TABLE 2. CONDUCTIVITIES ($k$) AND CONDUCTANCES ($C$) OF BUILDING AND INSULATING MATERIALS—Concluded

*These constants are expressed in Btu per (hour) (square foot) (Fahrenheit degree temperature difference). Conductivities ($k$) are per inch thickness and conductances ($C$) are for thickness or construction stated, not per inch thickness.*

| Material | Description | Density (Lb per Cu Ft) | Mean Temp (Fahr Deg) | Conductivity or Conductance ($k$) | Conductivity or Conductance ($C$) | Resistance Per Inch Thickness $\left(\frac{1}{k}\right)$ | Resistance For Thickness Listed $\left(\frac{1}{C}\right)$ | Authority |
|---|---|---|---|---|---|---|---|---|
| INSULATING MATERIALS—Continued | | | | | | | | |
| INSULATING BOARD—Continued | Made from licorice root | 16.1 | 81 | 0.34 | .... | 2.94 | ..... | (3) |
| | ½ in. insulating boards without special finish[7] (eleven samples) | 16.5 to 21.8 | 90 | 0.33 to 0.40 | .... | 3.03 to 2.50 | ..... | (1) |
| | 1 in. insulating board[8] | 13.2 | .... | 0.34 | .... | 2.94 | ..... | (4) |
| LOOSE FILL TYPE | Made from ceiba fibers | 1.90 | 75 | 0.23 | .... | 4.35 | ..... | (3) |
| | Made from ceiba fibers | 1.60 | 75 | 0.24 | .... | 4.17 | ..... | (3) |
| | Fibrous material made from dolomite and silica | 1.50 | 75 | 0.27 | .... | 3.70 | ..... | (3) |
| | Fibrous material made from slag | 9.40 | 103 | 0.27 | .... | 3.70 | ..... | (1) |
| | Redwood bark | 3.00 | 90 | 0.31 | .... | 3.22 | ..... | (1) |
| | Redwood bark | 5.00 | 75 | 0.26 | .... | 3.84 | ..... | (3) |
| | Glass wool fibers 0.0003 in. to 0.006 in. in diameter | 1.50 | 75 | 0.27 | .... | 3.70 | ..... | (3) |
| | Granular insulation made from combined silicate of lime and alumina | 4.20 | 72 | 0.24 | .... | 4.17 | ..... | (3) |
| | Expanded vermiculite | ..... | .... | 0.48 | .... | 2.08 | ..... | (1) |
| | Expanded vermiculite, particle size—3 + 14 | 6.2 | .... | 0.32 | .... | 3.12 | ..... | (3) |
| | Regranulated cork about ⅛ in. particles | 8.10 | 90 | 0.31 | .... | 3.22 | ..... | (1) |
| | Hand applied granular mineral wool 2 in. to 6 in. thick; horizontal position[9]. No covering | 6.05 to 7.13 | .... | 0.30 to 0.33 | .... | 3.33 to 3.03 | ..... | (4) |
| | 4 in. machine blown granular mineral wool, horizontal position[9]. No covering | 5.74 | .... | 0.30 | .... | 3.33 | ..... | (4) |
| | Rock wool | 10.0 | 90 | 0.27 | .... | 3.70 | ..... | (1) |
| SLAB INSULATIONS | Corkboard, no added binder | 14.0 | 90 | 0.34 | .... | 2.94 | ..... | (1) |
| | Corkboard, no added binder | 10.6 | 90 | 0.30 | .... | 3.33 | ..... | (1) |
| | Corkboard, no added binder | 7.0 | 90 | 0.27 | .... | 3.70 | ..... | (1) |
| | Corkboard, no added binder | 5.4 | 90 | 0.25 | .... | 4.00 | ..... | (1) |
| | Corkboard[8] | 8.7 | .... | 0.29 | .... | 3.45 | ..... | (4) |
| | Corkboard, asphaltic binder | 14.5 | 90 | 0.32 | .... | 3.12 | ..... | (1) |
| | Chemically treated hog hair with film of asphalt | 10.0 | 75 | 0.28 | .... | 3.57 | ..... | (3) |
| | Sugar cane fiber insulation blocks encased in asphalt membrane | 13.8 | 70 | 0.30 | .... | 3.33 | ..... | (3) |
| | Made from 85 per cent magnesia and 15 per cent asbestos | 19.3 | 86 | 0.51 | .... | 1.96 | ..... | (1) |
| | Made from shredded wood and cement | 24.2 | 72 | 0.46 | .... | 2.17 | ..... | (3) |
| | Made from shredded wood and cement[8] | 29.8 | .... | 0.77 | .... | 1.30 | ..... | (4) |

