are given in Chapter 37 but should always be verified locally. In lieu of this tedious work, the average gallons per minute per ton may be taken as 80 per cent of design gallons per minute per ton with reasonable accuracy, for the condition of variable temperature of entering water obtained from rivers and lakes.

When cooling towers or evaporative condensers are used, the windage and evaporation losses are usually between 3 per cent and 5 per cent of the water circulated.

Heating

The method of estimating fuel consumption to balance the building heat loss is given in Chapter 20. It is important to include the fuel required to heat ventilation air as used in ventilating and air conditioning systems. In estimating fuel consumption for ventilation air, the tendency of the conventional control systems to use less than the estimated quantity of outside air in cold weather should be considered in its effect in lowering fuel consumption. In addition, the heat required to accomplish winter humidifying must not be neglected, when this feature is included in the equipment.

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CHAPTER 45

INDUSTRIAL AIR CONDITIONING

General Requirements; Typical Applications in Storage and Processing: Air Quality Control, Control of Moisture Content and Regain, Conditioning and Drying, Control of Rate of Chemical and Biochemical Reactions, Control of Rate of Crystallization, Elimination of Static Electricity; Calculations

INDUSTRIAL air conditioning is as much concerned with the atmospheric conditions required for maintaining the health, safety and efficiency of workers as with those required for the manufacture, processing, and preservation of material, equipment and commodities.

GENERAL REQUIREMENTS

Specialists in the field of industrial hygiene should be consulted in case of doubt concerning the presence of airborne industrial hazards to health. Chapter 10, Air Contaminants, Chapter 12, Physiological Principles, and Chapter 13, Air Conditioning in the Prevention and Treatment of Disease, will be of help in determining the atmospheric conditions which should be maintained around the worker. Comfortable conditions are desirable because they are likely to increase the efficiency of workers.

Table 1 lists the temperatures and relative humidities required for storage of certain commodities and for manufacturing and processing of others. The desirable relative humidity may range from a low of 5 per cent in certain industrial applications, such as insulation winding processes, up to a condition approaching saturation, as in processes relating to textile, tobacco and baking industries. Relative humidities of 50 per cent or less are on the dry side and are conducive to low regains in hygroscopic materials, drying out, increased brittleness of fibrous materials, increased static electricity, and tendencies toward increased dust liberation from the product. Relative humidities higher than 50 per cent are considered to be on the damp side. These conditions are conducive to high regain, promote softness and pliability in materials, decrease static electricity and tend to reduce the generation of product dust.

The most favorable temperature will vary according to the specific material and particular process. In some cases the temperatures listed in Table 1 have no direct influence upon the product itself but do affect the efficiency of employees, which in turn affect workmanship, uniformity and the cost of production. Frequently a compromise between the known optimum condition for processing and that required for worker comfort is unavoidable.

In many processes, the optimum air conditions are variable according to the stage and progress of the processing cycle from the raw material to the finished product. Some materials, such as cotton textiles, begin with a low relative humidity in the carding and picking rooms, and after passing through the various intermediate steps with a gradual increase of relative humidity, are subjected to relative humidities of from 75 to 85 per cent in the final stage of weaving. Other processes are encountered that require the reverse of this procedure, starting with a high relative humidity and finishing with a low relative humidity, as in the manufacture of glue and gelatinous materials, and making various types of gelatine capsules.