CELLOFOAM®
North America Inc.

TECHNICAL NOTE #105

Incremental R-Value for Cellofoam Poly Shield®
EPS Insulation with a Reflective Facer

Cellofoam's Poly Shield® heat laminated sheathing is made of Cellofoam expanded polystyrene (EPS) rigid insulation, faced on both sides with a tough poly laminate. These facers add considerable strength and durability, enhancing the storing, handling, and installation of this high-efficiency and low-cost insulation. A popular Poly Shield® option is to replace the clear poly laminate backing with a reflective metalized facer. In a properly designed wall assembly, the reflective facer retards radiant heat flow and offers a significant increase in R-value, or thermal resistance, relative to non-reflective insulation. This option is offered for all Poly Shield® EPS insulation products, including standard 4 x 8 ft sheathing as well as Fan-Fold configurations.

When properly installed in an appropriately designed wall system or assembly, expanded polystyrene insulation with a reflective facer can provide a boost in insulative performance due to its enhanced deterrence of radiative heat transfer. This incremental R-value compared to plain insulation is highly dependent upon a number of factors, particularly the reflectivity of the facer or its inverse, the effective emittance, the position of the dead air space (vertical, sloped, horizontal, etc.), the mean temperature of the wall assembly, the temperature differential from one side of the wall assembly to the other, the angular direction of the heat transfer through the wall assembly, and the depth of designed-in dead air space that the reflective side faces. The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbook provides tabular data for this incremental R-value for insulation based on variations of these parameters. These variations are quite extensive, and with different assumptions a wide range in incremental R-values can be found. The “dead air space” is an enclosed and unventilated air cavity designed to minimize air flow into and out of the cavity.

To promote consistency and fair advertising, the US Government has enacted laws on how insulation R-values can be claimed. The Code of Federal Regulations *CFR Title 16, Chapter I, Subchapter D, Part 460 - Labeling and Advertising of Home Insulation, Para 460.5 R-value Tests,* specifies several of these assumptions used in testing and calculating R-values. The CFR requires, for example, home insulation manufacturers to periodically acquire thermal resistance test data for their insulation and use the tabular data provided by the ASHRAE Handbook to determine the incremental R-value for the EPS insulation with a reflective facer. The CFR specifies that the R-value tests must be accomplished at a mean temperature of 75 deg F and with a temperature differential of 50 deg F plus or minus 10 deg F. The tests must be done on the EPS insulation material alone, excluding the facer and any air space, and the total R-value of the insulation is simply the tested R-value of the plain insulation added to the incremental R-value from the ASHRAE tables for particular dead air spaces. The CFR also specifies several of the assumptions, including the use of the incremental R-value data for reflective facers taken at a mean temperature of 50 deg F with a temperature differential of 30 deg F.

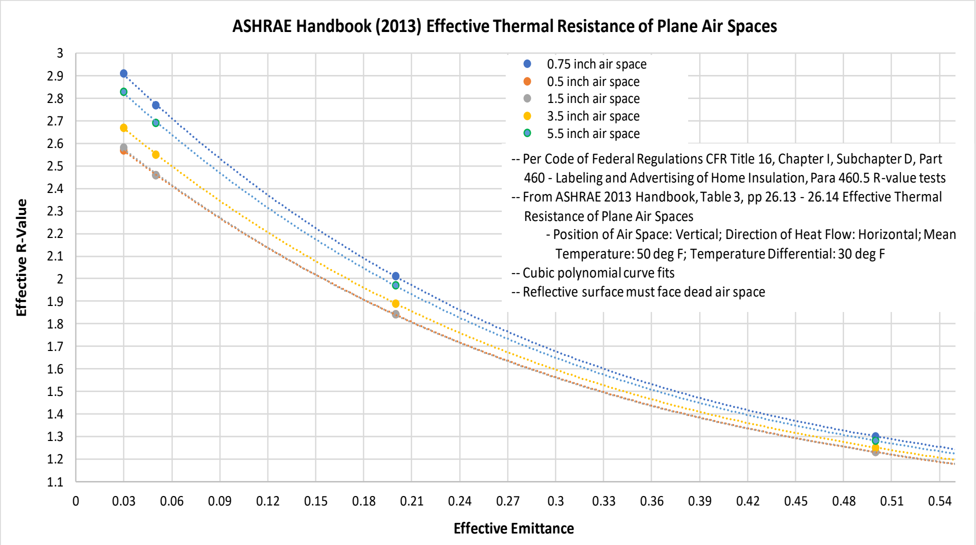

Figure 1. Incremental Thermal Resistance for a Reflective Facer with Dead Air Space

