## PIPE INSULATIONS

Pipe insulations are of several general forms and are made of various types of material. The most common form is the rigid sectional covering either split longitudinally into halves or cut through on one side and scored on the other, to facilitate assembling on pipes. Preformed materials are supplied in segments for assembly on large pipes. The sectional coverings are generally supplied with a pasted-on canvas jacket. Blanket insulations are sometimes used for wrapping large pipes, particularly where removal for frequent servicing of the pipe is necessary. Fittings and bends are commonly covered with portions of standard preformed insulation or, when irregular in contour, with plastic materials known as insulating cements. Insulation is secured to pipes with staples which are used to bridge the joint between half sections, and with metal pipe covering bands or rings of wire which secure individual sections and effect a junction between abutting sections. Surface finishes used over pipe insulation depend upon the service encountered and appearance desired. Canvas jackets are most common, although asbestos paper or asbestos finishing cements are sometimes employed. Insulation outdoors should be waterproof, and is generally protected with an asphalt felt for piping and asphaltic cements for fittings. Insulation on lines carrying cold water, brine, or other cold fluids is carefully finished to obtain adequate sealing against the penetration of water vapor.

The selection of pipe insulation for a particular service condition must be made with full consideration of a number of properties in addition to thermal conductivity. Factors which may be of more importance than the thermal conductivity are: ease of application, fire resistance, heat stability, weathering stability, resistance to damage by physical abuse, and others which may apply to a particular installation. A complete evaluation of pipe insulation cannot be included here. Insulation manufacturers should be consulted in regard to the selection of insulation which is to meet specific requirements.

TABLE 1. HEAT LOSSES FROM HORIZONTAL BARE STEEL PIPES

*Expressed in Btu per (hour) (linear foot) (Fahrenheit degree difference between the pipe and surrounding still air at 70 F)*

| Nominal Pipe Size (Inches) | Hot Water | | | | Steam | | |
|---|---|---|---|---|---|---|---|
| | 120 F | 150 F | 180 F | 210 F | 227.1 F (5 Lb) | 299.7 F (50 Lb) | 337.9 F (100 Lb) |
| | Temperature Difference | | | | | | |
| | 50 F | 80 F | 110 F | 140 F | 157.1 F | 227.7 F | 267.9 F |
| ½ | 0.455 | 0.495 | 0.546 | 0.584 | 0.612 | 0.706 | 0.760 |
| ¾ | 0.555 | 0.605 | 0.666 | 0.715 | 0.748 | 0.866 | 0.933 |
| 1 | 0.684 | 0.743 | 0.819 | 0.877 | 0.919 | 1.065 | 1.147 |
| 1¼ | 0.847 | 0.919 | 1.014 | 1.086 | 1.138 | 1.324 | 1.425 |
| 1½ | 0.958 | 1.041 | 1.148 | 1.230 | 1.288 | 1.492 | 1.633 |
| 2 | 1.180 | 1.281 | 1.412 | 1.512 | 1.578 | 1.840 | 1.987 |
| 2½ | 1.400 | 1.532 | 1.683 | 1.796 | 1.883 | 2.190 | 2.363 |
| 3 | 1.680 | 1.825 | 2.010 | 2.153 | 2.260 | 2.630 | 2.840 |
| 3½ | 1.900 | 2.064 | 2.221 | 2.433 | 2.552 | 2.974 | 3.215 |
| 4 | 2.118 | 2.302 | 2.534 | 2.717 | 2.850 | 3.320 | 3.590 |
| 5 | 2.580 | 2.804 | 3.084 | 3.303 | 3.470 | 4.050 | 4.385 |
| 6 | 3.036 | 3.294 | 3.626 | 3.886 | 4.074 | 4.765 | 5.160 |
| 8 | 3.880 | 4.215 | 4.638 | 4.960 | 5.210 | 6.100 | 6.610 |
| 10 | 4.760 | 5.180 | 5.680 | 6.090 | 6.410 | 7.490 | 8.115 |
| 12 | 5.590 | 6.070 | 6.670 | 7.145 | 7.500 | 8.800 | 9.530 |

