

greater than those given. Therefore, it is essential that insulation be applied in such a manner that air circulation within it or between it and the pipe is avoided.

Fig. 4 shows the loss of heat from canvas-covered, cylindrical surfaces of various outside diameters when the surface to air temperature difference is low. The data are from tests made at Mellon Institute.

The frequent practice of omitting insulation on that portion of a pipe which passes through a masonry wall or which may be in contact with other metals should be avoided. Physical contact between the pipe surface and other structural materials of high thermal conductivity will

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
1/2	1.5	0.110	0.502	2.0	0.098	0.446	2.8	0.087	0.394
3/4	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
1 1/4	1.6	0.155	0.357	2.4	0.131	0.300	3.1	0.113	0.260
1 1/2	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
2 1/2	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
3 1/2	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

result in heat transfer much greater than that shown in Tables 1 and 2 for transfer from bare pipe to air.

The saving due to use of insulation on piping is illustrated in *Example 4*.

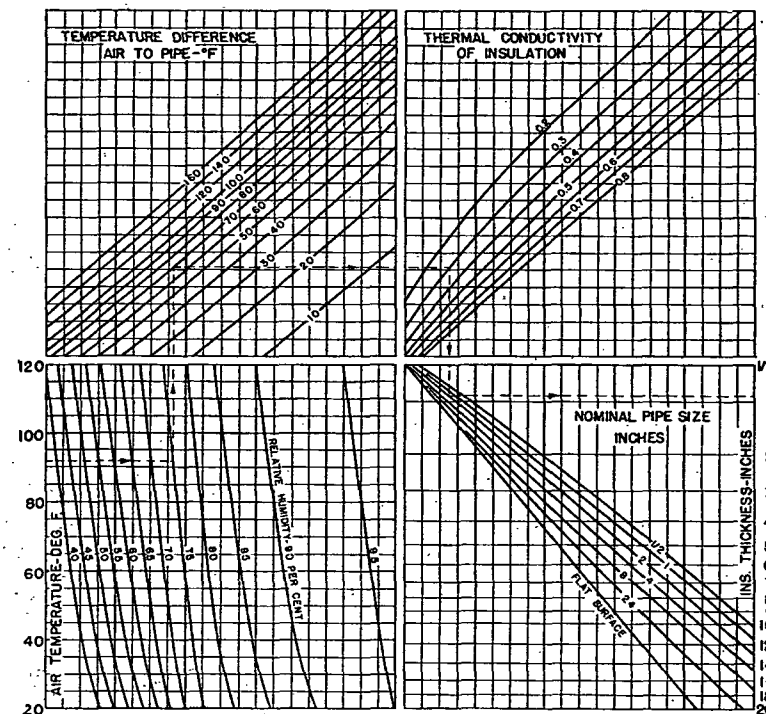
Example 4. If the steam line given in *Examples 1 and 2* is covered with 1 in. thick 85 per cent magnesia, determine the resulting total annual loss through the insulation. Also compute the monetary value of the annual saving and the percentage of saving over the heat loss from the bare pipe.

Solution. By referring to Fig. 1, the coefficient for 1 in. magnesia on a 2-in. pipe is found to be 0.300 Btu per (hour) (linear foot of pipe) (degree temperature difference) at a temperature difference of 169.4 F. The total hourly loss per linear foot of pipe will then be $0.300 \times 169.4 = 50.8$ Btu. The total annual loss through the insulation = 50.8×165 (linear feet) $\times 4000$ (hours) = 33,500 Mb. The annual bare pipe loss as determined in the solution of *Example 1* was found to be 181,600 Mb. The saving due to insulation is then $181,600 - 33,500 = 148,100$ Mb per year.

From the solution of *Example 2*, it was found that the heat supplied to the system cost \$0.804 per thousand Mb. Therefore, the monetary value of the saving = 0.804 (dollars) $\times 148.1$ (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. 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



*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 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