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A PERFORMANCE OVERVIEW OF THE CHEMICAL POLYMERS IN AIR BARRIER TECHNOLOGIES

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This article is developed for the design professional or construction professional to assist in choosing and specifying an air barrier material.

Various synthetic polymers are used in today's air barrier product formulations. As of today, the industry has done a lackluster job of explaining these polymers, differences, strengths, and weaknesses to the design professional, consulting, construction and specifying communities.

The various polymers incorporated lead to different physical properties and application rates, such as:

A. Wet Film Thicknesses (WFT) application of 22 to 90 mils
B. Dry Film Thicknesses (DFT) final of 21 to 60 mils
C. Tensile Strength (psi)
D. Elongation (%)
E. Crack Bridging Ability
F. Water Resistance/Water Absorption (%)
G. Curing/Set Time/Skin Over Time (min/hrs.)
H. Environmental/Climatic Conditions, i.e., temperature restrictions, sensitivity to unanticipated rain impact shortly after application.
I. Labor: it takes more labor to apply a 60 mil WFT than a 22 mil WFT. Thinner applications occur due to the use of more advanced and highly engineered polymers.
J. Percent solids in the air barrier formula, the solids or active ingredients can range from 55% to 98%. Many acrylic and asphalt emulsions are around 55%, and the water must evaporate before the set occurs. Whereas a modified silyl terminated polyether (MSTPE) is generally 98% solids and cures in the presence of moisture or rain.
K. Chemical compatibility with the other components in the wall, i.e., window and thru-wall flashing, window sealants, and some foam plastic insulations, is critical for long-term performance.

Over the last seven years, I have given over 140 AIA Health, Safety and Welfare Learning Units and several building envelope conference presentations on this subject alone.

The USA air barrier industry is roughly 23 years old as of this article. There have been many great improvements in the product formulas. The most significant advance in air barrier performance has been the development of more highly engineered polymers. This article explains to the design and construction communities that choosing a specific polymer-based air barrier has positive effects beyond just the Air Barrier Association of America (ABAA) Evaluated Materials/Assemblies criteria.

CHEMICAL COMPATIBILITY

Today's walls are a chemical soup of materials that may not play well with each other. Lack of compatibility is the silent killer of long-term air barrier performance. It is insidious and only becomes apparent after it occurs, which is too late to remedy. The new era of energy savings and the drive to more energy-efficient, sustainable buildings via building code requirements can contribute to this problem.

If you specify a single source manufacturer, the problem does not occur. If there are different labor jurisdictions on-site, it could happen. Who installs the window flashing, thru-wall flashing, and roof-to-wall transition membranes? If there are various trades, they may purchase materials from different distributors, distributors where they have credit but perhaps not the exact same product that has been specified.

What can you do to protect your work? The chart below indicates the vast compatibility range that an MSTPE-based product gives you.
In place of that, you should always require letters of chemical compatibility from all manufacturers whose products touch each other.

The air barrier and thru-wall flashing chart to the right *(Table 1)* will indicate the extent of this concern and provide you with a better way to view and write specifications.

ADHESION FOR LONG-TERM PERFORMANCE

Architects design buildings for aesthetics, function, and durability. Some of the issues addressed in this article will be unsightly, like wrinkling, and could lead one to the conclusion that there is a problem. Adhesive performance is one of those issues that doesn't look good. These less-than-optimum appearances lead design and construction professionals to conclude that this is not an appearance they want as it is suspect for long-term performance. Please know that the supplier of the construction products will tell you that this appearance is acceptable to them and won't cause a problem, but you still have your concerns.

