the removal of dust and dirt.

The construction of commercial air washers is indicated in Figs. 1 and 2. Any air washer consists essentially of a chamber through which the air passes in intimate contact with water. The lower portion of the washer chamber serves as a sump for the spray water.

Contact between the air and the washer water is secured: (1) by breaking the water into a very fine mist, (2) by passing the air over surfaces which are continuously wetted by water, or (3) by a combination of water sprays and wetted plates. Scrubber-plate types of washers are used largely to wash heavy reclaimable products from the air, and are generally composed of one to three eliminator-type baffle scrubber plates across the air stream. Water is supplied at the tops of the scrubber plates by flooding nozzles placed across the top of the washer. Spray washers have one or more banks of water atomizing nozzles placed in the air stream above the level of the water in the sump. The direction of the water sprays may be against the air stream, with the air stream, or with