Cool Coatings Heat Up Savings

Cool roof coatings demonstrate their energy-saving and performance-enhancing capabilities

— By Dr. Lisa M. Gartland

Cool roof coatings offer managers expanded opportunities for both energy savings and better performance. They reflect much of the sun's energy, allowing the roof surface to stay cooler and transfer less heat to the building. Demonstration projects have shown the coatings can save an estimated 20-70 percent of a building's cooling energy.

Coatings can save money, increase comfort and help reduce air pollution and reroofing needs. But there are technical and industrial challenges in the way of widespread adoption of coatings as a roofing standard. For more on coatings standards and research, see sidebar below.

Cool roofing properties

Roofing materials have two properties that help them stay cool in the sun. The first is solar reflectivity, sometimes called albedo, which indicates how much light and heat from the sun bounces off their surface. The coolest materials have reflectivities of 50 percent or higher, which means they only absorb 50 percent of the sun's energy. Typical asphalt roofing materials have reflectivities of 5-25 percent, meaning they absorb 75-95 percent of the sun's energy.

The second property is emissivity, the ability to radiate away absorbed heat. Most cool roof coating materials have emissivities of 90 percent or higher, which helps keep them cool. Metallic roof coatings have much lower emissivity — from 20-70 percent depending on surface finish and condition — and high reflectivity. Unfortunately, metallic roof coatings don't stay cool. Their low emissivities don't allow them to radiate away the solar energy they absorb.

Demonstrated savings

Many projects have studied the effects of cool roof coatings on roof surface temperature and cooling energy use. All studies confirm the ability of cool coatings to reduce roof surface temperatures dramatically — by 50-80 degrees — and to save significant amounts of cooling energy during summer months.

An ongoing project funded by the U.S. Environmental Protection Agency and administered by Lawrence Berkeley National Laboratory is studying the effect of cool coatings on three large, single-story commercial buildings in California. The rooftop of a Gilroy, Calif., building was coated with a white elastomer during the first week of August 1996, raising its reflectivity from 25-60 percent.

Coatings similar to the elastomer used on this roof have albedos of 75-85 percent when measured on smooth surfaces in the laboratory. The roughness of the capsheet surface, however, reduces the albedo by increasing the absorption of the reflected solar radiation.

Of the three buildings, the Gilroy building had the highest initial rooftop albedo, as well as the greatest amount of roof and ceiling insulation. Its coated albedo, at 60 percent, also was not extremely high. Nonetheless, this building showed roof surface temperature reductions of 60

degrees and cooling energy savings of 13 percent.

Non-energy benefits

Besides saving energy, cool roof coatings provide improved comfort and lower cost, and they reduce air pollution and waste.

Cool coatings also are effective at cutting roof maintenance costs. The accompanying table shows the cost of using a cool roof coating compared to using conventional roofing practices. The comparison studies 10 years over a roof's life under the conventional route, the roof is torn off and replaced, while in the cool coating path the roof can be coated without removal.

After 10 years, the conventional roof needs a new layer, while the coated roof can be recoated at one-third the cost. The coated roof realizes an energy savings of 20-70 cents a square foot over 10 years, but this savings is small compared to the avoided costs of reroofing. In 10 years, the cool roof saves more than $4 a square foot, mostly on reroofing fees.

Cool coatings are assumed to greatly slow down, if not stop, the aging process of the underlying roof materials. Since the coatings are much lighter than a new layer of asphalt, they can be applied indefinitely for decades before the old roof must be torn off and replaced. Theoretically, these cool coatings can be applied over any roof surface that does not leak.

Waste reduction

By increasing the longevity of roof materials by using cool coatings, organizations can avoid a substantial amount of roofing waste. There are an estimated 11 million tons of asphalt roofing waste going into landfills every year. Using cool coatings can greatly increase the life of existing roof materials and reduce the amount of torn-off roofing waste going into landfills. The roofing waste that remains can be recycled into road mixes using existing processes already operating.

Reduced air pollution also can be attributed to using cool roofing materials. Because less cooling energy is used, fewer emissions are produced for energy generation. Indirect reductions result if cool surfaces are used widely throughout an urban area. Cooler surfaces transfer less heat to the air, keeping urban air temperatures lower. Lower urban temperatures again translate into less cooling energy and reduced energy generation emissions. Lower urban temperatures also reduce smog formation. Ozone formation is highly dependent on temperature, so air temperature reductions slow the "cooking" of smog on hot summer afternoons.

Barriers to installation

The implementation of cool rooftop coatings has been slow for a variety of reasons, including technical confusion and market and aesthetic barriers.

