Residential Roofs: Cool Colors, Cool Gaps

The Problem

Heat entering a home through the roof puts a big load on residential air-conditioning systems. Cool roofs can cut those loads by up to 20 percent through the use of reflective materials that limit solar heat gain, but they also carry an energy penalty in the heating season. Conventional cool roofs feature light-colored surfaces—shades that commercial facilities with flat or low-sloped roofs find acceptable. However, homeowners have not adopted the cool-roof approach because they typically prefer the aesthetics of darker colors for their steep-sloped roofs. Until recently, there were no cool-roofing products available in darker, more appealing hues, and no means of getting benefits in both the heating and cooling seasons.

The Solution

Manufacturers have developed dark-colored pigments for roofing materials that reflect solar heat gain instead of absorbing it. These pigments are now being used in coatings for metal roofs, in clay and concrete tiles, and in the multicolored granules that make up shingles. Cool-colored roofing products look like their standard counterparts, but they reflect more long-wave radiation from sunlight and stay cooler. New research also shows that additional savings are possible if roofs are installed with an air-ventilation gap above the sheathing—the cool roof and air gap save energy in the summer, and the air space cuts heat loss in the winter.

Features and Benefits

Overall, by reformulating their pigmented coatings, manufacturing partners in the Cool Colors Project, funded by the Public Interest Energy Research (PIER) Program, have raised the solar reflectance of commercially available roofing products from the 0.05 to 0.25 range to 0.30 to 0.45. Light-colored roofs have a reflectance of about 0.70. Solar reflectance is the portion of the sun's incident radiation that a material's surface reflects. The higher the reflectance of a roofing material, the cooler the roof will be. New products resulting from the project include a line of cool-colored siliconized-polyester coatings from BASF Industrial Coatings; 11 products with solar reflectances above 0.25 from MCA Clay Tile; and the Prestique Cool-Color Series of light-gray and light-brown asphalt shingles from Elk Corp. Several utilities, including Pacific Gas and Electric and Southern California Edison, now offer rebates for the use of these products.

Adding an air space between the roof sheathing and the roof surface can decrease attic temperatures through thermally induced natural ventilation that is set in motion as the roof heats the air in the gap. Field tests have shown that the combination of venting and increased reflectance can reduce the heat penetrating the roof deck by about 70 percent for clay tile and by about 45 percent for stone-coated metal roofs compared with an attic covered with an asphalt shingle roof. Ongoing research with standing-seam cool-colored metal roofs is showing 70 percent reduction for a two-inch air gap and almost 90 percent reduction for a four-inch gap.

To help manufacturers ensure the quality of cool roofing products, the Cool Colors Project provides field-testing and analysis services. Oak Ridge National Laboratory (ORNL) established a steep-slope test assembly at its facility in Tennessee to evaluate samples from manufacturing partners (**Figure 1**). Researchers are measuring the changes in physical composition and appearance as a result of exposure to ultraviolet light, weathering, and temperature changes, and also monitoring the effects of above-sheathing ventilation.

A team from Lawrence Berkeley National Laboratory (LBNL) and ORNL also set up a series of test sites in several different California climate zones to measure how the roofing materials degraded over time. More than two years of testing showed that the cool-roof products weathered at about the same rate as conventional products.

To measure thermal performance, three residential demonstration sites were set up with pairs of homes outfitted with painted metal shakes, concrete tiles, and asphalt shingles (**Figure 2**, next page). Each pair includes one building roofed with a cool-colored product and a second building roofed with

Figure 1: Steep-slope test facility

The test facility set up by Oak Ridge National Laboratory tests roofing samples from participating manufacturers.