So, what does product compatibility mean? Most people think of compatibility as where one product will degrade the physical properties of the connecting product and affect its long-term performance, which is chemical compatibility. Chemical compatibility is a critical issue, but it is not the only type of compatibility that needs to be addressed. The simplest way to ensure compatibility is to specify using single source materials or a self-adhered stainless steel transition membrane and thru-wall flashing material. Better yet, utilize an air barrier system with a polymer base with the broadest spectrum of compatibility and the highest substrate adhesion. Based on extensive testing and literature review, the MSTPE-based products fit this consideration

To ensure adhesive compatibility and superior adhesion, you should request that the manufacturer performs the

Flashing	Acrylic Liquid Air Barrier	Asphalt Liquid Air Barrier	MSTPE Polyether Liquid Air Barrier	Silicone Liquid Air Barrier	Peel & Stick Asphalt Membrane
Copper Asphalt					
Copper Drainage					
Copper Fabric (Asphalt)					
Copper Fabric (Non-Asphaltic)					
Copper Sheet Metal					
EPDM					
EPDM Self-Adhered (Asphalt)					
PVC					
PVC Thermoplastic Vinyl					
PVC Thermoplastic Asphalt SA					
Rubberized Asphalt (Peel & Stick)					
Stainless Steel Drainage					
Stainless Steel Fabric					
Stainless Steel Self-Adhered					
Stainless Steel Sheet Metal					
Not Compatible	Chart developed by York Flashings and Roy Schauffele				
Caution					
Compatible					

Table 1. Compatibility of various thru-wall flashing and air barriers

ASTM D903 (Peel Adhesion) test between the air barrier and substrate. This test is a quick and easy way to verify that the chosen air barrier system will have the holding power to keep your building air and watertight. What should the peel adhesion value be? The ABAA (Air Barrier Association of America) requires a 16-psi minimum adhesion resistance for air barrier adhesion in lab testing. While this is a rigorous requirement, testing to ASTM E2357 (99 MPH max wind) and higher testing by ASTM E330 (up to a 175-mph wind condition) should be conducted. These test results will allow the design or construction professional a greater degree of comfort. Many of today's polymer systems used in air barriers meet this 16-psi requirement; others, for instance, MSTPE, have formulations that can withstand Category 5 hurricane-force winds.

In the graphs to the rignt *(Figure 1)*, the MSTPE-polymer-based air barrier products have the best adhesion to the most commonly used exterior gypsum sheathing material and test out to have better adhesion to other substrates.

Climatic, Environmental, and Weather Conditions

Many acrylic and asphaltic-based emulsion products can require extreme caution during low-temperature applications. These water-based products can only be applied above 40°F and rising for both air and substrate temperatures. The 95+% polymer-based, like the MS-based products (MSTPE), can be applied at much lower temperatures.

Since weather forecasting is rarely 100% accurate and reliable, special precautions are necessary for products sensitive to rain events or pop-up showers in the spring and summer. Rain-washing events can have an extreme effect on water-based (emulsified) air barrier technology.

The photo to the right indicate what happens during an unexpected rain event *(Figure 2)*. The tests were conducted on 20 mil DFT samples. It was at a 5° angle after a one-hour cure with a two-hour rain test (0.3 gallons per hour irrigation emitters) and then dried for 24 hours at room temperature.

The picture shows that MSTPE is unaffected by rain. The water-based formulations of the acrylic and asphaltic-based air barriers can be adversely impacted.

Architects often overlook skin over time as a desirable property. The quicker the skin over, the less dirt pick-up; the quicker the skin over, the better the resistance to sudden rain showers.

