TABLE 1. THERMAL CONDUCTIVITY (k) OF INDUSTRIAL AND PIPE INSULATIONS
(For Mean Temperatures Indicated)
Expressed in Btu per (hour) (square foot) (Fahrenheit degree temperature difference per in.)

Form	Material (Composition)	Accepted Max. Temp. for Use[a] F	Density Lb/Cu Ft	Typical Conductivity k at Mean Temp. Fahr. 40	70	100	200	300	500	700	900
BLANKETS	MINERAL WOOL (*Rock, Slag, or Glass*)										
	Metal Reinforced	1200	6–15			0.29	0.35	0.42	0.56		
	Felt-Flexible Type	450	0.5–3	0.23	0.25	0.26	0.34	0.45			
	Felt-Semi-Rigid Type	450	2–8	0.24	0.25	0.27	0.35	0.44			
	VEGETABLE & ANIMAL FIBER										
	Hair Felt or Hair Felt plus Jute	180	10	0.27	0.28	0.30					
BLOCKS AND BOARDS	ASBESTOS										
	Molded Amosite & Binder	1200	18			0.37	0.40	0.47	0.56	0.66	0.76
	Laminated Asbestos Paper	700	30			0.40	0.45	0.50	0.60		
	Corrugated & Laminated Asbestos Paper										
	4 ply	300	11–13		0.54	0.57	0.68	0.80			
	6 ply	300	15–17		0.49	0.51	0.59	0.69			
	8 ply	300	18–20		0.47	0.49	0.57	0.65			
	CALCIUM SILICATE	1200	11			0.33	0.38	0.43	0.53	0.64	0.75
	CELLULAR GLASS	800	9	0.37	0.39	0.41	0.48	0.55			
	CORKBOARD (*Without Added Binder*)	200	6.5–8	0.26	0.27	0.28					
	DIATOMACEOUS SILICA	1500	22						0.60	0.64	0.68
		1900	25						0.70	0.75	0.80
	85% MAGNESIA										
	Mag. Carb. & Asbestos	600	11–14			0.35	0.38	0.42	0.46		
	MINERAL WOOL (*Rock, Slag or Glass*)										
	Low Temp. (Asphalt or Resin Bonded)	200	6–18	0.28	0.29	0.30					
	High Temp. (Resin Bonded)	600	6–10			0.28	0.35	0.43			
	(With Inorganic Binder)	1600	16–24			0.34	0.39	0.44	0.54	0.64	
	PLASTICS (Foamed)	175	1.6	0.26	0.28	0.30					
	RUBBER (Foamed)	150	5	0.23	0.24	0.25					
PIPE INSULATION	ASBESTOS										
	Molded Amosite & Binder	1200	16			0.33	0.38	0.43	0.53		
	Laminated Asbestos Paper	700	30			0.40	0.45	0.50	0.60		
	Corrugated & Laminated Asbestos Paper										
	4 Ply per in.	300	11–13		0.54	0.57	0.62	0.80			
	6 Ply per in.	300	15–17		0.49	0.51	0.59	0.69			
	8 Ply per in.	300	18–20		0.47	0.49	0.57	0.65			
	CALCIUM SILICATE										
	Calc. Sil. & Asbestos	1200	11			0.36	0.40	0.44	0.55		
	CELLULAR GLASS	800	9	0.37	0.39	0.41	0.48	0.55			
	CORK (*Without Added Binder*)	200	7–10	0.27	0.28	0.29	0.30				
	DIATOMACEOUS SILICA	1500	22						0.64	0.66	0.71
		1900	25						0.70	0.75	0.80
	85% MAGNESIA										
	Mag. Carb. & Asbestos	600	11–14			0.39	0.42	0.45	0.51		
	MINERAL WOOL (*Rock, Slag or Glass*)										
	Low Temp. (Asphalt or Resin Bonded)	200	15	0.28	0.30	0.33	0.39				
	Low Temp. (Fine Fiber Resin Bonded)	450	3	0.22	0.23	0.24	0.27	0.31			
	High Temp. Blanket-Type (Metal Reinforced)	1200	6–15			0.29	0.36	0.42	0.56		
	PLASTICS (Foamed)	175	1.6	0.26	0.28	0.31					
	RUBBER (Foamed)	150	5	0.23	0.24	0.25					
	VEGETABLE & ANIMAL FIBER										
	Wool Felt	180	20	0.29	0.31	0.33					
	Hair Felt or Hair Felt plus Jute	180	10	0.27	0.28	0.30					
INSULATING CEMENT	85% MAGNESIA										
	Mag. Carb. & Asbestos	600	18			0.46	0.52	0.58			
	MINERAL WOOL (*Rock, Slag or Glass*) With Colloidal Clay Binder	1800	24–30			0.49		0.61	0.73	0.83	

