EnergyIdeas Clearinghouse

PTR #16.1
May 2007

Product & Technology Review

Insuladd®

A ceramic-based additive for paint that helps reflect radiant heat.

Manufacturer

TECH TRADERS INC.
The INSULADD Company
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Merritt Island, FL 32952
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Distributor

Same as Manufacturer (see above)

Product History

The product debuted in the Pacific Northwest in January 2004.

Product Function and Application

The following three sections are based on information from the manufacturer. See the section titled *"Additional Reviewer Comments"* for our assessment of these claims.

Insuladd is a paint additive that helps it to reflect radiant energy. Insuladd can be added to ordinary paint and stucco mixes and used on both interior and exterior walls, ceilings and roofs. On exterior surfaces, Insuladd reflects the radiant energy of the sun to help reduce the cooling load. On interior surfaces, Insuladd reflects the radiant energy from heated objects, reducing energy transfer to the walls.

Insuladd additive is a blend of microscopic hollow ceramic spheres. When the paint dries, these little spheres pack together, making a tight layer with increased reflectivity.

Image provided by The Insuladd Company

Energy Saving Claims

The manufacturer claims that Insuladd paint additive, when mixed with light-colored house paint and painted on exterior walls, can reduce solar heat gain through the walls by over 20% during the summer. Energy consumption is reduced regardless of color when using Insuladd paint additive, but lighter colors are better. Winter savings from the reflection of

Product & Technology Reviews (PTR) are developed for Northwest electric utilities. EnergyIdeas Clearinghouse engineers review published literature for objective, independent test results. No primary testing was conducted by the reviewer for the preparation of this document. PTR factsheets describe the technology, discuss available data, and suggest additional testing needed to verify energy saving claims.
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infrared radiation from interior painted walls are less than summer savings, but the reduced loss of radiant heat from the occupants to room surfaces makes the space feel more comfortable.

Non-Energy Benefits

The manufacturer claims that Insuladd reduces heating and cooling equipment maintenance costs by reducing the run time of the equipment. The manufacturer also claims that the additive reduces condensation of water vapor on the walls, which helps reduce mold and mildew growth.

Independent Testing Results

To help readers better understand this information, a fact sheet on heat transfer building products is available at: *www.energyideas.org/documents/factsheets/PTR/HeatTransfer.pdf*.

Geoscience Ltd[1] was commissioned by Insuladd's manufacturer for the first three studies discussed in this section. Geoscience's President, Heinz F. Poppendiek, PhD, P.E., is author of these studies.

1. *A Study of the Energy Savings That Can Occur When Using Insuladd® Solar Reflective Paint on Irradiated Building Walls*, April 2003.

In this study, Geoscience was tasked with determining the amount of insulation that needed to be added to a building wall painted with ordinary paint to yield the same thermal heat flux as one painted with Insuladd ("equivalent R-value")[2] and defining a mathematical thermal wall model that would allow the calculation of thermal performance characteristics when system parameters are changed.

Based on experimental results under one particular set of conditions, Dr. Poppendiek calculated that an insulation value of R-6.0 would have to be added to the panel painted with latex paint to match the heat flux of an Insuladd-painted panel. As a reference point, the conditions used in the test approximately correspond to a horizontal surface, such as a roof, at high noon in June in Seattle, Washington. Therefore, these results indicate the maximum equivalent R-value with freshly applied paint in the Pacific Northwest. The average equivalent R-value for a roof exposed to a sunny and cloudy weather and at various times of day would be less than this, and for a vertical wall would be significantly less.

The mathematical model proposed by Geoscience was "elementary" by Dr. Poppendiek's own admission and did not treat radiation heat transfer in sufficient detail to model the effect of Insuladd analytically. Regardless, Geoscience's study did provide crucial experimental results that can be used in a more rigorous heat transfer model (see *"Additional Reviewer Comments"*). These results are:

- Total solar absorptivity of light green latex paint with Insuladd: 0.19
- Total solar absorptivity of light green latex paint without Insuladd: 0.30

2. *Comments on How Exterior Paints and Interior Paints Can Play Roles in Conserving Energy*, June 2002.

