SUPER THERM®

THEORY OF HEAT TRANSFER

This tutorial is simply intended to give some of the basics of Thermodynamics , and how it relates to insulation and ceramic insulation coatings.

HOW DOES HEAT MOVE?

Heat moves through one of three basic methods:

- **Conduction** is the energy transfer through solids. Different types of solids transfer heat more easily than others, with metals among the most conductive and ceramics among the least conductive.
- **Convection** is energy transfer through gasses or liquids. Currents carry heat energy through the liquid or gas. Most heat energy is transferred through Convection.
- **Radiation** is energy transferred through electromagnetic waves. One of the most well-known forms of Radiation heat is the heat created by the sun.

Radiation converts to Conduction or Convection heat when it comes into contact with a solid, liquid or gas.

HOW DOES THE SUN'S RADIATION WORK?

Engineering studies performed by the US Government using independent research firms have concluded that the sun's **Radiation** produces heat from the following sources:

- Ultra Violet (UV) which represents 3% of the heat
- Visual light or short wave radiation represents 40% of the heat
- Infrared radiation or long wave represents 57% of the heat

HOW IS HEAT ATTRACTED?

As a simple rule, heat always follows cold. Just like water, heat will move through the path of least resistance until it reaches a state of equilibrium.

HOW DOES CONVENTIONAL INSULATION WORK?

Traditional insulation, including fiberglass, cellulose, polyurethane foam and other solids, contain small pockets of air that slow the Conduction heat transfer. They do not block or prevent the transfer of heat. Traditional insulation only slows the Conduction heat transfer. However, heat will be absorbed, will load, and will transfer. The rate of transfer is also substantially effected from the moment water/moisture is present.

Traditional insulation absorbs 100% of the Radiation heat, and then attempts to slow down the transfer of Convection and Conduction heat.

WHAT IS R-VALUE?

An R-value is a measure of how well a conventional insulation resists heat transfer through Conduction only. It was developed to test the insulating properties of traditional insulation and ignores heat transfer by Radiation and Convection. It measures only "Conduction heat transfer" – how much and how fast it absorbs heat and transfers it through a specific insulation.

IS THERE A DOWNSIDE TO R-VALUE TESTING?

Yes - The R-value system was originally developed when the first mass insulation, fiberglass, was initially developed. When the tests were put into place, they were designed to measure the properties of fiberglass in a *best case scenario.* The ASTM test is specifically designed to measure Conduction, in a controlled environment.

- The test does not account for environmental impacts such as air movement (wind) or any amount of moisture (water vapor).
- The test does not measure insulation against Convection or Radiation heat transfer.

Real world situations can compromise the R-value of traditional insulation substantially. For example, traditional insulation can lose 35% of its R-value when as little as 1.5% humidity is introduced.

HOW IS SUPER THERM DIFFERENT?

SUPER THERM has the ability to block all 3 of the different Radiation waves produced by the sun. SUPER THERM not only blocks these waves when first applied, but continues to block them after the coating becomes dirty (unlike traditional “reflective paints” that only reflect the Visual light (40% of the problem) due to their white colour, but lose effectiveness drastically when the paint becomes dirty).

The ceramics used in SUPER THERM were chosen from over 3,200 compounds, which were studied and tested in order to prove that they would block the 3 different Radiation waves as effectively as scientifically possible, producing the following results:

- SUPER THERM blocks 99% of UV heat
- SUPER THERM blocks 92% of Visual Light (short wave) heat
- SUPER THERM blocks 99% of Infrared (long wave) heat

This results in an average of over 96% of the Radiation heat being blocked!

What does this mean? In order to block heat using the old methods of insulation, such as fiberglass, rock wool, foam, etc., the Radiation heat is 100% accepted and absorbed into the initial surface facing the sun. In order to slow down the heat transfer into the interior area, a thick material is placed on the opposite side of the initial surface to control/delay the Conductive heat load. The ability to do this determines the "R" value of the insulation.

But in the case of SUPER THERM, the "R" value is determined by an insulation’s capability to control heat "after the fact" - meaning that the initial surface facing the sun has absorbed 100% of the Radiation heat. SUPER THERM blocks 95%+ of the initial Radiation heat meaning that the initial surface facing the sun only absorbs 5% of the Radiation heat load, not 100% as in traditional insulating technologies. This ability alone is sufficient to beat any form of fiberglass, cellulose, polyurethane foam etc… as the most effective heat barrier.

Based on these results, debating the effectiveness of Conduction heat transfer with R-value's for the remaining 5% of energy input into or out of a building is insignificant. However, there is more … In order to fully understand the potential of SUPER THERM, it should be stated that of the 5% that is absorbed a further 91% is "emitted" from the surface after it has been absorbed.

WHAT IS EMISSIVITY?

The emissivity of a material (usually written ε or e) is the relative ability of its surface to emit energy by Radiation. It is the ratio of energy radiated by a particular material compared to energy radiated by a black body at the same temperature.

A true black body would have an $\varepsilon = 1$ which means it retains the full load of absorbed Radiation heat while any real object would have $\varepsilon < 1$. In general, the duller and blacker a material is, the closer its emissivity is to 1. The more reflective a material is, the lower its emissivity. Bodies with lustrous surfaces such as mirrors or burnished aluminium have low emissivity around 0.08 and thus retain practically no Radiation heat within themselves. Highly polished silver has an emissivity of about 0.02. SUPER THERM has the incredibly low emissivity value of 0.05, thus making it unable to retain almost any heat.

"Emissivity" has recently become very important issue in heat control for engineering and architectural groups. The higher the emissivity value, the more effective the surface of the coating is in throwing off the heat that was absorbed. The "black box" testing procedure is used to determine how much of the Radiation heat loading is emitted after it has been absorbed. SUPER THERM firstly absorbs only 5% of the Radiation heat (read above) and then throws off 91% of this absorbed heat due to emissivity. This has been tested and listed by three agencies to be correct under the newly developed testing procedures.

In short, this means that of the 5% Radiation heat that SUPER THERM absorbs, a further 91% of this heat is emitted back into the atmosphere, leaving only 9% of the 5% to be transferred through the material via Conduction. Ie: only 0.45% of the initial Radiation heat remains applicable for the measuring of SUPER THERM's traditional "R-value" rating, that in comparison to the 100% remaining for all other traditional insulators.

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SUPER THERM's ingenuous way of addressing an age-old problem is forcing even the most conservative of analysts to view "insulation" in a completely different way to what we were taught in the traditional school books.

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