RESOLATOR+

Easy to produce heat insulation.

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Resolator+

In this experiment our idea was to create a sustainable, low-cost and easy-to-make heat insulation that could possibly be used to create better housing conditions in third-world countries that lack the money and/or access to building materials that are usually more expensive and thus create a more prosperous environment through the application of this thermal insulation in houses.

Considering the fact that used paper can be found very easily anywhere and that cork is a natural product and not very expensive, we have created Resolutor+, with these two ingredients, as a thermal insulator.

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Thermal insulation with Resolator+

Initial guidelines:

Thermal conductivity (***k***), which is the basis for this experiment, is the property of a material that can conduct heat. This is specially important as the main idea behind our project is to develop a material that presents a low thermal conductivity, since heat transfer will occur more slowly in this kind of material in accordance to Fourier's law of heat conduction:

$$\text{Fourier's law}: q = \frac{k \cdot A \cdot (T_H - T_C)}{L}$$

where
q = heat transferred per unit time (W)
A = heat transfer area (m^2)
k = *thermal conductivity of the material* (W/m.K0
T_H = hot temperature (K)
T_C = cold temperature (K)
L = material thickness (m)

Creating an actual real size insulation for a house would present itself problematic as it would be very difficult as both to apply and test experimentally the material. In order to overcome this issue we created a cube with an edge size of roughly 21 cm and thickness of 1.2 cm to try and get a sense of how well it could work on a larger scale.

The cube was then placed in a freezer to check if the material could lower the heat transferred per unit of time in comparison to an object with no thermal insulation, in a situation of different heat temperatures inside and outside the cube, and thus observe for how long the cube could maintain an acceptable temperature. The material should be able to reduce the amount of heat per second that is transferred from inside the cube, which is the hottest zone (**T_H**), to the outside, the freezer, which represents the coldest zone(**T_C**).

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Objectives:

- Understand the concept of heat conduction.
- Observe how different materials react to heat alternations.
- Develop an environmentally sustainable and easy-to-do insulation.

Materials Required:

- 1m^2 of cork sheet.
- Newspapers or used paper
- A box-cutter.
- Ruler.
- Marker.
- White glue.
- Thermometer.
- Freezer.
- Electric mixer.
- Paintbrush.
- Bucket.

Procedure:

1. With the help of a ruler and marker draw 8 squares, with an edge of 20 cm, in the cork sheet and after, draw 4 more squares, with an edge of 22cm.
2. Cut all the 12 squares from the cork sheet using the cutter.
3. Shred a big amount of newspapers or old paper into very small pieces into a bucket and add some water to the mix.
4. Turn on the mixer and use it on the water-paper mix until you see that you have a pasty but not totally liquid solution.
5. Spread white glue with a paintbrush on one side of a cork square. Next, take a portion of the paper paste and squeeze it in order to drain the water in excess from it. After that, spread a layer of the squeezed paper paste on top of the glued surface of the square.
6. Spread white glue on one side of another square cork sheet with the same size as the one used in step 5. Place this square on top of the paste smeared on the first square. The glued surface must be placed facing the paper paste.
7. Repeat steps 5 and 6 with all the squares until you have 6 «walls» composed of cork sheet and paper paste and let it all dry until it is solid. The thickness of the walls should be 1.2cm as stated in the initial guidelines.
8. Glue all the 20cm edge walls with one another in order to build a cube with no top nor bottom and then glue a 22cm-edge-wall to the base.
9. Grab a thermometer and put it inside the cube, then cover the cube with the leftover 22cm-edge-wall (<u>note</u>: register the temperature inside the cube before you put it in the freezer).

