

# The Science of Elastomeric Roof Coatings

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**W**HITE, ELASTOMERIC, WATER-DISPERSED roof coatings are not only aesthetically pleasing, but can improve the durability and longevity of a roofing system while offering energy savings. An elastomeric polymer, by definition, is a natural or synthetic polymer which, at room temperature, can be stretched repeatedly to at least twice its original length and which, after removal of the load, will immediately and forcibly return to its approximate original length.<sup>1</sup> This means that a white elastomeric roof coating can potentially stretch and recover repeatedly to accommodate cyclic stresses imposed by the roofing system. A white elastomeric roof coating is a water-dispersed, liquid-applied material spread over roofing substrates to protect and increase the longevity of the roof. It cures to a seamless, fully-adhered membrane, providing energy savings and aesthetic appeal.

## Formulation of Elastomeric Roof Coatings

A white elastomeric roof coating is the result of the raw materials and their integration in the formulation. Let us look at the raw materials in a white elastomeric roof coating and each of their functions. One of the most important ingredients is the binder, also known as the resin, latex, or polymer. A binder holds the pigment and filler particles together and the coating film as a whole to the material to which it is applied.<sup>2</sup> The binder can provide strength, elongation, durability and water resistance. Acrylics and styrene acrylics are examples of the most common binders used in water-dispersed roof coatings. Binders have different physical properties that can affect the finished coating. For example, styrene acrylic binders have inherent water resistance because the styrene monomer is hydrophobic—that is, "afraid of water" or water repellent.

Fillers or pigments are dry compounding materials added to the coating to improve the coating performance properties such as permanence, strength, and reflectance, and may also lower the cost. Examples of fillers or pigments are calcium carbonate, titanium dioxide, and zinc oxide. Again, each filler or pigment has its own purpose. Calcium carbonate is used to add strength and lower the cost of the coating, while titanium dioxide increases the whiteness, opacity, and reflectance of the coating. Zinc oxide offers long-term release mildew resistance (mold control) and tensile strength to the film. It is necessary to note that zinc oxide can add considerable tensile strength, but at the expense of elongation or stretch.

Additives are those substances used in small quantities to improve coating performance and facilitate the manufacturing

process. Dispersants aid in manufacturing by providing a sort of lubrication to the grinding of the fillers and pigments against the rest of the coating. This lubricating action results in less friction against the dispersing blade and shaft. Friction generates undesirably high levels of heat in the manufacturing process which can lead to deterioration of the coating. Dispersants prevent flocculation (accumulation of small particles) and stabilize color and viscosity. Too much dispersant, however, can reduce the water resistance of the coating.

Defoamers or anti-foams are the additives that decrease air entrapment in the coating during manufacture. This is important because excessive air entrapped in a wet coating can result in a dry film that contains pinholes. Pinholes are defects or "doors" in the coating through which water can penetrate and potentially cause damage to the coating and the roofing membrane that it is supposed to protect.

Glycols (ethylene, propylene, etc.) are additives used for freeze-thaw resistance of the coating. Stabilizers like potassium tri-polyphosphate (KTPP) are used to increase the in-can stability and consistency (avoiding syneresis/separation) of the coating before use.

Alkaline additives, such as ammonia, are used to activate a thickener and/or raise the pH of the coating for stability, if necessary.

Thickeners come in many different types and with different functions. Generally, their function is to increase the viscosity or body (rheology) of the coating. Some of the most common thickeners are cellulose, associatives, clays or inverse emulsions. The proper amount and type of thickener are necessary to maintain the proper viscosity for application while avoiding water sensitivity in the coating.

Coalescers, like butyl cellosolve, improve the film-forming capability of the coating and affect the cure rate. Improperly formed films contribute to premature degradation of the coating.

Finally, a number of proprietary additives are used for different functions in coatings available today. For example, fire retardant additives can be solid materials, or, in some cases, other types of binders added to a coating. These are important to provide the fire resistance necessary to meet the requirements for an Underwriters Laboratories (UL) roof system listing often required by building codes. Adhesion promoters are also used to ensure that the coating has excellent adhesion to the roofing membrane. Loss of coating adhesion leads to rapid and usually catastrophic degradation of the coating.

It should be evident at this point that there is a significant number of raw materials used in the formulation of an elastomeric roof coating. Each of the raw materials contributes a function to the coating. At the same time, all of these materials must work together for the coating to be properly formulated and to perform its function.

Elastomeric roof coatings can be tested for a number of performance and physical properties using standard ASTM test methods. ASTM D-6083 is a newly-issued standard specification for "Liquid Applied Acrylic Coating Used in Roofing," listing properties, suggested values and ASTM test methods for each of the properties listed. The properties listed include things like tensile stretch, elongation, water swelling, accelerated weathering, adhesion, permeance, fungi resistance, low temperature flexibility, along with viscosity, volume, and weight solids. The initial reflectance of these coatings can be determined using ASTM E-903, standard test method for "Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Sphere." Fire resistance of roof coatings in roofing assemblies can be tested in accordance with Underwriters Laboratories (UL) 790.

