

inlet to tank must be arranged to minimize erosion of tank, turbulence, and aeration of water.

5. Return pumps should be sized to handle at least 120 percent of supply water quantity.

6. Return pump and supply water control valves or pumps should be interlocked to prevent flooding in event of return pump failure.

7. Proper air venting is extremely important because of the release of large amounts of air dissolved in the water.

BRINE PIPING

Brines are used instead of water as the circulating heat transfer fluid whenever the fluid temperature in the system is below about 35 F. The entire design of low temperature systems, including brine piping, is a specialized field and becomes more critical and complex with decreasing operating temperatures. (See Chapters 61 through 63.) The material presented herein is intended only as an introduction to the general principles involved. Recommendations and application information concerning specific projects can be obtained from manufacturers of low temperature equipment or brines. A design engineer with proven experience and proficiency in this specialized field should be consulted on all such important or unusual applications.

Further information on brines is contained in Chapter 20 of the 1961 GUIDE AND DATA BOOK.

The selection of brine type is based upon consideration of the following factors:

1. Freezing point—suitable for lowest operating temperatures.
2. Process involved—open or closed piping system, danger of product contamination by brine.
3. Cost and availability—quantity of make-up required.
4. Safety to operating personnel—toxic, poisonous, explosive, flammable, operating pressures.
5. Thermal performance—specific heat, density, viscosity, and film coefficient.
6. Chemical—stability and (corrosion) suitability for use with piping and system equipment material.
7. Acceptance by codes, ordinances, regulatory agencies, and insurer.

Calcium chloride, sodium chloride, and ethylene glycol brines are commonly used in open systems. Volatile brines such as methylene chloride (Refrigerant 30), methanol, trichloroethylene and trichloromonofluoromethane (Refrigerant 11) are usually applied with closed piping systems to prevent brine evaporation. The above brines are generally

suitable to applications between -30 and +30 F. Volatile refrigerants such as Refrigerant 30 or Refrigerant 11 are used for temperatures below this range.

All materials in the piping system, including flange gaskets, valve seats and packing, pump seals and other specialties must be compatible with the brine. Provision must be made for thermal expansion and contraction. Ordinary copper tubing and nickel steel pipe are suitable for operating temperatures down to below -100 F. Standard steel pipe is suitable for general use above -20 F, and with special precaution to code requirements may be used at lower temperatures.

Special attention should be given to providing adequate space around piping and equipment for the proper installation of insulation. Extensions of valve bonnets, thermometer wells and other items are usually necessary to permit proper insulation. An adequate vapor seal is necessary, and special efforts should be made to obtain an adequate seal around valve bonnets, thermometer wells, and other items which pierce the vapor barrier.

Piping for volatile refrigerant brines should be installed similar to conventional refrigerant piping, kept as clean as possible, and dehydrated by evacuation before brine is charged into the system. A closed expansion tank pressurized with dry nitrogen is usually provided to permit expansion of brine on system warm-up and maintain suitable operating pressures in the system at design temperature.

Pumping head is obtained by calculating the total equivalent length of piping in the system and multiplying this by the friction rate for the brine type and temperature. The correct friction rate for a specific application can be obtained from brine or equipment manufacturers, or can be calculated through the use of Reynolds' number and the Darcy equation. Pipe friction, equipment pressure drop expressed in feet of brine, and hydrostatic lift, if applicable, are added to obtain total system pumping head. The pump rating and motor horsepower should be based upon the particular brine being used and the actual operating temperature.

REFERENCES

- 1 B. P. Morabito: How higher cooling coil differentials effect system economies (ASHRAE JOURNAL, August 1960, p. 60).
- 2 Chapter 1, Piping Design—General (Part 5, System Design Manual, Carrier Corp., 1961, pp. 4 and 6).
- 3 Chapter 2, Water Piping (Part 5, System Design Manual, Carrier Corp., 1961, p. 40).