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Figure 1 shows a plot of incremental R-values for insulation with a reflective facer as a function of dead air space and effective emittance of the facer, acquired from the ASHRAE 2013 Handbook using Table 3, pp 26.13 - 26.14, *Effective Thermal Resistance of Plane Air Spaces,* with the following parameters: Position of Air Space: Vertical; Direction of Heat Flow: Horizontal; Mean Temperature: 50 deg F; and Temperature Differential: 30 deg. The data was curve-fit with cubic polynomials and the reflective surface is assumed to face the dead air space.

A quick look at the data reveals several notable points. First, we see that the incremental R-value for EPS foam with a reflective facer can range from about 1.2 to 3.0, depending upon the circumstance, a nice addition to the insulation's performance. Second, the incremental R-value drops dramatically with increasing effective emittance. This is intuitive as one would expect the radiative heat transfer to decrease with increasing reflectivity of the facer material.
The change in incremental R-value with dead air space, however, isn't as intuitive. As shown in Figure 1, the effective or incremental R-value is greatest for the 0.75 inch dead air space, drops significantly with increasing air space at 1.5 inches but climbs again with the 3.5 and 5.5 inch air spaces. This nonlinearity of the data suggests rather complex transport media might be involved such as fluid dynamics of air convection currents, impacted by wall friction, boundary layers and other dimensional effects, well beyond the scope of this Tech Note.

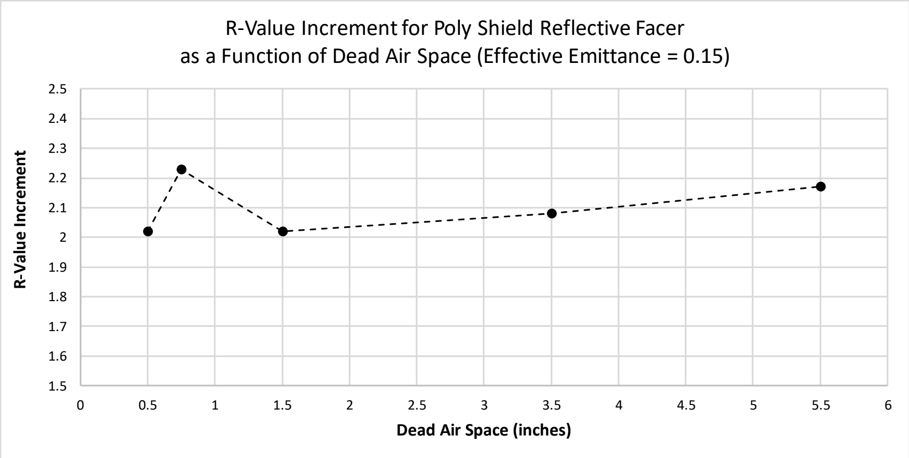

Figure 2. R-Value Increment for Cellofoam Poly Shield® EPS Insulation with a Reflective Facer as a Function of Dead Air Space in a Wall Assembly

The metalized reflective facer used by Cellofoam North America Inc in manufacturing Poly Shield® EPS insulation has an effective emittance of about 0.15. Figure 2 presents a plot of the incremental R-values from Figure 1 for the different dead air spaces at this effective emittance.

Figure 2 shows that an air space of about three-fourths of an inch can provide an R-value increment of 2.2 for Cellofoam Poly Shield® EPS insulation when it is manufactured with its reflective facer option and the insulation correctly installed in a well-designed wall system. Similarly, air spaces of even as small as half of an inch can provide an incremental R-value of slightly over 2.0, while the data shows larger air spaces of even 3.5 or 5.5 inches can significantly improve the insulation's thermal resistance by roughly 2.1 and 2.2, respectively.

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