

study. Among these inhibitors are oil, sodium silicate, sodium hydroxide, tannin, and various other organic compounds, some of which release ammonia gas. The possible toxic effects, particularly if the steam is used for contact cooking of food, should not be overlooked.

In view of the fact that corrosion is most frequently found in the return lines from special equipment, which constitute a relatively small part of the total piping in a building, a simple solution of the corrosion problem may be to use non-corroding materials in those certain portions of the piping system, since the higher cost will usually be an unappreciable portion of the total. Brass and copper are undoubtedly less subject to this type of corrosion than the ferrous metals, and considerable attention is now being given to corrosion-resistant linings for ferrous pipe. Cast-iron pipe, sometimes alloyed with other metals, also deserves consideration.

Eighteen ferrous and non-ferrous metals and alloys were tested in a large air conditioning installation⁸. Observations were made in the wash water of the dehumidifier and in the air stream beyond the eliminator plates. The corrosion rates of all metals and alloys utilizing a dichromated-treated wash water were extremely low. Localized attack in the form of pitting was found to occur on steel in crevices or under solid accumulations. Just beyond the dehumidifier eliminator plates corrosive conditions were observed to be particularly severe and in such locations non-ferrous metals and alloys and stainless steels were most resistant. Alloy steels were found to be superior to mild steel.

REFERENCES

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²—See API Specification 5L for Line Pipe, American Petroleum Institute.

³—Welding Handbook (American Welding Society, 1942). Standard Manual on Pipe Welding, (Heating, Piping and Air Conditioning Contractors National Association).

⁴—General Specifications for Inspection of Material, Appendix VII, Welding (U. S. Navy Department, Jan. 3, 1939).

⁵—New Light on Heating System Corrosion, by J. H. Walker (Heating and Ventilating, May, 1933). A.S.H.V.E. RESEARCH REPORT No. 983—Corrosion Studies in Steam Heating Systems, by R. R. Seeber, F. A. Rohrman and G. E. Smedberg, (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 253). A.S.H.V.E. RESEARCH REPORT No. 1037—Corrosion Studies in Steam Heating Systems, by R. R. Seeber, F. A. Rohrman and G. E. Smedberg, (A.S.H.V.E. TRANSACTIONS, Vol. 42, 1936, p. 263). A.S.H.V.E. RESEARCH REPORT No. 1071—Corrosion Studies in Steam Heating Systems, by R. R. Seeber and Margaret R. Holley (A.S.H.V.E. TRANSACTIONS, Vol. 43, 1937, p. 461). Corrosion in Steam Heating Systems, by L. F. Collins and E. L. Henderson, (Heating, Piping and Air Conditioning, September, 1939 to May, 1940).

⁶—Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, by R. E. Hall and A. R. Mumford (A.S.H.V.E. TRANSACTIONS, Vol. 38, 1932, p. 121).

⁷—A Method of Measuring Corrosiveness, by J. H. Walker, (Proceedings, American Society for Testing Materials, 1940).

⁸—A.S.H.V.E. RESEARCH REPORT No. 1203—Corrosion Tests in a Water-Recirculating Air Conditioning System, by W. Z. Friend (A.S.H.V.E. TRANSACTIONS, Vol. 48, 1942, p. 233).

Pipe Insulation

Heat Losses from Bare and Insulated Pipes, Low Temperature Pipe Insulation, Insulation of Pipes to Prevent Freezing, Economical Thickness of Pipe Insulation, Underground Pipe Insulation

THE heat loss from uninsulated pipes may be of considerable magnitude if the temperature of the surrounding medium differs appreciably from that of the fluid conveyed. Losses are increased by rapid motion of the surrounding air or by contact of the pipe with bodies of high conductivity. Careful consideration must, therefore, be given to this factor in a properly designed system and adequate insulation provided, if necessary.

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 2¹.

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 temperature difference of 169.4 F is found to be 1.624 Btu per (hour) (linear foot) (Fahrenheit degree). The total annual heat loss from the entire line = $1.624 \times 169.4 \times 165$ (linear feet) $\times 4000$ (hours) = 181,600 Mb. (Mb = 1000 Btu.)

Example 2. Coal costing \$11.50 per ton and having a calorific value of 13,000 Btu per pound is being burned in the furnace supplying steam to the pipe line given in the previous example. If the system is operating at an over-all efficiency of 55 per cent, determine the monetary value of the annual heat loss from the line.

Solution. The cost of heat per 1000 Mb supplied to the system = $1,000,000 \times 11.5$ (dollars) $\div [13,000 \text{ (Btu)} \times 2000 \text{ (lb)} \times 0.55 \text{ (efficiency)}] = \0.804 . The total cost of heat lost per year = 0.804×181.6 (thousand Mb) = \$146.00.