Based on 123.8 F entering air temperature the new mean temperature difference will be 81.9 F and the new transmission coefficient will be 0.515. Resubstituting in Formula 3, t_1 becomes 123.9 F, which value is evidently exact within one tenth of one degree.

Substituting in Formula 1,

$$H = 0.515 \times 10 \times 70 \left[\left(\frac{123.9 + 120}{2} \right) - 40 \right]$$

$$H = 0.515 \times 10 \times 70 \times 81.95$$

$$H = 29{,}543 \text{ Btu.}$$

TABLE 15. HEAT TRANSMISSION THROUGH DUCT WALLS INSULATED WITH MATERIALS OF VARYING CONDUCTIVITIES[a]

Values are expressed in Btu per hour per square foot of flat surface per degree Fahrenheit difference in temperature between air inside and still air outside at 90 F for cold air and 50 F for warm air in ducts

Conductivity of Insulation at 86 F Mean Temp	Thickness of Insulation (Inches)	Cold Air 40 F	Cold Air 60 F	Cold Air 80 F	Warm Air 90 F	Warm Air 120 F	Warm Air 150 F	Warm Air 180 F
		Temperature Difference 50 F	30 F	10 F	40 F	70 F	100 F	130 F
0.200	½	0.319	0.323	0.328	0.324	0.330	0.337	0.344
	1	0.175	0.177	0.180	0.178	0.181	0.184	0.188
	1½	0.121	0.122	0.124	.....	0.125	0.127	0.129
	2	0.092	0.093	0.095	.....	.....	.....	.....
0.250	½	0.382	0.387	0.392	0.390	0.397	0.404	0.412
	1	0.214	0.217	0.220	0.218	0.221	0.225	0.229
	1½	0.149	0.151	0.153	.....	0.154	0.156	0.159
	2	0.114	0.115	0.117	.....	.....	.....	.....
0.300	½	0.440	0.445	0.450	0.448	0.457	0.466	0.475
	1	0.252	0.255	0.258	0.256	0.260	0.264	0.268
	1½	0.176	0.178	0.180	.....	0.181	0.184	0.187
	2	0.135	0.137	0.139	.....	.....	.....	.....
0.350	½	0.494	0.499	0.505	0.502	0.511	0.521	0.530
	1	0.286	0.289	0.292	0.290	0.295	0.300	0.306
	1½	0.202	0.204	0.207	.....	0.208	0.211	0.215
	2	0.156	0.158	0.160	.....	.....	.....	.....
0.450	½	.....	0.596	0.602	0.599	0.610	0.621	0.633
	1	.....	0.356	0.360	0.358	0.364	0.370	0.376
	1½	.....	0.254	0.257	.....	0.259	0.263	0.267
	2	.....	0.198	0.200	.....	.....	.....	.....
0.550	½	.....	0.682	0.688	0.685	0.699	0.714	0.730
	1	.....	0.417	0.422	0.418	0.425	0.432	0.440
	1½	.....	0.302	0.305	.....	0.307	0.312	0.317
	2	.....	0.236	0.239	.....	.....	.....	.....

[a]For round ducts less than 30 in. diameter, increase heat transmission values by the following percentages:

Thickness of Insulation (Inches)	½	1	1½	2
21 to 30 in. Duct Diameter	1%	2%	3%	4%
12 to 21 in. Duct Diameter	3%	5%	7%	9%

LOW TEMPERATURE INSULATION

Surfaces maintained at temperatures lower than the surrounding air are insulated to reduce the flow of heat and to prevent condensation and frost. The insulating material should absorb a minimum amount of moisture, for one reason that the absorption of moisture substantially increases the conductivity of the material. This property is particularly important in the case of surfaces to be insulated 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.

The thickness of insulation which should be used to prevent condensation on pipes and flat metallic surfaces may be obtained from Fig. 2. The maximum permissible temperature drop is indicated at the point where the guide line passes through the horizontal scale at the left center of the chart. This temperature drop represents the difference between the dry-bulb temperature and the dew-point temperature for the conditions involved. (See discussion of Condensation in Chapter 7). The surface resistances used for calculating the family of curves in Fig. 2 are based on tests made on canvas covered pipe insulation surfaces at *Mellon Institute*. However, it has been found that the resistance for asphaltic and roofing surfaces is practically the same as for canvas surfaces, so that the curves may be followed with no alteration for surfaces commonly used.

Heat gains for pipes insulated with a material having a conductivity of 0.30 Btu per square foot per hour per degree Fahrenheit difference per inch thickness are given in Table 16.

Heat gains for insulated ducts are given in the cold air column of Table 15. The heat gains are based on a uniform series of conductivities at 86 F mean temperature and an air temperature of 90 F outside of the duct. The gains may be interpolated for odd material conductivities and temperatures. For cases where the surrounding air temperature is other than 90 F the gains may be selected on the basis of temperature difference.

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. Insulation can materially prolong the time required for the water to give up its heat, and if the velocity of the water flowing in the pipe is maintained at a sufficiently high rate, freezing may be prevented.

Table 17 may be used for making estimates of the thickness of insulation necessary to take care of still water in pipes at various water and