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No. 18: REFLECTIVE INSULATIONS AND RADIANT BARRIERS

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WHAT THEY ARE

Reflective insulations and radiant barriers use aluminum foil and air spaces to provide reflective surfaces with low values for the emission of radiant energy (emittance). Reflective insulations have been used in residential applications for over 40 years. Radiant barrier products on the other hand are relatively new in the U.S. market. Reflective insulations and radiant barrier systems are energy conserving products that provide an alternative or supplement to mass insulations like fibrous or foam insulation materials used in building envelopes.

HOW HEAT IS TRANSFERRED

The performance of any thermal insulation system depends on how well lit reduces the flow of heat. heat moves from warm locations to cool locations in three ways. heat is transferred by conduction through solid or fluid materials, by radiation from surface to surface through an air space, and by the physical movement of fluids (convection). Different types of insulation products reduce these three types of heat transfer by different amounts, therefore, they have different thermal performances or R-values.

MASS INSULATION vs. REFLECTIVES

Heat moves across empty wall cavities or between roof and attic floors by all three mechanisms. A reflective insulation or radiant barrier system reduces the radiative part of the heat transfer to a very low level and in some products reduces heat transfer by convection. Mass insulations reduce radiative convective heat transfer to low levels. Both types of insulation increase the conduction across the insulated region because solid material is put between the warm and cool regions.

REFLECTANCE AND EMITTANCE

Reflective insulations and radiant barriers greatly reduce heat flow by radiation in two ways. The aluminum foil surfaces that are commonly part of the product reflect a large part (94-97%) of the incident radiation. These surfaces also have low emittance which means that they do not re-radiate or emit heat very well. A material with an emittance of one radiates at the highest rate while a surface with the emittance of zero would radiate no energy. Aluminum surfaces can have emittances in the range of 0.03 to 0.06 which means that they radiate very little. The desirable combination for a product is a reflectivity near one and an emittance near zero.

HOW REFLECTIVE INSULATIONS WORK

Reflective insulations are typically viewed as products that include trapped air spaces as part of the insulation system. The trapped air spaces, which may be layers or closed cell, may result from the way the reflective insulation is manufactured or it may result from the way it is installed. The advertised performance of a reflective insulation requires that the air spaces that are part of the system be present after the product is installed. The label R-values will not be achieved if the air spaces are not present as stipulated by the manufacturer. Figure 1 shows three applications for reflective insulations. In these examples the trapped air spaces are an important part of the product design and thermal performance.

REFLECTIVE INSULATION TESTING AND LABELING

The label R-values for reflective insulations generally require a reduction on the convective heat movement. The amount of convection that remains depends on the direction of heat flow. A layer of air that is warm on the bottom and cool on the top will readily transfer energy by convection while the reverse is not true. As a result, reflective insulations are tested to provide R-values for horizontal heat flow, heat flow up, and heat flow down. The R-values are different in each of these three heat flow directions. The Federal Trade Commission's Home Insulation Labeling Rule identifies test methods and conditions for determining the R-values for reflective insulations: ASTM C236, The Guarded Hot Box, or ASTM C976, The Calibrated Hot Box. The label R-values require installation that results in a system like that specified by the manufacturer.

HOW RADIANT BARRIERS WORK

Radiant barrier products differ from reflective insulations in that they do not include a "trapped" air space as part of the product. A radiant barrier system is generally designed to significantly reduce the movement of heat by radiation across a space like, for example, an attic. Figure 2 shows a typical radiant barrier configuration. One type of radiant barrier system has aluminum foil on both sides of a supporting medium. The barrier system has aluminum foil on both sides of a supporting medium. the side facing the warm environment reflects incoming radiation while the side facing the cool environment emits very little radiative energy.

A radiant barrier product may change the convective heat movement in an attic because the surface temperatures in the attic are affected by the presence of the barrier. Spacing, however, is generally not as important for radiant barrier systems as it is for reflective insulations. It is important to know, however, that air spaces must be present for a radiant barrier to perform. An aluminum foil sandwiched between two gypsum boards, without air gaps, will have negligible effects on the heat follow through the gypsum.

