NATURE WITHIN THE WALLS

Introduction

The project aims to investigate the insulative properties of natural materials. We hope to find each material's thermal conductivity value and compare to a polystyrene control.

The objective of the experiment is to determine thermal conductivity for a known material sample. The materials supplied for testing is a nonmetal, natural material. This experiment is to be conducted at room temperature to compare the effectiveness of the insulative properties of the material in the construction industry.

The experiment utilises an experimentally purposed designed cavity wall. A wooden pallet is used as a faux wall interior to insert the chosen insulative material; the pallet has a plasterboard on either side. There is a 100mm gap for placing our insulative material. The experiment will measure and calculate the thermal conductivity and U-values of the materials chosen, including hay, wool, bottles of air and hair, egg cartons and bottles of carbon dioxide to compare to our controls air and polystyrene.

Experimental Procedure:

Determining Temperature using an Infrared camera

An Infrared camera was used to detect the infrared energy. The infra red camera was used to detect the temperature of room before heating and after heating. It was also used to measure the difference in temperature between distance thermometer one and thermometer two when an insulative material was placed between the distance gap between the two thermometers.

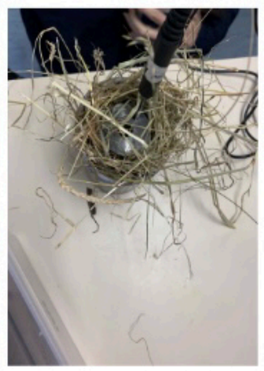
Note: This data was not valid and hence disregarded due to calibration issues

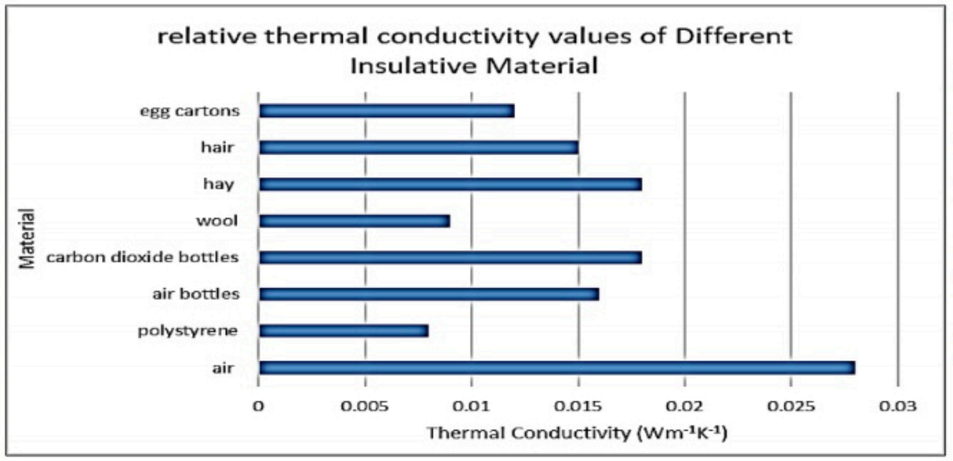
Procedure for Determining Thermal Conductivity using a simulated wall cavity:

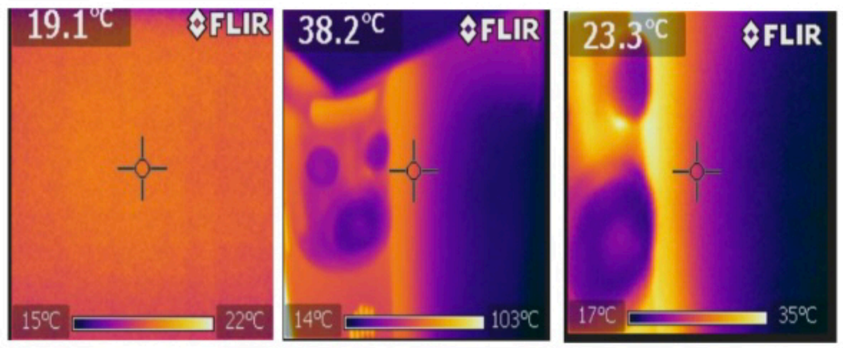
1. Check the room temperature with a thermometer.
2. Start the experiment by switching on the radiator and making suitable heating at the end.
3. Carefully measure the distance from one thermometer to another thermometer.
4. After every 5 seconds, take the reading of each thermometer from the datalogger
5. Continue this for 15 minutes.
6. Record the temperature changes using the data logging app
7. Find the thermal conductivity of the selected material
8. Repeat for each material