CHAPTER 74

ODOR CONTROL

Odor Removal by Ventilation, Absorption, and Adsorption; Reactivation; Activated Charcoal: Use, Quantity, Systems; Odor Masking; Application of Compounds, Control; Odor Modification: Air-Conditioned and Industrial Spaces, Application; Combustion: Use and Life of Catalysts, Recovery of Heat

DEVELOPMENT of methods to purify air has furthered the progress of air conditioning. Whether air is conditioned in order to enhance comfort, raise production efficiency, or extend food preservation, the quality of the air—its freedom from contamination—has come to be regarded as of equal importance with its temperature and relative humidity.¹ Air polluting substances are divided into two kinds—those which are suspended, like dust, soot, and smoke; and those consisting of gases and vapors, which are in the form of individual molecules. Elimination of the former, or suspended, substances is accomplished by filtration which is discussed in Chapter 48 of the 1961 GUIDE AND DATA BOOK. This chapter therefore, is devoted particularly to the means and procedure for preventing or controlling the accumulation of air-entrained vaporous and gaseous impurities or odors within an enclosure.

The first important consideration in approaching a problem of air purification is to determine whether the source of air contamination lies within or outside the enclosure. If outside the enclosure, as is frequently the case in congested or industrial areas, the usual solution is the removal of the contaminants from the air entering the space. It will be obvious that this cannot be accomplished unless the air supply is controlled and purified at the point of entry. Also, the volume of air to be supplied and purified must, usually, be adequate at least to maintain a positive inside pressure sufficient to counteract any uncontrolled infiltration of contaminated air.

When the source of contamination is confined to the inside, as is more generally the case in occupied enclosures, two alternative solutions are available. The objectionable accumulation of air-entrained impurities may be controlled by ventilation—i.e., by continuous dilution with outside air—or by continual elimination of the impurities generated within the enclosure. When the space is not air conditioned (heated or cooled), the first solution is simple and practicable, if the outdoor air is of suitable purity. When, however, the enclosure is air conditioned or heated, the cost of conditioning the outdoor dilution air is often considerably greater than that of eliminating the internally generated impurities. Elimination may be obtained by the same process that would be required to purify contaminated outdoor intake air except that it is applied instead to indoor air in recirculation. Therefore, as

will be seen, the already known standards of ventilation will serve to determine the volume of recirculated air to be purified.

Because many vaporous and gaseous impurities manifest themselves as odors or are recognized by the olfactory sense, the methods for their elimination have acquired the common designation deodorization or odor control. Before proceeding to the application of air purification, therefore, an understanding of both the properties of odors and our reaction to them is essential. The reader is referred to Chapter 10, Air Contaminants, in the 1961 GUIDE AND DATA BOOK for a discussion of the basic properties and principles of odors.

ODOR REMOVAL BY VENTILATION

Ventilation is an effective means of removing the contaminated air in an enclosed space by dilution. In this process the vitiated air containing objectionable gaseous odors, irritants, particulates that obscure vision, and toxic matter are replaced by outdoor air. As shown in Fig. 5 of Chapter 10, Air Contaminants, of the 1961 GUIDE AND DATA BOOK, an outdoor ventilation rate of only 4 cfm per person is sufficient to meet the requirement for oxygen supply and carbon dioxide removal.² It has been shown that the carbon monoxide concentration in smoking rooms is in general too small to have any known effect. It is usually less than 5 ppm at the breathing zone as compared to a maximum allowable concentration of carbon monoxide of 100 ppm for exposures of 8 hours a day.³ Air is required in excess of this amount to provide for dilution of body, cigarette smoking, cooking, or other odors. If the person is active, more air is required to remove generated body odors than if the person is sedentary. The amount of air to remove such odors is a function of the cubic feet of space occupied per person. Ventilation requirements for acceptable conditions will normally fall between curves C and D, above mentioned Fig. 5. These curves present limitations based on research. They indicate a requirement range of 20 to 23 cfm of air per person to reduce to an acceptable level objectionable body and smoking odors for a population density of 150 cubic feet per person. At 300 cu ft of space per person, the ventilation requirement ranges between 12 and 18 cfm per person.

These parameters present what may be considered the