See notes on Page 117.

## Surface Conductance

The surface conductance of a wall is the combined heat transfer to or from the wall by radiation, convection and conduction. Each of the three portions making up the total may vary independently of the others, thus affecting the total conductance. The heat transfer by radiation between two surfaces is controlled by the character of the surfaces (emissivity), the temperature difference between them, and the solid angle through which they *see* each other. The heat transfer by convection and conduction is controlled by the roughness of the surface, by air movement and temperature difference between the air and the surface.

The importance of the effect of temperature of *surrounding surfaces* on the surface conductance due to the effect on radiation is illustrated in



Table 3, which applies to a vertical surface at 80 F, with ambient air at 70 F and effective emissivity equal to 0.83 [3].

In many cases, because the heat resistance of the internal parts of the wall is high compared with the surface resistance, the surface factors are of minor importance. In other cases, *e.g.* single glass windows, the surface resistances constitute almost the entire resistance and are therefore very important. In a building heated by convection there is only a slight difference between the temperatures of the interior wall surface and the surroundings, but if the building is heated by radiant panels there may be a considerable difference [4]. (See also Chapter 31.)

The convection part of the surface conductance coefficient is affected markedly by air movement. This is illustrated by Fig. 3, which shows the surface conductances for different materials at a mean temperature of 20 F and for wind velocities up to 40 mph. These include the radiation portion of the coefficient, which for ordinary building materials under these conditions would be constant at about 0.7 Btu.

TABLE 3. VARIATION IN SURFACE CONDUCTANCE COEFFICIENT WITH DIFFERENT TEMPERATURES OF SURROUNDING SURFACE

| Surrounding Surface Temperature | 75 F | 70 F | 69 F | 60 F | 50 F |
|---|---|---|---|---|---|
| Convection—Btu per (hr) (sq ft) | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 |
| Radiation—Btu per (hr) (sq ft) | 4.4 | 8.6 | 9.6 | 17.0 | 24.9 |
| Total—Btu per (hr) (sq ft) | 11.0 | 15.2 | 16.2 | 23.6 | 31.5 |
| Surface Coefficient—surface and air temperature only—Btu per (hr) (sq ft) (F deg difference of surface and air) | 1.10 | 1.52 | 1.62 | 2.36 | 3.15 |

Due to these variations for different conditions the selection of surface conductance coefficients for a practical building becomes a matter of judgment. In calculating the over-all heat transmission coefficients for the walls, etc. of Tables 5 to 18, 1.65 has been selected as an *average inside surface conductance* and 6.0 as an *average outside surface conductance* for a 15-mile wind. These values apply only to ordinary building materials and should not be used for bright metal surfaces having a low emissivity.

In special cases, where surface conductance coefficients become important factors in the over-all rates of heat transfer, more selective coefficients may be required. The surface conductance values given in Table 1, **Section A** are based on recent tests and are for still air conditions and surface emissivities of 0.83 and 0.05 respectively, and may be used where it is desirable to differentiate between horizontal and vertical surfaces or where coefficients applicable to low-emissivity surfaces are required.

## Air Space Conductance

The transfer of heat across an air space involves the boundary surfaces as well as the intervening air, consequently the factors influencing surface conductance play an important part in determining the conductance of the air space. The coefficients given for air space conductance represent the total conductance from surface to surface.

The radiation portion of the coefficient is affected by the difference in temperature between the boundary surfaces and by their respective