U.S. Department of Energy - Energy Efficiency and Renewable Energy

A Consumer's Guide to Energy Efficiency and Renewable Energy

Radiant Barriers

Radiant barriers are installed in homes—most commonly in attics—to reduce summer heat gain and winter heat loss, which helps lower heating and cooling costs. The barriers consist of a highly reflective material that reflects radiant heat rather than absorbing it. They don't, however, reduce heat conduction like thermal insulation materials.

How They Work

Heat travels from a warm area to a cool area by a combination of conduction, convection, and radiation. Heat flows by *conduction* from a hotter material to a colder material when the two materials touch. Heat transfer by *convection* occurs when a liquid or gas is heated, becomes less dense, and rises. *Radiant* heat travels in a straight line away from the hot surface and heats anything solid as the wave of energy hits it.

When the sun heats a roof, it's primarily the sun's radiant energy that makes the roof hot. A large portion of this heat travels by conduction through the roofing materials to the attic side of the roof. The hot roof material then radiates its gained heat energy into the cooler attic (some of the roof's heat will radiate in other directions too). A radiant barrier reduces the radiant heat transfer from the roof to the attic space.

A radiant barrier's performance is determined by three factors:

- *Emissivity (or emittance)* – the ratio of the radiant energy (heat) leaving (being emitted by) a surface to that of a black body at the same temperature and with the same area. It's expressed as a number a between 0 and 1. The higher the number, the greater the emitted radiation.

- *Reflectivity (or reflectance)* – a measure of how much radiant heat is reflected by a material. It's also expressed as a number between 0 and 1 (sometimes, it is given as a percentage between 0 and 100%). The higher the number, the greater the reflectivity.

- The angle the heat wave strikes the surface—a right angle (perpendicular) usually works best.

All radiant barriers must have a low emittance (0.1 or less) and high reflectance (0.9 or more). Of these factors, the angle the heat wave strikes the surface has the most influence on how well any shiny surface acts as a thermal insulator. From one brand of radiant barrier to another, the reflectivity and emissivity are usually so similar that it makes little difference as far as thermal performance. (Most products have emissivities of 0.03–0.05, which is the same as a reflectivity of 97%–95%.) Also, the greater the temperature difference between the sides of the radiant barrier material, the greater the benefits a radiant barrier can offer.

Radiant barriers are more effective in hot climates than in cool climates. Some studies show that radiant barriers can lower cooling costs between 5%–10% when used in a warm, sunny climate. The reduced heat gain may even allow for a smaller air conditioning system. But in cool climates, it's usually more cost effective to install more than the minimum recommended level of insulation rather than a radiant barrier.

Types of Radiant Barriers

Radiant barriers come in a variety of forms, including reflective foil, reflective paint coatings, reflective metal roof shingles, reflective laminated roof sheathing, and even reflective chips, which can be mixed with loose-fill insulation. The reflective material, usually aluminum, is applied to one or both sides of a number of substrate materials. Substrate materials include kraft paper, plastic films, cardboard, plywood sheathing, and air infiltration barrier material. Some products are fiber reinforced to increase the durability and ease of handling.

Also, radiant barriers—which don't provide a significant amount of thermal insulation—can be combined with many types of insulation materials. These combinations are called reflective insulation systems. In these combinations, radiant barriers can also act as the insulation's facing material.

Installation

Radiant barriers can be installed between the roof sheathing and attic floor insulation, in cavity walls, and around door openings, water heaters, and pipes. It's easier to incorporate radiant barriers into a new home, but you can install them in an existing home too.

An installer typically drapes a rolled-foil radiant barrier *foil-face down* between the roof rafters to minimize dust accumulation on the reflective faces (double-faced radiant barriers are available). This is generally done just before the roof sheathing goes on if it's not too windy, but it can also be done afterwards from inside the attic by stapling it to the bottom of the rafters.

When installing a foil-type barrier, it's important to allow the material to "droop" between the attachment points to make at least a 1.0 inch (2.5 cm) air space between it and the bottom of the roof. This air space has mainly two functions: it creates an air channel for the soffit and ridge ventilation system to work more effectively, and it acts as a second reflector since there are two shiny sides (one facing up/ one facing down.)

Some builders also try to attach the radiant barrier directly onto the roof sheathing prior to their installation on the roof rafters. However, a more effective method is to simply buy foil-faced plywood sheathing instead. There are also metal roof shingles that have a reflective underside. If you need roof shingles, these are a practical option, but the cost of this type of radiant barrier is considerably higher than other types.

A radiant barrier installed on top of attic floor insulation is more susceptible to dust accumulation. This undesirable installation method may also trap moisture in fiber insulation during cold weather. A radiant barrier installed on the cold side of the insulation acts as a vapor barrier in the wrong location. When warm moisture carrying house air leaks into the attic in the winter, it may condense on the underside of the barrier. Even a perforated radiant barrier can trap moisture in cold climates since the water can freeze in the small holes and seal them. Because of these hazards, it's strongly recommended that you NOT apply radiant barriers directly on top of the attic floor insulation. Of course, installing them at all in a cold climate is not generally cost effective anyway.

A radiant barrier's effectiveness depends on proper installation. Therefore, it's best to have a certified installer do it.

If you want to install a radiant barrier yourself, obtain instructions and safety precautions from the manufacturer. Carefully study and follow these directions. You should also check your local building and fire codes.

Learn More

Product Information

- Reflective Insulation Manufacturers Association
- Buyers Guide: Reflective Insulation/Radiant Barriers
  Insulation Contractors Association of America

Professional Services

- Contractor Locator
  Insulation Contractors Association of America

Department of Energy Resources

- Radiant Barrier: Attic Fact Sheet
  Oak Ridge National Laboratory

Related Links

- Radiant Barriers and Reflective Insulation
  National Research Council Canada
- Radiant Barriers
  Toolbase Services
- Radiant Barriers: How They Work and How to Install Them
  Florida Solar Energy Center
- Radiant Barrier and Ridge Soffit Venting
  Sustainable Building Sourcebook

Reading List

- *Radiant Barriers* (PDF 39 KB). (2002). Energy Fact Sheet 14. Southface Energy Institute.