

series is the sum of the resistances of its component parts provided condensation does not take place within the assembly. Expressed in the more usual terms, the permeances (M_1, M_2, M_3 , etc.) of the individual pieces may be combined by use of the formula

$$M = \frac{1}{\frac{1}{M_1} + \frac{1}{M_2} + \frac{1}{M_3} + \dots + \frac{1}{M_n}} \quad (10)$$

Equation 10 holds for materials that are reasonably homogeneous and in a condition of *steady state* where the transmission at all points is a vapor diffusion process as, for example, in a vapor transmission test. Actually, the conditions of moisture movement through a building wall are generally

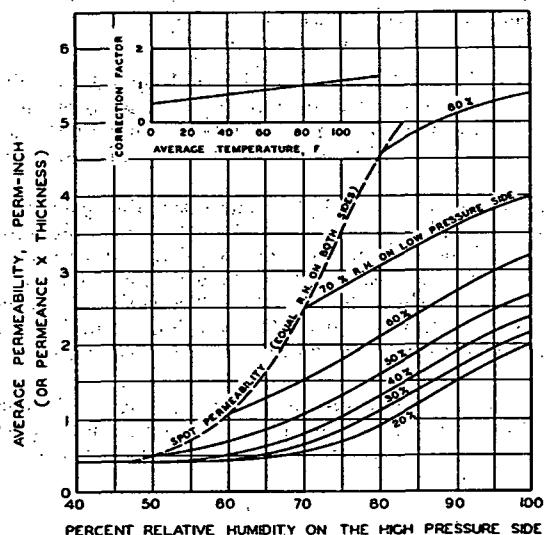


FIG. 7. PERMEABILITY OF WOOD (SUGAR PINE)

different. A steady state, where the entering and leaving moisture are equal, rarely exists, and frequently, the moisture in some portion of the path is liquid, in which case forces of capillarity and gravity are usually more important. It is therefore evident that the formula can be used only for certain portions of a building structure. Another caution is that the permeances of the several pieces must apply at the existing conditions.

The permeability of a material has been defined as one of its properties but it is not a fixed property for all conditions of exposure. Some materials like wood, because of their structure and hygroscopicity, are much more permeable to water vapor when the relative humidity is high. Since the equilibrium moisture content of permeable materials is increased to a greater or less degree by exposure to high relative humidity, it is likely that this sorbed moisture contributes to the mechanism of transfer.

The variations in the permeability of sugar pine wood are shown in Fig. 7.¹⁸ It is notable that high relative humidity on either side of a specimen increases its permeance and the average permeability of the piece.

The *spot permeability* is shown, but the average is more readily used in practical calculation. Temperature also affects permeability, but for most materials is considered a minor factor, although data are few. These variations are to be expected in most materials and therefore, due care is required in choosing for each the proper value at its exposure conditions. Exact calculation by any of the preceding formulas, therefore, requires a knowledge of such variations as shown in Fig. 7 for each material, but approximate calculations are readily made and are adequate for most requirements.

Permeance Data and Testing

The simplest method of finding the vapor permeance of a specimen is to seal it over the top of a cup containing desiccant or water, placing it in a

TABLE 21. CONVERSION FACTORS FOR VAPOR TRANSFER UNITS

MULTIPLY NUMBER OF		WVT UNITS	
BY	TO OBTAIN ↓	grains (24 hrs) (sq m)	grains (hr) (sq ft)
grains (24 hrs) (sq m)	by same method*	1	16.7
grains (hr) (sq ft)	by same method*	0.0597	1
Perms by same method*	method A & B, 73.4 F method C & D, 90 F method E, 100 F	0.144 0.0840 0.0344	2.41 1.41 0.575

NOMINAL TEST CONDITIONS		% RELATIVE HUMIDITY ON THE TWO SIDES OF SPECIMEN:	
Method	Temperature-F	In cup	Outside cup
A	73.4	0	50
B	73.4	100	50
C	90	0	50
D	90	100	50
E	100	0	90

* Data obtained by one method cannot be reliably converted to another method.

controlled atmosphere, and weighing it periodically. The steady rate of weight gain or loss is normally the water vapor transfer. When the cup contains a desiccant the procedure is called the *dry-cup method* and when the cup contains water, the *wet-cup method*. Usually the outside atmosphere is held at 50 percent relative humidity, thus providing in either method substantially the same difference of vapor pressure, but the results obtained by the two methods on the same specimen are likely to be much different, the wet method producing the higher values.

It is obvious that any statement of permeance of a specimen should include the conditions of test. The permeance of a piece of material in a given service is best known if tested under conditions duplicating the service. Its permeance may be adequately judged, however, if it is tested by both dry and wet methods thus providing relative humidity conditions that usually include those to be encountered in service.

Unfortunately, the conditions of testing have not been standardized, and test data have frequently been presented in terms of weight transmitted