

Correct comparisons should take into consideration many different factors, including conductivities or conductances, thicknesses installed and manner of installation, while the selection of an insulation should also give consideration to structural qualities, as well as to material and application costs. Fire, vermin, and rot resistance are other important factors to be considered when comparing materials. At present there is no universally recognized method of rating insulations. Conductivities and conductances of building materials and insulations are useful to the heating engineer in determining over-all coefficients of heat transmission of walls, floors, roofs and ceilings.

Computed Transmission Coefficients

Computed heat transmission coefficients of many common types of building construction are given in Tables 3 to 13, inclusive, each construction being identified by a serial number. For example, the coefficient of transmission (U) of an 8-in. brick wall and $\frac{1}{2}$ in. of plaster, is 0.46, and the number assigned to a wall of this construction is 1-B, Table 3.

Example 1. Calculate the coefficient of transmission (U) of an 8-in. brick wall with $\frac{1}{2}$ in. of plaster applied directly to the interior surface, based on an outside wind exposure of 15 mph. It is assumed that the outside course is of face brick having a conductivity of 9.20, and that the inside course is of common brick having a conductivity of 5.0, the thicknesses each being 4 in. The conductivity of the plaster is assumed to be 3.3, and the inside and outside surface coefficients are assumed to average 1.65 and 6.00, respectively, for still air and a 15 mph wind velocity.

Solution. k (face brick) = 9.20; x = 4.0 in.; k (common brick) = 5.0; x = 4.0 in.; k (plaster) = 3.3; x = $\frac{1}{2}$ in.; f_i = 1.65; f_o = 6.0. Therefore,

$$U = \frac{1}{\frac{1}{6.0} + \frac{4.0}{9.20} + \frac{4.0}{5.0} + \frac{0.5}{3.3} + \frac{1}{1.65}}$$

$$= \frac{1}{0.167 + 0.435 + 0.80 + 0.152 + 0.606}$$

= 0.46 Btu per hour per square foot per degree Fahrenheit difference in temperature between the air on the two sides.

The coefficients in the tables were determined by calculations similar to those shown in Example 1, using Fundamental Formulae 2, 3, 4 and 5 and the values of k (or C_a), f_i , f_o and a indicated in Table 2 by asterisks. In computing heat transmission coefficients of floors laid directly on the ground (Table 10), only one surface coefficient (f_i) is used. For example, the value of U for a 1-in. yellow pine floor (actual thickness, 25/32 in.) placed directly on 6-in. concrete on the ground, is determined as follows:

$$U = \frac{1}{\frac{1}{1.65} + \frac{0.781}{0.80} + \frac{6.0}{12.0}} = 0.48 \text{ Btu per hour per square foot per degree difference in temperature between the ground and the air immediately above the floor.}$$

The thicknesses upon which the coefficients in Tables 3 to 13, inclusive, are based are as follows:

Brick veneer.....	4 in.
Plaster and metal lath.....	$\frac{3}{4}$ in.

Plaster (on wood lath, plasterboard, rigid insulation, board form, or corkboard).....	$\frac{1}{2}$ in.
Slate (roofing).....	$\frac{1}{2}$ in.
Stucco on wire mesh reinforcing.....	1 in.
Tar and gravel or slag-surfaced built-up roofing.....	$\frac{3}{8}$ in.
1-in. lumber (S-2-S).....	$2\frac{5}{32}$ in.
$1\frac{1}{4}$ -in. lumber (S-2-S).....	$1\frac{1}{4}$ in.
2-in. lumber (S-2-S).....	$1\frac{3}{8}$ in.
$2\frac{1}{4}$ -in. lumber (S-2-S).....	$2\frac{1}{8}$ in.
3-in. lumber (S-2-S).....	$2\frac{3}{8}$ in.
4-in. lumber (S-2-S).....	$3\frac{3}{8}$ in.
Finish flooring (maple or oak).....	$1\frac{3}{16}$ in.

Solid brick walls are based on 4-in. face brick and the remainder common brick. Stucco is assumed to be 1-in. thick on masonry walls. Where metal lath and plaster are specified, the metal lath is neglected.

Rigid insulation refers to the so-called board form which may be used structurally, such as for sheathing. Flexible insulation refers to the blankets, quilts or semi-rigid types of insulation.

Actual thicknesses of lumber are used in the computations rather than nominal thicknesses. The computations for wood shingle roofs applied over wood stripping are based on 1 by 4 in. wood strips, spaced 2 in. apart. Since no reliable figures are available concerning the conductivity of Spanish and French clay roofing tile, of which there are many varieties, the figures for such types of roofs were taken the same as for slate roofs, as it is probable that the values of U for these two types of roofs will compare favorably.

The coefficients of transmission of the pitched roofs in Table 12 apply where the roof is over a heated attic or top floor so the heat passes directly through the roof structure including whatever finish is applied to the underside of the roof rafters.

Combined Coefficients of Transmission

If the attic is unheated, the roof structure and ceiling of the top floor must both be taken into consideration, and the combined coefficient of transmission determined. The formula for calculating the combined coefficient of transmission of a top-floor ceiling, unheated attic space, and pitched roof, per square foot of roof area, is as follows:

$$U = \frac{U_r \times U_{ce}}{n \times U_r + U_{ce}} \quad (6)$$

where

U_r = coefficient of transmission of the roof.
 U_{ce} = coefficient of transmission of the ceiling.
 n = the ratio of the area of the roof to the area of the ceiling.

In using this formula, a correction factor must be applied. As the amount of heat transferred through an air space is proportional to the difference of the fourth powers of the absolute temperatures of the surfaces enclosing the air space, a greater amount of heat is absorbed or emitted by radiation by the surfaces enclosing an unheated attic than by the surfaces of a wall or ceiling in a room under still-air conditions, where the surrounding objects are only slightly higher in temperature than the interior surfaces of the walls and ceiling. For example, the average