What is a Perm?

By Laverne Dalgleish

A perm is simply a unit of measure for the amount of water vapor that will pass through a given area of a material over a period of time when there is a static vapor pressure difference between the two atmospheres on each side of the material. So, put differently, when the vapor pressure (the combination of relatively humidity and temperature) is different on one side of a material than on the other, the water molecules in the air (water vapor) want to work their way through the material. The direction of movement is always from high water vapor pressure to low water vapor pressure.

A practical example would be when the interior temperature and humidity (between 68 and 72 deg. F in the winter and 30 to 60 percent relative humidity per ASHRAE guidelines) is maintained in the building and it is cold and dry outside. In cold climates, the interior conditions are warm and moist and the outside is cold and dry. The water molecules that are in the air inside the building want to work their way through the building materials to the outside. Similar vapor pressure differences can also be experienced in summer conditions when the temperature and humidity (between 72 deg. and 80 deg. F and 30 to 60 percent relative humidity per ASHRAE guidelines) vary from the hot and humid environment at the exterior. In this instance, the water molecules on the outside want to work their way through the building materials to get inside.

But let’s go back to what is a perm. Sure, it’s a unit of measurement, but how much water are we really talking about?

Well, a US perm is one grain of water vapor per hour per square foot per inch of mercury. In metric it is 57.2135 nanograms per second per meter squared per Pascal (57.213 $ng \cdot s \cdot m^2 \cdot Pa$).

A nanogram is one billionth of a gram. To put this into perspective, a US penny weighs about 2.5 grams. So, take a penny and cut it into 2,500,000,000 pieces. Yes, that is right - two billion five hundred million pieces. Now, take 57 of those pieces (or go wild and take 58 pieces) and now you have the weight equal to the weight of water that is considered one Perm. So, the point here is that one Perm is a very small amount of water – well, it’s an *extremely* small amount of water.

It is also important to understand how materials are tested to determine their water vapor transmission rate. The most common standard is *ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.*

In this test method, there is the “dry cup” and the “wet cup”. In both methods, a circular glass dish, normally is about eight inches in diameter, is used. For the dry cup method, desiccant is used in the dish. For the wet cup method, water is used in the dish. Then material is put over the mouth of the dish and sealed with a paraffin wax and bees wax combination to prevent any water vapor from escaping out of the dish other than through the material. This creates an atmosphere of either 0% relative humidity or 100% relative humidity on the side of the material that is inside the dish. Next, to produce a water vapor pressure across the material, you put it in an oven that will maintain a constant 50% relative humidity at a temperature of 73.4 *F (23 *C).

If you are testing for the dry cup method, the desiccant will absorb the water that transfers through the material and will increase in weight. For the water method, the weight of the water will decrease as the water moves through the material and escapes out of the dish. From this, you can calculate how much water is transferred in or out of the dish over time.

To give you a sense of scale about how much water is transferred through a material over time, I asked Oak Ridge National Laboratory to calculate the water that would transferred through a material which would have a permeance of 0.1 Perms, 1.0 Perms and 10 Perms.

A perm is equal to 57.2 nanograms meter^{-2} second^{-1} Pascal^{-1}.

Since there are 31,536,000 seconds in a year,

2985Pa of vapor pressure at saturation,

1,000,000,000 Ng per gram

The vapor pressure for both the wet cup (100%-50%Rh) and dry cup (50%-0%RH) is 50% of the saturation vapor pressure or 1492Pa,

The weight of water vapor going through one square meter of a 0.1 perm (inch-pound) in a year would be 0.1*1492*31,536,000/1,000,000,000 or 4.71 grams (0.166 ounces).

The weight of water vapor going through one square meter of a 1.0 perm (inch-pound) in a year would be 1.0*1492*31,536,000/1,000,000,000 or 47.1 grams (1.66 ounces).

The weight of water vapor going through one square meter of a 10 perm (inch-pound) in a year would be 10*1492*31,536,000/1,000,000,000 or 471 grams (16.60 ounces).

Going back to the test method, that means for a material that is 0.1 Perm, it will take a whole year to get 0.166 ounces of water to pass through one square meter of material (slightly less than 11 square feet).

Keep in mind that no building ever would have a steady state condition with the moisture flow only in a single direction for a whole year – that is a water vapor flow from high vapor pressure on one side of the assembly to low water vapor pressure on the opposite side of the assembly. The rate of water vapor transmission will change from hour to hour, day to day and season to season. The direction of the water transmission can change and one day you may be “wetting” the building assembly and the next hour, the next day or the next month, the change can reverse and go to “drying” the building assembly.

Additionally, one side of the building assembly can be “wetting” and at the same time the building assembly could be “drying” on the opposite side.

So, when you look at the water vapor transmission of a 10 Perm material and it says that over a year you could have two cups of water enter into a stud cavity, those numbers have no relation to real life. The differences of 1492 Pa of pressure difference in the same direction will never be there for 365 days and that does not take into account any drying that is happening at the same time. The actual volume of water will only be a fraction of the two cups, and in some assemblies in specific locations, you could be looking at a net of zero. However, this does not mean that vapor retarders should be completely ignored in some building assemblies.

The point of this article is simply to point out that the amount of water that enters a building assembly due to water vapour permeance is exceedingly small. Information is available to show that air leakage can result in much larger rates of moisture transfer; therefore, as you reduce air leakage the potential for moisture problems are reduced and if you have no air leakage, the moisture problems are almost eliminated.

Buildings are becoming more complicated to design and construct and the old “rules of thumb” cannot give us the information we need to understand the performance of materials after they are installed. Work is being done to produce better modeling, to better characterize materials and research is being done to better understand how various materials perform under real life conditions. We need all of this to produce the buildings we need for the future.