

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 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

The power cost of refrigeration, from Question 4, is

\$1,840
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
1,929

The cost of the steam, from Question 5, is

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 is negligible, but in the dichlorodifluoromethane system it may be approximated from 1/4 to 1/3 of the refrigerant charge per year.

Chapter 11

HUMIDIFICATION AND DEHUMIDIFICATION

Air Washers, Atmospheric Water Cooling Equipment, Cooling Towers, Design Wet-Bulb Temperature, Cooling Ponds, Natural Draft Deck Type Towers, Mechanical Draft Towers, Winter Freezing

EQUIPMENT for humidifying and dehumidifying is of varied character and its functions will be discussed in this chapter. An air washer is essentially a chamber in which air is brought in intimate contact with water, the object being (a) to wash the air or (b) to regulate the moisture content of the air and at the same time wash it. The air comes in contact with the water by passing it through water sprays 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.

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. 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 washer units steel wool filter sections serve as eliminators. However, specially designed plates are used more generally than other devices because they offer the least resistance to the flow of air, while still performing effectively the function of free moisture elimination. They also have the advantage of acting as scrubber surfaces when flooded.

It is essential to uniform performance in a washer, that air enter evenly distributed over the washer inlet. To insure this, a perforated plate or eliminator plates are installed at the inlet. Eliminator plates are now more generally used. They serve a second purpose in preventing the escape of spray through the washer inlet.

Water is supplied to scrubber type units through flooding nozzles. The capacity of these nozzles varies with the manufacturer although a fair value of 5 gpm may be used. The nozzles are spaced on one-foot centers across the top of the washer over the scrubber plates.

Water is supplied to spray type units through atomizing nozzles generally arranged in banks across the washer. The nozzles spray either in the direction of the air flow, that is, downstream, or against the air flow, or upstream. Nozzle capacities vary with the manufacturer, from 1-1/2 to 2 gpm at a water pressure of about 25 lb per square inch which pressure