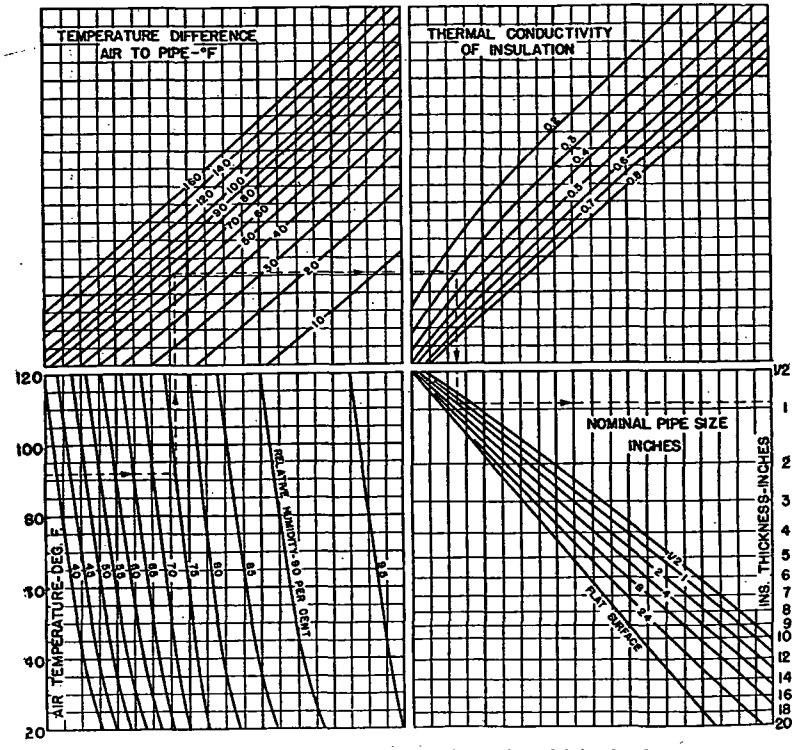
third inches would be averaged and the pipe size for list price would be that nearest the average pipe size of the second and third inch.

A rapid method for determining the economical thickness of insulation by use of tables has been published.[3]




[a] Solve problems as indicated by dotted line, entering chart at lower left hand scale

FIG. 7. THICKNESS OF PIPE INSULATION TO PREVENT CONDENSATION ON OUTER SURFACE[a]

## LOW TEMPERATURE PIPE INSULATION

Surfaces maintained at temperatures lower than the surrounding air are insulated to reduce the flow of heat and to prevent condensation. The insulating material should absorb a minimum amount of moisture, because the absorption of moisture substantially increases the conductivity of the material. This property is particularly important in the insulation of surfaces that are below the dew point of the surrounding air. In such cases, due to vapor pressure difference, it is necessary to seal the surface of the insulating material against the penetration of water vapor which would condense within the material, causing a serious increase in heat flow, possible breakdown of the material, and corrosion of metal surfaces. An insulating material with a high degree of moisture absorption might pick up moisture before application and then, when the vapor



seal is in place and the temperature of the insulated surface reduced, release that moisture to the cold surface. There are a number of methods of producing vapor seals, some of which have been worked out by insulation manufacturers to suit their products, and others by applicators and users. Unless time-proven methods are known, specifications of insulation manufacturers should be obtained and followed carefully.

Equipment must be carefully protected against corrosion caused by condensation of water vapor. All metallic surfaces should be coated with a vapor-impervious barrier (some types of which have an asphaltic or tar base) without any breaks or openings in order to prevent corrosion.

The thickness of insulation required to prevent condensation on the outer surface is that thickness which will raise the temperature of the outer surface of the insulation to a point slightly higher than the dew point of the surrounding vapor. The dew point for various humidities can be readily ascertained from a psychrometric chart. The external vapor barrier must be made as nearly perfect as possible in order to prevent migration of vapor into the insulation.

TABLE 8. HEAT GAINS FOR INSULATED COLD PIPES

*Rates of heat transmission given in Btu per (hour) (Fahrenheit degree temperature difference between fluid in pipe and surrounding still air)*

*Based on materials having conductivity, k = 0.30*

| Nominal Pipe Size (Inches) | Ice Water Thickness | | | Brine Thickness | | | Heavy Brine Thickness | | |
|---|---|---|---|---|---|---|---|---|---|
| | Thickness of Insulation (Inches) | Btu Per Linear Foot | Btu Per Sq Ft Pipe Surface | Thickness of Insulation (Inches) | Btu Per Linear Foot | Btu Per Sq Ft Pipe Surface | Thickness of Insulation (Inches) | Btu Per Linear Foot | Btu Per Sq Ft Pipe Surface |
| ½ | 1.5 | 0.110 | 0.502 | 2.0 | 0.098 | 0.446 | 2.8 | 0.087 | 0.394 |
| ¾ | 1.6 | 0.119 | 0.431 | 2.0 | 0.111 | 0.405 | 2.9 | 0.094 | 0.340 |
| 1 | 1.6 | 0.139 | 0.403 | 2.0 | 0.124 | 0.352 | 3.0 | 0.104 | 0.294 |
| 1¼ | 1.6 | 0.155 | 0.357 | 2.4 | 0.131 | 0.300 | 3.1 | 0.113 | 0.260 |
| 1½ | 1.5 | 0.174 | 0.351 | 2.5 | 0.134 | 0.270 | 3.2 | 0.118 | 0.238 |
| 2 | 1.5 | 0.200 | 0.322 | 2.5 | 0.151 | 0.244 | 3.3 | 0.134 | 0.214 |
| 2½ | 1.5 | 0.228 | 0.303 | 2.6 | 0.170 | 0.226 | 3.3 | 0.147 | 0.197 |
| 3 | 1.5 | 0.269 | 0.293 | 2.7 | 0.186 | 0.202 | 3.4 | 0.162 | 0.176 |
| 3½ | 1.5 | 0.295 | 0.282 | 2.9 | 0.191 | 0.183 | 3.5 | 0.176 | 0.167 |
| 4 | 1.7 | 0.294 | 0.248 | 2.9 | 0.209 | 0.176 | 3.7 | 0.182 | 0.154 |
| 5 | 1.7 | 0.349 | 0.239 | 3.0 | 0.241 | 0.165 | 3.9 | 0.202 | 0.138 |
| 6 | 1.7 | 0.404 | 0.233 | 3.0 | 0.259 | 0.150 | 4.0 | 0.228 | 0.130 |
| 8 | 1.9 | 0.455 | 0.201 | 3.0 | 0.318 | 0.140 | 4.0 | 0.263 | 0.116 |
| 10 | 1.9 | 0.559 | 0.198 | 3.0 | 0.383 | 0.135 | 4.0 | 0.309 | 0.110 |
| 12 | 1.9 | 0.648 | 0.194 | 3.0 | 0.438 | 0.131 | 4.0 | 0.364 | 0.108 |

The approximate required thickness of insulation to prevent condensation on pipes and flat metallic surfaces may be obtained from Fig. 7 in which a surface resistance of 0.606, corresponding to a film conductance of 1.65, was used in calculating the curves. This value provides a slight factor of safety and its use is known to give satisfactory field results. In using the chart it is advisable to specify the next thicker, rather than the next thinner, commercial insulation in cases where an intermediate thickness is indicated.

Heat gains for pipes insulated with a material having an installed conducitivity of 0.30 Btu per (sq ft) (hr) (F deg per in.) are given in Table 8. This table may be used for any of the commercial insulations offered for this purpose since they have conductivities very near the 0.3 value used.