

White

There's nothing new under the sun about white roofs. Builders in ancient Greece and Rome realized light-colored materials, particularly white, kept buildings cooler. The Greeks and Romans obviously weren't worried about energy savings in those days, but they were concerned with comfort.

Contemporary cool roofs can significantly reduce utility bills by supplying a high degree of reflectivity against punishing solar rays. Drew Ballensky, manager of the Sigourney, Iowa plant of Duro-Last Roofings, Inc., a major manufacturer of cool roofing materials, estimated typical annual energy savings of 25 to 40 percent by combining a cool roofing system with adequate insulation. Jim Schlagel, president of San Dimas, Calif.-based CCS, Inc., a cool roofing contractor, pegged the savings range even wider at 20 to 70 percent, depending on the amount of air-conditioned space in the building. Research has verified that reflective roof products have greatly reduced air conditioning loads in buildings, cutting energy bills up to 50 percent and reducing peak usage by 10 to 15 percent.

One of the most active organizations on the cool roofing front is the Heat Island Group, a

research arm of the Lawrence Berkeley National Laboratory in Berkeley, Calif. Paul Berdahl, staff scientist and materials specialist for the group, said energy savings from cool roofing can be enormous when the gains are factored over large areas, such as entire cities.

The Heat Island Effect

Cities typically have large clusters of dark roofs in close proximity to each other. On hot days, they heat the air around them, contributing to the "heat island effect," which puts added drains on air conditioning systems and increased loads on municipal power plants.

According to the Heat Island Group, black surfaces in sun can become up to 70 degrees hotter than white reflective surfaces. Ballensky defines heat islands as those urban locations with temperatures eight to 10 degrees warmer than surrounding rural areas.

"Not only do urban heat islands tax the air conditioning units of local buildings, they also have significant impact on pollution," he said.

Cities with urban heat islands tend to show higher ozone levels. Failing to control the ozone not only creates a serious health threat to the general population, but may also result in the loss of federal support for infrastructure improvements because of failure to comply with government mandates for pollution control, Ballensky said.

Recently, the Heat Island Group analyzed light-colored roofs in 11 U.S. metropolitan areas using about 10 residential and commercial building prototypes in each city.

HOT

In the quest for energy savings, cool roofing proves an effective tool for building owners and managers *by John Bell*

"We considered both the savings in cooling and penalties in heating," Berdahl explained. "We estimated savings potentials of about \$175 million per year for the 11 cities. On a national basis, extrapolated energy savings totaled about \$750 million a year."

Action Items

Given the heat island scenario, it's no surprise the roof issue is heating up. The federal government has mandated a 30-percent reduction in energy use for federal office buildings by 2005 increasing to 35 percent by 2010. Many states and communities have active programs to promote energy-efficient building practices, including the California Cool Roofs Commission and the Atlanta Cool Community program. Building owners, architects, specifiers and consultants are selecting reflective roof materials to save energy and promote sustainable design.

On the subject of energy rebates, Ballensky said a number of states have featured energy incentive programs that include roofs. With various states in budget crisis, many of these programs are no longer being funded and the rebates have been turned over to utility companies. "Rebates vary widely," he explained, "some are up front and some represent discounts off the bill if energy savings can be proven."

The rebate programs allow utilities to reduce peak power levels in the summer and avoid building new plants or purchasing expensive power on the open market, he continued. California's state-sponsored rebate program offers \$.15 per square foot of energy-efficient roofing, or \$15 a square. "As long as one of the approved products has been installed, owners are eligible for rebates," Schlagel said.

Cool Roofs, Dark Colors

The dominant color for cool roofs remains white but researchers are moving ahead on several fronts to counter the solar offensive with new and improved reflective materials.

Tom Bollnow, senior technical director of the Rosemont, Ill.-based National Roofing Contractors Association, said most technology has been focused on developing more effective reflective coatings and on studies involving cool, dark colors for roofs.

Ballensky also cites experimentation with darker colors to make them more reflective. "For example, one color may contain eight to 10 different pigments. One of these pigments may be more reflective of solar radiation, making the color usable for cool roofing," he said.

Berdahl said colors are being produced for metal roofing that are darker, yet highly reflective and much cooler than conventional materials.

"These cooler colors contain pigments that have infrared reflectivity while maintaining the same visual appearance as conventional roofing," he explained. One example is dark brown. "Cool, dark colors such as these are available now in metal roofing and some tile roofing, but are not expected to be introduced in asphalt shingles until 2005," he said.

Heat Island Group researchers are also targeting experiments with the molecular structure of paints to make them more reflective. The pigment hematite, which is used on shingles, contains impurities of magnetite that absorb light near the infrared part of the spectrum. Finding a way to get rid of the magnetite, Berdahl said, could create a more reflective paint without noticeably changing its rust-red color.

"It comes down to a question of understanding how the structure of a material contributes to its performance in the sun," he said.

Charles Dorgan, Ph.D., professor emeritus at the University of Wisconsin-Madison and a roofing energy consultant, said the most important consideration is how well the material reflects radiant energy.

