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Assistant Secretary
Energy Efficiency and
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RADIANT BARRIER ATTIC FACT SHEET

Contents:

Introduction

What is a radiant barrier?

Radiant barriers are materials that are installed in buildings to reduce summer heat gain and winter heat loss, and hence to reduce building heating and cooling energy usage. The potential benefit of attic radiant barriers is primarily in reducing air-conditioning cooling loads in warm or hot climates. Radiant barriers usually consist of a thin sheet or coating of a highly reflective material, usually aluminum, applied to one or both sides of a number of substrate materials. These substrates 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.

Radiant barriers can be used in residential, commercial, and industrial buildings. However, this fact sheet was developed only for applications of radiant barriers in ventilated attics of residential buildings. For information on other applications, see the references at the end of the Fact Sheet.

How are radiant barriers installed in a residential attic?

Radiant barriers may be installed in attics in several configurations. The simplest is to lay the radiant barrier directly on top of existing attic insulation, with the reflective side up. This is often called the attic floor application. Another way to install a radiant barrier is to attach it near the roof. The roof application has several variations. One variation is to attach the radiant barrier to the bottom surfaces of the attic truss chords or rafter framing. Another is to drape the radiant barrier over the tops of the rafters before the roof deck is applied. Still another variation is to attach the radiant barrier directly to the underside of the roof deck.

How do radiant barriers work?

Radiant barriers work by reducing heat transfer by thermal radiation across the air space between the roof deck and the attic floor, where conventional insulation is usually placed. All materials give off, or emit, energy by thermal radiation as a result of their temperature. The amount of energy emitted

depends on the surface temperature and a property called the "emissivity" (also called the "emittance"). The emissivity is a number between zero (0) and one (1). The higher the emissivity, the greater the emitted radiation.

A closely related material property is the "reflectivity" (also called the "reflectance"). This is a measure of how much radiant heat is reflected by a material. The reflectivity is also a number between 0 and 1 (sometimes, it is given as a percentage, and then it is between 0 and 100%). For a material that is opaque (that is, it does not allow radiation to pass directly through it), when the emissivity and reflectivity are added together, the sum is one (1). Hence, a material with a high reflectivity has a low emissivity, and vice versa. Radiant barrier materials must have high reflectivity (usually 0.9, or 90%, or more) and low emissivity (usually 0.1 or less), and must face an open air space to perform properly.

On a sunny summer day, solar energy is absorbed by the roof, heating the roof sheathing and causing the underside of the sheathing and the roof framing to radiate heat downward toward the attic floor. When a radiant barrier is placed on the attic floor, much of the heat radiated from the hot roof is reflected back toward the roof. This makes the top surface of the insulation cooler than it would have been without a radiant barrier and thus reduces the amount of heat that moves through the insulation into the rooms below the ceiling.

Under the same conditions, a roof mounted radiant barrier works by reducing the amount of radiation incident on the insulation. Since the amount of radiation striking the top of the insulation is less than it would have been without a radiant barrier, the insulation surface temperature is lower and the heat flow through the insulation is reduced.

Radiant barriers can also reduce indoor heat losses through the ceiling in the winter. Radiant barriers reduce the amount of energy radiated from the top surface of the insulation, but can also reduce beneficial heat gains due to solar heating of the roof. The net benefits of radiant barriers for reducing winter heat losses are still being studied.

How does a radiant barrier differ from conventional attic insulation?

Radiant barriers perform a function that is similar to that of conventional insulation, in that they reduce the amount of heat that is transferred from the attic into the house. They differ in the way they reduce the heat flow. A radiant barrier reduces the amount of heat radiated across an air space that is adjacent to the radiant barrier. The primary function of conventional insulation is to trap still air within the insulation, and hence reduce heat transfer by air movement (convection). The insulation fibers or particles also partially block radiation heat transfer through the space occupied by the insulation.

Conventional insulations are usually rated by their R-value. Since the performance of radiant barriers depends on many variables, simple R-value ratings have not been developed for them.

What are the characteristics of a radiant barrier?

All radiant barriers have at least one reflective (or low emissivity) surface, usually a sheet or coating of aluminum. Some radiant barriers have a reflective surface on both sides. Both types work about equally well, but if a one-sided radiant barrier is used, the reflective surface must face the open air space. For example, if a one-sided radiant barrier is laid on top of the insulation with the reflective side facing down and touching the insulation, the radiant barrier will lose most of its effectiveness in reducing heating and cooling loads.

Emissivity is the property that determines how well a radiant barrier will perform. This property is a number between 0 and 1, with lower numbers indicating better potential for performance. The emissivity of typical, clean, unperforated radiant barriers is about 0.03 to 0.05. Hence they will have a reflectivity of 95 to 97 percent. Some materials may have higher emissivities. It is not always possible to judge the emissivity just by visual appearance. Measured emissivity values should be part of the information provided by the manufacturer.

A radiant barrier used in the attic floor application must allow water vapor to pass through it. This is necessary because, during the winter, if there is no effective vapor retarder at the ceiling, water vapor from the living space may condense and even freeze on the underside of a radiant barrier lying on the attic floor. In extremely cold climates or during prolonged periods of cold weather, a layer of condensed water could build up. In more moderate climates, the condensed water could evaporate and pass through the radiant barrier into the attic space. While most uniform aluminum coatings do not allow water vapor to pass through them, many radiant barrier materials do allow passage of water vapor. Some allow water vapor passage through holes or perforations, while others have substrates that naturally allow water vapor passage without requiring holes. However, excessively large holes will increase the emissivity and cause a reduction in the radiant barrier performance. The ability to allow water vapor to pass through radiant barrier materials is not needed for the roof applications.

What should a radiant barrier installation cost?

Costs for an attic radiant barrier will depend on several factors, including the following:

- Whether the radiant barrier is installed by the homeowner or by a contractor.
- Whether the radiant barrier will be installed in a new home (low cost) or in an existing home (possibly higher cost if done by a contractor).
- What extra "features" are desired; e.g., a radiant barrier with perforations and reinforcements may be more expensive than a "basic" radiant barrier.
- Any necessary retrofit measures such as adding venting (soffit, ridge, etc.)
- Whether the radiant barrier is installed on the attic floor or on the rafters.

Radiant barrier costs vary widely. As with most purchases, some comparison

shopping can save you money. A survey of nine radiant barrier manufacturers and contractors representing 14 products, taken by the Reflective Insulation Manufacturers Association (RIMA) in 1989, shows the installed costs of radiant barriers to range as shown in Table 1.

In some cases, radiant barriers are included in a package of energy saving features sold to homeowners. When considering a "package deal", you may want to ask for an itemized list that includes material and installation costs for all measures included. Then shop around to see what each item would cost if purchased individually before you make a decision.

What should conventional insulation cost?

Heating and cooling bills can also be reduced by adding conventional attic insulation. So that you can have some basis for comparison shopping, typical installed costs for adding various levels of insulation are given in Table 2. These costs are typical for insulation installed by contractors. Actual insulation costs will vary from region to region of the country, will vary with the type of insulation selected (blown, or loose-fill, insulation is usually lower in price than "batt" insulation), and may vary from one local contractor to another. You can expect to deduct 20% to 50% for a do-it-yourself application.

You should always check with your local or state energy office or building code department for current insulation recommendations or see the DOE INSULATION FACT SHEET.

Next Section - Effect of Radiant Barriers on Heating and Cooling Bills

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