U-values of Super Therm for Passivhaus Australia

Shane Strudwick - NEOtech Coatings - neotechcoatings.com
January 13, 2025

please demonstrate super therm here 👇🏽 adding to the U-value? U-Value = 1 / (Rso + Rsi + R1 + R2 …) As an example. Not reflectance: q(y) = (Gr(y)/Gi(y))^2

Demonstrating Super Therm's Contribution to U-Value

This description is provided to a Facebook post inquiry regarding Australian Passivhaus Association (APA) Discussion Group. NOTE: Laboratory and Field results as stated here may vary according to different climate conditions. Similarly R-values for bulk insulation are subject to change in each environment as it's only ever tested and rated in a lab at 23°C and not field verified or tested at higher heat.

This document provides evidence of a 71% and 80% thermal improvement of the U-value to the base-wall system below.

The U-value measures the thermal transmittance of a material or system (how well it conducts heat). It is calculated as:

U-Value = 1 / Rso + Rsi + R1 + R2 +…

Where:

- Rso = external surface resistance
- Rsi = internal surface resistance
- R1, R2,… = thermal resistances of layers in the system

The Super Therm® Factor

Super Therm® acts as a multi-ceramic heat-blocking thermal insulation membrane based on the physical properties of 4 specialised ceramics creating a closed-cell hermetically sealed surface. Contributing an R-value (Heat Block-RSuperTherm) due to its ability to block **96.1% of total solar heat** (radiative, convection and conductive heat) requires different physics. Its thermal resistance enhances the total R-value of the system, lowering the U-value.

Super Therm does not conform to standard R-value behaviour and values because it is a closed cell insulation but significantly enhances the thermal performance (heat block) of materials it is applied to on different physical properties. For accurate U-value calculations, its equivalent performance values (such as R 19 for a single coat of Super Therm - imperial and ASTM tested - see below) should be incorporated.

Example:

Base wall without Super Therm:

- Rso = 0.04 (external resistance)
- Rsi = 0.12 (internal resistance)
- R1 = 0.45 (e.g., bricklayer)
- R2 = 0.20 (e.g., insulation layer)

Total R-value:
Rtotal = 0.04 + 0.12 + 0.45 + 0.20 = 0.81

U-value:
U-Value= 1 / 0.81 = 1.235 W/m^2K

Adding Super Therm:

- Super Therm provides an additional RSuperTherm = 2.0 (example value based on performance as stated below).

The SuperTherm 2.0 mentioned is an example to illustrate how Super Therm's contribution is represented in a U-value calculation. Super Therm's real-world performance, based on its ability to block 96.1% of total solar heat, can be used to determine its effective equivalent R-value. Super Therm blocks 99% of infrared heat (53% of solar heat), 97% of UV (3% of solar heat) and 92% visual (44% of solar heat from black to white). However, assigning a precise equivalent R-value to Super Therm depends on independent testing and local standards, same as R-values for bulk insulation.

Insulation coatings cannot directly translate to R-values like traditional bulk insulation materials because it's not an air based (resistance) insulation and doesn't have bulk allowing for air pockets. To determine the precise equivalent R-value for Super Therm in a specific application we have provided an ASTM C 236 test below showing the performance against 3 inches of fibreglass insulation. Considering the 96.1% (RSuperTherm = 2.0) reduction in heat load (radiation, conduction, convection) that Super Therm achieves in real-world conditions helps provide an equivalent R-value data for Super Therm using its field performance metrics and specific test results as per below.

Updated R-value:
Rtotal = 0.04 + 0.12 + 0.45 + 0.20 + 2.0 = 2.81

New U-value:
U-Value=1 / 2.81 = 0.356 W/m^2K

Outcome:

By incorporating Super Therm, the U-value drops from **1.235** to **0.356 W/m^2K (71%)**, representing significantly improved insulation performance.