In this study, two panels (sheetrock painted with white interior latex, one with Insuladd and one without) were tested according to ASTM E-408 and ASTM E-1918 to determine the infrared emissivities. Infrared emissivity results were:

- With Insuladd: 0.75 (ASTM E-408) and 0.81 (ASTM E-1918)
- Without Insuladd: 0.85 (ASTM E-408) and 0.85 (ASTM E-1918)

3. *A Study of the Energy Savings that can Occur when Using Insuladd Solar Reflective Paint on the Inside of Building Walls*, April 2003.

In this study, the value of painting the inside surface of a wall to achieve a reduction in energy by reflecting energy back into a room

was examined. Tests were conducted to compare ordinary house paint with paint containing Insuladd. The results of this test show an increase in the measured R-value for this particular configuration from R-5.59 to R-5.94 due to the change in radiation heat transfer at the surface under the specific conditions of the test[3]. This corresponds to an equivalent R-value of 0.35, representing a 6.26% increase under these specific conditions of the test (see *End Note 2* on "Equivalent R-Value").

4. *Measured Cooling Energy Savings From Reflective Roofing Systems In Florida: Field And Laboratory Research Results*, Florida Solar Energy Center, FSEC-PF-293-95, 1995, available online at *:www.fsec.ucf.edu/en/publications/pdf/FSEC-PF-293-95.pdf*

The Florida Solar Energy Center (FSEC) states on their website at *www.fsec.ucf.edu/en/consumer/buildings/homes/faq.htm* that they have "tested ceramic paints and found them to have no significant advantage over ordinary paint in terms of their ability to retard heat gains through exterior building surfaces." In e-mail communication with a FSEC representative, they referred us to the Oak Ridge National Laboratory study below for information on ceramic products.

FSEC performed field studies of reflective white elastomeric coatings applied to roofs composed of asphalt shingles, tile, metal, and tar paper. This study did not include studies of ceramic paint additives. These white elastomeric roof coatings significantly reduced the heat flux through the roofs. Solar reflectivity of these coatings and the associated thermal performance degraded by 17% after a year of exposure at one site and by 37% after three years at another site. Coated roofs were wet for much longer periods than conventional roofs because the lower temperatures of the roof, decking, and attic cause the roof surface to fall below the dew point earlier each evening and require more time each morning to warm.

5. *Radiation Control Coatings Installed on Federal Buildings at Tyndall Air Force Base (Volumes 1 and 2)*, Thomas W. Petrie and Phillip W. Childs, Oak Ridge National Laboratory, ORNL/CON-439/VI and ORNL/CON-439/V2, 1998. Refer to summary at *www.ornl.gov/sci/roofs+walls/roof/coatings.html*

Oak Ridge National Laboratory (ORNL) conducted studies of several reflective roof coatings, including white coatings containing ceramic microspheres. This study did not include ceramic material added to latex paint of various colors nor coatings applied to walls. The reflectivities of white ceramic coatings applied to smooth surfaces declined from initial reflectivities of 0.8-0.9 to 0.7 after 500 days of exposure and to 0.55 after 800 days of exposure. Regarding the economic payback of coated roofs, this study concluded that "[i]nstallation of a radiation control coating on anything but a poorly insulated smooth surface is difficult to justify on the basis of savings in energy costs alone."

Cost

Product	Manufacturer's Suggested Retail Price
32 oz. for adding to 1 gallon of paint	$12.99
160 oz. for adding to 5 gallons of paint	$44.95

Alternative Products and Strategies

There are several other paints, coatings and paint additives on the market with similar characteristics, each with unique claims and applications. Competing products include:

- Hollow ceramic "popcorn-shaped" particles added to paint;
- Hollow-core ceramic micro-spheres, titanium dioxide and 20 other ingredients in an acrylic resin, water-borne suspension;
- Ground microscopic ceramic spheres that form "plating" to act as insulation that blocks heat;

- Liquid ceramic coating that uses hollow ceramic particles in a micro-porous latex base; and

- Acrylic elastomeric roof coating that contains micro spheres and rust inhibitors for application over metal roofs.

Case Studies

Several case studies and test results are available on the manufacturer's website. Other than these, we have not been able to find independent case studies on the product.