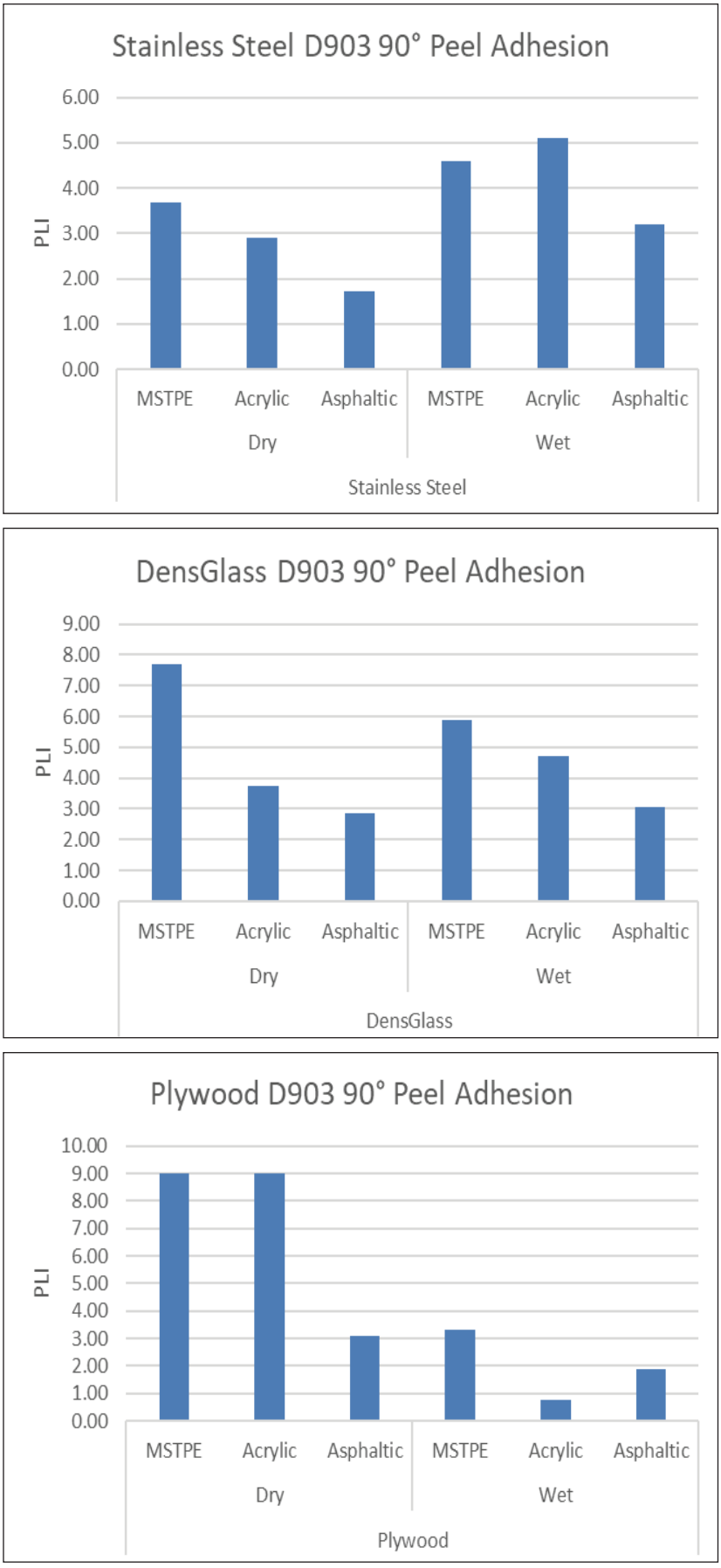

Figure 1. Peel adhesion test result of fluid-applied air barriers on various substrates