## Elastomeric Roof Coating Function in a Roofing System

The function of the white, water-dispersed, elastomeric roof coating is to protect the roofing membrane from the effects of sun and weather, including ultraviolet radiation, heat, and water. These coatings are also almost always formulated to enhance the fire resistance of the roofing membrane. To provide this protection from the elements as well as fire, the elastomeric coating must adhere well to the substrate to which it is being applied. Coatings today are expressly formulated for excellent adhesion to the roofing membrane which they are meant to protect.

With the increased adhesion and resistance to water, today's white elastomerics provide resistance to ponding water on the roof. As is always the case, even with an excellent coating, proper slope-to-drain and avoidance of ponding on the roof are good roofing practices.

## Performance Benefits

Roof coatings in general are used to protect the roofing membrane. Roof coatings can be thought of as a renewable surfacing that keeps the underlying surface from UV exposure and heat, thus slowing the aging process. Elastomeric roof coatings are available in many colors, for aesthetics and—for the lightest colored coating—energy savings as well. For years, people have been using white or light-colored clothing to keep cool in hot weather. The same principle applies to roofing systems. Highly reflective white coatings significantly reduce the temperature of the roofing membrane which leads to improved long-term durability of the system. This lower temperature also leads to heat load reduction in the building with resultant lower cooling costs for the building.

The most popular color for elastomeric roof coatings is white; however, these coatings can be pigmented in a variety

## Roof Coatings and the RCMA

By 3000 BC, Egyptians were using cold-process coatings made of beeswax, gelatin, and clay to waterproof their wooden boats. It is recorded that in the year 1122 BC, the Chinese invented a coating and used it to protect virtually every structure known to them. Early on, in what became Europe and the Americas, various structures utilized cold-applied mixtures of clay soil and water to waterproof roofs and walls. Some of these early materials are still in use today. Cold-applied roof coatings and cements have been successfully used as a part of roof systems for well over 50 years, gaining both recognition and market share.

It is no surprise that this ancient technology is now used to produce a sophisticated variety of coatings that serves virtually every purpose imaginable, including roofing. Today's users of these products are the beneficiaries of significant technological strides that have resulted in new and ever-improved products. Hundreds of cold-applied roof coatings and cements are available in the marketplace today. Present state-of-the-art cold-applied coatings and cements employ a variety of resin technologies ranging from bituminous resins (asphalt or coal tar) to polymeric resins (acrylic, SBS, PVA, neoprene, and others). These resins can be used as either stand-alone binders or in combination with one another to achieve a blend of performance properties. When coupled with reinforcing fabrics, these cements and coatings provide performance-oriented roof systems rivaling present-day modified bitumen systems while significantly reducing the risk of rooftop fires associated with open flames or smoldering materials.

The roof coatings industry supports the U. S. Gross National Product with over \$500 million in sales volume each year. The Roof Coatings Manufacturers Association (RCMA) was established in 1982 to represent manufacturers of cold-applied roof coatings and cements. There are currently over 60 company members. The agency is headquartered near Washington DC and serves as forum for sharing technological advancements in the industry. The accompanying article was written by members of RCMA at the request of RCI. For further information regarding roof coatings or RCMA, contact the organization at (301) 348-2003; fax to (301) 348-2020; or visit the RCMA web site at [www.roofcoatings.org](http://www.roofcoatings.org).

of colors. Color coordination of roof coatings is popular as architects are making roofs an integral part of the color scheme. Warmer regions tend to use white and lighter, more reflective colors. Colored roof coatings are also used to match trim or exterior walls of buildings, particularly in metal roof applications.

Several years ago, the federal government began to look at reflective materials in an effort to reduce the urban heat island effect or the excess heat build-up in cities versus the surrounding countryside. The heat build-up is a result of the buildings,



A completed job shows the aesthetic value and high reflectivity of white roof coatings. RCMA and Oak Ridge National Laboratories are currently researching the effect of reflective roof coatings on the reduction of heat flow through the roofing system and aging of roofing membranes.

roads, and lack of trees in urban areas. Lawrence Berkeley Laboratories in California began work toward the reduction of heat build-up through the use of reflective surfaces. Roofs were considered one of the most promising areas of heat reduction, either through the use of white or highly reflective coatings or membranes. Roof coatings are perhaps the easiest way to reduce temperatures because they can be applied to existing roofs. Used properly, they can also lengthen the life of the roof.

Oak Ridge National Laboratories currently has a research project in progress studying the effect of reflective roof coatings on the reduction of heat flow through the roofing system and effect of aging of roofing membranes. The project, undertaken with the Roof Coating Manufacturers Association (RCMA), is a long-term study of the aging characteristics or change in reflectivity of coatings over time. The purpose is to determine the contribution of the roof coating to heat flow reduction through the roofing system.

