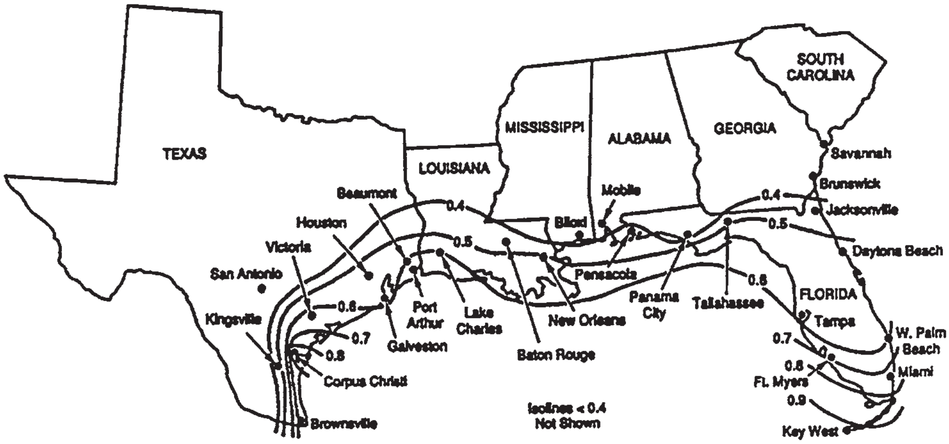


Figure 9-54 Vapor drive map for hot, humid climates. (*From Tobiasson,* Vapor Retarders to Control Summer Condensation, *1989.*)

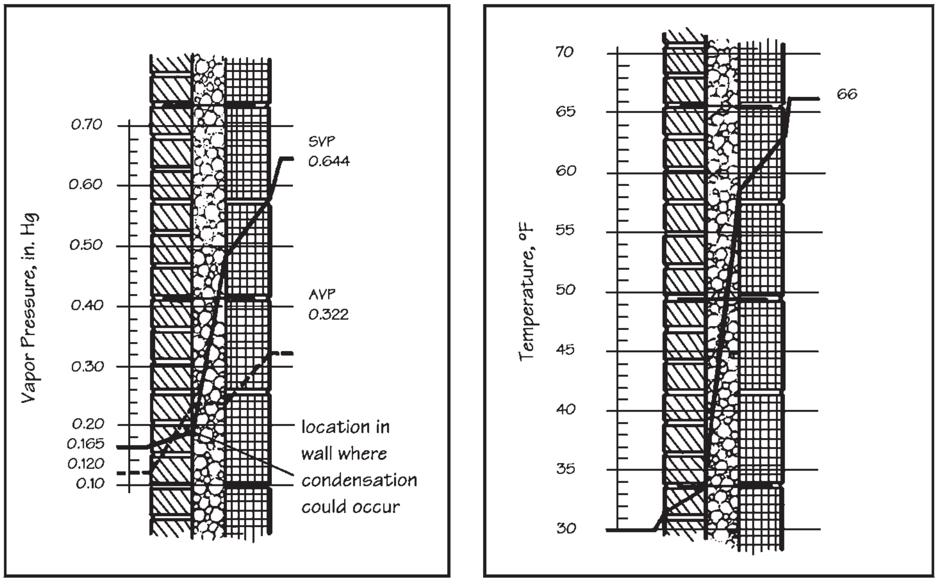
are determined for the indoor and outdoor temperatures, and the actual vapor pressures calculated as a percentage based on relative humidity conditions [i.e., saturated vapor pressure (SVP) × relative humidity (RH) = actual vapor pressure (AVP)]. The difference between the indoor and outdoor AVP is called the *vapor pressure differential.* Vapor moves from the warm, higher-pressure atmosphere to the cool, lower-pressure atmosphere. During winter, this is normally an outward movement; during summer, an inward movement.

Using the thermal resistance of each material in the wall, a temperature gradient through the section is established, and the SVP at each temperature layer is listed. Using the vapor resistance of each material, the AVP at each layer can then be determined. At any location in the wall where actual vapor pressure exceeds saturated vapor pressure, condensation will occur.

Figure 9-55 show a sample calculation and graphic analysis for one set of conditions. In this particular case, condensation will occur at the cavity face of the exterior brick wythe, where it can do little damage. A vapor retarder on the cavity face of the interior wythe or on the interior wall surface will all but eliminate vapor diffusion to the cavity, and therefore reduce the risk of condensation. Every wall must be analyzed individually, because changes in materials or in temperature/humidity conditions change the location of the dew point. If condensation is expected to occur in masonry cavity or veneer walls, it should be designed to occur at the drainage cavity rather than in the masonry itself, where saturation might lead to freeze-thaw damage or efflorescence.

It is obvious that the introduction of vapor retarders within a wall assembly must be studied carefully to avoid trapping moisture in an undesirable location. Regional climatic conditions and the resulting direction of vapor flow must be analyzed and condensation points determined for both summer and winter conditions. If the flow of vapor is impeded by a highly vapor-resistant material on the warm side of the wall, the vapor cannot reach that point in the wall at which the temperature is low enough to cause condensation. Each design condition must be analyzed individually to determine the need and location for a vapor retarder within the wall assembly.

The infiltration and exfiltration of air through cracks and openings in a wall moves substantially higher quantities of moisture vapor (*see Fig. 9-56*). In high-rise buildings, air leakage rates are increased by the stack effect—



Material	Thermal Analysis				Vapor Analysis				
	R	%	ΔT	°F	SVP	Rep	%	ΔV	AVP
Inside air temperature				66	0.644				0.322
Inside air film	0.68	9	3	63	0.580				0.322
4-in. unglazed facing tile	1.11	14	5	58	0.486	0.678	40.5	0.082	0.240
2-1/2 in. vermiculite insul.	5.50	70	25	33	0.188	0.016	1.0	0.002	0.238
4-in. brick	0.44	5	2	31	0.172	0.977	5.5	0.118	0.120
Outside air film	0.17	2	1	30	0.165				0.120
Outside air temperature				30					0.120
Total	7.90	100	36			1.671		0.202	

R = R-value
ΔT = temperature difference (°F)
SVP = saturated vapor pressure (in.Hg)
Rep = vapor resistance (1/perm)
ΔV = vapor pressure difference (in.Hg)
AVP = actual vapor pressure (in.Hg)

Figure 9-55 Sample condensation analysis. (*From BIA* Technical Note 7D.)

the inward movement of cool air at lower stories and outward movement of warm air at upper stories due to vapor pressure differentials. Seasonal patterns of efflorescence or dampness near the tops of buildings can be evidence of significant air leakage. Cracks between the backing wall and columns, slabs, or cross walls can provide paths for moisture-laden air to move back and forth between the wall cavity and the building interior. Perimeter sealant joints can provide air barriers at such locations. Building wrap materials are vapor-permeable air barriers which stop the airborne transmission of vapor but do not prevent the wall from "breathing" or drying out.

9.4.7 Coatings

In walls of solid masonry or single-wythe construction, greater care must be taken to avoid trapping moisture. Protective coatings are often used to prevent