Analytical Chemistry of Industrial Poisons, Hazards and Solvents, by M. B. Jacobs (Interscience Publishers, New York, 1941).

Bibliography of Industrial Hygiene, 1900–1943 (*U. S. Public Health Service Bulletin* No. 289, 1945).

Clouds and Smokes, by W. E. Gibbs (P. Blakiston's Son & Co., Philadelphia, Pa., 1924).

Determination and Control of Industrial Dust, by Bloomfield and DallaValle (*U. S. Public Health Service Bulletin* No. 217, 1935).

Dust, by S. C. Blacktin (The Sherwood Press, Cleveland, 1934).

(The) Environment and Its Effect upon Man (Harvard School of Public Health, Boston, 1937).

Industrial Dust, by Drinker and Hatch (McGraw-Hill Book Co., New York, 1936).

Industrial Health Engineering by A. D. Brandt (John Wiley & Sons, Inc., New York, 1947).

Industrial Hygiene and Toxicology, edited by F. A. Patty (Interscience Publishers, Inc., New York, Vol. I, 1948 and Vol. II, 1949).

Journal of Industrial Hygiene and Toxicology (monthly) (Harvard School of Public Health, Boston, Mass.). See cumulative abstract and subject indexes.

Manual of Industrial Hygiene, by W. M. Gafafer, et al (*U. S. Public Health Service*, W. B. Saunders Co., Philadelphia, 1943).

Noxious Gases and the Principles of Respiration Influencing Their Action, by Henderson and Haggard (*American Chemical Society Monograph Series No.* 35, Reinhold, New York, 1943).

Occupation and Health, two volumes (*International Labor Office*, Washington, D. C.).

Toxicology and Hygiene of Industrial Solvents, by Lehmann and Flury, translated by Eleanor King and H. F. Smyth, Jr. (Williams and Wilkins, Baltimore, 1943).

CHAPTER 9

HEAT TRANSMISSION COEFFICIENTS OF BUILDING MATERIALS

Heat Transfer Symbols; Calculating Overall Coefficients; Conductivity of Homogeneous Materials; Soil Conductivity; Surface Conductance; Air Space Conductance; Practical Coefficients and Their Use; Computed Coefficients of Walls, Roofs, Ceilings and Floors; Combined Ceiling and Roof Coefficients; Calculating Surface Temperatures; Water Vapor and Condensation; Vapor Transmission; Condensation Control

THE design of air conditioning or heating systems for buildings requires a knowledge of the thermal properties of the walls enclosing the space. (The term *walls* in this case, includes windows, doors, ceilings, floors, roofs and skylights). The rate of heat flow through the walls under steady-state conditions at design temperatures is usually the basis for calculating the heat required. For a given wall under standard conditions the rate is a specific value designated as U, the *overall coefficient of heat transmission.* It may be determined by test in a guarded hot box apparatus, or it may be computed from known values of the thermal conductance of the various components. Because testing of all combinations of building materials is impracticable, the procedure and necessary data for calculation of the value of U are given in this chapter, together with tables of computed values for the more common constructions.

HEAT TRANSFER SYMBOLS

U = overall coefficient of heat transmission (air to air); the time rate of heat flow expressed in Btu per (hour) (square foot) (Fahrenheit degree temperature difference between air on the inside and air on the outside of a wall, floor, roof or ceiling). The term is applied to the usual combinations of materials, and also to single materials, such as window glass, and includes the surface conductance on both sides.

k = thermal conductivity; the time rate of heat flow through a homogeneous material under steady conditions through unit area per unit temperature gradient in the direction perpendicular to the area. Its value is expressed in Btu per (hour) (square foot) (Fahrenheit degree per inch of thickness). Materials are considered homogeneous when the value of k is not affected by variation in thickness or size of sample within the range normally used in construction.

C = thermal conductance; the time rate of heat flow through a material from one of its surfaces to the other per unit temperature difference *between the two surfaces.* Its value is expressed in Btu per (hour) (square foot) (Fahrenheit degree). The term is applied to specific materials as used, either homogeneous or heterogeneous.

f = film or surface conductance; the time rate of heat flow between a surface and the surrounding air. Its value is expressed in Btu per (hour) (square foot of surface) (Fahrenheit degree temperature difference). Subscripts i and o are used to differentiate between inside and outside surface conductances, respectively.

a = thermal conductance of an air space; the time rate of heat flow through an air space per unit temperature difference *between the boundary surfaces.* Its value is expressed in Btu per (hour) (square foot of area) (Fahrenheit degree). The conductance of an air space is dependent on the temperature difference, the height, the depth, the position and the character of the boundary surfaces. The relationships are not linear, and accurate values must be obtained by test and not by computation.

R = thermal resistance. Its value is obtained from the reciprocal of heat transfer as expressed by U, k, C, f or a. It is expressed in (hours) (square feet) (Fahrenheit degrees) per (Btu). For example, a wall with a U value of 0.25 would have a