Suggestions for Further Research and Testing

Independent test studies resulting in solar reflectivities and infrared emissivities for certain paint products with and without Insuladd have been performed in indoor, laboratory environments. Such tests are not adequate to predict how this product will perform over time in a real application. It is most important to determine how the reflectivity and infrared emissivity of this product are maintained over time when exposed to weather, dirt build-up and solar radiation. Existing laboratory results may also be specific to the base paints used in the testing. If further testing is performed in an exterior environment over time and/or for a broader range of paint products, colors and substrates, we suggest complete documentation of testing methods and products. Documentation should include details of the paint product (e.g., manufacturer, interior or exterior use, gloss versus flat, binder) and the surface on which it was painted (e.g., exterior sheathing, sheetrock).

The maximum possible heat gain reduction under ideal conditions can be established in standard heat transfer calculations, as were performed as part of this review, using properties that must be measured experimentally (refer to the section *"Additional Reviewer Comments: Analysis Results"*). Such a heat transfer analysis could be combined with building load calculations and annual weather data for a range of scenarios to predict maximum possible energy savings for typical building applications. Whether such further study is warranted should be carefully considered, however, given that reflectivity of painted surfaces generally declines considerably with time and that heat gain reductions even for surfaces freshly painted with Insuladd are significant only for sun-bathed surfaces.

If applied to interior surfaces, this type of product might be beneficial in buildings with radiant heating systems or industrial facilities where there are large temperature differences. Such applications were not investigated in this review and might be considered for further study. Again, in any application, the effectiveness of the product will depend on maintaining its reflectivity over time. For non-radiant heating systems and more typical temperature differences, calculations indicate that the potential benefit of reflective paint coatings on interior surfaces is small even for freshly painted surfaces.

One result of analytical and experimental studies might be equivalent R-values (R_e)[4]. We emphasize, however, that an equivalent R-value is most useful if averaged over the entire year and cataloged for specific climates and constructions. Equivalent R-values determined under steady-state laboratory conditions, such as those posted on the websites of some of Insuladd's competitors, are useful only insofar as they define the maximum possible benefit for the given construction. Conditions used in such testing must be examined carefully and skeptically.

Many tests are being conducted on reflective paint products to determine their true R-value (as opposed to an equivalent R-value). Because these products are applied in very thin layers, they cannot significantly reduce conduction through a building envelope. Even a product with a very low conductivity will not provide significant insulation value when applied as paint. Therefore, further study of conductivity and true R-value is not recommended for these products.

Additional Reviewer Comments

As part of this review, we performed heat transfer calculations based on standard methods described in texts such as Incropera and Dewitt (2002). This analysis was limited to interior and exterior walls and interior ceilings. Reflective coatings applied to roofs have previously been studied by FSEC and ORNL as described above. Our analysis method included solar insolation and used an iterative calculation of radiative and convective air films[5], using laboratory test results reported by Geoscience for freshly painted light green and white surfaces. Contact the EnergyIdeas Clearinghouse for details of our calculations.

Analysis Results:

Calculations indicate the following trends for the *freshly applied paint* with Insuladd additive:

- For an exterior, light green surface, summer heat gain may be reduced by a maximum of approximately 20% when fully exposed to the sun. Actual heat gain reduction depends on maintenance of the surface's higher reflectivity over time and so will be less as reflectivity declines in a real environment.
- For an exterior, light green surface exposed to the sun, winter heat loss may be *increased* by approximately 35%. In the Pacific Northwest, however, Insuladd would likely only negligibly increase heating energy use, if at all, even on freshly painted surfaces because our winters are predominantly overcast.
- Insuladd appears to have no significant effect on the heat gain or heat loss of light green exterior wall surfaces if the wall is not exposed to the sun, i.e. shaded or on overcast days.
- When applied to white interior wall surfaces, the reductions in heat loss and gain are negligible (1.5% or less) for indoor temperatures typical with standard heating systems. Savings may be somewhat greater with radiant heat, but we did not explore by how much.
- When applied to white interior ceilings, the reduction in heat loss and gain are negligible (0.3%) when roofs are well-insulated, and approximately 3% when roofs are uninsulated.

