Liquid Air Barriers

Air barriers are a critical component to the building envelope design.1,2 Selection of the specific type of air barrier relies on a variety of factors, such as type of environmental climate, specific wall assembly design, or building type. In almost all climates, the conservation of heating or cooling through the installation of an air barrier can result in a more comfortable building and substantial energy savings over the lifetime of ownership.

Moisture vapor will diffuse in and out of the building wall assembly over time naturally moving from higher to lower concentrations, also referred to as vapor drive. Temperature and humidity differences inside and outside the building will affect the rigor of the vapor drive. Vapor permeable air barriers impart control over the water vapor transmission rate minimizing the opportunity for moisture to be trapped within the wall assembly. Alternatively, vapor impermeable air barriers seek to eliminate the movement of moisture and air through the wall assembly by inhibiting vapor transmission through the membrane. Among many benefits, vapor permeable and impermeable liquid-applied air barriers specifically regulate the transmission of air and vapor through the wall assembly generating energy efficient, comfortable, and durable buildings.

Benefits of Liquid-Applied Air Barrier

1. Speed of application by spraying
2. Ease of detail work around window openings and corners
3. Creates a monolithic elastomeric film
4. Excellent nail or fastener sealability

It’s All About the Chemistry

Formulation of a liquid-applied air barrier requires a balance between the desired application, specifications, and performance requirements. Striking a balance between ease of application and air barrier performance will look different for air barriers of different chemistries. Even air barriers with analogous chemistries can have structural differences within the polymer backbone at the molecular level that can give rise to dramatically different physical properties. Meeting all the desired outcomes relies on careful selection of chemistries that make up the liquid coating. A central component to all coating formulations is the type of polymer chemistry, sometimes referred to as binder or resin. The polymer chemistry can effects nearly all physical properties.

Acrylic latex, silicone, and more recently silane-terminated polymers (STP) are amongst some of the most common chemistries used as liquid applied air barriers in today’s market. These different chemistries allow the development of liquid air barrier products that meet required specifications, such as permeance, ability to create a seal around a fastener, or the mechanical properties of the membrane. Additionally, one chemistry may be more favorable than another to meet high performance demands, such as cure time, thermal stability or UV resistance. During GCP’s development of a new air barrier formulation using a specific chemistry, the formulation will undergo numerous rounds of testing in order to define the upper and lower limits of the air barrier membrane. During these rigorous testing cycles the film thickness specification will be defined.

Does Film Thickness Really Matter?

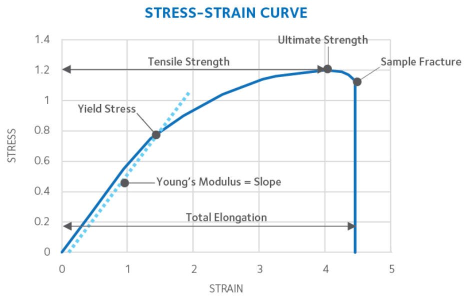
Yes, but not for the reasons one may think. A common misconception is that greater film thicknesses equates to higher performance, which is not necessarily accurate. Liquid air barriers are typically applied by spray, roller, or trowel above a certain thickness required to form a monolithic membrane. Unlike sheet-applied air barriers that are supplied at a fixed film thickness, the liquid air barriers must be applied at a specified wet film thickness usually measured in mils (1000th of an inch). The chemical composition of the liquid air barrier formula dictates the end performance properties of the dried monolithic film. During the development of the formulation, GCP balances many factors, such as ease of application, solids content of liquid coating, cost, and performance of the end-use membrane, which is used to define the film thickness specification. Different chemical compositions may require different film thickness specifications. For example, latex based air barriers have solid contents around 60% and may be applied at a thicker wet film thicknesses and dry to a thinner dry film thickness. Whereas a high solids silane-terminated polyether (STPE) air barrier will likely have very similar wet and dry film thicknesses due to minimal loss of volatiles during cure time. Despite having different dry film thickness specifications, both GCP latex and STPE based air barrier technologies meet high performance requirements.

