are both under control during the heating season, and in the summer the humidity must be maintained constant, but the temperature must be allowed to rise in accordance with the increase of the wet-bulb temperature above the minimum desired. Temperature variations under mill conditions will be from 75 F to 90 F. Such results are superior from the standpoint of comfort and well-being of the operators than those previously experienced without the control. Automatic humidity control has resulted greatly in increasing the effectiveness of the workers, but the provision of ventilation also has improved greatly the conditions in mills as to dust, lint, and odors. In the spinning of fine cotton yarns, automatic humidity control is of great value in producing an improved product as well as in bettering working conditions. The uniform air motion results in the lowering of the effective temperature with a consequent increase in comfort and efficiency of the workers at temperatures and humidities which are necessarily high because of the requirements of the product. The air motion results also in removing the heat directly and immediately from the point of production on the spinning frame, thus avoiding localized increase of temperature and decrease of relative humidity. In other words, it permits the entire process to be subjected more nearly to the average room conditions. For additional information on the control of humidity and instruments used therefor, refer to page 432.

Where large quantities of power are generated in a limited space and where a comparatively high relative humidity is required, it is often feasible and economical to use a combination of direct and indirect humidification. The indirect humidification provides the desired quantity 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.

DEHUMIDIFIERS

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 F to 10 deg F, 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 fpm through the cross-sectional area.