We caution that our analysis relies on reflectivities reported by Geoscience. Geoscience's laboratory tests were commissioned by Insuladd and so cannot be considered independent. In addition, these results apply only to freshly painted surfaces and so define the maximum possible impact. These results cannot be used to predict how the product will perform over time in a real environment. The reduction of solar reflectivity over time when exposed to weather has been well documented for many products and Insuladd is likely no exception. While a decline in reflectivity is especially true of roofs due to their horizontal orientation and poor accessibility for cleaning, it is in general also true for walls.

Even in the ideal case of high reflectivity maintained over the long term, keep in mind that the 20% reduction in heat gains calculated above applies only to freshly painted walls when exposed to direct sunlight. As all walls typically comprise less than a quarter of total building loads and at any time the sun-exposed wall may be just a quarter of this, the total reduction in cooling energy use will be much less, with the total dependent on the building layout and construction and the climate.

Applied to interior surfaces, the effect of Insuladd is small, but appears to be most effective when applied to the ceiling. Since this effect does not depend on sun exposure, this small benefit will apply to all interior surfaces painted with Insuladd.

Conclusion

The ORNL study previously found that, considering their decline in reflectivity over time, white reflective coatings applied to roofs are cost effective only for poorly insulated smooth surfaces. Regarding exterior walls, our heat transfer analysis – which relied on

reflectivities determined in laboratory tests commissioned by the manufacturer – indicate that Insuladd may reduce heat gains of exterior walls exposed to direct sunlight by at most 20% for freshly painted surfaces. However, its effect on total building energy use and peak cooling loads will necessarily be less than this, since at any time sun-exposed walls constitute a fraction of the building envelope. On interior walls, the benefit was found to be negligible with conventional heating systems.

Most importantly, any heat gain reductions depend on maintenance of the surface's higher reflectivity over time. Reflectivity of coated surfaces in general decreases – often dramatically and quickly – with exposure to weather, dirt build-up and solar radiation. Therefore, the benefit of this product over time on exterior walls in a real environment, while unknown, very likely may be small. Laboratory measurements on freshly painted surfaces in an indoor, protected environment are not adequate to predict how the product will perform over time in a real application and should be considered skeptically.

References

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Additional Information

Northwest businesses and utilities can contact the EnergyIdeas Clearinghouse for additional information on this, or other energy technologies and products. Contact:

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Reviewer

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Note: Product & Technology Reviews are peer reviewed by objective industry professionals prior to publishing.

End Notes

1 Geoscience Ltd, 6260 Marindustry Drive, San Diego, CA 92121. Geoscience's Thermal Property Testing Laboratory has received accreditation, certification, approval, or acceptance by the California Energy Commission, the Bureau of Home Furnishings, the National Voluntary Laboratory Accreditation Program, the International Conference of Building Officials, the Southern Building Code Congress International, Inc., Loral Aeronutronic, and the Special Process Supplier's Certification through Aerojet Liquid Rocket Company.

2 An "Equivalent R-Value" (expressed as R_e) is the increase in thermal resistivity (i.e. insulation value) that would result in an equivalent improvement in thermal performance as the non-conductive effect, in this case increased reflectivity. It is only valid under the particular set of conditions of the test. An R_e-value is useful, for both lay people and building scientists, in quantifying the benefit in terms that are more intuitive. An R_e-value must not be confused with a true R-value. Such confusion can lead to, for example, the false impression that painting a house with reflective paint will result in a high insulation value under all conditions (some manufacturers claim unrealistic values of R-20).

3 We emphasize that this change in R-value is not due to a reduction in conduction due to the insulative value of the paint layer, but to the effect a change in reflectivity has on radiation heat transfer at the surface. In any measurement of R-values there is both a convective and radiative component of heat transfer at the surface and this will be reflected in the final result.

4 An equivalent R-value is useful, for both lay people and building scientists, in quantifying the benefit in terms that are more intuitive. See **Heat Transfer Basics**, *a factsheet to be published in 2006 by the Energy*Ideas Clearinghouse.

5 Tabular values for film coefficients, such as those given in **ASHRAE 2005 Fundamentals** *(Chapter 25, Table 1) or* **McQuiston, Parker and Spitler**, *2000 (Table 5.2a), are not appropriate in this case because they were developed for specific surface properties and under specific temperature and convective conditions. To study the effects of varying emissivity and windspeed, film coefficients must be calculated.*

WSUEEP07-008