Mechanical Properties & Nail Sealability

Mechanical properties are exhibited when a material is put under force. A stress-strain curve can be generated by applying a force to a material and observing the deformation of the material (Figure 1). The stress-strain curve teaches a tremendous amount of valuable information, such as tensile strength, elongation, yield stress, and Young's modulus. In particular, the linear elastic region can be used to identify the Young's modulus also referred to as the modulus of elasticity, which is the slope of the linear portion of the curve (highlighted by the dotted line in Figure 1). The higher the modulus the more rigid the material. Likewise the lower the modulus the softer or more elastic the material.

FIGURE 1.

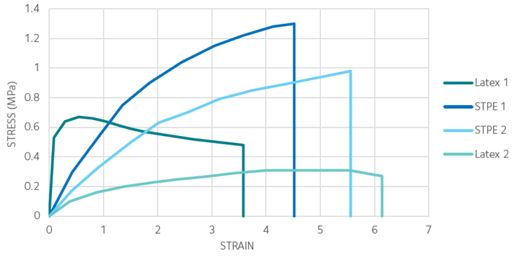
Stress-strain curve of air barrier membrane highlighting the mechanical properties.



Analysis of the stress-strain curve for four different air barriers each formulated with different polymer chemistries shows differences in the Young's modulus, Figure 2. Latex 1 has the highest modulus. Conversely, latex 2 has a significantly lower modulus producing a much softer membrane. While both air barriers are classified as latexbased chemistries, the structural differences in the polymeric structure give rise to dramatically different mechanical properties.

FIGURE 2.

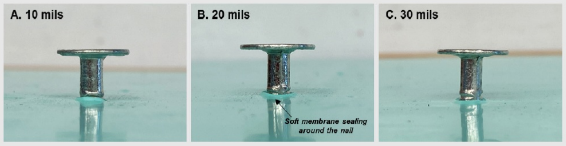
Stress-strain curves for different air barrier membranes.



The practical application of the stress-strain curve is illustrated by driving a nail through an soft elastomeric air barrier at different film thicknesses, seen in Figure 3. The ability of the air barrier membrane to form a seal around a nail or fastener is driving by the mechanical properties, arising from the specific chemical composition of the membrane. The lower the Young's modulus the more elastomeric the membrane. Subsequently, soft elastomeric membranes form excellent seals around nails or fasteners when driven into the surface of the membrane even at thinner film thicknesses (Figure 3). At 10 mils, the soft elastomeric STPE membrane shows material starting to hug and seal the nail. This seal inhibits the transport of bulk water through the nail or fastener penetration preventing water migration into the wall assembly.

FIGURE 3.

Nails in GCP STPE air barrier membranes at different film thicknesses.
Note: ASTM D1970.



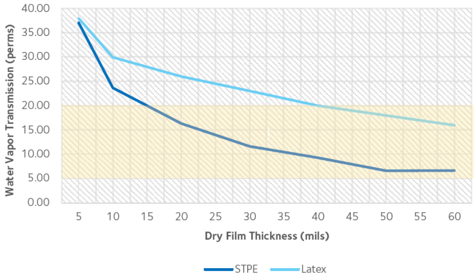
Water Vapor Transmission

Arguably the most significant performance feature of an air barrier membrane is the ability to control the movement of air and vapor through a wall assembly. While the industry accepted definition of a vapor permeable air barrier is greater than 10 perms, studies have shown that highly permeable membranes may create a risk for water condensation within the wall assembly cavity.3 Vapor permeable membranes between 10-20 perms impart the most efficient control over the movement of air and vapor.4 For vapor permeable liquid air barriers there is a relationship between the water vapor transmission across the membrane and film thickness, reiterating the importance of monitoring the film thickness during application.

FIGURE 4.

Decrease in water vapor transmission (perms) as film thickness (mils) was increased.

Note: ASTM E96, Method B.



To demonstrate the relationship between film thickness and water vapor transmission, two different vapor permeable air barrier samples were prepared at different film thicknesses then tested following ASTM E96 (wet cup, B). Illustrated in the chart above (Figure 4), as film thickness increased there was a steady decrease in water vapor transmission measured in perms for both products. While the slope of the line for each product may differ due to the different chemical compositions, the correlation between film thickness and permeance remains the same. The data indicate the critical relationship between film thickness and water vapor transmission highlighting the need for accuracy during application of a liquid-applied vapor permeable air barriers. For optimal vapor and air control, consult the manufacturers recommended film thickness. Applicators are encouraged to regularly monitor film thickness during application of liquid-applied air barriers.

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