Where Radiant Barriers Really Shine

Manufacturers of radiant barrier materials claim that their products significantly cut cooling costs by reducing summertime radiant heat gain through attics and ceilings (see "Conservation Clips: Radiant Barriers Test Well," p. 45). A new study confirms that radiant barriers can indeed conserve cooling energy. However, the study's authors found that radiant barriers are much more effective at reducing energy losses from attic air conditioner duct runs than at directly lowering heat transfer through the attic floor into conditioned living space. Furthermore, the study demonstrated that radiant barrier savings can be significant even in a new, well-weatherized house, and that these savings may justify specifying smaller-capacity cooling systems.

The authors of the study, Robert Hageman of KoolPly, a radiant barrier manufacturer, and Mark P. Modera of Lawrence Berkeley National Laboratory (LBNL), performed pre- and post-retrofit tests on a new house in Austin, Texas, during July 1995. They measured ambient conditions; envelope leakage; duct air flows; temperatures in the attic, living space, and ducts; and electrical consumption and demand of the air conditioner. The house was built in 1995 to the local Good Cents efficient new construction program specifications. The 1530 ft^2 house was equipped with a 2.5-ton air conditioner and an R-38 attic, and showed envelope leakage of 5.2 air changes per hour (ACH) at 50 Pascals (Pa). The authors used a thermostat setpoint of 75°F for the study. The house's pitched roof covered an attic 10 ft high at the peak, and the aluminized plastic radiant barrier material used in this study was stapled to the underside of the roof sheathing in the attic.

Ducts, Not Ceilings

The authors found that daytime cooling energy use dropped by 16%, and that 80% of this was attributable to improved duct performance in the attic, where average ambient temperatures were lowered by 18°F. On the preretrofit test date, the A/C ran from 2:50 PM to 9:00 PM; on the postinstallation date, it ran only from 5:30 PM to 8:00 PM. The barrier caused supply duct conduction losses to fall by 30%, and return duct losses (from conduction and leakage) were lowered by 25%. The reduction in leakage losses in the return ducts was due to the lower temperature of the attic air leaking into the ducts, adding less heat for the air conditioner to remove.

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Even in a test house with R-38 ceiling insulation, radiant barriers significantly lowered cooling costs. The reason is that the reduced attic temperatures lessened heat gain through the ducts.

The Wind Factor

The researchers collected data at the test site for several days before and after the radiant barrier was installed. They then selected a preretrofit and a postretrofit day with closely matching weather data for comparison. The chief difficulty in validating the results lay in the fact that wind speeds were somewhat higher on the postinstallation date. According to Hageman and Modera, higher wind speeds can affect cooling load in three ways: by increasing the attic ventilation rate, by cooling the outside roof surface, and by increasing envelope infiltration rates. They conclude that the effect on infiltration is the most significant of these factors, so the net effect of the higher wind speed on the postretrofit date was to increase cooling load. Thus, the cooling load reduction attributed to the radiant barrier might have been even greater had the wind conditions been the same on both days.

"There are two reasons that higher wind speeds serve to increase cooling loads in this case," explains Modera. "One is the high latent loads or high humidity. And two, the attic's insulation serves to isolate it from the house, meaning that wind-driven infiltration will impact the interior temperature more strongly than will the increase in attic ventilation or the decrease in attic radiant heat gain." Slightly higher ambient temperatures on the postinstallation date also serve to make the study's conclusions conservative.

About the Size of It

What effect might radiant barriers and their duct-related energy and demand savings have on A/C equipment-sizing decisions? The authors conclude that the presence of a radiant barrier should be a factor in specifying equipment, but they do not extrapolate from their experience with the single residence used in this study to propose any general rules or guidelines. They note that the Air Conditioning Contractors of America (ACCA)'s Manual J, the industry standard sizing reference for residential A/C equipment, does not address radiant barriers as a factor at all.

Hageman and Modera's study may help builders and energy officials to identify the types of houses that benefit most from radiant barrier installation. Their results suggest that houses with air conditioning ducts located in the attic will have greater energy savings than houses with ducts in other locations, in which case the attic radiant barrier is used strictly to reduce direct through-the-ceiling radiant heat gains. Furthermore, it appears that even new, well-insulated homes can reap significant benefits from radiant barrier installation.

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