

A REVIEW OF INTERIOR RADIATION CONTROL COATING RESEARCH

An Interior Radiation Control Coating (IRCC) is a low-emittance paint or coating applied to building materials to reduce the thermal transmission across the space. Emittance or emissivity refers to the percent of radiant heat that a hot object emits or radiates. Building materials like wood and masonry typically have a very high thermal emittance and can have upwards of 80% radiant heat transmission. Due to the low-emissive properties of the coating, a building product's thermal emissivity can be reduced down to 25% or less.

While similar in function, an IRCC is notably different from a sheet radiant barrier. A sheet radiant barrier is a separate building component with a low emissive surface (0.10 or less) added to the building assembly, while an IRCC is a coating applied to an existing building component to lower that component's emissivity. To qualify (under the ASTM definition) as an IRCC, the coating must be able to reduce the emissivity to 0.25 or less.

IRCC technology has been proven by numerous laboratory and field experiments to significantly reduce the radiant heat transfer across vented spaces between roofs and ceilings of buildings. The exact reduction in radiant heat transfer can be partly explained by the equation below, which represents the net transfer of heat by radiation between two surfaces (e.g., the roofing materials, and the top surface of the ceiling insulation). Basically, the IRCC works by altering the emittance value ε of at least one of the surfaces in the assembly. Note that this equation is oversimplified in many ways, but it presents a snapshot of the physics involved when an IRCC is installed in the space.

$$\dot{q}_{12} = \frac{\sigma(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

In this equation, ε represents the surface emissivity. The term σ is called the Stefan-Boltzmann constant and it has a value of 0.1714 Btu/hr · ft² · °R⁴, and T is the temperature of the surface in °R (degrees Rankine). A degree Rankine is equal to the temperature in °F plus 459.69. For simplicity, this equation assumes that the areas of the top surface (e.g., the roof) and the bottom surface (e.g., the insulation) are equal and that all the radiant heat that is emitted by the roof arrives at the insulation.

The two most common materials used for roof decks in residential buildings are plywood and oriented strand board (OSB). The average emissivities of plywood and OSB are 0.91 and 0.93, respectively (Infrared Services, Inc., 2010). The average emissivity of attic insulation, including fiberglass and cellulose, is 0.85 (ASHRAE, 2009). Therefore, assuming a deck temperature of 130 °F and a top-of-insulation temperature of 110 °F, which are not uncommon values in most parts of the U.S. during the summertime; and assuming the deck to be OSB and the insulation fiberglass, this equation gives the rate of radiant heat transfer as 21.4 Btu/hr ft². A typical value for an IRCC is about 0.23 (Yarbrough, 2006), so depending on exactly how the IRCC is applied, the total radiant heat transfer rate can be reduced by as much as 72.4%.

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TB #112

05/14

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