A Study of the Energy Savings that can Occur when Using Insuladd Solar Reflective Paint on the Inside of Building Walls

For

Tech Traders

By

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Introduction

If the emissivities in the infrared region of interior wall paints are lower than ordinary paints, then the radiant heat transfer from the outer walls of rooms can influence the energy savings and comfort of persons in the rooms. Under wintertime conditions, where furnace heating is normally required in residences and buildings, if the interior wall paints have lower emissivities than normal paints, ambient room temperature cooling would be less and the comfort level of persons in the rooms would be greater. Specifically, the radiation heat loss to cold, interior outer walls would be less, and the ambient air temperature reduction would be less. Thus, energy can be conserved if low emissivity interior wall paints are utilized.

David Page, of Tech Traders, Inc., asked Geoscience to investigate this thermal system.

Mathematical Thermal Room Model That Defines Energy Savings via Low IR Emissivity Paints

This thermal room model describes heat transfer processes that are operative in the wintertime. Specifically, convection from warm room air and radiation from warm inside walls to the inside surface of the outer room wall surface are conducted through the outer room wall and finally lost by convection and radiation to the ambient, could outside air and the could outside surroundings. The equations that define the heat transfer follow:

1) The heat flux from the warm room to the interior surface of the outer wall, $\frac{q_i}{A}$, is*

$$\frac{q_i}{A} = \left(\frac{1}{R_{cv_i}} + \frac{1}{R_{r_i}}\right)\left(t_{a_i} - t_i\right)$$

Where, R_{cv_i} = convective air resistance for the inside surface of the outer wall, hr ft^2 °F/Btu

R_{r_i} = radiative resistance for the inside surface of the outer wall, hr ft^2 °F/Btu

t_{a_i} = mean room air temperature, °F

t_i = hot side temperature of the outer wall, °F

2) The heat flux through the outer building wall, $\frac{q_w}{A}$, is

$$\frac{q_w}{A} = \frac{t_i - t_o}{R_w}$$

where, t_o = cold side temperature of the outer wall, °F

R_w = thermal resistance of the outer wall, hr ft^2 °F/Btu

3) The heat flux from the exterior surface of the outer wall, $\frac{q_o}{A}$, is

$$\frac{q_o}{A} = \left(\frac{1}{R_{cv_o}} + \frac{1}{R_{r_o}}\right)\left(t_o - t_{a_o}\right)$$

where, R_{cv_o} = convective air resistance for the outside surface of the outer wall, hr ft^2 °F/Btu

R_{r_o} = radiative resistance for the outside surface of the outer wall, hr ft^2 °F/Btu

t_{a_o} = mean ambient air temperature of the environment, °F

* In this thermal model, it is postulated that the air and mean radiant temperatures are equal, in the building room as well as in the outside environment, respectively.

Upon rearranging Equations (1), (2) and (3) and taking note that the three heat fluxes in the three equations are all equal at steady state, one adds the three equations and obtains,

$$\frac{q}{A} = \frac{t_{a_i} - t_{a_o}}{\frac{1}{\frac{1}{R_{cv_i}} + \frac{1}{R_{r_o}}} + R_w + \frac{1}{\frac{1}{R_{cv_o}} + \frac{1}{R_{r_o}}}}$$

The denominator in this Equation is the total thermal resistance of this thermal heat flow circuit.

The Experimental System

A wall test panel having an R value of 2.75 hr ft^2 °F/Btu was chosen to perform this test work. It is pointed out that a typical building wall R value is about 11 hr ft^2 °F/Btu and the R value for a window system with a ½" air space between two glass panes is about 0.6 hr ft^2 °F/Btu. Thus, it was thought to be appropriate to use a panel having an intermediate R value for the subject test effort* (specifically, a R value of 2.75 hr ft^2 °F/Btu). The surfaces of the panel were instrumented with surface thermocouples and a thin, calibrated heat flux transducer was located on the cold side of the wall panel. A cardboard box with an open side was placed over the hot side of the test panel; this box then simulated a building room. A large plate electric heater was located opposite the panel to heat the simulated building room. Hot and cold air thermocouples, as well as a hot wall room thermocouple were also added to the system. The various heat transfer processes that occur in the test system were previously defined in section II above.

Test Procedure

The hot and cold panel surface temperatures, the hot and cold air temperatures and the hot wall temperatures and steady state heat fluxes were measured. One set of data was obtained for the case where the room walls and the test panel interior surface were painted with ordinary house paint; another set of data was obtained for the case where Insuladd paint was used.

From the two sets of data, the energy savings that accrue when using Insuladd is determined.

*In future testing, it would be better to perform two separate tests, one where only a wall is used and another test where only a window is used.

Test Results

The test results for the two paint types follow:

	Test System with Ordinary paint	Test System with Insuladd paint
Heater power, watts	42.5	37.9
Wall panel heat flux, Btu/hr ft2	2.38	1.97
Hot wall surface temperature, °F	100.2	99.0
Hot side temperature of wall panel, °F	90.8	91.8
Hot air temperature, °F	92.1	91.2
Cold air temperature, °F	78.8	79.5
Total thermal resistance (air to air) hr ft2 °F/Btu	5.59	5.94

Concluding Comments by Tech Traders

The results outlined in the previous section clearly demonstrate an energy Savings as a result of using Insuladd; specifically the total thermal resistance of the model has increased with a corresponding drop in the Heat Flux.

Real life Energy Surveys find that the energy savings realized from the inclusion of Insuladd into interior house paint ranges from 10% to 22% depending on the type of construction, location, and exposure of the home.

An energy savings increase of only 10% in actual heat flux (heat loss) can equate to a much greater increase in actual energy savings due to the increased amount of time that Insuladd helps a homes interior remain in the "human comfort zone".

The human comfort zone is that small range of temperature where humans (and animals) feel most comfortable. This zone is quite narrow and tends to be between 70 deg. F. to 78 deg. F. When indoor temperatures stray outside of the "human comfort zone" we use heating or air-conditioning to bring the temperature back within the zone.