resistance to heat flow inherent in the insulation itself. The maximum increase in heat loss due to air velocity ranges from about 30 per cent in the case of 1-in. thick insulation, to about 10 per cent in the case of 3-in. thick insulation, provided that the insulation is thoroughly sealed so that air can flow only over the surface.

If the conditions are such that the air may circulate through cracks and crevices in the insulation, the increases may be far greater than those given. Therefore, it is essential that insulation be sealed as tightly as possible. Pipe insulation exposed to the elements should be thoroughly waterproofed.

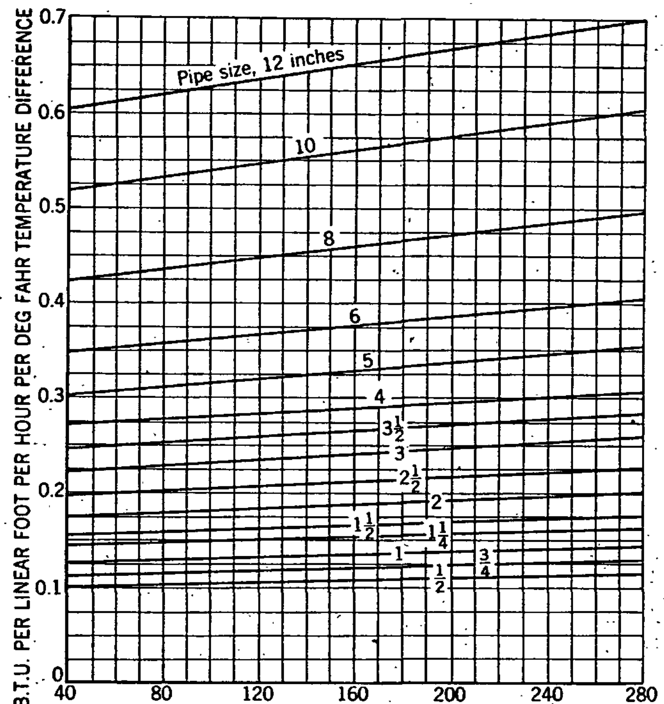

FIG. 4. HEAT LOSS THROUGH 2 IN. THICK 85 PER CENT MAGNESIA TYPE COVERING

Example 3. 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. 2, the coefficient for 1 in. magnesia on a 2 in. pipe is found to be 0.285 Btu per hour per linear foot of pipe per degree temperature difference at a temperature difference of 169.4 F. The total hourly loss per linear foot of pipe will then be 0.285 × 169.4 = 48.3 Btu. The total annual loss through the insulation = 48.3 × 165 (linear feet) × 4000 (hours) = 31,900 *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 − 31,900 = 149,700 *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) × 149.7 (thousand *Mb*) = $120.36, or 82.4 per cent of the cost when using uninsulated pipe.

TABLE 8. CONDUCTIVITY (*k*) OF VARIOUS TYPES OF INSULATING MATERIALS FOR MEDIUM AND HIGH TEMPERATURE PIPES[a]

TYPES OF INSULATING MATERIALS	MEAN TEMPERATURE, DEG F				
	100	200	300	400	500
85 per cent Magnesia Type	0.359	0.403	0.448	0.493	0.539
Corrugated Asbestos Type (4 Plies per 1 in. thick)	0.495	0.618	0.741	0.864	-------
Corrugated Asbestos Type (8 Plies per 1 in. thick)	0.505	0.598	0.692	0.786	-------
Laminated Asbestos Type (30-40 Laminations per 1 in. thick)	0.326	0.380	0.434	0.488	0.543
Laminated Asbestos Type (14-20 Laminations per 1 in. thick)	0.374	0.445	0.518	0.589	0.662
Mineral Wool Type	0.350	0.410	0.470	0.530	0.590
High Temperature Type (Diatomaceous Earth and Asbestos)	0.576	0.614	0.652	0.689	0.726
Brown Asbestos Type (Felted Fiber)	0.338	0.396	0.453	0.510	0.568

[a]From tests conducted at *Mellon Institute*.

TABLE 9. PIPE COVERING FACTORS

TYPES OF INSULATING MATERIALS	TEMPERATURE DIFFERENCE, PIPE TO AIR, DEG F					
	100	200	300	400	500	600
85 per cent Magnesia Type	1.050	1.024	0.997	0.971	0.944	0.918
Corrugated Asbestos Type (4 Plies per 1 in. thick)	1.425	1.465	1.505	1.545	-------	-------
Corrugated Asbestos Type (8 Plies per 1 in. thick)	1.435	1.437	1.438	1.440	-------	-------
Laminated Asbestos Type (30-40 Laminations per 1 in. thick)	0.969	0.960	0.951	0.942	0.933	0.924
Laminated Asbestos Type (14-20 Laminations per 1 in. thick)	1.103	1.104	1.105	1.106	1.107	1.108
Mineral Wool Type	1.023	1.028	1.033	1.038	1.043	1.048
High Temperature Type (Diatomaceous Earth and Asbestos)	1.560	1.489	1.418	1.347	1.276	1.205
Brown Asbestos Type (Felted Fiber)	1.003	0.997	0.990	0.984	0.977	0.971

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 and frost. 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