Table 4. Conductivities (k) of Various Types of Insulating Materials for Medium and High Temperature Pipes[a]

	Mean Temperature				
	100 F	200 F	300 F	400 F	500 F
85 per cent Magnesia Type	0.425	0.465	0.505	0.550	0.590
Corrugated Asbestos Type (4 Plies per 1 in. thick)	0.530	0.650	0.770	0.890	
Corrugated Asbestos Type (8 Plies per 1 in. thick)	0.480	0.555	0.630	0.705	
Laminated Asbestos Type (30–40 Laminations per 1 in. thick)	0.360	0.415	0.470	0.525	0.585
Laminated Asbestos Type (20 Laminations per 1 in. thick)	0.545	0.605	0.665	0.725	0.785
Rock Wool Type	0.350	0.410	0.470	0.530	0.590
High Temperature Type (Diatomaceous Earth and Asbestos)	0.515	0.545	0.575	0.605	0.635
Brown Asbestos Type (Felted Fibre)	0.600	0.640	0.675	0.715	0.750

[a] *Mechanical Engineer's Handbook*, Marks, 3rd Ed., 1930.

conductivities makes it possible readily to calculate the heat loss through single or compound sections. It should be emphasized that the conductivities given in Table 4 for the various insulations are the average of values obtained from a number of tests made on each type of material, also that 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 six of the types of insulation given in Table 4 for 1, 1½ and 2-in.-thick materials, and for temperatures commonly encountered in engineering practice can be obtained from Tables 5 to 10, inclusive. The loss through other thicknesses of the materials, and for other hot water or steam temperature conditions may be obtained by interpolation. The heat loss coefficients given in Tables 5 to 10 are based on the conductivities in Table 4 and were computed from data given in Chapter 22, The Guide 1931, as in the following problem:

Example 1. Determine the total heat loss for a period of 30 days through a 1-in. (4 ply) thickness of corrugated asbestos insulation on 100 ft of 3-in. pipe carrying steam at 5 lb pressure, and with surrounding air at 60 F. Also determine percentage of heat saving over bare pipe loss.

Solution. Difference in temperature between pipe and surrounding air = 227.1 − 60 or 167.1 deg. From Table 6 the coefficients of transmission for 1-in. corrugated asbestos (4 ply) are 0.608 and 0.652 Btu per hour per square foot per degree temperature difference at temperature differences of 157.1 deg and 227.7 deg, respectively. The difference is 0.044 Btu per hour per square foot per degree temperature difference for a temperature difference of 70.5 deg. For a temperature difference of 167.1 deg (10 deg higher than 157.1 deg) the coefficient of transmission is then $0.608 + \left(\frac{10}{70.5} \times 0.044\right)$, or 0.614 Btu per hour per square foot per degree temperature difference. From Table 2 the area per linear foot of 3-in. pipe is 0.917 sq ft. The total heat loss is therefore $0.917 \times 0.614 \times 167.1 \times 100$ (linear feet) $\times$ 720 (hours) = 6,774,000 Btu.

From Table 1, and in the same manner it is determined that the loss through an uninsulated 3-in. pipe for the same conditions will be 25,917,000 Btu. The saving due to insulation is 19,143,000 Btu or 74 per cent of the bare pipe loss.

Table 5. Coefficients of Transmission (U) for Pipes Insulated with 85 Per Cent Magnesia Type Insulation

These coefficients are expressed in Btu per hour per square foot of pipe surface per degree Fahrenheit difference in temperature between pipe and surrounding still air at 70 F

Thickness of Insulation (Inches)	Nominal Pipe Size (Inches)	Hot Water				Steam		
		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
1	½	0.744	0.754	0.764	0.774	0.779	0.802	0.814
	¾	0.672	0.681	0.689	0.697	0.701	0.721	0.731
	1	0.613	0.621	0.629	0.637	0.641	0.659	0.670
	1¼	0.562	0.570	0.577	0.585	0.589	0.606	0.617
	1½	0.532	0.539	0.546	0.553	0.557	0.573	0.582
	2	0.500	0.506	0.512	0.519	0.523	0.538	0.547
	2½	0.475	0.481	0.487	0.493	0.497	0.512	0.520
	3	0.455	0.461	0.467	0.474	0.477	0.492	0.500
	3½	0.441	0.447	0.452	0.458	0.462	0.475	0.483
	4	0.429	0.435	0.441	0.446	0.449	0.463	0.471
	4½	0.420	0.425	0.431	0.437	0.440	0.453	0.460
	5	0.411	0.416	0.422	0.427	0.430	0.443	0.450
	6	0.402	0.408	0.413	0.419	0.422	0.435	0.442
	8	0.387	0.392	0.397	0.403	0.405	0.418	0.425
	9	0.380	0.385	0.390	0.395	0.398	0.410	0.417
	12	0.369	0.374	0.378	0.383	0.386	0.398	0.405
1½	½	0.617	0.625	0.633	0.642	0.646	0.665	0.676
	¾	0.550	0.558	0.566	0.573	0.577	0.596	0.606
	1	0.496	0.503	0.511	0.518	0.522	0.540	0.549
	1¼	0.453	0.459	0.465	0.472	0.475	0.490	0.498
	1½	0.424	0.430	0.436	0.442	0.445	0.459	0.467
	2	0.394	0.400	0.405	0.410	0.413	0.427	0.434
	2½	0.371	0.376	0.382	0.386	0.389	0.401	0.408
	3	0.352	0.357	0.362	0.367	0.370	0.380	0.387
	3½	0.339	0.343	0.347	0.351	0.354	0.364	0.370
	4	0.328	0.333	0.337	0.341	0.343	0.353	0.359
	4½	0.320	0.324	0.328	0.332	0.334	0.343	0.350
	5	0.312	0.316	0.320	0.324	0.326	0.336	0.342
	6	0.303	0.307	0.311	0.315	0.318	0.328	0.333
	8	0.287	0.291	0.295	0.299	0.301	0.311	0.316
	9	0.280	0.284	0.288	0.292	0.294	0.303	0.308
	12	0.272	0.275	0.279	0.283	0.285	0.294	0.299
2	½	0.543	0.551	0.558	0.565	0.569	0.587	0.597
	¾	0.484	0.490	0.497	0.503	0.507	0.523	0.532
	1	0.433	0.439	0.445	0.451	0.454	0.467	0.476
	1¼	0.393	0.398	0.403	0.409	0.412	0.424	0.432
	1½	0.365	0.370	0.376	0.381	0.384	0.397	0.402
	2	0.338	0.343	0.347	0.351	0.354	0.364	0.370
	2½	0.316	0.320	0.324	0.328	0.331	0.341	0.347
	3	0.297	0.301	0.305	0.309	0.312	0.321	0.326
	3½	0.284	0.288	0.292	0.295	0.297	0.306	0.311
	4	0.275	0.278	0.282	0.285	0.287	0.296	0.301
	4½	0.266	0.270	0.273	0.276	0.278	0.286	0.290
	5	0.258	0.262	0.265	0.268	0.270	0.278	0.283
	6	0.250	0.254	0.257	0.260	0.262	0.270	0.274
	8	0.236	0.239	0.242	0.245	0.247	0.255	0.258
	9	0.228	0.231	0.234	0.237	0.239	0.246	0.250
	12	0.219	0.222	0.225	0.228	0.230	0.237	0.240