<u>Functional principle of SIGA MAJREX® 200</u>

Vapor drive in heating dominated climates

The terms absolute humidity and relative humidity (RH) should be defined when referring to moisture content in the air.

Absolute moisture content provides the value of the amount of moisture per volume of air in g / m³, whereas the relative moisture content provides a percentage range of contained moisture divided by the maximum amount of moisture the air is able to hold in form of vapor (0% – 100%).

Fig 1: Absolute humidity (left) versus relative humidity RH (right)

The relative moisture content, as its name already implies, is relative to another value. Air has a variable ability to contain moisture in vapor form depending on its temperature. Therefore the relative humidity value is always affixed to a temperature, e.g. 60% RH @ 20 °C.

An RH of 0% means no moisture is contained at all and 100% means that at this point the water molecules will transform from a gas form to a liquid form or simply condensate. This is also referred to as the dew point. Generally the rule is that the colder the air gets the lesser amount of water molecules it can absorb. Whereas at 30°C we reach the dew point with ~30 g / m³, at 5 °C we already reach it with ~6 g / m³.

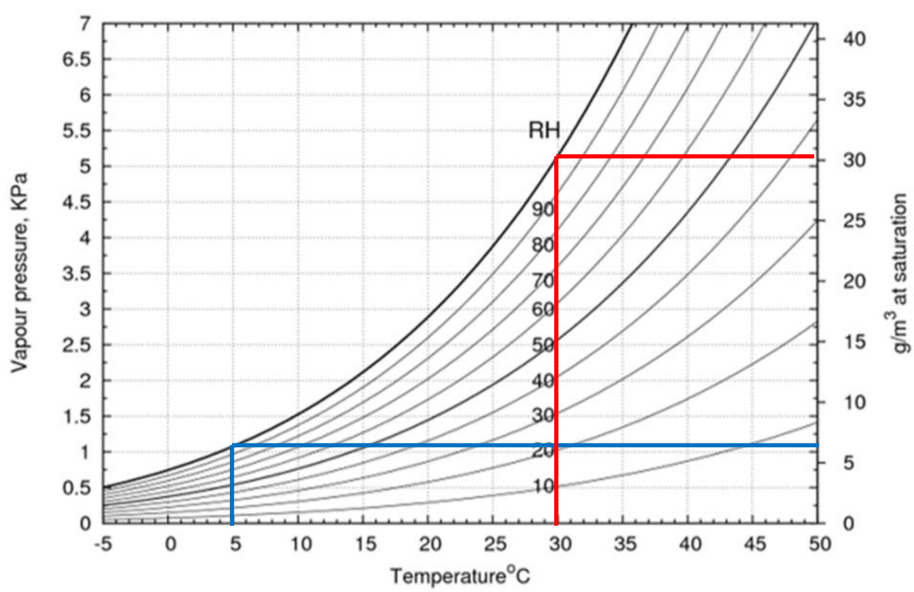

Fig 2: Vapor pressure diagram for air, showing dew points at 5°C (blue) and 30°C (red)

Moisture imbalance is the motor of vapor drive mechanisms

Because air can contain different amounts of water molecules at different temperatures, an imbalance of absolute moisture content is created when different temperatures on interior vs exterior are experienced. Experts also refer to this as the vapor pressure difference.

As a result water molecules strive to create an equilibrium between both sides, moving from a high concentration to a low concentration. This happens either through convective movement (transported by air through leaks and cracks) or diffusion as vapor moves through a material. Most building codes in heating dominated climates therefore require a vapor barrier or vapor retarding layer on the room facing side of the building to avoid excess intake of moisture and the creation of condensation inside the wall.

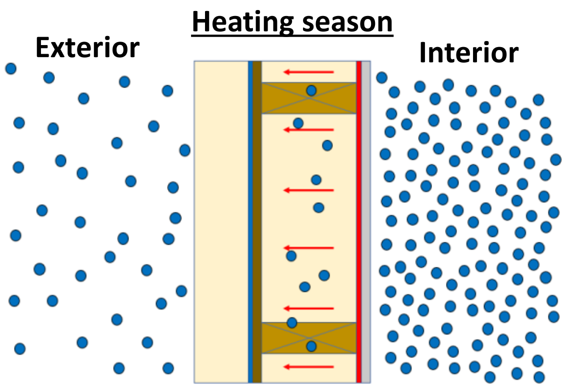

Fig 3: Direction of vapor drive during the heating season

This concept works great throughout most of the year. Depending on geographical location there are around 8 months a year where this directional vapor pressure difference can be experienced. However, in the hot months of summer this vapor pressure difference is reversed. The increased use of AC units conditions the interior to even lower average temperatures. Vapor trying to move in reverse direction is now blocked by traditional vapor barrier materials, which then condensates on the colder surfaces inside the wall as a result of the air reaching critical RH levels.

