

# Thermal insulation analysis using heat flux sensors

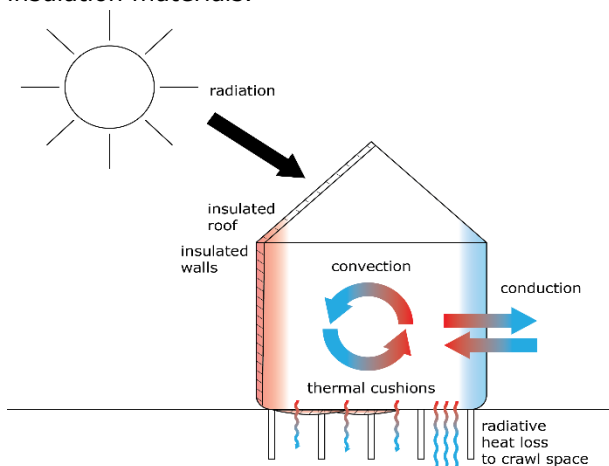
*TONZON & Hukseflux have worked together to improve home insulation products even further. By using Hukseflux's heat flux sensors, an accurate thermal image can be obtained regarding the value and direction of heat flow.*

## Introduction

To reduce our carbon footprint, it becomes increasingly important to thermally insulate residential homes. Not only does this reduce the energy bill, but it also increases thermal comfort. A market leader in this domain is **TONZON** which manufactures innovative insulation solutions.

## Heat loss in homes

There are various ways in which residential homes lose heat. From the components listed in Figure 1, radiative and conductive heat loss are most substantial regarding the effectiveness of insulation materials.



**Figure 1** Homes lose heat in various ways. The radiative and conductive heat loss are usually most significant.

A unique design property of TONZON's products is the ability to reduce radiative heat loss to near zero. This radiative heat transfer is described by:

$$q = \epsilon\sigma(T^4 - T_0^4)$$

Here,  $q$  is radiative heat transfer,  $\epsilon$  the emissivity factor, and  $\sigma$  a constant. The temperature of the surface and surrounding air is given by  $T$  and  $T_0$ . The direction of heat transfer is indicated by the sign of  $q$ . To minimise heat loss, TONZON uses materials with low emissivity properties.

Another important factor is the conductive heat loss that takes place due to direct contact of two

substances that differ in temperature. The performance of insulation is evaluated using the R-value. This measure represents thermal resistance such that higher values indicate better insulating properties. The following equation can be used to calculate the R-value:

$$R = \frac{\Delta T}{q}$$

Here,  $\Delta T$  is the temperature difference across the material and  $q$  the heat flux. A high heat flux intuitively indicates a low R-value, reflecting poor insulating properties and significant heat loss.

Higher R-values can be achieved by increasing volume (and thereby weight) of the insulating material. However, TONZON uses remarkably efficient designs that contain air as low thermal conductivity substance while also reducing radiative heat loss.

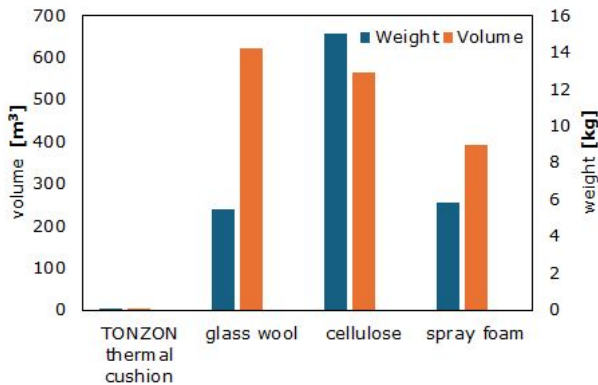
## Floor insulation

Homeowners can significantly reduce their energy bill and increase thermal comfort by using **TONZON's thermal cushions**, see Figure 2. These thermal cushions are designed to block radiative and conductive heat transfer to the crawl space and foundation walls.



**Figure 2** TONZON's thermal cushions significantly reduce heat loss and ensure thermal comfort through warmer floors and heat retention.