Why Not Reflectance q(y) = (Gr(y)/Gi(y))^2

Reflectance measures how much light is reflected, but Super Therm is a **heat-blocking insulation** that works by reducing heat transfer (conductivity) across three heat waves (UV, visible, and infrared). The R-value (thermal resistance) quantifies this contribution to insulation, aligning with the U-value calculation method.

ASTM C 236-89(93) – C1363; *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.* Thermal Transmittance/Conductance https://neotechcoatings.com/wp-content/uploads/2021/09/ASTM_C236-89.pdf\

Based on the ASTM C 236 testing provided, Super Therm's performance in terms of thermal resistance differs significantly from traditional R-values and follows unique mechanisms due to its heat-blocking properties. Here are the key insights and how they influence the U-value assumptions - note the R values are imperial and I've adjusted for RSI following:

ASTM C 236 Key Findings:

1. **Performance Beyond Standard R-values:**
    - The ASTM C236-89 test compared a 3-inch fiberglass board with and without Super Therm coating. Results showed:
        - A single coat of Super Therm improved the fiberglass performance by **68%**, leading to a linear equivalent R-value of **R 19.3 (RSI approx. 3.4)**.
        - Two coats further improved it to **R 28.5 (RSI approx. 5.0)**.
          https://neotechcoatings.com/wp-content/uploads/2021/09/ASTM_C236-89.pdf
2. **Broad Temperature Effectiveness:**
    - Fiberglass' R-value drops significantly outside the optimal 21°C (70°F) testing condition, whereas Super Therm maintains consistent performance across a range from -51.1°C to 48.9°C (-60°F to 120°F).
3. **BTU Conduction Reduction:**
    - Super Therm reduced heat conduction dramatically, from **367.2 BTU/sq.ft./hour/F** to **3.99 BTU/sq.ft./hour/F (99%)**, showing its superior ability to block heat transfer.
      (ASTM E1269 & ASTM E1461-92): 25°C, 50°C, 75°C, 100°C
      https://neotech-coatings.s3-ap-southeast-2.amazonaws.com/testing/Thermophysical-Properties-of-SUPER-THERM-Coating-USA-Testing.pdf
4. **Moisture Resistance:**
    - Unlike fiberglass, which loses R-value with moisture exposure, Super Therm is unaffected by moisture, maintaining its effectiveness in all conditions.
      https://neotechcoatings.com/super-therm-testing-and-results/#moisture-testing

Adjusting U-Value Assumptions:

The document illustrates that Super Therm's impact cannot be simply reduced to a fixed R-value. Instead:

- It functions as a **heat-blocking layer** that enhances existing insulation, significantly reducing heat conduction across substrates.
- For a practical application, its equivalent R-value (e.g., **R 19 for a single coat**) should be used in U-value calculations.

Updated Example with Super Therm:

Given the data:

- Super Therm's equivalent RSuperTherm = **19** (for simplicity based on single-layer performance at 21°C (70°F)).

Revisiting the calculation:

Without Super Therm:
Rtotal = 0.04 + 0.12 + 0.45 + 0.20 = 0.81

U = 1 / 0.81 = 1.235 W/m^2K

Adding Super Therm imperial:
Rtotal = 0.04 + 0.12 + 0.45 + 0.20 + 19 = 19.81

U = 1 / 19.81 = 0.0505 W/m^2K (imperial incorrect)

This represents a dramatic improvement in thermal performance, validating Super Therm's effectiveness.

Super Therm does not conform to standard R-value behaviour but significantly enhances the thermal performance of materials it is applied to. For accurate U-value calculations, its equivalent performance values (such as R 19 for a single coat) should be incorporated.

