features not obtainable with the coil and bunker method. Higher suction temperature operation, more uniform temperatures, higher relative humidities with the defrosting cycle, moderate first cost, and a minimum of installation expense are likewise factors in their development.

New uses have appeared for unit air cooler application in industrial and commercial processes involving both the raw materials and finished product, where the maintenance of low temperatures is a necessary part of these processes. Of particular interest is the new field of extreme low temperature application where many new uses for refrigeration are being found.

Types of Units. The two standard types are the suspended or ceiling type, and the vertical or floor mounted type. There are variations of these such as the panel type which is wall mounted and arranged to take in air from the lower section and discharge it from the upper section.

The ceiling type has the appearance of a unit heater, with its propeller type fan blowing air through a bank of coils. Singly or in combination, they are easily installed and occupy little or no useful space. Alterations may be accomplished with little cost by relocating units or adding additional ones for increased capacity.

The floor mounted types employ blower type fans, as their air deliveries are higher and their locations may be remote from the space to be refrigerated. Air velocities and volumes must be designed for the individual application. Due to the small temperature difference between coil and air, the air volumes handled are many times greater than in comfort air conditioning work. Where a defrosting cycle is not practicable, this type of unit may employ a pump to spray a eutectic solution over the coils for the purpose of avoiding frosting.

Ratings. In order to rate and test equipment of this kind which normally operates below the frost temperature, a proposed code, Standard Methods of Rating and Testing Forced-Circulation and Natural Convection Air Coolers for Refrigeration[3], has been issued. In this standard, the gross cooling effects are taken since the motor power input equivalent is to be computed as part of the load.

REFERENCES

[1] Prepared by a Joint Committee of the *American Society of Refrigerating Engineers*, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, *Refrigerating Machinery Association*, *National Electrical Manufacturers' Association*, and *Air Conditioning Manufacturers' Association* (*A.S.R.E. Circular* No. 13-42).

[2] Standard Method of Rating and Testing Self-Contained Air Conditioning Units for Comfort Cooling prepared by a Joint Committee of the *American Society of Refrigerating Engineers*, AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, *Refrigerating Machinery Association*, *National Electrical Manufacturers' Association*, and *Air Conditioning Manufacturers' Association* (*A.S.R.E. Circular* No. 16).

[3] Proposed A.S.R.E. Standard Methods of Rating and Testing Forced-Circulation and Natural Convection Air Coolers for Refrigeration (*A.S.R.E. Circular* No. 25-44).

CHAPTER 37

SPRAY APPARATUS

Air Washers, Humidification with Air Washer, Dehumidification and Cooling with Air Washers, Well and Water Main Temperatures, Apparatus for Direct Humidification, Water-Cooling Towers, Water Use and Conservation, Rivers and Lakes, Spray Cooling Ponds, Atmospheric and Mechanical Draft Cooling Towers, Mechanics of Atmospheric Water-Cooling, Design Conditions, Water-Cooling Tower Design, Selection of Water-Cooling Towers, Operation and Maintenance

AIR humidification is effected by the vaporization of water and always requires heat from some source. This heat may be added to the water prior to the time vaporization occurs or it may be secured by a transformation of sensible heat of the air being humidified to latent heat as the vapor is added to the air. The thermodynamics of the process are discussed in Chapter 3. The removal of moisture from air may or may not involve the removal of heat from the air-vapor mixture. With spray equipment, dehumidification of air always necessitates the removal of heat.

AIR WASHERS

An air washer consists essentially of a chamber or casing in which is provided a spray nozzle system, a tank at the bottom of the chamber for collecting the spray water as it falls, and an eliminator section at the leaving end of the chamber for removal of drops of entrained moisture from the delivered air. Air is drawn through the casing of the washer, where it comes into intimate contact with the spray water. A heat transfer takes place between the air and water, resulting in either humidification or dehumidification of the air, depending upon the method of operation and the relative temperatures of air and spray water.

To prevent backlash of spray ahead of the washer chamber and to aid in more uniform air distribution, inlet diffusion plates or eliminator baffles, where necessary, are provided in the air entrance end of the air washer. Inlet diffusion plates are used when the air flow and water spray are in the same direction; eliminator baffles of special design are used where one or more of the water sprays opposes the air flow. At the outlet end of the washer suitable flooded eliminator plates are used. These plates, for the removal of entrained moisture, usually cause four to six changes in direction of the air flow.

Figs. 1 and 2 show the essential construction features of conventional air washers. Intimate contact between the air and the water is secured; (1) by breaking the water into fine drops, (2) by passing the air over surfaces continuously wetted by water, or (3) by a combination of the two.

The wetted surfaces in an air washer may be of fibre glass, metal or scrubber plate construction. Scrubber plate types of washers are generally used to wash reclaimable products from the air and are composed of several baffle type plates located across the air stream. Water is supplied at the top of the washer to spray over these plates. In the case of the fiber glass or metal surfaces the water spray is usually rather coarse and at