

product feature

BY DAVID W. YARBROUGH, PHD, PE

ADVANCES IN REFLECTIVE TECHNOLOGY

BACKGROUND

The past decade has seen significant changes and advances in the design, manufacturing, and utilization in North America of reflective insulation and radiant barrier materials. The most prominent change has been the use of metallized aluminum film to provide the reflective material for *enclosed reflective air spaces*. This is closely followed in importance by the use of reflective technology in conjunction with other types of insulation such as cellular plastic or mineral fiber insulations to create “hybrid” insulation assemblies that can economically deliver high thermal resistance values (R-values). These advances result in an expansion of choices available for insulating buildings to reduce the cost of providing comfortable enclosures and while reducing destructive emissions to the atmosphere.

FOIL TO FILM

The use of films metallized with aluminum in place of aluminum foil has resulted in an improved performance of reflective products in the widely recognized and required test for flame spread/smoke developed, ASTM E 84/D2599. E 84 tests on the present generation of reflective products is yielding flame-spread values less than 25 (often designated “Class A”). The flame-spread test on reflective products is one of the evaluations required by the “*Verification Program*” managed by the reflective industry association, RIMA-I.¹

The RIMA-I verification program includes a review of technical data on product tables and technical bulletins and the basis for the claims. Metallized films, properly protected from reaction with atmospheric oxygen, have slightly higher emittances than polished aluminum foil. The RIMA-I verification program includes a test that verifies the performance of the protective coating protecting the metallized film. The coated metallized films in the market have emittances around 0.05 while foil surfaces are generally around 0.03 on a scale of 0 to 1. The higher emittance for the film products is due to a thin transparent coating that blocks oxygen from contacting the metallized sur-

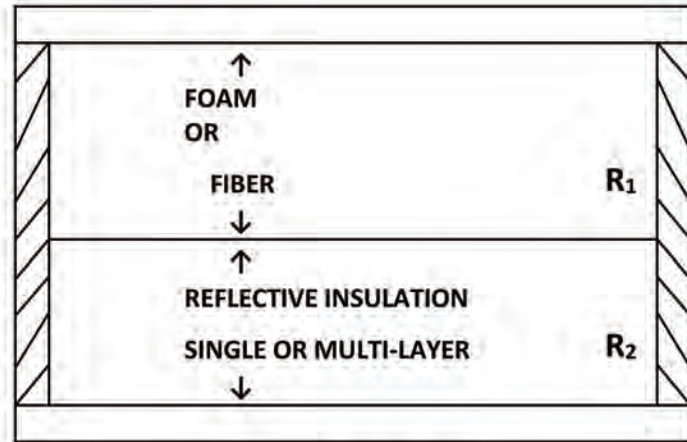
face. The increase in emittance results in a small decrease in the thermal resistance of the *enclosed reflective air spaces* created by installation of the reflective product in a building construct. **Table 1** contains R-values calculated with effective emittances of 0.03 and 0.05 to show the magnitude of the decrease in thermal resistance. The calculation is based on published hot-box data.^{2,3} The R-values in Table 1 are for an average air space temperature of 75°F and a temperature difference across the air space of 10°F. The differences in R-value for the cases listed in Table 1 are tenths of an R-value in most cases. The maximum differences in R-value between enclosed air spaces with effective emittances (E) 0.03 and 0.05 occurs for heat-flow down because thermal radiation in a dominate mode of heat transfer for heat-flow down and thermal radiation is proportional to emittance. The R-values in Table 1 have units $ft^2 \cdot h \cdot ^\circ F / Btu$ commonly used in the United States.

TABLE 1. R-VALUE COMPARISON

Heat Flow Direction	Air Space (inches)	R-value E=0.03	E=0.05	R-value difference
Up	0.5	2.17	2.07	0.10
	1.0	2.42	2.30	0.12
	2.0	2.64	2.50	0.14
Horizontal	0.5	2.52	2.39	0.13
	1.0	3.87	3.58	0.29
	2.0	3.76	3.49	0.27
Down	0.5	2.55	2.42	0.13
	1.0	4.58	4.18	0.40
	2.0	7.64	6.59	1.05

product feature

BY DAVID W. YARBROUGH, PHD, PE



$$R_{TOTAL} = R_1 + R_2$$

Figure 1: Hybrid Assemble with Additive R-values

Hybrid Insulation Assemblies

Increases in required amount of thermal resistances, the march toward zero-energy buildings, and the need to control the cost of construction has promoted the use of combined insulation technologies to create hybrid assemblies with additive R-values as diagramed in Figure 1 provides a designer or specifier an opportunity to optimize a building's insulation package with respect to performance and cost. Insulation systems that combine reflective technology with foam insulation or mineral fiber insulation are currently available in the marketplace. An example of an established type of hybrid assemble with a reflective component is pictured in Figure 2.

