

between zero and 140 F can be estimated by considering a straight-line relationship between the two values given.

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

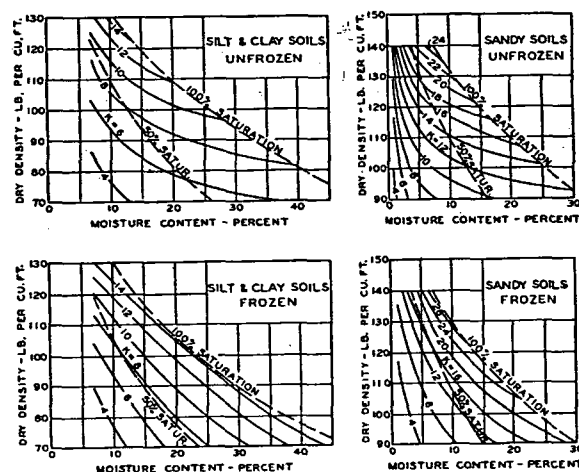


FIG. 3. DETERMINING THERMAL CONDUCTIVITY OF SOILS FROM DENSITY AND MOISTURE CONTENT

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 4, which applies to a vertical surface at 80 F, with ambient air at 70 F and effective emissivity equal to 0.83.⁴

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. An analysis of various factors affecting surface conductance and the difference between surface and air temperatures will be found in Reference 5. (See also Chapter 24.)

The convection part of the surface conductance is affected markedly by air movement. This is illustrated by Fig. 4, which shows the results of tests⁶ made on 12 in. square samples of different materials at a mean temperature of 20 F, and for wind velocities up to 40 mph. These conductances include the radiation portion of the coefficient which, for the conditions of the tests, was about 0.7 Btu per (hr) (sq ft) (F deg). More recent tests⁷ on smooth surfaces show that surface length also affects sig-

nificantly the convection part of conductance; the average value decreases as the surface length increases. Moreover, observations⁸ of the magnitude of low temperature radiant energy received from outdoor surroundings show that only under certain conditions may the out-of-doors be treated as a black body radiating at air temperature.

Because of these factors, the selection of surface conductance coefficients for a practical building becomes a matter of judgment. In calculating the overall heat transmission coefficients for the walls, etc., of Tables 6, 7, 8, 9, 15, 16, 17, 18, 19, and 21, 1.65 has been selected as an average inside surface conductance, and 6.0 as an average outside surface conductance for a 15 mph wind. Both values combine the effects of convection and radiation, and are applicable to ordinary building materials. They should not be used for low emissivity surfaces such as bright metal. Values of U for windows in Table 20 have been computed from somewhat different data, as described in a later section, in order to give proper weight to actual surface conductance.

In special cases, where surface conductances become important factors in the overall rates of heat transfer, more selective coefficients may be

TABLE 4. VARIATION IN SURFACE CONDUCTANCE COEFFICIENT FOR VERTICAL SURFACES WITH DIFFERENT TEMPERATURES OF SURROUNDING SURFACE

SURROUNDING SURFACE TEMPERATURE	75 F	70 F	65 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

required. Data given in Table 1, Section A, and principles and data given in Chapter 5, Heat Transfer, may be applied in such cases.

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 transfer of heat across an air space involves the boundary surfaces as well as the intervening air, and depends markedly on the orientation of the air space and the direction of heat flow. The coefficients given for air space conductance represent the total conductance from one surface bounding the air space to the other. The total conductance is the sum of a component due to radiation and a component due to convection and conduction combined. These components may vary independently of each other.

The radiation portion of the coefficient is affected by the temperature of the two boundary surfaces, and by their respective surface emissivities, the combined effect of which is expressed by means of the effective emissivity of the air space. The radiation component is not affected by the thickness of the space or by its orientation or direction of heat flow. The heat transfer by convection and conduction combined, however, is markedly affected by the orientation of the air space and the direction of heat flow, is significantly affected by the temperature difference across the space and in some cases by the thickness of the space, and is affected to only a small extent by the mean temperature of its surfaces. For air spaces usually