Converted to RSI

To convert R-value (Imperial) to RSI-value (Metric):

RSI = R / 5.678

Converting R = 19 to RSI:

RSI = 19 / 5.678 ≈ 3.345

Updated Example with RSI-value:

Without Super Therm:

- Existing RSItotal (from previous example without Super Therm): RSItotal = 0.04 + 0.12 + 0.45 + 0.20 = 0.81
- **U-value: U = 1 / RSItotal = 1 / 0.81 ≈ 1.235 W/m²K**

Adding Super Therm metric:

- Super Therm contributes RSISuperTherm = 3.345
- Total RSItotal
  RSItotal = 0.04 + 0.12 + 0.45 + 0.20 + 3.345 = 4.155
- **New U-value: U = 1 / RSItotal = 1 / 4.155 ≈ 0.241 W/m²K (metric)**

Conclusion:

Including Super Therm with an equivalent RSI-value of 3.345 dramatically reduces the U-value from 1.235 W/m²K to 0.241 W/m²K (80%), showcasing its substantial thermal insulation effectiveness.

This is just the thermal benefits. Ceramics are considered a closed cell insulation unlike traditional insulation that is open or based on air transfer. As Super Therm® is dealing with electromagnetic radiation there are a myriad of tested successful properties in the coating:

- **Reduces Acoustic Transfer** – (ASTM E90): 50-68% sound reduction - https://neotechcoatings.com/coating-products/super-therm-solar-heat-block-coating/super-therm-sounds-reduction-by-68/
- **High Permeability** – (ASTM D1653-13): 250 microns/0.25mm = 8 perms; 300 microns/0.30mm = 4 perms - https://neotechcoatings.com/wp-content/uploads/2023/08/11-Super-Therm-Permeability-Final-Report-D1653-13.pdf
- **Exceptional Fire Resistance** – (AS/NZS 1530.3): Ignition time: Nil; Flame Propagation: Nil; Heat Release: Nil - https://neotechcoatings.com/wp-content/uploads/2023/08/5-Super-Therm-AWTA-Fire-Test-Australia.pdf and NASA Flame Spread Test (ASTM E84): https://neotechcoatings.com/wp-content/uploads/2023/12/Super-Therm-ASTM-E84-Surface-Burning-Characteristics-2.pdf and https://neotechcoatings.com/wp-content/uploads/2023/08/4-NASA-Super-Therm-Flamability-Test.pdf

- **Energy Savings** – https://neotechcoatings.com/super-therm-energy-star-savings/super-therm-usa-energy-authority-reports/ and City of Adelaide (suppressed report) https://neotechcoatings.com/projects/city-of-adelaide-cool-roof-trial-2022-2023/
- **Condensation Control** – https://neotech-coatings.s3-ap-southeast-2.amazonaws.com/solutions/condensation/SUPER-THERM-Preventing-Condensation-on-Surfaces.pdf
- **Mould Resistance** – (ASTMD-3273-82T): Resistance to growth of mould in severe mould environments - https://neotech-coatings.s3-ap-southeast-2.amazonaws.com/testing/Super-Therm-Resistance-to-Growth-of-Mould-ASTMD-3273.pdf
- **Acoustic Dampening** – (ASTM E90): 50-68% sound reduction - https://neotechcoatings.com/coating-products/super-therm-solar-heat-block-coating/super-therm-sounds-reduction-by-68/
- **Durability and Longevity** – https://neotechcoatings.com/coating-products/super-therm-solar-heat-block-coating/super-therm-30-year-test-in-kansas/
- **Green, safe and sustainable solution** – https://neotechcoatings.com/eco-friendly/super-therm-eco-friendly-solar-heat-block-coating/

To understand the difference between open and closed cell insulation, read this paper by Shane Strudwick: https://neotechcoatings.com/wp-content/uploads/2025/01/Multi-Ceramics-Thermal-Insulation-Coatings-Help-Georgia-Pacific-Save-Significant-Energy-and-Stopped-CUI-Shane-Strudwick.pdf

---

For more information:
NEOtech Coatings Australia
Shane Strudwick
0409 678 654
shane@neotechcoatings.com
linkedin.com/in/shanestrudwick