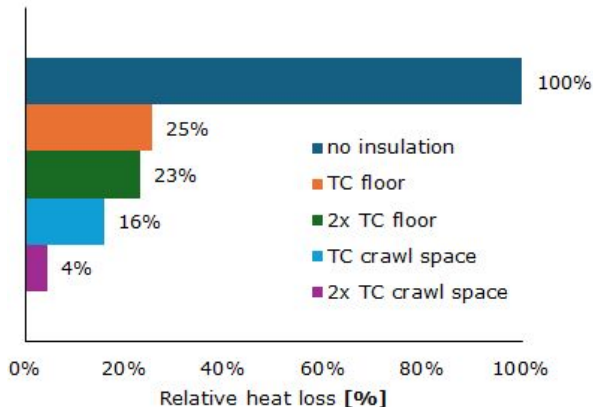
The material efficiency of TONZON’s thermal cushions compared to other common insulation materials is shown in Figure 3.



**Figure 3** Insulation materials require different thickness values to obtain an R-value of 7 (m<sup>2</sup>·K)/W. The blue and orange bar show the volume and weight for the necessary amount of each insulation material.

Heat flux sensors can help to analyse the complex heat transfer profile of this method of insulation. For example, a study done by TONZON measured the heat flux above and below the thermal cushions in scenarios with and without floor heating.

Results in Figure 4 show that the heat flux compared to floors without thermal cushions is reduced by around 84% or 96% when using one or two layers of thermal cushions respectively.



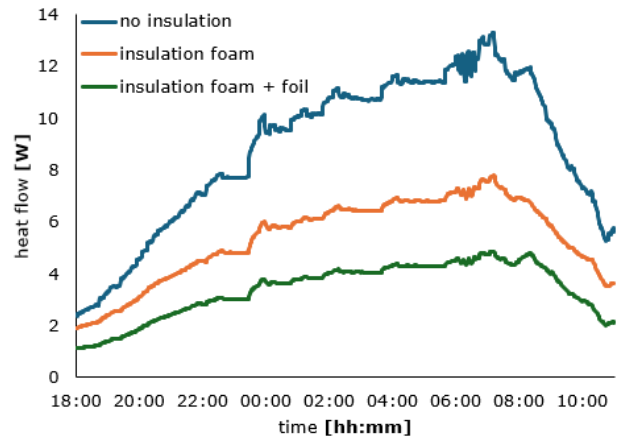
**Figure 4** Relative heat loss due to heat transfer without floor heating for a floor with no insulation (blue) and one or two thermal cushions. Heat flux sensors measured heat transfer towards the floor and crawl space.

### Pipe insulation

Another application of TONZON’s innovative insulation products is piping insulation. **TONZON’s reflective pipe wrap insulation foil** overcomes the inefficiencies of traditional foam insulation and reduces heat loss through radiation from your central heating system. An internal study analysed the heat flux under three different configurations: no piping insulation and piping

insulation with and without the reflective foil. Due to the curved surface, flexible heat flux sensors from the **FHF05 series** were used.

The capability of reflective pipe wrap insulation foil to block the radiative heat transfer is shown in Figure 5. Compared to piping with no insulation, the heat loss can be reduced by 62% when using TONZON’s reflective foil. Therefore, this easy-to-apply solution is an efficient insulation method that can significantly reduce energy consumption.



**Figure 5** The heat flow (heat flux times surface area) for the different insulation configurations. Adding reflective foil lowers the heat flow even further.

### Heat flux sensors for thermal analysis of insulation materials

The complex thermal image surrounding insulation materials can be analysed using heat flux sensors. Not only do they measure the heat loss, also the direction of heat transfer can be determined using heat flux sensors. If you would like a more personalised and free advice for your application, contact our experts.

### About Hukseflux

Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation- and heat flux measurement. Customers are served through the main office in the Netherlands, and locally owned representative sales offices in the USA, Brazil, India, China, Southeast Asia and Japan.

Are you interested in this product?  
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