The effective emittance (E) combines the emittances of parallel surfaces into a single value.⁴ The emittance of non-

reflective surfaces such as wood was taken to be 0.90 in the present case.

35,000 products in stock for when you need it...
YESTERDAY!

ABM Panel Lumber Trusses
Ridge Cap Ultra Vent (20' Rolls)
Windows 40-year Screws
GluLam Posts Stock Trims

And More!

82 Garden Spot Road Ephrata, PA 17522
35 Ridge Road Newville, PA 17241
717-445-6885 717-776-5951
Building Supplies for the East Coast • abmartin.net

A. B. MARTIN
ROOFING SUPPLY, LLC
Roofing & Siding • Hardware • Lumber

Circle Reader Service #291

**IN A WORLD WITH HAZARDS
YOUR PAINT SYSTEM SHOULDN'T BE ONE OF THEM**

When dealing with harsh environments that last thing you want to leave for chance is your paint system. At Everlast, your color will last longer, thanks to COLORBOND®. The COLORBOND® paint system provides superior protection and resistance against weather and UV exposure. Backed by 50 years of extensive research with both field and real-world testing, COLORBOND® has surpassed all other pre-painted steel.

Available in 17 long-lasting colors exclusively through Everlast Roofing in the U.S.A., COLORBOND® is our paint system of choice...not chance!

EVERLASTROOFING.COM
888.339.0059

Everlast Roofing, Inc.
OUR NAME SAYS IT ALL

Colorbond®

Circle Reader Service #407

product feature

BY DAVID W. YARBROUGH, PHD, PE

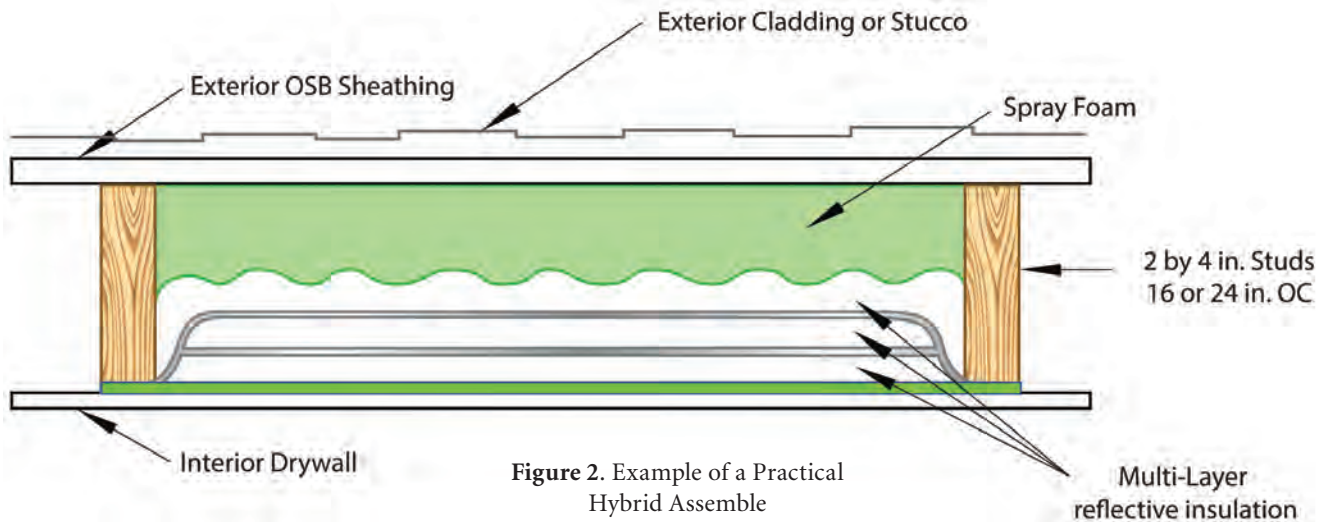


Figure 2. Example of a Practical Hybrid Assemble

R-values in series are additive and the temperature difference across each layer of insulation is a fraction of the total temperature difference across the region containing the hybrid assemble. Figure 3 illustrates this partitioning of the total temperature difference for a specific case with heat flow down across a 3.5-inch air space. The effective emittance of the air space is 0.05. The result for the R-value of the reflective air space was calculated

using a published iterative procedure.⁵ Hybrid assemblies like that in the Figure 3 diagram are especially favorable for reflective insulations since the reduced temperature difference across the air space is much less than the overall temperature difference thus reducing the magnitude of natural convection, if any, in the enclosed air space.

