ure curve, thereby confirming that the critical plane for condensation was correctly assumed.

With the vapor pressures thus established, the relative humidities may be found, by reference to the saturation vapor pressures. The permeances originally assigned to the various elements may then be re-examined in the light of the service conditions of temperatures and relative humidities indicated, and the analysis repeated, if necessary, using more appropriate permeance values.

In a more detailed analysis, individual values might be assigned to the elements forming the outer portion of the wall, which is here dealt with as a composite, homogeneous element.

The transmission of water vapor as outlined is based on the assumption of a diffusion process. The possibility of vapor being transferred as part of a moving air stream has thus far been ignored, except in *Example 1* in which it is implied that the air circulation on either side of the wall will be sufficient to eliminate surface film resistances to vapor flow. Differences in total pressure of the air may result in a transfer of vapor with air, augmenting and at times over-riding the effects of the flow produced by vapor pressure gradients alone. This can be particularly important in the transfer of vapor through cracks and pinholes or through air-permeable building constructions.

This means of vapor transfer is similar to that of transfer of heat by air leakage in and through building constructions, requiring for purposes of calculation information on the nature and amount of the air leakage. It will seldom be important in constructions without air spaces and having parged or plastered surfaces. It may, however, be an important means of vapor transfer through constructions lacking in air tightness, and may contribute to condensation difficulties, since the mechanism of condensation is not dependent upon the way in which the vapor is transferred.

PERMEANCE AND TESTING

The simplest method of finding the permeance of a specimen is to seal it over the top of a cup containing desiccant or water, placing it in a 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 specimens are likely to be much different, the wet cup method producing the higher values. The relationship between these values can best be understood by reference to Fig. 3, which shows a typical variation of spot permeability with relative humidity at one particular temperature (isothermal conditions) for a material such as wood. The vapor permeability is shown to vary only moderately at low humidities, but to increase at an increasing rate as higher humidities are reached. The dry-cup test of this material carried out with 0 percent relative humidity one side and 50 percent on the other, will experience throughout its thickness, because of the variation in relative humidity, a variation in spot permeability. The average permeability $\bar{\mu}$, is by definition (Equation 3), given by $\dfrac{\int_{p_1}^{p_2} \mu dp}{p_1 - p_2}$, and since at a fixed temperature there is a linear relationship between vapor pressure and relative humidity, this expression can be seen to correspond to the mean height of the area under the spot permeability curve, between the appropriate relative humidity limits. The average permeability as found for the dry-cup conditions should therefore have the value $\bar{\mu}_1$. Similarly for the wet-cup test between 50 percent and 100 percent relative humidity, the value should be $\bar{\mu}_2$. It is not uncommon for these values for wood and wood-fiber materials to be in the ratio of 1 to 3, or higher. (See Table 1.)

The average permeability $\bar{\mu}$ for any other relative humidities at a particular temperature is given by the mean height of the area under the curve of spot permeability for the material at that temperature, between

TABLE 1. PERMEANCE AND PERMEABILITY OF MATERIALS TO WATER VAPOR

MATERIAL	PERMEANCE PERM	PERMEABILITY PERM-INCH	% RH_1-RH_2	METHOD†	REF.‡
AIR (still)		120.	92-73	b	3
INSULATION					
Cellular glass		0.0		d	
Corkboard		2.1-2.6	75-0	d	4
Corkboard		9.5	100-45	w	9
Structural Insulating Board (vegetable, uncoated)		20-50	40-x	t	7
Mineral Wool (unprotected)		116.	100-30	w	6
WOOD					
Sugar Pine		0.4-5.4	various	tv	3
Plywood (Exterior type 3 ply D.F.), ¼ in.	0.72		50-	4	11
Plywood (Interior type 3 ply D.F.), ¼ in.	1.86		50-	4	11
MASONRY					
Concrete (1:2:4 Mix)		3.2	100-45	w	9
Concrete (8" cored block wall, limestone agrgt.)	2.4		79-68	t	3
Brick wall—with mortar—4 in.	0.8		50-x	t	8
Tile wall—with mortar—4 in.	0.12		50-x	t	8
INTERIOR FINISH					
Plaster on wood lath	11.		100-30	w	6
Plaster on metal lath—¾"	15.		40-x	t	7
Plaster on plain gypsum lath (with studs)	20.		40-85	t	3
Gypsum wall board—plain—⅜ in.	50.		50-20	v	13
Insulating wall board (uncoated)—½ in.	50-90		40-x	t	7
* PAINT—2 coats					
Asphaltic paint on plywood	0.4		100-30	w	6
Aluminum in varnish on wood	0.3-0.5		95-0	d	10
Enamels, brushed on smooth plaster	0.5-1.5		92-0	b	3
Primers or *Sealers* on insulating wall board	0.9-2.1		40-x	t	7
Various *Primers* + 1 coat flat paint on plaster	1.6-3.		40-x	t	7
Flat paint (alone) on insulating wall board	4.		40-x	t	7
Water Emulsions on insulating wall board	30.-85.		40-x	t	7
* PAINT—Exterior, 3 coats					
White *lead & oil* prepared paint on wood siding	0.3-1.0		50-0	d	13
White lead-zinc oxide & linseed oil on wood	0.9		95-0	d	10

	Lb. per 500 sq ft	PERMEANCE-PERMS dry cup	PERMEANCE-PERMS wet cup	
* BUILDING PAPERS AND FELTS				
Duplex sheet, asphalt laminae, *aluminum foil* one side	43	0.002	0.176	12
Saturated and *coated* felt heavy roll roofing	328	0.05	0.24	12
Kraft and *asphalt laminae*, Reinforced 30-120-30	34	0.3	1.8	12
Insulation back up, asphalt-sat., one side glossy	31	0.4	0.6-4.2	12
Asphalt-saturated and coated sheathing paper	43	0.3	0.6	12
Asphalt-saturated sheathing paper	22	3.3	20.2	12
15-pound asphalt felt	70	1.0	5.6	12
15-pound tar felt	70	4.0	18.2	12
Single sheet Kraft, double infused	16	30.8	41.9	12

* Description is a guide only, and does not insure permeance.

† Methods: d—dry cup; w—wet cup; t—two temperatures; b—special cell; v—air velocity both sides; 4—average of four methods.

‡ References. No. 7 also includes *Bulletins* 22 and 25 of the *Engineering Experiment Station, University of Minnesota*. No. 13 includes data to be published by the *Engineering Experiment Station, The Pennsylvania State College*.