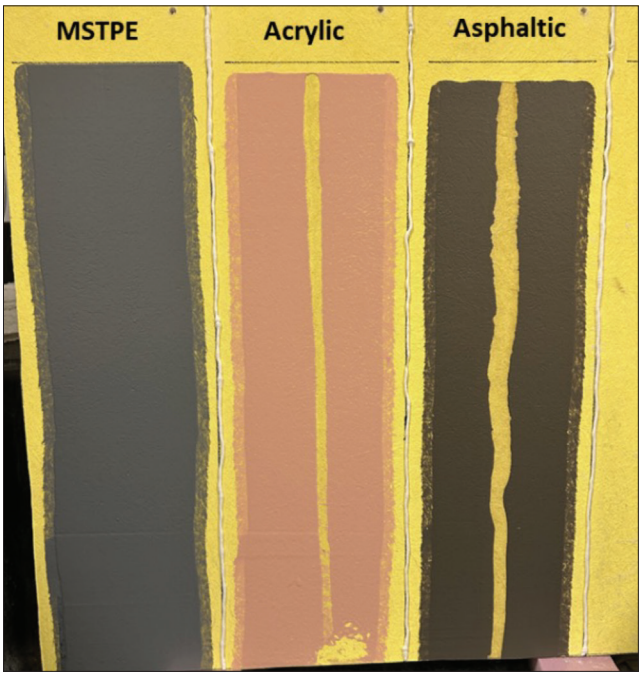

Figure 2. Pictures of rain wash off test

Quicker Skin Over Time is generally a function of percent solids and the method of curing or taking a set:

MSTPE	95%+ Solids	71 minutes Skin Over
Acrylic	55-60% Solids Water Based	> 320 minutes Skin Over
Asphaltic	55-60% Solids Water Based	> 320 minutes Skin Over

Water absorption is one of those properties that is an evaluation point for in-the-wall performance. A water absorption test was performed on the three polymer categories. The samples of MSTPE and acrylic were applied at 15 mils wet film thickness (WFT), the asphaltic was applied at 40 mils WFT, and a water absorption test was conducted after four days. The MSTPE product absorbed 8.4% water, the acrylic absorbed 23%, and the asphalt absorbed 26% moisture. This testing indicates that the MSTPE polymer formula is significantly more moisture-resistant in place (on the wall) than the other product technologies. Again, water absorption is critical to film integrity and long-term performance.

Viscosity

Viscosity is an intrinsic property of all liquid-applied products/coatings. In thinking about viscosity, think about water and honey. Water is thin and readily pourable; honey is thicker and takes longer to flow out. So why is this an essential property for the design professional or construction professional to consider?

The water-based polymer formulations, with 55-60% solids, need to be thicker (higher viscosity) to go on to the wall at the correct WFT so they dry down to their tested Dry Film Thickness (DFT). The higher percentage solids material, 95%+solids like MSTPE, goes on at a much thinner WFT to achieve their tested DFT.

Generally, a low/lower viscosity air barrier material will have a quicker application rate using less labor effort. There is a viscosity test that many manufacturers run; the measurement unit of viscosity is in centipoise (cP). Below is test data illustrating viscosity; the lower the number, the less viscous and more fluidic a product is. This test is not an absolute test but a comparison test.

MSTPE	92, 000 cP
Acrylic Base	147,000 cP
Asphaltic Base	404,000 cP

Conclusion

All chemical-based products referenced are Air Barrier Association of America (ABAA) evaluated materials/assemblies. The difference is in the polymer makeup or chemical base of the formula. This article dug into some of the lesser-known but critical physical properties of the air barriers in today's market. Many physical characteristics, like Rain Water Wash-off, water absorption, Skin Over Time, and viscosity, are more important than they are given credit for.

This article is for the design community and construction community to assist in fleshing out their decision-making choices. As a design or construction professional, you must dig deep into the wealth of technical data before deciding on your preferred polymer technology.

About the Author

Roy F. Schauffele, FCSI, CCPR, FABAA, CABS is an internationally published author and speaker in energy conservation and sustainable building envelopes, including air barrier technology, insulation, roofing & waterproofing, to improve building science and performance for over 50 years.

He has served in various positions with ABAA, including three terms as Board Chair. He was the first to receive the Wagdy Anis Dedication Award for excellence in volunteerism, leadership, and mentorship within ABAA. He was among the first to achieve the Certified Air Barrier Specialist (CABS) designation and served as the Executive Advisor to the Board.

Schauffele is also a multiple award winner from Build San Antonio Green, a former elected official, and a Gubernatorial and Texas Senate appointee. He serves the City of San Antonio as the Chairperson of the Small Business Development Advocacy Committee and the Bexar County Small Minority and Woman Business Enterprise Committee.

Globally, he is the only person to be a Fellow of CSI and ABAA. He continues to be a continually requested national speaker on energy conservation, air barriers, and sustainability, with over 800 AIA presentations.