"White does have high reflectivity, but its reflective properties depend on its pigments and not all whites are the same. Other colors can also be used," he said.

Change and Adapt

According to Ballensky, other ways in which cool roofing materials are being improved include changes to components in the waterproofing layer of the membrane and new

manufacturing methods to increase reflectivity of coatings, materials and shingles.

There are several ways to create a cool roof, ranging from covering the conventional surface with a reflective coating accompanied by underlying insulation to installing an all-new roof. Components include single-ply membranes, built-up surfaces, asphalt shingles, metal tiles and coatings. Selecting an appropriate option depends on a number of variables including age, condition, composition and drainage profile of the roof, climate and, most importantly, what you're trying to accomplish.

Do's And Don'ts

Robert Illo, principal of Lancaster, Penn.-based Architecture & Engineering Innovation, a consulting firm, said, "Coatings

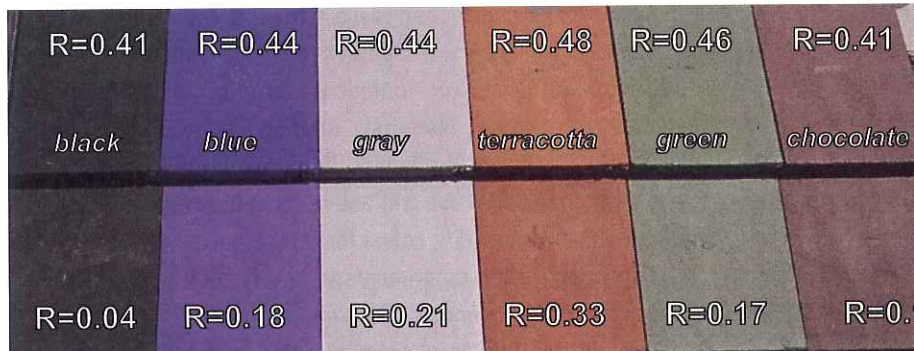
are less costly but don't work on all roofs because of incompatibility of materials and the age of the roof. If the roofing material is beyond its useful life, it's not cost-effective to coat."

Bollnow said coatings are more of a maintenance item and have to be replaced periodically. "Like paint, they're not permanent," he said. "If the roof is worn and has reached a large portion of its expected life span, coating is only a short-term solution. At that point, it should be replaced versus applying a coating over the top."

Schlagel said coatings should be applied to roofs in fair to good condition and done in conjunction with proper repairs. "The roof should be replaced only when a roofing professional tells you it's in poor condition," he said.

Illo cited another alternative: an earth-sheltered or landscaped roof, which can also keep surfaces cooler. However, experts claim the initial cost of a green roof is much higher than that of a conventional cool roof.

The Environmental Protection Agency's ENERGY STAR® Roof Products



Twelve color-matched cool and hot coatings (top) of the type used on a demonstration home in Sacramento, Calif. (bottom)

photos by William Miller/Oak Ridge National Lab

Nice Reflection

Cool roof systems are divided into three categories: shingles, tile and metal.

Following is a list of some cool roof materials and their reflectance increases over conventional roofing, compiled by industry sources:

- White asphalt shingle with premium white granules—15-30 percent over asphalt shingle (composition, fiberglass or organic).
- White clay or tile—35-55 percent over clay tile.
- White concrete tile—40-70 percent over concrete tile.
- White cementitious/fiber cement shingle—30-70 percent over cementitious shingle.
- White painted metal—up to 10 percent over metal and metal shingle.
- Built-up roof with white gravel—30-35 percent over built-up roof or coal tar with dark gravel.
- Built-up roof with gravel coating—50-55 percent over coal tar (or mopped on) roof, smooth surface.
- White or reflective single-ply membrane—60-75 percent over black single-ply membrane (EPDM, CPE, CSPE*).

*Acronyms refer to different types of single-ply thermoplastic membranes used in roofing.

Program affords building owners and managers resources about cool roofing alternatives. ENERGY STAR has approved a wide range of cool roof products, maintaining a list of those that demonstrate initial solar reflectivity of more than 65 percent and retained reflectivity of more than 50 percent after three years of weathering.

There are some pitfalls for owners and managers to avoid when switching to a cool roof. Dorgan advised to avoid hiring untrained workers to install the roof or coating. "It's scary when the contractor is conducting on-site training as the work is being done," he said.

"The system needs to be applied properly. Use a roofing professional and don't try to do it yourself," Schlagel said.

Ballensky advised managers to stay focused on what they're trying to accomplish. "Don't just jump on

the bandwagon to get a cool roof," he said. Bollnow echoed a similar sentiment and said, "Be wary of advertising claims that certain types of coatings are replacements for roofs. Coatings don't replace roof coverings themselves."

What's been the single biggest obstacle to the growth of cool roofing? In Berdahl's view, it's people. "It's a question of aesthetics," he said. "Though it varies somewhat from place to place and over time, white has been basically regarded as an unsuitable color for roofs in residential areas."

However, that barrier may be removed by the introduction of new, darker reflective colors for cool roofs. □

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