Table 3. Areas of Flanged Fittings, Square Feet

Nominal Pipe Size I. D.	Flanged Coupling		90 Deg. Ell		Long Radius Ell		Tee		Cross	
	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy	Standard	Extra Heavy
1″	0.320	0.438	0.795	1.015	0.892	1.083	1.235	1.575	1.622	2.07
1¼″	0.383	0.510	0.957	1.098	1.084	1.340	1.481	1.925	1.943	2.53
1½″	0.477	0.727	1.174	1.332	1.337	1.874	1.815	2.68	2.38	3.54
2″	0.672	0.848	1.65	2.01	1.84	2.16	2.54	3.09	3.32	4.06
2½″	0.841	1.107	2.09	2.57	2.32	2.76	3.21	4.05	4.19	5.17
3″	0.945	1.484	2.38	3.49	2.68	3.74	3.66	5.33	4.77	6.95
3½″	1.122	1.644	2.98	3.96	3.28	4.28	4.48	6.04	5.83	7.89
4″	1.344	1.914	3.53	4.64	3.96	4.99	5.41	7.07	7.03	9.24
4½″	1.474	2.04	3.95	5.02	4.43	5.46	6.07	7.72	7.87	10.07
5″	1.622	2.18	4.44	5.47	5.00	6.02	6.81	8.52	8.82	10.97
6″	1.82	2.78	5.13	6.99	5.99	7.76	7.84	10.64	10.08	13.75
7″	2.17	3.46	6.17	8.62	7.38	9.73	9.37	12.33	12.00	16.83
8″	2.41	3.77	6.98	9.76	8.56	11.09	10.55	14.74	13.44	18.97
9″	3.00	4.44	8.71	11.44	10.57	13.17	13.18	17.23	16.78	22.10
10″	3.43	5.20	10.18	13.58	12.35	15.60	15.41	20.41	19.58	26.26
12″	4.41	6.71	13.08	17.73	16.35	18.76	19.67	26.65	24.87	34.11
14″ O. D.	5.39	8.30	16.38	22.31	20.17	25.70	24.81	33.63	31.48	43.15
15″ O. D.	6.18	9.52	18.50	25.28	22.92	29.34	27.91	38.04	35.48	48.79
16″ O. D.	6.69	10.05	20.17	27.18	25.41	31.73	30.32	40.94	38.34	52.35

tions are the average values from a number of tests on each type of material, also that all variables due to differences in thickness, different pipe sizes, and different air conditions are eliminated.

The heat losses through any of the insulations shown in Fig. 4 for various thicknesses of covering and for any temperatures generally used in engineering practice can be obtained from Table 7 and Figs. 5, 6 and 7.

In these curves the unit loss through 1, 1½ and 2 in. thick covering is given for temperature differences up to 700 deg. fahr. The loss through other thicknesses of covering can be obtained from the curves by interpolation.

Table 7 gives the factor by which the loss from the curves shown in Figs. 5 to 7 must be multiplied to give the loss through any of the coverings whose conductivity values are given in Fig. 4.

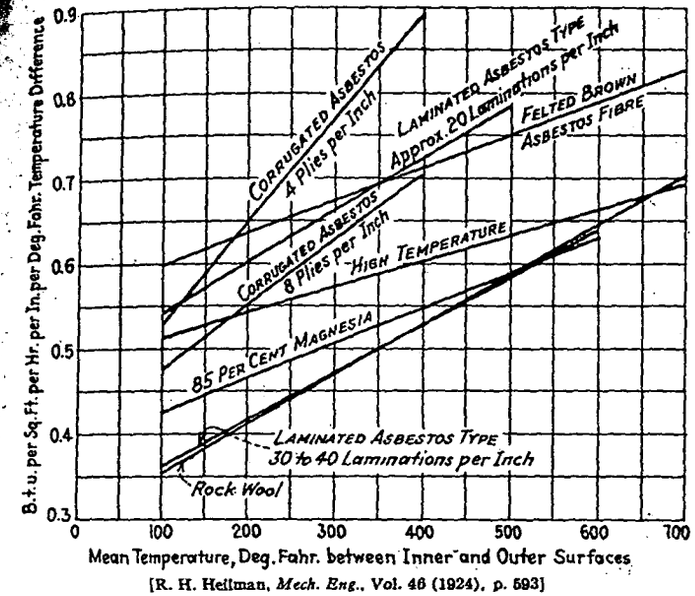
Table 4. Emissivity Values (ε) for Various Surfaces

Surface	Temperature, degrees Fahrenheit						
	100	200	300	400	500	600	700
Polished silver	0.0221	0.0252	0.0292	0.0315	0.0295	0.0308	0.0312
Lampblack	0.945	0.945	0.945	0.945	0.945	0.945	0.945
Asbestos paper	0.930	0.934	0.943	0.955	0.929	0.938	0.943
Rough steel plate	0.945	0.950	0.955	0.961	0.969	0.975	0.975
Aluminum-surfaced roofing	0.216	.....	.....	.....	.....	.....	.....
Polished brass	0.096	0.096	0.098	0.098	0.096	0.096	.....
Flat black lacquer	0.96	0.98	.....	.....	.....	.....	.....
Black lacquer	0.80	0.95	.....	.....	.....	.....	.....
White lacquer	0.80	0.95	.....	.....	.....	.....	.....

INSULATION FOR COLD SURFACES

Surfaces maintained at a low temperature should be insulated so as to retard the flow of heat from the outside into the low temperature area and to prevent the formation of condensation and of frost if the temperatures are low enough, as well as to prevent corrosion, induced by the presence of condensed moisture on metal surfaces.

Coverings are available commercially to meet varying temperature gradients. For example: The thickness of insulation for ice water is approximately 1½ in. if the temperature in the line is not lower than 25 deg. fahr.; the thickness of insulation for brine is approximately 2½ in.,



[R. H. Heilman, *Mech. Eng.*, Vol. 46 (1924), p. 593]

Fig. 4. Thermal Conductivity

where the temperature ranges from 0 deg. to 25 deg. fahr.; and the thickness of insulation where the brine temperature ranges from −30 to 0 deg. fahr. is approximately 4 in.

The thermal conductivities of the materials commonly used for low temperature insulation for pipes and surfaces are given in Table 4.

In some cases, the prevention of condensation rather than the conservation of heat is the governing factor in determining the thickness of insulation required. Fig. 8 may be used for the determination of thickness of any material of known conductivity which should be used to prevent sweating on pipes and flat metallic surfaces. The curves in Fig. 8 have been calculated on the basis of using an insulating material which has a thermal conductivity of 0.3 B.t.u. per hour per square foot per degree fahrenheit per inch of thickness. The surface resistance used