surfaces made available by different manufacturers will have different transmission values. It is recommended that the designer consult the latest manufacturers' catalogs because more accurate ratings are being issued from time to time.

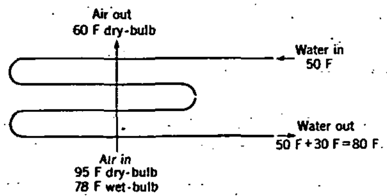


FIG. 4. COUNTER-FLOW SURFACE COOLING DIAGRAM

*Example 6.* It is desired to cool and dehumidify 30,000 cfm of air at 95 F dry-bulb, 78 F wet-bulb, and 72 F dew point, to a 60 F dew point. Cooling water is available at 50 F in a quantity which will allow a 30 F rise in temperature to be used. The counter-flow surface cooling used is sketched in Fig. 4.

*Solution.* The pounds of partially saturated air cooled and dehumidified per hour equal 60 times the cubic feet of air at 95 F dry-bulb and 78 F wet-bulb brought past the coil surface per minute, multiplied by the pounds per cubic foot of the air as determined from Table 3, Chapter 1.

$$30{,}000 \times 60 \times 0.0708 = 127{,}440 \text{ lb per hour.}$$

The total heat $H_t$ to be removed per hour by the surface coil is found to be equal to the pounds of partially saturated air passed over the coil per hour times the difference between the total heat of air at 78 F wet-bulb and at 60 F wet-bulb.

$$H_t = 127{,}440\ (41.42 - 26.37) = 1{,}918{,}000 \text{ Btu per hour.}$$

The latent heat $L$ to be removed per hour will be found by multiplying the pounds of partially saturated air passed over the coils per hour by the difference in the latent heat of the air per pound at the initial and final dew points.

$$L = 127{,}440\ (1091.6 - 1086.2) = 688{,}000 \text{ Btu per hour.}$$

The sensible heat $H_s$ to be removed per hour is equal to the total heat of the air less its latent heat.

$$H_s = H_t - L = 1{,}918{,}000 - 688{,}000 = 1{,}230{,}000 \text{ Btu per hour.}$$

Manufacturers' standard ratings for surface coolers are usually based on the cubic feet of air passed through their equipment per minute, reduced to the conditions of saturated air measured at a temperature of 70 F. In the present example, to convert the 127,440 lb of air cooled per hour to a basis which will permit the use of such standard ratings, it is necessary to multiply the pounds of air cooled per hour by the specific volume of the air, and to divide by 60.

$$\frac{127{,}440 \times 13.68}{60} = 29{,}100 \text{ cfm of 70 F saturated air.}$$

The amount of cooling water necessary when a 30 deg rise in its temperature is to be used is:

$$\frac{1{,}918{,}000}{30 \times 8.34 \times 60} = 128 \text{ gpm.}$$





With counter flow of air and water, it is necessary to determine the mean temperature difference between the air and the water in order to properly use the transmission coefficients given in apparatus rating tables.

$$\text{Mean temperature difference} = \frac{D_1 - D_2}{\log_e \frac{D_1}{D_2}} \qquad (6)$$

*where*

$D_1$ = the difference between the temperatures of inlet air and outlet water, degrees Fahrenheit.

$D_2$ = the difference between the temperatures of outlet air and inlet water, degrees Fahrenheit.

$$\frac{(95 - 80) - (60 - 50)}{\log_e \frac{(95 - 80)}{(60 - 50)}} = 12.33 \text{ F.}$$

If from apparatus rating tables based on air velocities over the coils and water velocities through the coils, it has been found that the transmission coefficient is equal to 8.0 Btu per square foot per degree difference in mean temperature between the air and the water, the area of cooling coil surface necessary will be equal to the sensible heat divided by the transmission coefficient and also by the mean temperature difference.

$$\frac{1{,}230{,}000}{8.0 \times 12.33} = 12{,}450 \text{ square feet of cooling coil surface necessary.}$$

The latent heat is taken out at the same time the sensible heat is extracted, but no extra surface is required unless the latent heat exceeds approximately 40 per cent of the total heat. This is because the wetted surface has a much higher coefficient of transmission. Approximately 10 per cent more surface should be added if the latent heat exceeds 40 per cent of the total heat.

## AUXILIARY EQUIPMENT

Consult Chapters 14, 17, 19, 20, 22, and 42 for information on the air distribution system; air outlets and inlets; static pressure on fan; fans; motor and drive; and the control system.

## PROBLEMS IN PRACTICE

**1 ● What is meant by the term evaporative cooling?**

Evaporative cooling, or adiabatic saturation of the air, is only effective when the air to be cooled is very dry. It is accomplished by passing the air in an unsaturated condition through a water spray which evaporates a part of the water at the expense of the sensible heat. In this adiabatic transfer the total heat content of the air remains constant while the dew point rises and the dry-bulb falls until the air is saturated.

**2 ● In summer air conditioning what factors control the difference between the dry-bulb temperature of the conditioned space and the dry-bulb temperature of the entering air?**

1. The duct and supply grille arrangement permitted by architectural and structural requirements for the particular space, *e.g.*, ceiling height and obstructions on ceilings, such as beams.
2. The state of activity of the occupants.
3. The velocity at the inlet grille, as limited by noise level requirements.