The reflective region of a hybrid assemble can be designed to have a single low-emittance surface, can be used to

form two enclosed reflective air spaces, or a multi-layer reflective insulation can be installed if space permits. The thermal resistance contributed by the introduction of two, three, or more enclosed reflective air spaces in a region like that shown in Figure 2 significantly increases the reflective contribution to the overall thermal resistance. Large air spaces for example between floor joists provide space for multi-layer reflective surfaces



About The Author

David Yarbrough is with R&D Services, Inc. a testing and consulting company located in Cookeville, Tennessee. He is a registered professional engineer in the states of Tennessee and Florida. He is a Professor of Chemical Engineering, emeritus and a retired researcher from the Oak Ridge National Laboratory. Dr. Yarbrough is a "Fellow" of the American Society of Testing and Materials (ASTM), the Tennessee Academy of Science, and the International Thermal Conductivity Conference.

GREINER
BUILDING SOLUTIONS

"Building Solutions For The Future"

www.greinerbuildingsolutions.com

(319) 863-3232

Providing safety and convenience with new building solutions

- Greiner Earth Anchor Systems
- Temporary Frame Anchor & Cabling system

Contractor Friendly, Affordable

- Your One Stop Shop for Post Frame & Building needs

product feature

BY DAVID W. YARBROUGH, PHD, PE

SUMMARY

Improvements in design, testing, quality control, and verification are contributing to an insulation technology that provides flexibility in specifying materials and systems for insulating the building enclosure.

References

- 1 RIMA International: www.rimainternational.org
- 2 Robinson, H.E., F. J. Powell. and R.S. Dill, "The Thermal Insulation Value of Air Spaces", Housing Research Paper 32, U.S. National Bureau of Standards (1954).
- 3 Desjarlais, Andre O. and David W. Yarbrough, "Prediction of the Thermal Performance of Single and Multi-Airspace Reflective Insulation Materials, ASTM STP 1116, Insulation Materials: Testing and Applications, Second Volume, edited by R. S. Graves and D. C. Wysoci, American Society for Testing and Materials (1991).
- 4 2017 ASHRAE Handbook – Fundamentals, Chapter 26, Table 3, note "e".
- 5 Ibid 3

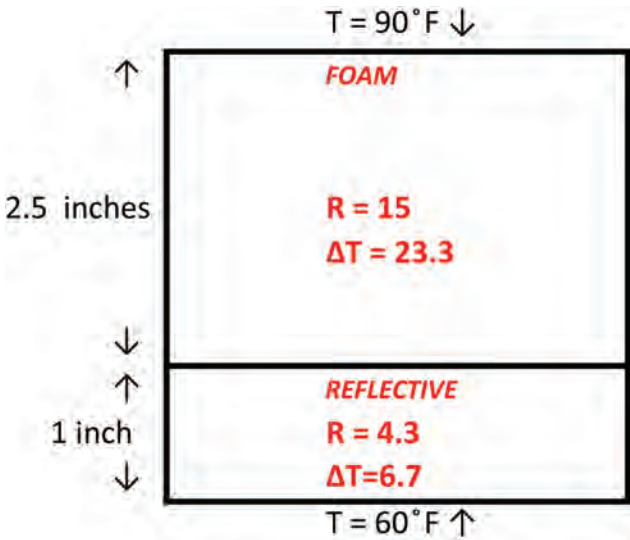


Figure 3. Illustration of Temperature Differences Across a Hybrid Assemble

and creative combinations of insulation technologies. Aluminum foils and metallized films also contribute to the control of water vapor transmission and

qualify as air barrier material in many cases thus adding to the versatility of the product type. **RB**

Royal Crowne Cupolas

717-288-2630

*** 120 mph Wind Rated**

*** Easy installation**

*** Sizes 24" - 72"**

*** Square or Octagon**

*** Louvers or Windows**

*** Weathervanes**

www.royalcrowne.com

Circle Reader Service #426

Thermal Building Concepts
1-877-703-2323 Insulation3Ht.com

Thermal 3Ht's unique combination of components create a high performance insulation. It can be used with all types of construction: agricultural, commercial, residential, basement walls and under concrete. To properly insulate any building you must find an insulation that controls all three forms of heat transfer and can perform in any climate zone. Does your current insulation provide, prevent, resist **Y N** or have the following check list?

<input checked="" type="checkbox"/> or have the following check list?	<input type="checkbox"/> Radiant Heat <input type="checkbox"/> Convection <input type="checkbox"/> Conduction <input type="checkbox"/> Thermal Bridging <input type="checkbox"/> Water Resistant <input type="checkbox"/> Insect & Mold Resistant <input type="checkbox"/> Stable Performance <input type="checkbox"/> Non-toxic / Recyclable <input type="checkbox"/> Durable <input type="checkbox"/> Saves Energy <input type="checkbox"/> Lowers Utilities <input type="checkbox"/> Recyclable
--	---

Real World Results

Circle Reader Service #411
WWW.CONSTRUCTIONMAGNET.COM