Copper Roofs Are Cool

Cool roofing is an established component of sustainable architecture. And copper is considered the most sustainable of metals in building construction because it is totally natural, long lasting, manufactured largely from recycled material, and completely and easily recyclable. But can a copper roofing system also save energy? Can it be considered “cool?”

To answer that, the Copper Development Association conducted tests at Oak Ridge National Laboratory (ORNL). The result: copper roofing systems can be energy-efficient and cost-effective. Here’s how.

Typically, cool roofs rely on paint pigments to reflect solar radiation and to emit heat. By doing this, less solar heat is captured by the roof and transferred to the building interior. This results in lower cooling costs for the building owner and reduced electrical energy usage.

Are *R* and *E* the only tests for energy efficiency?

Roof systems are given values for Reflectance (*R*), the solar energy reflected away from a roof, and for Emittance (*E*), the infrared radiation energy released from the roof to the night sky. Since copper is a bare metal that patinates with time, the *R* and *E* values will change as the copper oxidizes and changes color. So, how is copper going to perform compared with painted metals or shingles? Remember, the goal is to reduce energy costs.

Values for both *R* and *E* are ranked from 1, the highest and best, to 0, the worst. Roof slopes are also taken into account as is the age of the roof covering. Slopes of 2/12 (2" of vertical rise over 12" of horizontal run) and less are considered low slope. Anything greater than that, such as 4/12, is considered steep slope. EPA's Energy Star program recommends an initial *R* of 0.25 for steep slope roofs with no initial requirement for *E* and a three-year aged value of 0.15. The State of California’s requirements are more complicated and are the toughest in the country. Depending on the climate zone, they require an aged *R* of 0.55 and an aged *E* of 0.75 for low sloped roofs and an aged *R* of 0.15 and aged *E* of 0.75 for steep slope roofs. Aged values are taken for roof coverings at the three-year mark.

However, meaningful energy savings can’t be measured by the roofing material alone. You have to look at what effect the entire roofing system has on the heat gain, cooling load and energy usage of the building and it's systems.

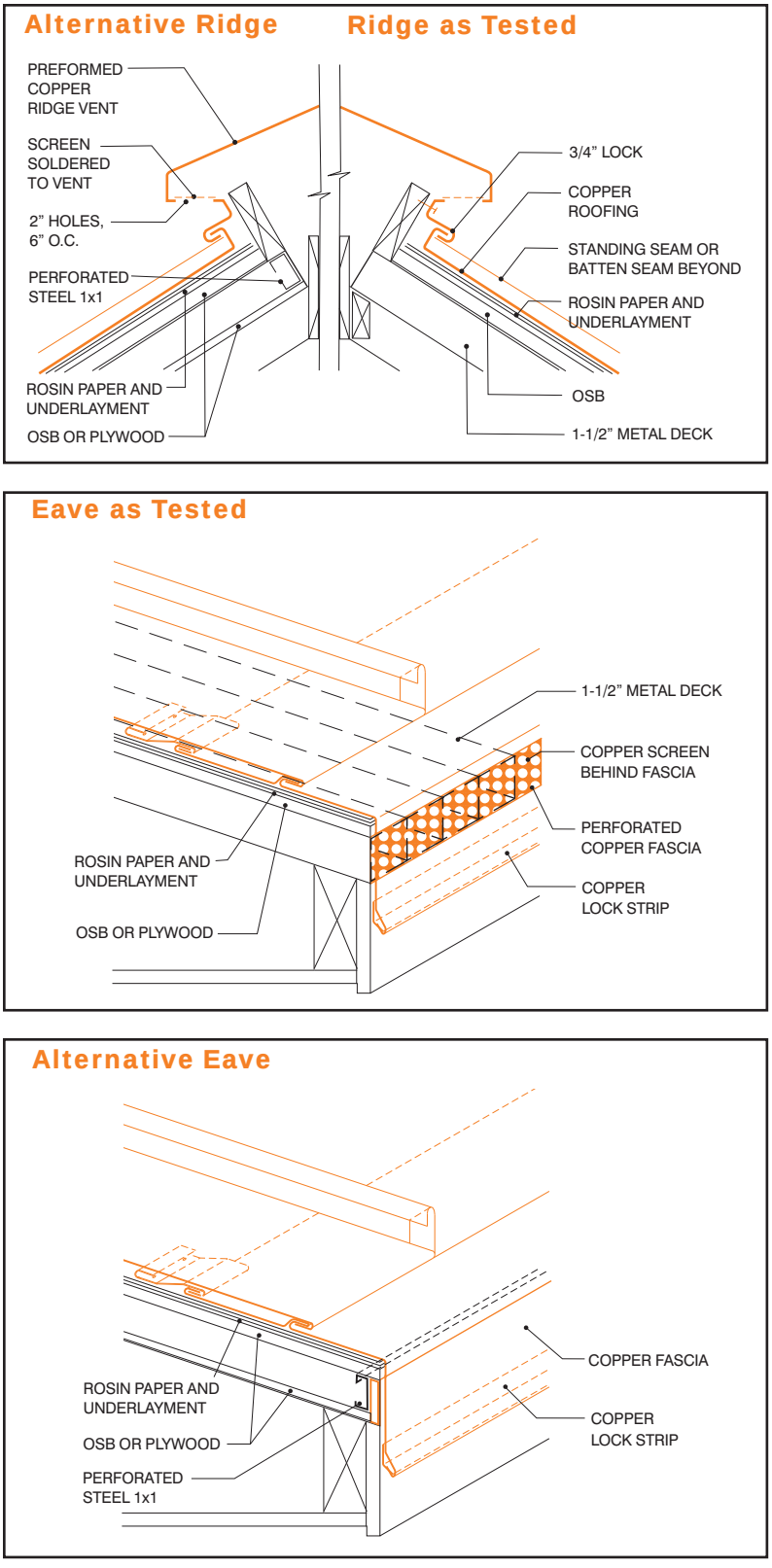

Figure 1. Vented copper roofing system enables significant reductions in heat flux and heat flow, making the assembly highly energy-efficient and cost-effective.

