Substitute in Equation 15. Q = 2900 cfm, from solution of Question 5; $\Delta t = 116 + 4 - 70 = 50$ F; h_{fg} = 968 Btu, from steam table in Chapter 1.

$$W = \frac{60\,dQ \times 0.24 \times \Delta t}{h_{fg}} = \frac{60 \times 0.07492 \times 2900 \times 0.24 \times 50}{968} = 161.8 \text{ lb per hour.}$$

7 ● The same rooms are converted to chemical laboratories, requiring the introduction of 12 changes of outside air, measured at 70 F, per hour to permit the exhaust fans connected to the chemical hoods to maintain only a slight negative pressure in the rooms. At what temperature must the air enter the rooms to maintain 70 F with 0 F outside?

Substitute in Equation 2. $H = 110{,}100 + 34{,}200 = 144{,}300$ Btu per hour; $Q = \frac{12}{60} \times 27{,}000 = 5400$ cfm; $t = 70$ F; $t_y = \frac{H}{60\,dQ \times 0.24} + t = \frac{144{,}300}{60 \times 0.07492 \times 5400 \times 0.24} + 70 = 94.7$ F.

8 ● In the preceding question, if the air drops 2 F between the heater and the rooms, how many pounds of steam per hour at 1-lb gage will the heating system condense?

Substitute in Equation 15. Q = 5400 cfm; $\Delta t = 94.7 + 2 = 96.7$ F, from solution of Question 7; h_{fg} = 968 Btu, from steam table in Chapter 1.

$$W = \frac{60\,dQ \times 0.24 \times \Delta t}{h_{fg}} = \frac{60 \times 0.07492 \times 5400 \times 0.24 \times 96.7}{968} = 583 \text{ lb per hour.}$$

9 ● The combination hot blast heating and ventilating system for the dining rooms of a hotel is to heat the rooms to 70 F with 0 F outside, and permit the exhaust fan from the adjoining kitchen to draw 5000 cfm from the dining rooms. The transmission losses from the dining rooms total 240,000 Btu per hour. The infiltration into the dining rooms amounts to 1000 cfm from outdoors and 1000 cfm from heater rooms. How many cubic feet per minute, measured at 70 F, must be supplied the dining rooms if the air enters at 112 F?

First find the infiltration loss by substituting in Equation 1.

$t = 70$ F; $t_o = 0$; $M_o = d \times Q = 0.07492 \times 60 \times 1000 = 4497$ lb per hour. In this case d and Q are figured at 70 F. $H_o = 0.24\,(t - t_o)\,M_o = 0.24\,(70 - 0) \times 4497 = 75{,}550$ Btu per hour.

Next by substituting in Equation 3, find the cubic feet per hour to be circulated. H = sum of transmission and infiltration losses in room = $240{,}000 + 75{,}550 = 315{,}550$ Btu per hour; $t_y = 112$ F; $t = 70$ F;

$$Q = \frac{H}{60\,d \times 0.24\,(t_y - t)} = \frac{315{,}500}{60 \times 0.07492 \times 0.24\,(112 - 70)} = 6950 \text{ cfm.}$$

10 ● In Question 9, 3000 cfm of outside air will be drawn in by the supply fan and 3950 cfm will be recirculated. What will be the output of the heating sections in Btu per hour if there is a loss of 2 F between the heaters and the room?

The average temperature of the mixture of outdoor and recirculated air entering the heater $= \frac{3000 \times 0 + 3950 \times 70}{6950} = 39.8$ F. Air leaves the heater at $112 + 2 = 114$ F.

Referring to Equation 15, $W \times h_{fg}$ = amount of heat required per hour $= 60\,dQ \times 0.24 \times \Delta t = H$. Q = 6950 cfm; $\Delta t = 114 - 39.8 = 74.2$ F. $H = 60 \times 0.07492 \times 6950 \times 0.24 \times 74.2 = 557{,}000$ Btu per hour.

Chapter 10

CENTRAL SYSTEMS FOR COOLING AND DEHUMIDIFYING

Types of Systems, Dehumidifiers, Designing the System, Zoning, Location of Apparatus, Temperature of the Air Leaving Room Inlets, Air Quantity Required, Heat to be Removed by Cooling and Dehumidifying Apparatus, Size of Reheaters, Surface Cooling Problem, Auxiliary Equipment

CENTRAL systems, equipped for cooling and dehumidifying, are used principally in the air conditioning of theaters, restaurants, office buildings, or other places where people gather, and in manufacturing establishments where air conditions have an important influence on the quality of product or rate of production. A central cooling and dehumidifying plant is one in which the fans, dehumidifiers, and other related apparatus are assembled in suitable apparatus rooms from which supply and return ducts lead to the conditioned spaces. The design of such systems is considered in this chapter, while in Chapter 9 central systems for heating and humidifying are described. Air conditioning for industrial processes is considered in Chapter 40.

TYPES OF SYSTEMS

Dehumidification or cooling of air may be accomplished by several methods and by use of many heat transfer mediums. Most comfort-conditioning, central station, air-conditioning systems employ cold water or the direct expansion of a refrigerant in either spray type or surface type equipment to accomplish the required cooling and dehumidification. Among the several other methods that may be employed are: passing the air through or over a dehydrating agent and then lowering the dry-bulb temperature to the proper level, and evaporative cooling. With the former method the excess sensible heat may be removed with cold water and where this is not available, mechanical refrigeration must be used after the air has been dehydrated. The latter method is applicable to comfort conditioning only in regions where the summer wet-bulb temperature is low.

If the system is intended solely for summer conditioning, the apparatus will consist essentially of a dehumidifier of the surface type or spray type; filters; fan and motor; reheater; outside air, return air, and supply air duct work; air inlets and outlets; spray pump for spray dehumidifier; refrigera-