The Cool Communities Program, a project sponsored by the U.S. Department of Energy and U.S. Environmental Protection Agency, is trying to determine ways to reduce the heat island effect and prevent global warming. This effort has resulted in the recent formation of the Cool Roof Ratings Council, an organization comprised of roof coating manufacturers, membrane manufacturers, shingle manufacturers, roofing contractors, architects, energy providers, and other interested parties. The group was formed to provide a credible rating system related to potential energy savings for roof surfacing materials.

## Application of Elastomeric Roof Coatings

Elastomeric coatings have different application rates. Typically 20 to 55 mils dry film thickness is recommended for roof surfaces. Recommendations of the manufacturer should always be followed; otherwise, poor performance will result. Dry film thickness and as-applied wet film thickness are related by the volume solids of the coating. If 40 wet mils of coating are applied and the volume solid of the coating is 55 per-

cent, the resultant dry coating film thickness will be 22 mils.

Elastomeric coatings vary widely. Some can be used over certain types of asphalt surfaces; others are not recommended on asphalt, but are formulated more for metal roofing. Be sure to contact the manufacturer or read the product data to determine which coating is recommended for which substrate.

Proper roof surface preparation must precede the application of the elastomeric coating. The level of preparation will depend on the current surface of the roof. This preparation may be as simple as sweeping and priming or could involve pressure washing, rust removal, priming, and seam repairs. Use of a primer is recommended for most surfaces and may also be required by the manufacturer before the elastomeric coating is applied. In some cases, a base coat is applied one to four hours after the primer is dry. The base coat is then applied at the recommended film thickness and is often pigmented differently than the primer or top coat to assist in complete coverage. The top coat is applied perpendicularly to the base coat, allowing any irregularities or brush or roller marks to be minimized. In some cases, the coating can be applied in a single application. Again, manufacturers' instructions must be followed to ensure that the coating will perform as expected.

Elastomeric roof coatings dry fairly rapidly if the temperature is moderate and the humidity is low. However, it is recommended that traffic be kept off the roof for several days. Common sense also dictates that these water-dispersed coatings must not be applied if precipitation is expected before the coating can dry to wash-off resistance. Further, the manufacturer's minimum application temperatures must be followed. The lower the temperature and higher the humidity, the longer it will take the coatings to dry.

Today, elastomeric roof coatings are formulated specifically to permit the use of a variety of application equipment, including roller, brush, or high pressure airless spray equipment. For large jobs and well-controlled application, spray application is recommended. In any case, coating application rates should be monitored during application with a wet film thickness gauge to ensure proper quantity of coating is applied.

### Further Reading:

- Downey, Patrick L., "When You're Hot You're Hot; When You're Not, You're Cool Construction Materials," *Interface*, October 1996, p. 10.
- Downey, Patrick L., "Georgia Amends State Energy Codes to Recognize Benefits of High Albedo Roof Systems," *Interface*, May 1997, p. 21.
- Dregger, Phil, "Group Aims to Rate 'Cool Roofing,'" *Interface*, May 1998, p. 27.
- Gartland, Lisa M., "Demonstrated Energy Savings of Cool Roof Coatings and Future Directions for Research," *Interface*, November 1997, p. 9.
- Kirn, William A., "Life Cycle Cost Analysis Using Roof Coatings," *Interface*, April 1998, p. 4.

## Conclusion

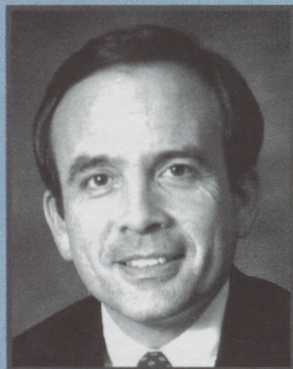
Elastomeric roof coatings, used for surfacing and restoring roofing systems for many years, have been improved in almost every aspect of performance when compared to the first of these coatings 20 years ago. This is especially true in terms of adhesion to a variety of roofing substrates as well as long-term performance. The formulation of these materials is a science requiring the use of many raw materials which must work together with a binder to impart all of the desired characteristics to the coating. Development in binders continues and provides a strong, chemically-sound, fundamental build-

ing block for the coating. Governmental regulation may, at some point in the near future, provide more incentive to use these roof coatings as a means to improve reflectance of roofing systems and to reduce the need for air conditioning and power consumption. Coincidentally, these heat reduction efforts may also improve the long-term performance of the roofing system.

### Footnotes

1. LeSota, Stanley, *Coatings Encyclopedic Dictionary*, 1995, p. 101.
2. *Ibid.*, p. 34.

## About The Authors



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**Donald C. Portfolio** has been Director of Research and Development for the Tremco Roofing Group since 1987. He is a member of ASTM and the American Chemical Society and represents Tremco at ARMA and RCMA, where he is chairman of the Technical Committee. He is a faculty member of RIEI.

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