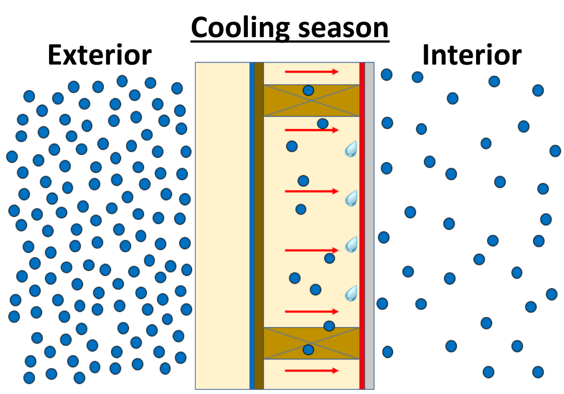

Fig 4: Direction of vapor drive during the cooling season

For regular “built-to-code” homes from our less energy-conscious eras, this moisture generally was able to dry out in the following heating season so it wouldn’t become a structural issue. However, it is a regular occurrence to find mold and mildew behind traditional vapor barrier materials like poly sheets when renovating or deconstructing buildings – something that many health-conscious customers don’t like to see. With walls becoming more energy-efficient, drying logically becomes slower, posing even greater risks from the use of traditional methods.

The industry has put some thought into this problem and developed sheet membranes that show a variable permeance dependent on local relative humidity contents. Those materials were designed to act as a vapor barrier at regular moisture loads (40-60% RH) and become more permeable at high moisture contents (70-100% RH). This benefits the wall's drying ability to the inside whenever critical moisture levels are reached behind the membrane in summer. The term "smart vapor control layer" was born, although this physical principle is nothing new. For example, wood-based panels show a high dependency between moisture levels and permeability as well.

Marketing material that is circulating around inaccurately implies that with use of these membranes no moisture can get through from interior to wall cavity, whereas the membrane opens up the other direction from wall cavity to interior. A more accurate description would be to show that at regular moisture loads only a little moisture diffuses through the membrane, whereas with high moisture loads, larger amounts of moisture are able to pass through – in both directions.

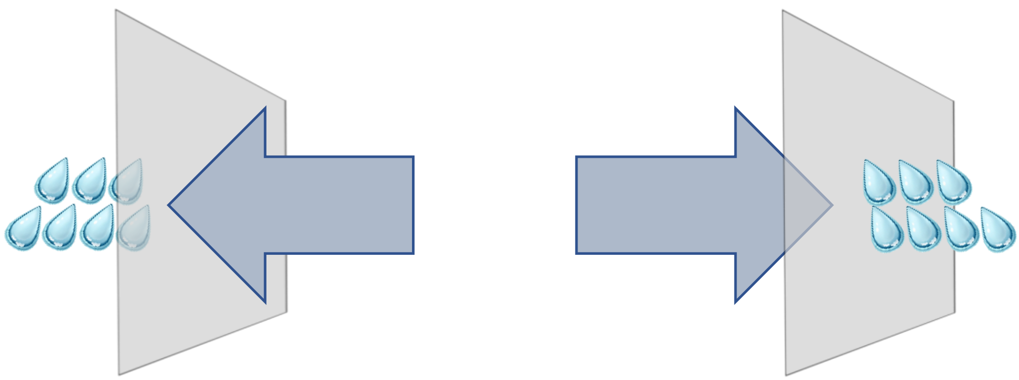

Fig 5: Accurate functional principle of smart vapor control layers at high moisture levels

For regular occupancy, the RH levels should not exceed 60% in average, at which point most smart membranes still function as a vapor barrier, letting only little moisture pass through. In high humidity applications such as pool rooms, saunas etc. where RH levels above 70% in average are expected for extended periods of time, the products do the opposite of what they're designed for - letting moisture into the wall. Therefore, most manufacturers clearly restrict the usage to regular moisture loads only.

