the refrigeration load factor is highest. The average gallons per minute per ton should be calculated from known or estimated water temperatures, because they vary through the season. Maximum water main temperatures are given in Chapter 34, but should always be verified locally. In lieu of this tedious work, the average gallons per (minute) (ton) may be taken as 80 percent of design gallons per (minute) (ton) with reasonable accuracy, for the condition of variable temperature of entering water obtained from rivers and lakes.

Cooling towers and evaporative condensers virtually eliminate condensing water charges since the windage and evaporation losses are seldom over two or three percent of the water circulated.

The savings in water consumed often times will not in itself justify the installation of water economizing equipment since the cost for pumping and the fixed or ownership charges may be in excess of the annual cost for once through condensing operation. If operating costs are to be the basis for selection, then fixed charges should be determined when studying application of this equipment which usually has a shorter life than the other components.

Usually the primary factors influencing the installation of water conservation equipment are the lack of an adequate water supply or local regulations intended to conserve an existing water supply.

Another factor influencing the installation of such equipment is the increasing trend toward the enactment of taxes and service charges for condensing water wasted into city sewers. Certain municipalities will remit the sewer taxes or service charge if the condensing water is submetered and discharged into a storm sewer or used for process purposes.

Heating

The method of estimating fuel consumption to balance the building heat loss is given in Chapter 18. 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 44

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 32, Fans; Chapter 30, Air Distribution; Chapter 31, Air Duct Design; Chapter 33, Air Cleaning; and Chapter 34, Spray Apparatus, will furnish information covering a broad range of industrial design conditions. Chapters 13, 35, and 36 provide data for mechanically cooled systems. Chapter 45, 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 23.

Information on globe thermometers and other instruments used to measure the industrial environment may be found in Chapter 52, 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 8, Air Contaminants; Chapter 6, Physiological Principles; and Chapter 7, 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