[a] These temperatures are generally accepted as maximum. When operating temperature approaches these limits the Manufacturer's recommendations should be followed.

insulation the user should consult the manufacturer or obtain the results of unbiased tests.

Other properties of thermal insulations that are of more or less importance, depending upon the use, are strength, hardness, density, compressibility, specific heat, resistance to high or low temperature, and thermal coefficient of expansion. The final choice of an insulating material for a given purpose usually involves a compromise with regard to several

desirable properties. For example, an insulating firebrick must have considerable strength and must be resistant to the temperature to which it is to be exposed. The desirable properties of low conductivity and light weight must be sacrificed to some extent to achieve these necessary properties of strength and temperature resistance.

TEMPERATURE RANGE OF USE OF INDUSTRIAL INSULATION

Since thermal insulation reduces the exchange of heat energy between an insulated surface and its surroundings, it can be useful at any temperature from the lowest to the highest. Actually insulation is used in industrial processes operating at temperatures from minus 400 F to 3000 F and higher.

At the low end of the scale are processes involving liquefied gases, usually in vessels or piping, at temperatures from the lowest up to about minus 40 F. From minus 40 F to normal atmospheric temperatures large amounts of low temperature insulation are used for enclosing freezing tunnels, cold-storage rooms, and a great variety of food and industrial processes requiring low temperatures.

At normal and near-normal temperatures insulation in building structures is required for economical operation of heating and air conditioning systems. Insulation for heating and cooling equipment and for the distribution ducts, piping, etc., is, however, usually considered as industrial. The range of temperatures is from that of chilled water or about 32 F up to steam at 100–125 psig (about 350 F).

Drying and baking ovens, boilers small and large, distillation equipment in oil refineries, high-pressure and superheated-steam piping call for insulation suitable up to 1200 F. Petroleum cracking units, heat treating furnaces, ceramic kilns may reach 2200–2400 F. Still higher temperatures with surfaces to be insulated up to 3000 F are found on melting furnaces for glass, iron, steel, and metals of all kinds as well as furnace enclosures for combustion spaces for many kinds of heating units.

Above 3000 F the variety of materials physically suited for walls and structural parts rapidly decreases with increasing temperature. Insulation for conservation of heat energy must, therefore, often be applied so as to permit enough heat to escape to retain mechanical strength.

TEMPERATURE LIMITATIONS OF INSULATIONS

Probably the greatest volume of low temperature insulations is used for temperatures from minus 100 F to atmospheric. The effect of temperature alone on physical integrity is not ordinarily very important for most types in the low-temperature field. There are more definite limitations for materials in the high-temperature field where decomposition, excessive linear shrinkage, softening or some other effect of temperature alone will put a maximum limit on the temperature for which a material is suited. As extremes in temperature are approached, both high and low, the selection of a material for a specific service becomes more and more critical and must be based on experience and factual performance data.

FORMS OF INSULATION

The physical form of industrial insulations varies from powders and loose fills which might be called *formless*, through materials with varying degrees of compressibility and flexibility, to completely rigid shapes often referred to as preformed insulation. After deciding that a material has the necessary insulating value, physical properties, and temperature resistance, the choice of the form desired will usually be governed by considerations of