

offered as a guide to current practice in heating and air conditioning. It is based on practice in a number of consulting engineers' offices and information extracted from Reference 7. It should be borne in mind that selection of material to be used will also be influenced by the familiarity of local artisans with methods of using different materials.

REFERENCES

- ¹ American Standard Code for Pressure Piping, ASA B-31.1—1942, American Standards Association.
- ² See *API Specification 5L for Line Pipe*, American Petroleum Institute.
- ³ *Standard Manual on Pipe Welding (Heating, Piping and Air Conditioning Contractors National Association, Second Edition, 1951)*. *Welding Handbook* (American Welding Society, 1942).
- ⁴ *ASME Power Boiler Code*, American Society of Mechanical Engineers.
- ⁵ Marine Engineering Regulations of the Coast Guard, American Bureau of Shipping.
- General Specifications for Inspection of Material, Appendix VII, Welding, U. S. Navy. Specifications for Welding, Appendix 5, Part 1—General—for Vessels of the U. S. Navy, Bureau of Ships, April, 1940.
- ⁶ See (1) *Piping Handbook*, by Sabin Crocker (McGraw-Hill Co.); (2) *A Manual for The Design of Piping for Flexibility by the Use of Graphs*, by E. A. Wert, S. Smith, E. T. Cope (The Detroit Edison Company).
- ⁷ Control Valves and Positioners, by C. S. Beard (*Industry and Power*, Vol. 64 March, 1953, p. 67-101).

CHAPTER 28

PIPE AND INDUSTRIAL INSULATION

Heat Losses from Bare and Insulated Surfaces and Pipes, Thermal Conductivities of Various Insulations, Low Temperature Pipe Insulation, Insulation of Pipes to Prevent Freezing, Economical Thickness of Pipe Insulation, Underground Pipe Insulation

H EAT LOSSES from or to uninsulated surfaces of pipes, ducts, vessels, or furnaces may be of considerable magnitude if the temperature of the surrounding medium differs appreciably from that of the surface. Losses are increased by motion of the surrounding air or by contact of the hot or cold surface with bodies of high thermal conductivity. Good design, therefore, must include careful consideration of such heat losses and provision for adequate insulation wherever indicated.

HEAT LOSSES FROM BARE SURFACES

The basic principles of heat loss from surfaces are discussed in Chapter 5. In that chapter radiation and convection are treated separately. Table 1, Section A, of Chapter 9 gives the surface conductance of flat surfaces of different emissivities and orientations in contact with still air, the values given including the effects of both radiation and convection.

HEAT LOSSES FROM BARE PIPES

Heat losses from horizontal bare steel pipes, based on tests at Mellon Institute and calculated from the fundamental radiation and convection equations (Chapter 5), are given in Table 1. Heat losses from horizontal copper tubes and pipes with tarnished surfaces, are given in Table 2.¹

Heat losses from bare pipe of materials having lower emissivities may be calculated from data appearing in Chapter 5.

The area in square feet per linear foot of pipe is given in Table 3 for various standard pipe sizes, and Table 4 for copper tubing, while Table 5 gives the area in square feet of flanges and fittings for various standard pipe sizes. These tables can be used to advantage in estimating the amount of insulation required.

Very often, when pipes are insulated, flanges and fittings are left bare, so as to allow for easy access to the fittings in case of repairs. The fact that a pair of 8-in. standard flanges having an area of 2.41 sq ft would lose, at 100 lb steam pressure, an amount of heat equivalent to more than a ton of coal per year, shows the necessity for insulating such surfaces.

Examples 1 and 2 show how the annual heat loss from uncovered pipe and its dollar value may be computed from the data in Table 1.

Example 1: Compute the total annual heat loss from 165 ft of 2 in. bare pipe in service 4000 hr per year. The pipe is carrying steam at 10 lb pressure and is exposed to an average air temperature of 70 F.

Solution: The pipe temperature is taken as the steam temperature, which is 239.4 F, obtained by interpolation from Steam Tables. The temperature difference between the pipe and air = $239.4 - 70 = 169.4$ F. By interpolation of Table 1 between temperature differences of 157.1 and 227.7 F, the heat loss from a 2-in. pipe at a