Example 3. Using the data from Example 2, if city water costs 20 cents per thousand gallons, and if 1.25 gal are used per minute per ton, estimate the annual water cost.

Solution.

$60 \times 1.25 = 75$ gal per ton-hour.
181,824 ton-hours $\times$ 75 = 13,620,000 gal per year.

$$\frac{13{,}620{,}000 \times \$0.20}{1000} = \$2{,}724 \text{ the yearly cooling water cost.}$$

Example 4. Using the data of Example 2, if a cooling tower were installed for re-using the condensing water, estimate the annual compressor power cost of a dichlorodifluoromethane refrigeration system if the final temperatures of the water leaving the cooling tower and the kilowatt input per ton are the following:

Tons	284	233	183	157	144	79	37
Temperature of water leaving tower, F	86.7	81.8	76.5	72.1	66.4	61.3	55.6
Kw input per ton	1.10	0.94	0.85	0.80	0.74	0.59	0.62

Solution.

Wet-Bulb Temperature F	Ton-Hours		Kw per Ton		Kwhr
80	1,704	×	1.10	=	1,875
79 – 75	23,300	×	0.94	=	21,900
74 – 70	50,700	×	0.85	=	43,300
69 – 65	51,800	×	0.80	=	41,400
64 – 60	39,900	×	0.74	=	29,500
59 – 55	12,500	×	0.59	=	7,370
54 – 50	1,920	×	0.62	=	1,200
Totals	181,824 ton-hours				146,545 kwhr

The 146,545 kwhr at 2 cents per kwhr will cost $2,931.

The average consumption will be $\frac{146{,}545 \text{ kwhr}}{181{,}824 \text{ ton-hours}} = 0.805$ kw per ton.

Example 5. If a steam ejector system were used to secure the refrigeration for the air conditioning system of Example 2, compute the annual steam cost if steam is sold for 53 cents per thousand pounds and if there is an average steam consumption of 20 lb of steam per hour per ton when used with a cooling tower system.

Solution. 181,824 tons $\times$ 20 lb of steam per ton = 3,636,480 lb of steam.

The 3,636,480 lb at 53 cents per thousand pounds will cost $1,929.

Chapter 25

HEAT TRANSFER SURFACE COILS

Coil Applications, Construction and Arrangement, Steam Coils, Water Coils, Direct-Expansion Coils, Flow Arrangements, Applications, Calculation of Heat Transfer, Air Flow Resistance, Coil Performance, Selection

THE coils described in this chapter are used in air conditioning systems for heating or cooling an air stream under forced convection. The surface coil equipment may be made up of a number of banks assembled in the field, or the entire assembly may be factory constructed. The applications of each type of coil are limited to the field within which it is rated. Other limitations are imposed by code regulations, by proper choice of materials for the refrigerants used and the condition of the air handled, or by an economic analysis of the possible alternates on each installation.

For heating service, these coils are used as preheaters, reheaters or booster heaters, (see Chapters 21 and 22). The function of the coils is air heating only, but the apparatus assembly may include means for humidification and air cleaning. Steam or hot water are the usual heating media, although others are used in special cases, such as reheating by means of discharge gas from a refrigerating system.

Coils are used for air cooling with or without accompanying dehumidification. Examples of cooling applications without dehumidification are precooling coils using well water or other relatively high temperature water to reduce the load on the refrigerating machinery, or water cooled coils to remove sensible heat in connection with chemical moisture-absorption apparatus. By proper coil selection it is possible to handle both sensible cooling and dehumidification together as further explained later. The apparatus assembly usually includes an air cleaning means to protect the coil from accumulation of dirt and to keep dust and foreign matter out of the conditioned space. Although cooling and dehumidification are the usual functions, there are cases of cooling coils purposely wetted as an aid to air cleaning and odor absorption.

The usual cooling media used in surface coils are cold water and volatile refrigerants such as dichlorodifluoromethane and methyl chloride, but others are used in special cases. Brines are seldom required for the range of applications covered by this chapter, although there are cases where low entering air temperatures with large latent heat loads require a refrigerant temperature so low that water becomes impractical. Some-