TABLE 2. HEAT LOSS FROM HORIZONTAL TARNISHED COPPER PIPE

*Expressed in Btu per (hour) (linear foot) (Fahrenheit degree difference between the pipe and surrounding still air at 70 F)*

| Nominal Pipe Size (Inches) | Hot Water (Type K Copper Tube) | | | | Steam (Standard Pipe Size Pipe) | | |
|---|---|---|---|---|---|---|---|
| | 120 F | 150 F | 180 F | 210 F | 227.1 F (5 Lb) | 297.7 F (50 Lb) | 337.9 F (100 Lb) |
| | Temperature Difference | | | | | | |
| | 50 F | 80 F | 110 F | 140 F | 157.1 F | 227.7 F | 267.9 F |
| ½ | 0.250 | 0.287 | 0.300 | 0.321 | 0.433 | 0.500 | 0.530 |
| ¾ | 0.340 | 0.381 | 0 409 | 0.429 | 0.533 | 0.543 | 0.654 |
| 1 | 0.440 | 0.475 | 0.509 | 0.536 | 0.636 | 0.746 | 0.803 |
| 1¼ | 0.500 | 0.559 | 0.618 | 0.622 | 0.764 | 0.878 | 0.934 |
| 1½ | 0.580 | 0.656 | 0.710 | 0.750 | 0.904 | 1.053 | 1.120 |
| 2 | 0.730 | 0.825 | 0.890 | 0.957 | 1.101 | 1.273 | 1.364 |
| 2½ | 0.880 | 1.000 | 1.091 | 1.143 | 1.305 | 1.490 | 1.605 |
| 3 | 1.040 | 1.175 | 1.272 | 1.343 | 1.560 | 1.800 | 1.940 |
| 3½ | 1.180 | 1.350 | 1.454 | 1.535 | 1.750 | 2.020 | 2.170 |
| 4 | 1.460 | 1.500 | 1.635 | 1.715 | 1.941 | 2.240 | 2.430 |
| 4½ | ..... | ..... | ..... | ..... | 2.131 | 2.465 | 2.650 |
| 5 | 1.600 | 1.812 | 1.980 | 2.071 | 2.387 | 2.770 | 2.990 |
| 6 | 1.840 | 2.125 | 2.270 | 2.430 | 2.740 | 3.210 | 3.440 |
| 8 | 2.400 | 2.685 | 2.910 | 3.110 | 3.310 | 4.050 | 4.370 |

## HEAT LOSSES FROM INSULATED PIPES

The conductivities of various materials used for insulating steam and hot water systems are given in Table 6. They are given as functions of the mean temperatures or the arithmetic mean of the inner and outer surface temperatures of the insulations. It should be emphasized that they are the average values obtained from a number of tests made on each type of material, also, that in the use of *conductivity* all variables due to differences in thickness, pipe sizes, and air conditions are eliminated. Individual manufacturer's materials will, of course, vary in conductivity to some extent from these values.

The heat losses through 1, 1½, and 2-in. thick, 85 per cent magnesia type of insulation for temperature differences between the pipe and the surrounding atmosphere up to 280 F, are shown in Figs. 1, 2, and 3.



TABLE 3. EXTERNAL SURFACE PER LINEAR FOOT OF PIPE

| Nominal Pipe Size (Inches) | Surface Area (Sq Ft) | Nominal Pipe Size (Inches) | Surface Area (Sq Ft) | Nominal Pipe Size (Inches) | Surface Area (Sq Ft) |
|---|---|---|---|---|---|
| ½ | 0.22 | 2 | 0.622 | 5 | 1.456 |
| ¾ | 0.275 | 2½ | 0.753 | 6 | 1.734 |
| 1 | 0.344 | 3 | 0.917 | 8 | 2.257 |
| 1¼ | 0.435 | 3½ | 1.047 | 10 | 2.817 |
| 1½ | 0.498 | 4 | 1.178 | 12 | 3.338 |

TABLE 4. EXTERNAL SURFACE PER LINEAR FOOT OF COPPER TUBING

*Outside diameter ⅛ in. greater than nominal size*

| Tube Size (Inches) | Surface Area (Sq Ft) | Tube Size (Inches) | Surface Area (Sq Ft) | Tube Size (Inches) | Surface Area (Sq Ft) |
|---|---|---|---|---|---|
| ½ | 0.164 | 2 | 0.556 | 5 | 1.342 |
| ¾ | 0.229 | 2½ | 0.687 | 6 | 1.604 |
| 1 | 0.295 | 3 | 0.818 | 8 | 2.128 |
| 1¼ | 0.360 | 3½ | 0.949 | ... | ..... |
| 1½ | 0.426 | 4 | 1.080 | ... | ..... |