RADIANT BARRIER TESTING

At the present time a universal test method for radiant barrier systems has not been agreed upon. This is partly because the radiant barrier system often includes the entire attic of a dwelling and such a structure can not be put into conventional test equipment. Radiant barrier evaluations have been performed in full scale buildings in Tennessee, Florida, and Mississippi where reductions in heat flow from roof to living space have been monitored. The radiant barrier systems that have been tested have been effective in reducing summer cooling loads but a direct relationship between this reduction and the R-value used to compare mass insulations can not yet be reliably stated.

Chapter 22 in the Handbook of Fundamentals published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (1993) contains information about reflective air spaces and tables that can be used to predict performance. The American Society for Testing and Materials has recommended practices (C727, C1152) and specifications (C1224, C1313) for the use of reflective insulations and radiant barriers that discuss important factors to be considered in the use of these products. These publications are good places to find reliable background information about reflective insulations.

SUMMARY

Reflective insulations must be installed in conformance with manufacturers' instructions. Reflective insulation R-values must be part of the label information and the values will depend on heat flow direction. Radiant barriers will reduce heat flow radiation across an adjacent air space. Radiant barrier systems usually include a large adjacent air space like an attic or room. The manufacturers' claims for energy savings should be documented by verifiable results. Because of the different types of products, installation methods, attic designs, and local weather patters, there is no agreed upon method at this time to rate the general performance of radiant barriers.