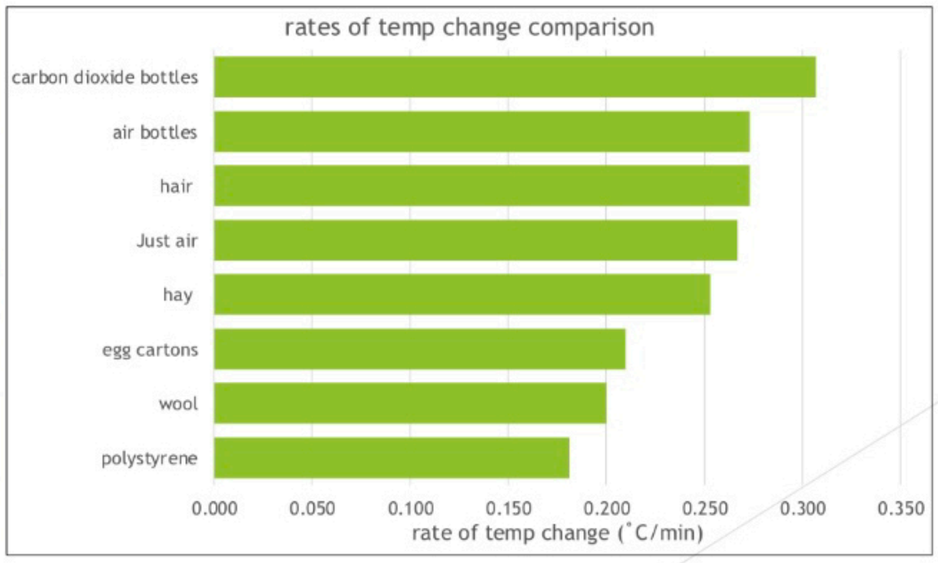
Procedure for Determining Thermal Conductivity using a Calorimeter:

1. Turn on the water bath until a temperature of 50˚C is reached.
2. Place the thermometer and metal block into the water bath using gloves. Ensure a consistent temperature is reached of 50˚C.
3. Chose a material to wrap the calorimeter. Quickly dry the calorimeter with paper towels and transfer the calorimeter and thermometer to the holding container and start recording the temperature.
4. Record the temperature change using the data logger every 5 seconds for 10 mins.









Background Information and Fundamental Principles

Convection: Convection is the transfer of heat through a fluid/gas by means of circulating currents of fluid caused by the heat. Because hot water/gas expands (thermal expansion), they have a lower density than cold liquid/gases and thus the heated fluid/gas naturally rises and the cold fluid/gas moves downward.

Conduction: Conduction is the movement of heat energy, from an object of high temperature to an object of a lower temperature through a substance by the passing on of molecular vibration from molecule to molecule without any overall movement of the substance.

Radiation: Thermal radiation is electromagnetic radiation generated by the thermal motion of particles in matter. Thermal radiation is generated when heat from the movement of charges in the material is converted to electromagnetic radiation. All matter with a temperature greater than absolute zero emits thermal radiation

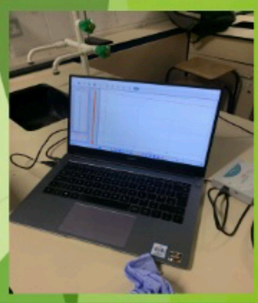
Thermal Conductivity: Thermal conductivity occurs through molecular agitation and contact and does not result in the bulk movement of the solid itself. Instead, heat moves along a temperature gradient from an area of high temperature and high molecular energy to an area with a lower temperature and lower molecular energy. This transfer will continue until thermal equilibrium is reached.

U Value: The U-value of a house is a measure of the rate of heat loss to the surroundings. U-Values are used in domestic situations to indicate how well a substance (roof, walls, tiles, etc.) allows heat to flow (conduct) through it.

Results

The Results Demonstrate that wool is the most effective insulative material with a relative thermal conductivity value of 0.008 in comparison to polystyrene which acts as control for the experiment as polystyrene is common insulative material used in Irish households with a relative thermal conductivity value of 0.009 $Wm^{-1}K^{-1}$

Wool was experimentally determined to have rate of heat loss of 0.200 °C/min is contrast to Polystyrene which has a rate of heat loss of 0.181 °C/min. Wool was determined to be 10.70% less effective in reducing heat loss than Polystyrene.



Conclusion

The results presented that Wool was the most effective natural insulator with the lowest thermal conductivity value and lowest rate of heat loss relative to polystyrene. This makes wool an excellent choice of an alternative sustainable insulative material for the construction industry. Wool is a potential low cost source of insulation for housing in Europe.
Currently, 90% of the sheep wool produced in Europe is either burned or buried each year; this could reduce the amount of wool wastage.

Future research

If we were to repeat this project again we would investigate methods to either vacuum pack/compress the material to further reduce the volume air takes up in the cavity wall to reduce the margin of error when calculate heat loss and thermal conductivity