of ventilation and cooling and the additional direct humidification provides for increase in humidity without interfering with the ventilation or the cooling effected by the indirect system.

In general, it may be stated that direct humidification is most satisfactory where high humidities are desired but where little cooling, ventilation or air motion is required. Therefore, the indirect system is most applicable where either low or high relative humidities are desired with maximum cooling and ventilation effect. For conditions that require an unusually large amount of heat to be absorbed by ventilation, together with the maintenance of high humidities, it is ofttimes preferable to make use of the combination system of indirect and direct humidification. If the indirect system alone were used it would mean an unusually large volume of air to be handled, which might interfere, due to air motion, with production, even though it would result in greater cooling effect. If direct humidification alone were used, no ventilation would be obtained, with consequently higher room temperatures.

Inasmuch as cooling and humidification requirements in summer are much more severe than those in winter, an excess of humidifying and cooling capacity must be provided to meet extreme conditions and this requires automatic control if the best results are to be obtained. Such applications of humidity control may be considered standard practice today in the United States.

The same type of equipment as used in cotton mills largely is applicable to other textile industries, including rayon manufacture and also is applicable to tobacco factories, paper mills and many other buildings.

Systems of Dehumidification

In many industries it is as important to control the temperature in summer as in winter and, at the same time, the relative humidity must be controlled both in summer and in winter. To accomplish this the air must be warmed and the humidity must be increased in winter, and the air must be cooled and the moisture content of the air must be reduced in summer, so that both temperature and humidity indoors may be held at a definite point regardless of outside weather conditions, and regardless of conditions within the plant itself.

The design of air distribution equipment and the external appearance of such equipment is the same as described for systems of humidification. The main differences are found in the internal construction of the dehumidifier, in the use of refrigeration or of heat as required for controlling the water temperature, and in differences in the general methods of control.

Dehumidifiers are of two general types. *First*, the spray type in which the water is cooled outside of the spray chamber and then introduced. *Second*, the type in which the refrigerating coils are placed directly in the spray chamber and in which the water is sprayed over this surface, air coming in contact both with the wetted coils and the spray.

The use of refrigerated surfaces for cooling and dehumidifying air has given way almost entirely to the use of the direct spray of cooled water. One of the principal reasons for this change is the high effectiveness of

heat transfer between the finely divided spray and the air, which is thereby lowered substantially to the temperature of the leaving water. This efficient heat transfer reduces greatly the temperature head required in refrigeration, and therefore, reduces the size and cost of the refrigerating equipment.

With the spray type of dehumidifier, all the water vapor is condensed from the air to the point of saturation at the temperature corresponding to that of the air leaving the dehumidifier and all free moisture is removed by a series of baffles or eliminators, in the same manner as in the standard air washer. The spraying of water into the air to remove moisture from it might seem paradoxical, except for the application thereto of easily understood laws of physics.

Both types of dehumidifiers have air-distributing baffles at the inlet end and eliminators at the outlet end. The dehumidifier usually is considerably longer than the humidifier and in the spray type there are two or more sets of sprays, some of which may be directed against the air flow.

The object is to obtain a coarser spray and, at the same time, a much larger quantity of cold water per unit of air to be treated, than in the humidifier. Heat absorbing capacity as well as surface must be provided in the spray water. The usual allowable rise in spray water temperature entering and leaving the dehumidifier is from 6 deg. to 10 deg. fahr., and in well-designed dehumidifiers of the spray type the final temperature of the air is substantially identical with the final temperature of the leaving water. This is made possible by the counter-flow effect employed in such apparatus. The air velocities through the dehumidifier usually are lower than those employed in the humidifier, normal velocities being from 400 to 550 ft. per minute through the cross-sectional area.

Greater care must also be taken to obtain the elimination of free water than with the humidifier, as an entrainment beyond the eliminator defeats the purpose of the equipment.

Dehumidifier systems usually are provided with two essential control elements; a dew-point control at the apparatus and a room control. The former maintains a uniform temperature of saturated air leaving the dehumidifier at all times of the year. In summer, in industrial work, this is so constructed as to use nearly all return air, thus reducing the refrigerating load required, while when the wet-bulb temperature outside is below the dew point required within the room the latter is controlled by the dew-point thermostat which brings about a mixture of fresh and return air as required. The room temperature is controlled independently at a definite point above the dew-point or saturation temperature either by a thermostat or by a hygrostat, depending upon whether the more important factor is the temperature or the relative humidity. Frequently the nature of the process is the governing factor in the selection of control. For example, if moisture is given off or taken up by the materials in the process of manufacture, and if the relative humidity is the more important factor, then the hygrostat would be used. The amount of infiltration, which affects both temperature and humidity, may also be the governing factor in the selection of control, and the instrument selected would depend on whether the control of temperature or humidity is the more important. The control operates either with volume dampers controlling