ORNL tests

Because copper is applied in its natural state, its *R* and *E* values can vary and are generally lower than painted metals. So CDA, decided to conduct tests evaluating the whole roofing system. Previous testing at ORNL shows that by employing the natural convection of heated air below the roof covering, temperatures in an attic space are reduced. Air enters at the eave, is heated by the roof, and, because hot air rises, it is naturally drawn up and vents to the outside. This natural convection controls heat gain and reduces the temperature in the attic below.

The test assembly consisted of 1½" fluted metal roof deck, ¾" OSB (plywood would work just as well), underlayment and red rosin paper and a standing seam copper roof (see **Figure 1**). The use of a fluted metal roof deck is optional; similar results can be obtained by using other designs that provide an air space below the deck. The test roof has a 4/12 slope and faces south. The system was compared with a control roof of typical black asphalt, a typical copper roof assembly, and two very good examples of above-the-sheathing, ventilated stone-coated steel roofs using Cool Roof colors.

The graph (**Figure 2**) shows the ceiling heat flux crossing the attic floors of the respective attic assemblies. The stone-coated metal roof (SR246E90) dropped the ceiling heat flux by roughly 29% of that measured for the asphalt shingle roof (SR093E89). The copper roof with the fluted metal deck further dropped peak ceiling heat flux an additional 23% of that for the coated steel shingle roof, bringing the total reduction for the copper roofing system to 50% of the asphalt control. Peak heat flux dropped an additional 1.5 Btu per hour per square foot for the copper roof as compared with the stone-coated metal roof.

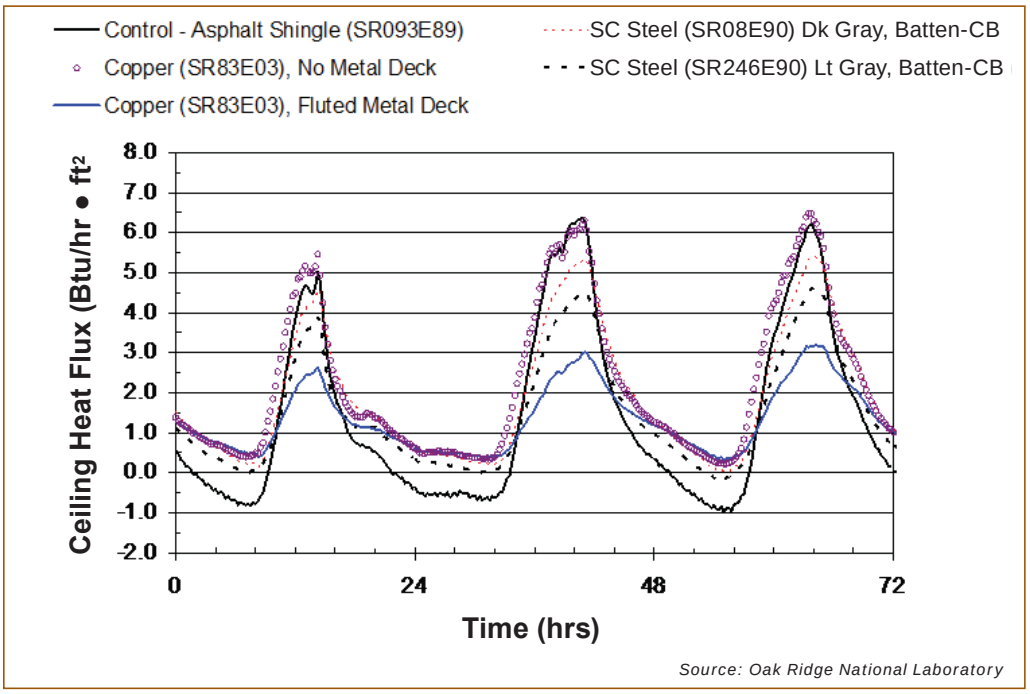

Figure 2. Heat flux variations of copper (with and without metal deck) vs. asphalt (control) and both dark and light gray stone-coated steel roofing with batten and counter-batten construction.

The bottom line for what you put on top

These results show clearly that a vented copper roof assembly will greatly reduce heat gain resulting in lower energy costs for the structure. Further, it dispels the notion that copper roofing must have high reflectance and emissivity in order to be effective in saving energy.

When all is said and done, there's no reason to overlook the many benefits that copper roofing has provided buildings for many hundreds of years. The recyclability, long life span, beauty and maintenance-free durability of a properly designed copper roof can meet or exceed the typical installations of other comparable materials and be one of the most environmentally sound assets of your green building.

Based on performance, which is what it's all about, a copper roof can be a cool roof and meet and often surpass other materials systems where it counts: energy savings. This is just one more reason why copper remains a design element of choice. Not only does its versatility provide various ways to tackle today's energy concerns, its durability and longevity are essential to long-term cost-effectiveness. And, of course, its natural weathering and varied hues provide a living, changing aesthetic that beautifies any building.