Dichlorodifluoromethane System:

Power requirements,

Cooling tower fan	17.8 bhp
Cooling tower pump	30.2
Total	48.0 bhp

$$\text{Power for cooling tower system} = \frac{48.0 \text{ bhp} \times 0.746 \times 1200 \text{ hr}}{0.80 \text{ motor efficiency}} = 53{,}700 \text{ kwhr.}$$

The water cooler in a dichlorodifluoromethane system of the surface type requires no additional pumping head other than the friction drop through the cooler, which in this problem is estimated to be 10 ft. The total pumping head is, therefore, 75 + 10 = 85 ft. Power required for the chilled water system will be,

$$\frac{1200 \text{ gpm} \times 8.34 \text{ lb per gallon} \times 85 \text{ ft head}}{33{,}000 \text{ ft lb} \times 0.75 \text{ pump efficiency}} = 34.3 \text{ bhp.}$$

$$\frac{34.3 \text{ bhp} \times 0.746 \times 1200 \text{ hr}}{0.80 \text{ motor efficiency}} = 38{,}300 \text{ kwhr.}$$

Thus, the total power required by the auxiliary equipment will be

$$53{,}700 + 38{,}300 = 92{,}000 \text{ kwhr.}$$

The 92,000 kwhr at 2 cents per kwhr will cost	$1,840
The power cost of refrigeration, from Question 7, is	2,931
The total annual power cost, using a dichlorodifluoromethane system, is	$4,771

Steam Ejector System:

Power requirements,

Cooling tower fan	35.6 bhp
Cooling tower pump	47.8
Total	83.4 bhp

$$\text{Power for cooling tower systems} = \frac{83.4 \text{ bhp} \times 0.746 \times 1200 \text{ hr}}{0.80 \text{ motor efficiency}} = 93{,}300 \text{ kwhr.}$$

In the flash tank or water cooler of the steam ejector system, the water is at a pressure corresponding to the chilled water temperature required. In this case it is at 46 F, which corresponds to an absolute pressure of 0.1532 lb per sq in. or 0.3118 in. Hg. This increases the pumping head on the chilled water circulating pump by 14.7 − 0.15 = 14.55 lb per square inch, or 33.5 ft. The total pumping head is, therefore, 75.0 + 33.5 = 108.5 ft.

$$\frac{1200 \text{ gpm} \times 8.34 \text{ lb per gallon} \times 108.5 \text{ ft head}}{33{,}000 \text{ ft-lb} \times 0.75 \text{ pump efficiency}} = 43.7 \text{ bhp.}$$

$$\frac{43.7 \text{ bhp} \times 0.746 \times 1200 \text{ hr}}{0.80 \text{ motor efficiency}} = 48{,}800 \text{ kwhr.}$$

The total power required by the auxiliary equipment is

$$93{,}300 + 48{,}800 = 142{,}100 \text{ kwhr.}$$

The 142,100 kwhr at 2 cents per kwhr will cost	$2,842
The cost of the steam, from Question 8, is	1,929
The total annual power cost, using a steam ejector system, is	$4,771

These calculations indicate that for the assumptions made, both the dichlorodifluoromethane system and the steam ejector system would cost 2.6 cents per ton-hour to operate. In order to obtain a complete analysis it would be necessary to compare the fixed charges which include interest, depreciation, obsolescence, and maintenance. These are customarily computed at 15 per cent of the initial cost per annum. To this cost must be added the cost of refrigerant make-up per year. In the steam system this cost is negligible, while in the dichlorodifluoromethane system it may be approximated at about 10 per cent of the refrigerant charge per year.

Chapter 12

HUMIDIFICATION, DEHUMIDIFICATION AND WATER COOLING EQUIPMENT

Air Washers, Apparatus for Direct Industrial Humidification, Spray Generation and Distribution, Self-Contained Humidifiers, Atmospheric Water Cooling Equipment, Design Wet-Bulb Temperatures, Cooling Ponds, Spray Cooling Towers, Natural Draft Deck Type Towers, Mechanical Draft Towers, Winter Freezing

THE several available types of spray equipment are discussed in this chapter which are used for properly humidifying and dehumidifying the air circulated in a comfort or industrial air conditioning system or for cooling the condensing water of a refrigeration system.

AIR WASHERS

An air washer is essentially a chamber in which air is brought into intimate contact with water to (a) regulate the moisture content of the air, and (b) to wash dust and dirt particles out of the air. The air comes in contact with the water by passing it through a spray of water broken up into a fine mist or by passing it over surfaces wetted by a continuous flow of water; hence the classification: spray, scrubber, and combination spray and scrubber type washers. (See Figs. 1 and 2.)

A washer chamber may be constructed of wood, or stone, but it is most often constructed of sheet metal. The lower portion of it is specially designed as a tank to receive the water dropping through the chamber and to serve as a reservoir from which the water may be recirculated.

It is desirable that air leaving a washer contain no water in suspension, and for this reason eliminators are provided at the washer outlet. These may be in the form of plates or baffles upon which the free moisture is deposited as the air is deflected through several changes from its original direction of flow.

In some washers, units of either steel wool or special glass fiber sections serve as eliminators. However, specially designed sheet metal plates are more generally used because they offer the least resistance to the flow of air, while performing effectively the function of moisture elimination. They also have the advantage of acting as scrubber surfaces when flooded. When the air has a high sulphur content tending to form a weak acid, the eliminators have been constructed of ribbed, wire glass plates set in a cypress frame so that frequent renewal will not be necessary.

It is essential to uniform performance in a washer, that air enter evenly