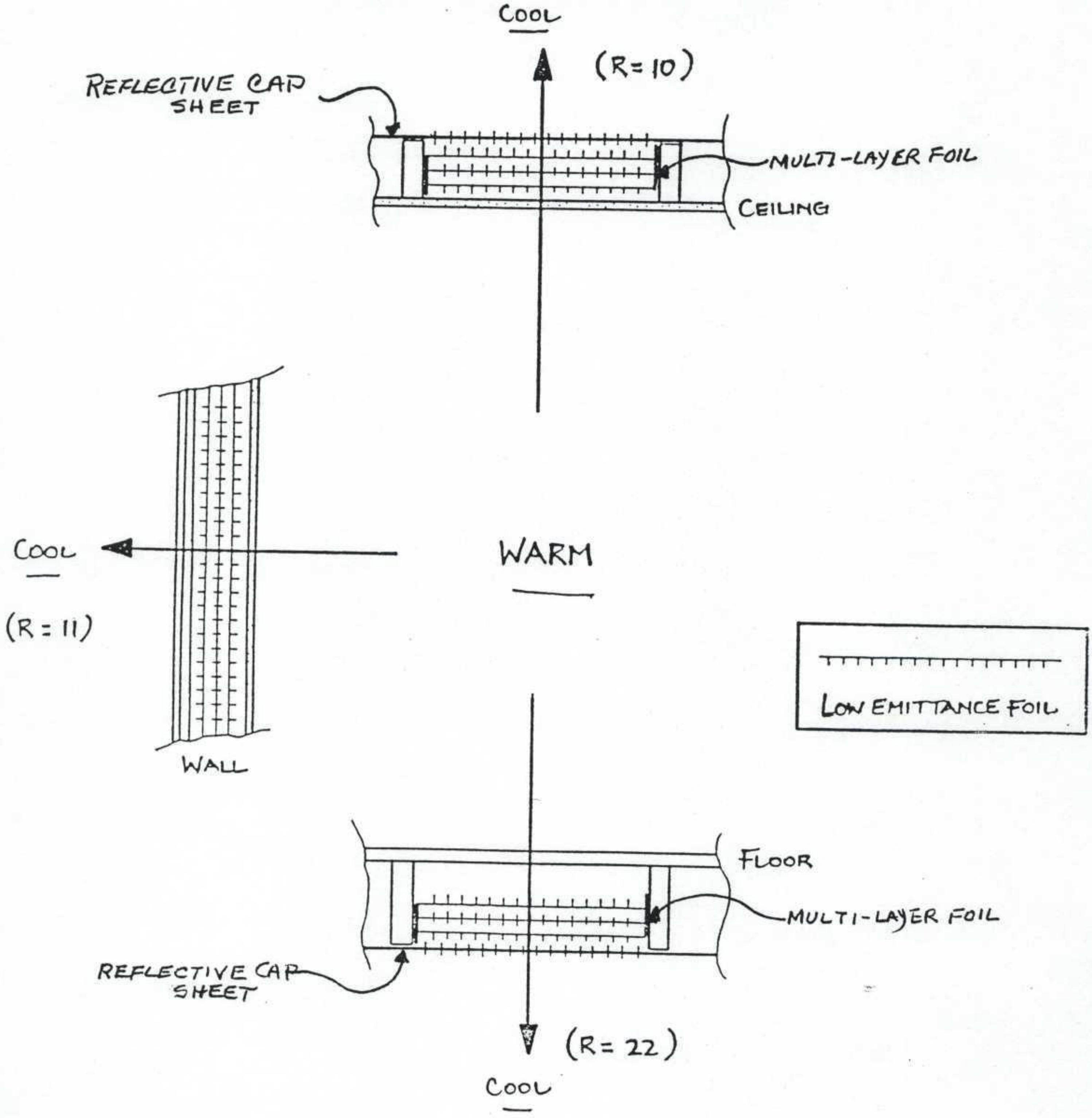

Figure 1. Diagram showing three reflective insulation applications yielding different R-values for different heat flow directions. (The numbers are example R-values that do not necessarily represent specific products).

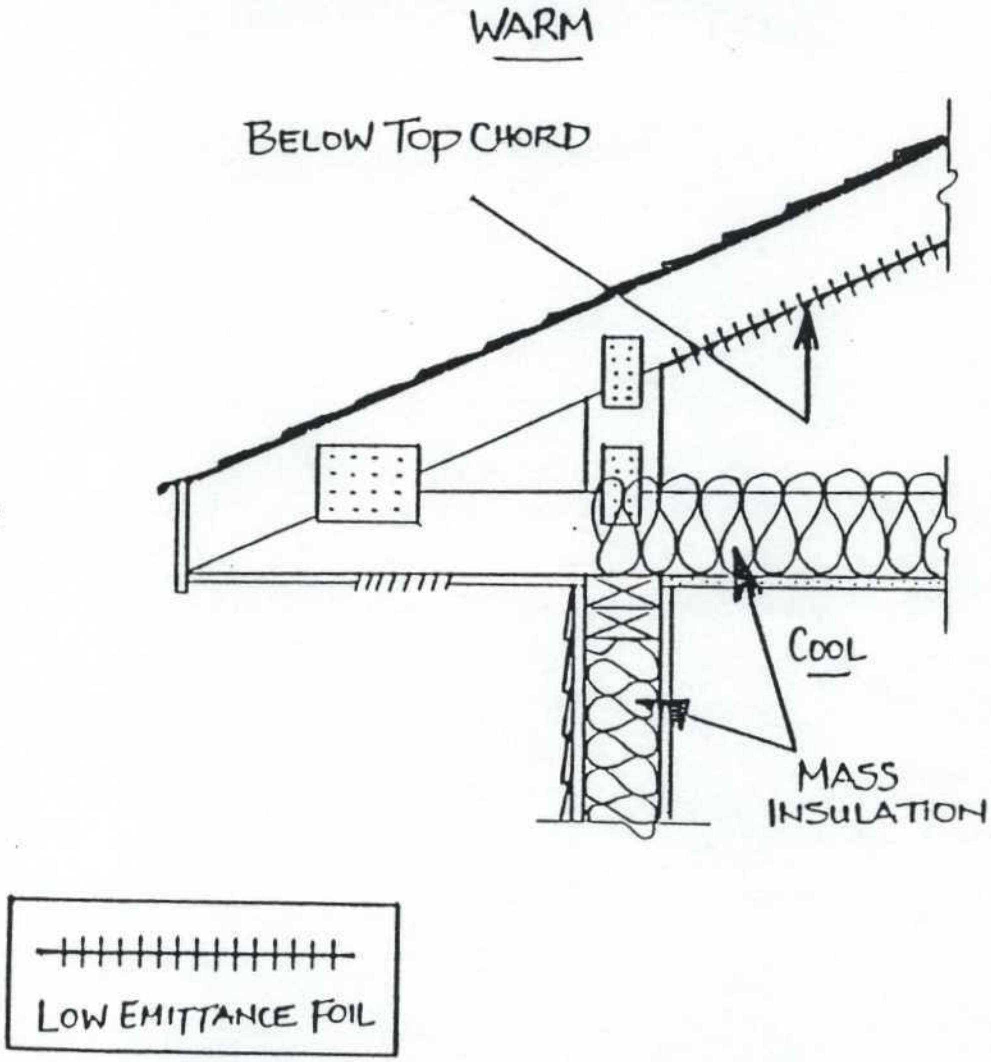

Figure 2. Diagram showing typical radiant barrier system installed in roof.