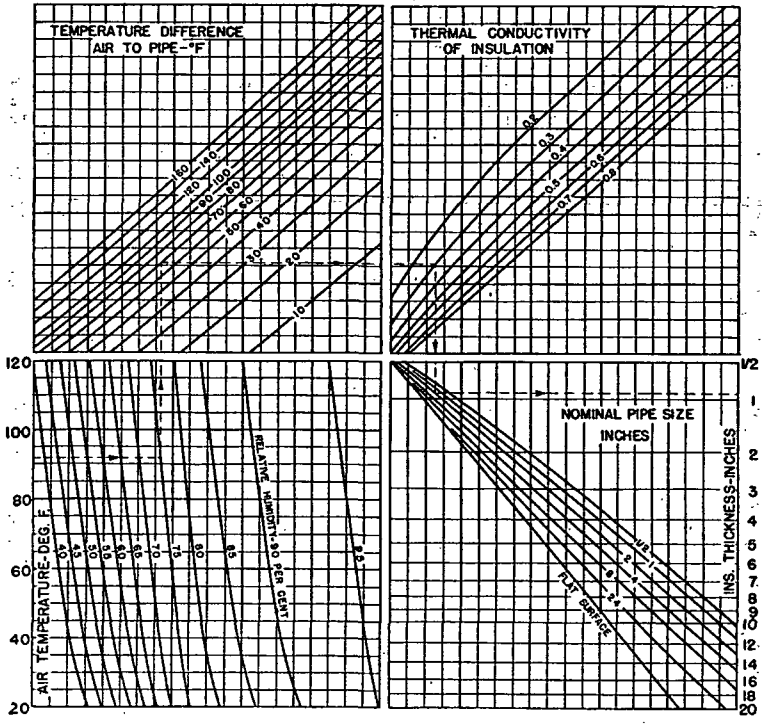
cost $0.804 per thousand Mb. Therefore, the monetary value of the saving = 0.804 (dollars) × 148.1 (thousand Mb) = $119.07, or 81.5 per cent of the cost when using uninsulated pipe.

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.



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

FIG. 5. THICKNESS OF PIPE INSULATION TO PREVENT CONDENSATION ON OUTER SURFACE[a]

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 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.

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 approximate required thickness of insulation to prevent condensation on pipes and flat metallic surfaces may be obtained from Fig. 5 in

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
⅛	1.5	0.110	0.502	2.0	0.098	0.446	2.8	0.087	0.394
¼	1.6	0.119	0.431	2.0	0.111	0.405	2.9	0.094	0.340
½	1.6	0.139	0.403	2.0	0.124	0.352	3.0	0.104	0.294
1	1.6	0.155	0.357	2.4	0.131	0.300	3.1	0.113	0.260
1¼	1.5	0.174	0.351	2.5	0.134	0.270	3.2	0.118	0.238
1½	1.5	0.200	0.322	2.5	0.151	0.244	3.3	0.134	0.214
2	1.5	0.228	0.303	2.6	0.170	0.226	3.3	0.147	0.197
2½	1.5	0.269	0.293	2.7	0.186	0.202	3.4	0.162	0.176
3	1.5	0.295	0.282	2.9	0.191	0.183	3.5	0.176	0.167
3½	1.7	0.294	0.248	2.9	0.209	0.176	3.7	0.182	0.154
4	1.7	0.349	0.239	3.0	0.241	0.165	3.9	0.202	0.138
5	1.7	0.404	0.233	3.0	0.259	0.150	4.0	0.228	0.130
6	1.9	0.455	0.201	3.0	0.318	0.140	4.0	0.263	0.116
8	1.9	0.559	0.198	3.0	0.383	0.135	4.0	0.309	0.110
10	1.9	0.648	0.194	3.0	0.438	0.131	4.0	0.364	0.108
12									

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 conductivity 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.

INSULATION OF PIPES TO PREVENT FREEZING

If the surrounding air temperature remains sufficiently low for an ample period of time, insulation cannot prevent the freezing of still water, or of water flowing at such a velocity that the quantity of heat carried in the water is not sufficient to take care of the heat losses which will result and cause the temperature of the water to be lowered to the freezing point.