Permeance vs. Permeability

Water Vapour Permeance: Is the time it takes water vapour to transmit through a unit area of material that has a vapour pressure difference between the two exposed surfaces of the material. It is normally expressed as Perm. It is used as a performance evaluation of a material. Permeance indicates the water vapour transmission rate over the course of one hour through one square foot of a material of a given thickness at a specified vapour pressure.

If a material has a perm rating of 1.0, we know that in 1 hour, when the vapor pressure difference between the cold side and the warm side of the material is equal to 1-inch of mercury (1-inch Hg), 1 grain of water vapor will pass through 1-square-foot of the material. One grain of water vapour is equal to 1/7,000 of a pound. As a static system, the Perm rating decreases with increasing thickness. A 1" thick piece of material with a Perm rating of 1 will reduce to 0.5 Perm when the thickness of the material is increased to 2". The process however is not a static; it's dynamic. The whole insulation slab remains semi-permeable.

Closed-pore Expanded Polystyrene (EPS) is moderately hygroscopic which means it will take on water vapour from its ambient environment and pass it on. So, a slab of insulation subject to a vapor pressure gradient will exhibit the same permeability regardless of thickness. Making EPS insulation thicker does not change the rate of flow - it simply increases the distance water vapor can travel into the EPS insulation slab.

When an environment of warmer, drier air surrounds EPS with higher vapour content, the vapor pressure surrounding the EPS is lower than the vapor pressure within the EPS. As a result, vapour within the EPS begins to migrate toward the area of low vapor pressure, eventually reaching moisture equilibrium with the surrounding drier environment.

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A prevailing misconception exists in understanding how water vapor moves through closed-pore foam insulation. It originates from the assumption that if foam insulation absorbs very little liquid water and is only semi-permeable to vapor, it must therefore function as a vapor barrier. Below I address this fallacy with a simple analogy, the bucket brigade.

Closed pore foam insulation is moderately hygroscopic which means it ADSORBS water vapor from its ambient environment. Diffusion through the closed pore matrix occurs when adsorbed water molecules nearest the moisture gradient source are safely " handed off' to its adjacent downstream surface. This process continues down a vapor pressure gradient, thereby establishing the bucket brigade. Instead of transporting liquid water, the 'buckets' (i.e. hygroscopic surfaces) contain water vapor. The combination of adjacency and hygroscopicity is important. It's this spatial continuity of recipient hygroscopic surfaces with upstream hygroscopic donors that makes this diffusion work – just as a bucket brigade is more efficient when its members are within arm's length.