The visible properties of roof materials do not necessarily indicate how cool they stay or how much energy they save. Materials with higher reflectivities, such as aluminum coatings, do not necessarily stay cool. The only way to know if a material will be cool is to know its reflectivity and emissivity, and this information is not generally available. Efforts are underway to adopt specifications which give this information.

Market barriers to the adoption of cool coatings also exist. Conventional roofing techniques have been used for decades, so there is a relative lack of experience with and availability of cool coatings. Many maintenance managers and roofing contractors are skeptical of claims made about cool coatings and have questions about their reliability and longevity.

Cool coatings also represent a potentially upsetting shift in the revenues of the roofing industry.

There are sometimes aesthetic concerns about cool roofing materials. The materials at this point are bright white, which is often considered unattractive.

White roofs are even deemed unacceptable on some flat rooftops where they will not be seen by

the majority of people, since there are sometimes building codes restricting what can be seen from surrounding hills or taller buildings.

Finally, cool white roofing materials can show dirt and biological growth. Most of these products contain agents to make them self-washing to encourage the action of rainwater to remove dirt particles.

Coatings also contain chemicals to reduce the formation of algae or mildew. The fear of reduced reflectivity remains, especially in areas of high dust and pollen and low rainfall. Evidence indicates reflectivities are reduced by less than 10 percent. Even with this reduction, cool coatings stay significantly cooler than traditional roofing materials.

Cool roofing is not a simplistic concept. The development of products and markets for cool coatings faces significant technical and industrial challenges, as well as market and sociological barriers. But cool roof coatings can also provide great benefits.

These coatings have the potential to save large amounts of money and energy, to increase building comfort, and to significantly reduce air pollution and roofing waste.

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Cost Check: Cool Coatings vs. Conventional Roofing

	Cool Coatings	Conventional Roofing
Initial cost	+ $0.50/sq. ft.	+ $3.50/sq. ft.
Energy savings over 10 years	- $0.20 to $0.70/sq. ft.	none
Recoat/relayer after 10 years	+ $0.50/sq. ft.	+ $1.50/sq. ft.
Total	$.030 to $.08/sq. ft.	$5/sq. ft.

Coating Futures

Governmental research institutions and industry groups are in the process of addressing the challenges regarding the adaptation of cool coatings for commercial and institutional facilities. Significant funding for research and development comes from the U.S. Department of Energy and the U.S. Environmental Protection Agency (EPA). Industry also is involved in funding studies and in collaborating to set standards.

Researchers at Lawrence Berkeley National Laboratory (LBNL) have been conducting demonstration projects of cool coatings in California and Florida, and they are making improvements in roof heat transfer modeling to the next generation of DOE-2 building energy models, the DOE-2.2 and EnergyBase programs.

A website features a database on roofing materials and their properties .

LBNL researchers also have urban climatological and air quality modeling underway that is designed to evaluate the effects of cool surfaces in cities throughout the United States.

Moisture and heat transfer

Work on cool roofing materials also is taking place at Oak Ridge National Laboratory (ORNL), another governmental laboratory. ORNL is performing tests at a comprehensive roof and attic facility. Researchers have produced detailed models of roof and attic systems heat transfer and are studying the effects of moisture buildup on roof materials.

Recently, the EPA unveiled specifications for cool roofing materials under its EnergyStar® program.

There are two classes of specifications:

- low-sloped roofs, which have less than a 2-in-12-inch slope, must have an initial reflectivity of 65 percent or higher. This reflectivity must stay above 50 percent after three years
- sloped roofs must have an initial reflectivity of 25 percent or higher, staying above 15 percent after three years.

The two different specifications are due to the types of materials available. Low-slope roofs can apply highly reflective roof coatings to increase their reflectivity.

Coatings don't work well over shingles used on sloped roofs, since they can block the flow of rainwater between shingles. There are very few cool roofing products on the market for sloped roofs.

Labeling roofing products

The EPA EnergyStar roofing specification is a good first step at labeling roofing products. Unfortunately, the standard only encompasses the reflectivity of roofing materials, not their emissivity. This means that metallic coatings, which have high reflectivity but aren't actually cool due to their low emissivity, still meet this specification.

The Cool Roof Rating Council (CRRC) is working on standards that encompass the reflectivity and emissivity of materials. CRRC members, a cross-section of experts from industry, government and research arenas, are developing test methods and specifications to classify cool roofing products.

Specification challenges

The cool roofing industry has many challenges in addition to setting specifications. There is a need to evaluate the life-cycle costs and externalities of cool roofing products, and to document environmental benefits over traditional materials. There is also a need to educate end users about the science behind cool roof coatings, as well as their potential benefits.

Finally, more maintenance managers and roofing contractors need information and equipment to apply coatings effectively and consistently, as well as to measure the coating properties to ensure they achieve targeted values.

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