Even if these regular moisture loads are kept throughout the occupancy of the building, moisture levels during construction can be significantly higher than 60% RH. Tiling, laying of gypcrete, drywall mudding and general construction moisture are creating a high humidity environment that can diffuse freely through smart membranes. Computer simulations and actual field experience show that it can take years until this accumulated moisture can fully dry, especially in encapsulated building components such as unvented flat roofs.

Fig 6: Moisture brought in during construction poses risks to smart membranes

Due to this problem the development team at SIGA created a new generation of vapor control layers. Majrex 200 shows the regular smart characteristics, as in increased permeance with higher moisture content. In addition, the permeance is different depending on which side the membrane is facing.

In short that means that if the wall cavity shows increased moisture levels its permeance is sufficient to allow this moisture to dry toward the interior. On the other hand, if increased moisture levels are experienced on the inside of the building, like moisture during construction, the membrane shows a lower permeance, adding to the overall safety and increasing the drying potential of the build-up. This is possible through a special surface treatment of the membrane, which makes an install facing the correct direction essential.

This patented, directional moisture dependency is unique on the market and has been confirmed by independent 3rd party laboratories.[1] This functional principle offers unmatched safety for envelopes, especially for applications like unvented flat roofs.

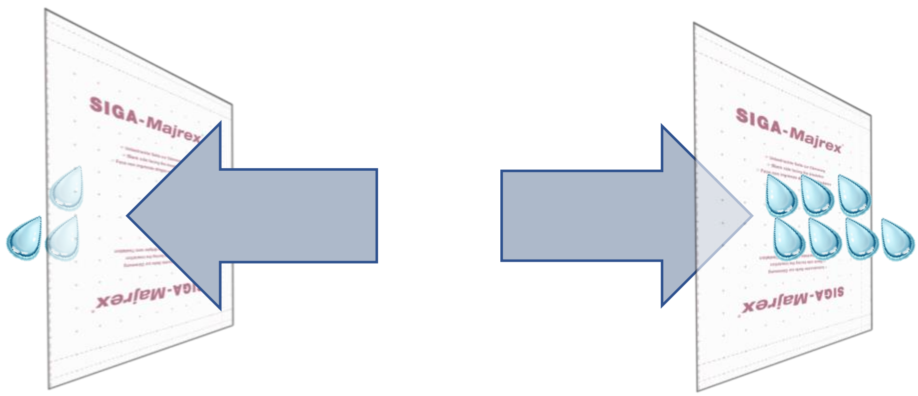

Fig 7: Functional principle of directional smart vapor control layer SIGA MAJREX 200

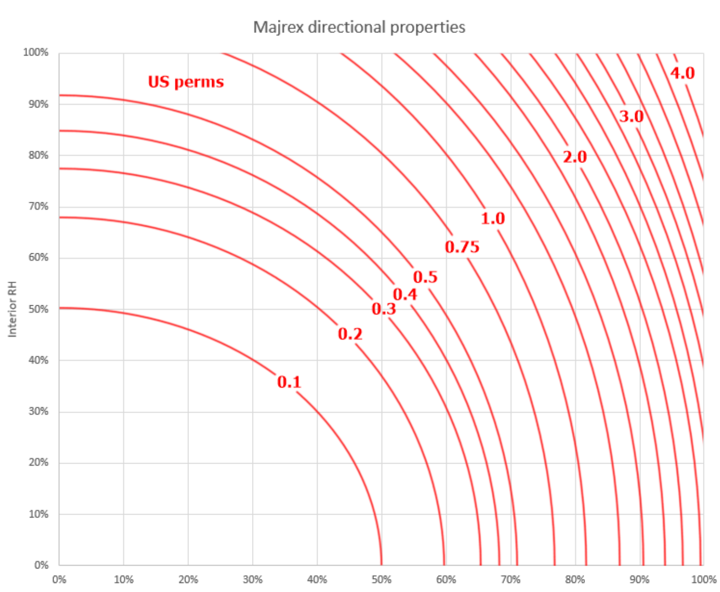

Fig 8: Directional properties of SIGA MAJREX 200

[1] https://media.siga.swiss/CIP/asset/download/medien/19598