In many processes, the optimum desired air conditions are a 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, the product is 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 is the case with gelatine capsule making, glue and gelatinous materials.

In some cases the temperatures listed in Table 1 have no direct influence upon the product itself, except as it affects the efficiency of the employees and thus the quality of workmanship, uniformity and the cost of production. In this category may be included the automobile assembly line. The time necessary to assemble the many parts into a complete unit is a factor recognized and associated with the worker's comfort, and the avoidance of fatigue with subsequent loss of efficiency.

Air conditioning contributes an important role during the processing, machining and honing of precision metal parts, instruments, tools, engines, guns, etc., which demand micrometric accuracy of dimensions, and which are affected by small temperature variations. Hence, some uniform condition is usually selected, both as to temperature and humidity to serve the demands of the worker's comfort and the exacting requirements of the process.

The temperatures and relative humidities listed in Table 1 should be analyzed with consideration in relation to the qualified requirements of the process. Conditions generally acceptable for *industrial processing* and for *general storage* are listed in these tables. While it is true that many storage requirements demand the control of some fixed air temperature and relative humidity condition, to hold and preserve the contents, it is not generally referred to as *processing*.

Logically many phases of drying may be included in the category of air conditioning for industrial processing, especially where temperature and humidity, by direct influence to product, bring about some definite change in physical characteristics as well as in weight. (See also Chapter 41.) As an illustration, refer to the conditions that are required to control the rate of crystallization in coating pans in which sugar syrup is applied to various forms of pills, nuts, gum, etc., in consecutive liquid doses, until a crystallized coating or jacket is built up to the required size and thickness. Here, the primary problem is one of drying which requires the supply of air at some fixed volume and velocity along with regulated control of both dry- and wet-bulb temperatures. The wet-bulb depression determines the rate of moisture pick-up or drying by the air and may be termed the *drying head*. Of equal importance is the uniformity at which the wet-bulb is maintained. If this is allowed to vary, poor results will follow due to checking and cracking of the unfinished coating. This is obvious when it is realized that continuous evaporation of moisture is taking place during the process and also that the temperature of the material corresponds to the air wet-bulb temperature and will vary accordingly. With undue expansion and contraction, with every temperature change, the thin crystallized coatings which are not elastic will check and crack before the process is completed.





## GENERAL REQUIREMENTS

Air conditioning apparatus for industrial purposes must be capable of absorbing heat from various sources such as machinery power, electric lights, people, sunlight and chemical reactions; of warming or cooling to any desired temperature; and of providing ample air supply. Refrigeration may or may not be required, depending upon natural conditions, the required relative humidity and the maximum permissible temperature. Washing, purifying and treating the air may be desirable. Good distribution is essential for the control of air motion and for the prevention of uneven conditions. Accurate, sensitive and reliable automatic control of humidity or temperature is vital in most cases.

Outside weather conditions and the ventilation required for workers are of secondary importance in relation to the total work to be done by the air conditioning system. In extreme cases of high concentration of industrial heat from machinery and ovens the error of entirely omitting the heat gain through the building structure would not be serious. At the other extreme, where low temperatures must be produced with refrigeration and where comparatively little power is required by the machinery, the heat gain through the building structure will become the major factor in determining the size of equipment and in this case the ventilation requirement assumes importance.

Buildings which are to be air conditioned should therefore be designed with careful consideration of overall cost and efficiency. Condensation resulting from high humidities must be prevented by suitable materials and construction, or else collected and drained to prevent loss of product or quick deterioration of the structure. Air leakage or filtration may add greatly to operating costs or make the maintenance of low humidities (relative or absolute) wholly impossible. Low temperatures require good insulation.

It is apparent that the subject of air conditioning for industrial processes is extensive and greatly involved, and that a detailed treatment is therefore beyond the scope of this chapter.

## CLASSIFICATION OF PROBLEMS

Any industrial air conditioning problem may be listed under one or more of the following five classifications: (1) control of regain, (2) control of rate of chemical reactions, (3) control of rate of biochemical reactions, (4) control of rate of crystallization, and (5) elimination of static electricity.

### Control of Regain

In the manufacture or processing of hygroscopic materials such as textiles, paper, wood, leather, tobacco and foodstuffs, the temperature and relative humidity of the air have a marked influence upon the rate of production and upon the weight, strength, appearance and general quality of the product. This influence is due to the fact that the moisture