creasing the relative humidity to at least 55 percent, if the material being processed is not damaged thereby.

It must be borne in mind that for successful elimination, the air that actually comes in contact with the material in the machine must be at a relative humidity of 55 percent or more. As some machines consume a great deal of power, which is converted directly into heat, the temperature in the machine may be considerably higher than the temperature adjacent to the machine where the relative humidity is normally measured. In such cases, the relative humidity in the machine will be appreciably lower than that elsewhere in the room, and it may therefore be necessary to maintain a room relative humidity of 65 percent, or even more, to maintain the desired humidity.

Control of Conditions for Material Test Laboratories

Laboratories having controlled conditions of temperature and humidity, are common, not only for the purposes of scientific research, but also for routine testing and for quality production control. A control of temperature and humidity within fairly-close plus or minus limits is usually required. Laboratories designed for scientific research may require control of conditions over a wide range, whereas the routine testing laboratory or quality control laboratory will usually be designed to maintain the ASTM Standard Conditions of 50 percent relative humidity and 23 C (73.4 F) temperature.

CALCULATIONS

The methods for determining the heating and cooling loads for the various industrial processes are similar to those outlined in Chapters 12 and 13. Some factors affecting heating or cooling requirements are given in Table 1. Because of the large number of motors and heat producing units usually found in an industrial application, it is particularly important that operating allowances, for the latent and sensible heat loads, be definitely ascertained and used in the calculations to determine the total design load.

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CHAPTER 51

CONTROL OF THE INDUSTRIAL ENVIRONMENT

Heat Control of Industrial Work Areas, Thermal Standards, Control of Heat Exposures, Radiation Shielding, Roof Ventilators, Local Relief Methods, Physiological Aspects of System Design, Types and Requirements of Systems, Outlet Types and Design, Control of Contaminants

CONTROL of the industrial environment is concerned with the design and application of equipment for providing the necessary conditions within industrial areas for maintaining the efficiency, health, and safety of workers. This chapter includes a comprehensive list of the requirements for heat control and for control of gases and vapors, and dust and fumes.

General ventilation may be relied upon in some cases to control the industrial environment, as outlined in this chapter. Additional information on natural ventilation may be found in Chapter 11. If mechanical ventilation is to be used, Chapter 20, Air Distribution; Chapter 21, Air Duct Design; Chapter 22, Fans; Chapter 24, Air Cleaning; Chapter 40, Evaporative Apparatus for Heat Rejection; Chapter 41, Evaporative Air Cooling and Humidification; and Chapter 43, Automatic Control; will furnish information covering a broad range of industrial design conditions. Chapters 13, 23, and 38 provide data for mechanically cooled systems. Chapter 52, Industrial Exhaust Systems, should be consulted for the design of hoods and their exhaust duct systems. For further information on estimating radiant heat conditions see Chapters 5 and 30.

Information on globe thermometers and other instruments used to measure the industrial environment may be found in Chapter 44, Instruments and Measurements. More complete information will be found in References[1] and[2] at the end of this chapter.

Specialists in the field of industrial hygiene should be consulted in case of doubt concerning the presence of airborne industrial hazards to health. Chapter 7, Air Contaminants; Chapter 6, Physiological Principles; and Chapter 8, Air Conditioning in the Prevention and Treatment of Disease, will be of help in establishing the atmospheric conditions that should be maintained around the worker. Local codes, ordinances, or state labor laws must likewise be observed, particularly with regard to ventilation requirements for hazardous trades. Comfortable conditions, if possible, or tolerable conditions at least, are desirable because they are likely to increase the efficiency and, hence, the output of workers. The majority of air-conditioning and ventilation installations in a typical industrial plant are concerned with the control of sensible, latent, or radiant heat.

HEAT CONTROL IN INDUSTRIAL WORK AREAS

In certain industrial work situations there is considerable release of heat from the process equipment to the environment. It is not economically feasible to stop the escape of all of this process heat or to offset it completely by the usual methods of *comfort* ventilation and air conditioning. In the design and operation of control measures it is frequently necessary to accept some heat exposure in excess of simple comfort requirements.

The engineer must distinguish between the control needs for *hot-dry* industrial areas and *warm-moist* conditions. In the first case, the process gives off only sensible and radiant heat without adding moisture to the air. The heat load on exposed workers is thereby increased but the rate of cooling by evaporation of sweat is not reduced. Heat balance may be maintained although this will be at the expense, perhaps, of excessive sweating. In the warm-moisture situation, the wet process gives off principally latent heat. There may be no significant rise in the heat load on the worker but the increase in moisture content of the air will seriously reduce the heat loss by evaporation of sweat. The warm-moist situation is potentially more hazardous than the hot-dry.

Examples of hot-dry work situations are seen around hot furnaces, forges, metal-extruding and rolling mills, glass-forming machines, and the like. Typical of warm-moist operations are laundries, dye houses, and deep mines where water is extensively used for dust control.

The industrial heat problem varies in magnitude with local climatic conditions. Solar heat gain and an elevated outdoor temperature will increase the heat load at the work place but these contributions may not be very important compared with the locally generated heat of the process itself. The moisture content of the outdoor air, on the other hand, is a most important climatic factor affecting hot-dry work situations and on a moist summer day will seriously restrict evaporative cooling. For the warm-moist job, in contrast, solar heat gain and elevated outdoor temperature are the more important, since, compared with the moisture release on the job, that contributed by the outdoor air will be of little significance.

Thermal Standards for Industrial Work Areas

The work situations considered here are those in which the attainment of simple thermal comfort is not always practicable. The heat stress must be kept below the level of outright hazard, but how much below? On what criteria should the specifications for control be based? How should the standards be varied in recognition of the differing demands and work rates from one kind of job to another? What differences exist between older and younger workers or between workers with differing degrees of physical fitness? To what