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 central systems for cooling and dehumidifying what factors fix the quantity of air required?

The weight or volume of air required depends wholly on the sensible heat gain in the room conditioned and on the difference between the dry-bulb temperature of the air at the room inlets and the dry-bulb temperature maintained in the room.

3 ● In central systems for cooling and dehumidifying can the dry-bulb temperature change be fixed arbitrarily?

No, because the change depends on factors at both the conditioner and the room. At the conditioner, temperature of the available water supply may limit the dry-bulb temperature of the leaving air. At the room, the dry-bulb temperature of the entering air may be further limited by: 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. 4. The direction of the jet relative to the occupants.

4 ● What factors determine the dew point of the air entering the space?

The maximum dew point desired in the conditioned space, and the moisture gain in the space per unit weight of air supplied.

5 ● Why must the air leaving a dehumidifying type air washer often have its dry-bulb temperature raised before delivery to the occupied zone of room?

The air leaves the dehumidifying air washer saturated at a relatively low temperature which in most cases is lower than the allowable delivery dry-bulb temperature as fixed by factors outlined under Question 3. Also, the air may possibly be carrying a small amount of entrained water which might settle out in the ducts near the washer and cause corrosion difficulties.

6 ● What methods may be used to raise the dry-bulb temperature of the air after it leaves the dehumidifying air washer and before it enters the room?

a. Sensible heat may be added by a reheating method from a source outside the air stream. This method passes all or part of the cold, dehumidified air over steam or hot water coils at the central conditioner or in the ducts, or over electric grids or similar devices. Any available source of sensible heat can be used.

b. A mixing method using sensible heat already in the air stream. In this method the cold, dehumidified air is mixed with air at a higher dry-bulb temperature and the dry-bulb temperature of the resulting mixture is higher than that of the air when it left the conditioner. The air at high dry-bulb temperature is obtained by not passing it through the dehumidifying washer. The mixing may take place at a central conditioner or in the rooms themselves.

c. Combinations of these methods.

7 ● What are the advantages of using counter flow of air and water in surface coolers?

Counter flow results in a higher mean temperature difference than does parallel flow for the same range of air and water temperatures, which means that less cooling surface is required. Counter flow permits higher initial water temperatures and also allows a greater temperature rise for the water. These factors combine to reduce the cost of circulating and refrigerating the cooling water.

Chapter 11

COOLING METHODS

Air Cooling Processes, Evaporative Cooling; Dehumidification, Refrigeration, Silica Gel System, Alumina System, Lithium Chloride System, System Design, Operating Methods, Steam Jet System, Refrigerating Compressors, Refrigerants, Evaporators and Coolers, Condensers

BY using any of the following four methods, or any combination of them, *effective temperature* (see Chapter 3) may be reduced.

a. Sensible cooling: Lowering of the dry-bulb temperature by the removal of sensible heat without change of the dew-point temperature.

b. Dehumidifying: Lowering of the dew-point temperature by the removal of moisture without change of the dry-bulb temperature.

c. Evaporative cooling: Lowering of the dry-bulb temperature through the evaporation of moisture without the addition or the subtraction of heat.

d. Air motion: Increasing the air motion over the body.

As an example, let the condition be considered of 92 F dry-bulb, with a 40 per cent relative humidity, corresponding to a wet-bulb temperature of 72.8 F, and an effective temperature for still air of 81.1 F. This *effective temperature* may be reduced 3.1 F by any of the four basic methods mentioned, as follows:

First, by lowering the dry-bulb temperature to 85.5 F without changing the dew-point of 64.2; this gives an effective temperature of 78 F.

Second, by reducing the moisture content of the air to 46 grains per pound of dry air without changing the dry-bulb temperature; this gives an effective temperature of 78 F.

Third, by reducing the dry-bulb temperature to 83.8 F without changing the total heat of the air. This requires the evaporation of 14 grains of moisture per pound of dry air, and the effective temperature will become 78 F.

Fourth, by increasing the air movement from still air to 460 fpm, a velocity which will reduce the effective temperature 3.1 F from 81.1 F to 78 F.

AIR COOLING PROCESSES

The best method of reducing the effective temperature in any specific case will depend on the accompanying circumstances and can be determined only by a thorough analysis made by a competent engineer. Generally speaking, the removal from the air of the sensible heat, or moisture, or both, by sensible cooling or dehumidifying is the most satisfactory method. Adequate results by the utilization of air motion or by evaporative cooling are difficult to obtain because of the dependence of both methods upon climatic conditions beyond the engineers' control although these methods are much less expensive than the first two