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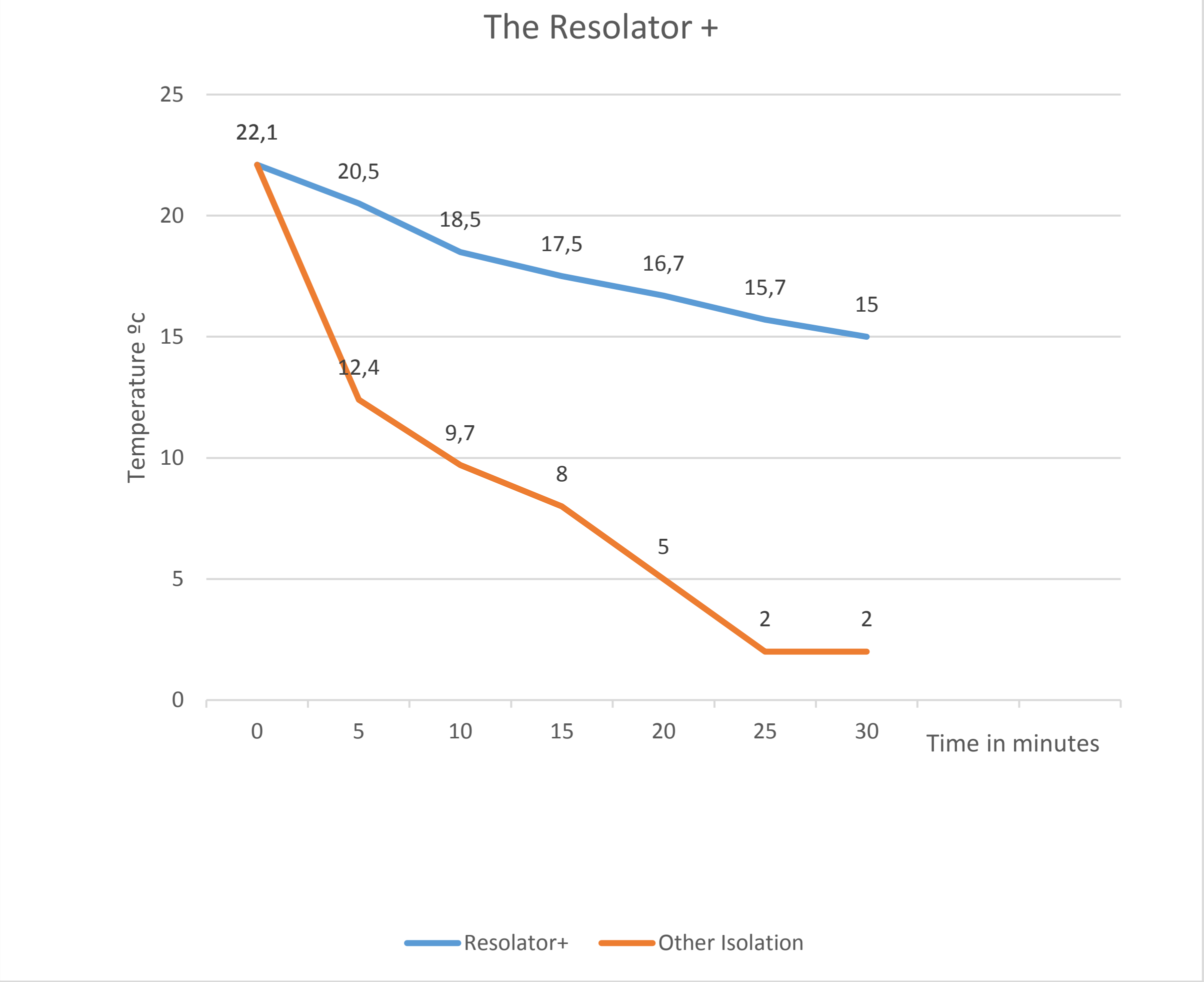
10. Put the cube inside a freezer and register the temperature value from inside the cube every 5 minutes for a period of 30 minutes.
11. Remove the thermometer from the cube and place it inside a small regular cardboard box and, and again register temperature values every 5 minutes for a period of 30 minutes(<u>note</u>: you should also register the pre-programmed temperature of the freezer).
12. Proceed to treat the data you have acquired.

Data treatment:



The data obtained from the The Resolator+ shows its behaviour compared to other materials. Both materials were exposed to temperatures of 2ºc but it is very clear that Resolator+ was much more efficient in preventing the heat conductivity and proving itself as a very good thermal insulator.

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Thermal conductivity of the Resolator+

In physics, **thermal conductivity** is the property of a material to conduct heat. It is evaluated primarily in terms of Fourier's Law for heat conduction (like shown before).

Heat transfer occurs at a lower rate across materials of low thermal conductivity than across materials of high thermal conductivity.

In SI units, thermal conductivity is measured in watts per meter kelvin (W/(m·K))

In order to calculate the thermal conductivity(**k**) of our material we did an average of both the thermal conductivity of paper and cork since they both occupy 0.6cm each in a total of 1.2cm thickness of the resolator+, as calculated below:

$$k(paper) = 0.050 \qquad k(cork) = 0.044$$

$$k = \frac{k(cork) + k(paper)}{2}$$

$$k = \frac{0.044 + 0.050}{2}$$

$$k = 0.047$$

And in the graph below we can see how it compares in relation to other materials.

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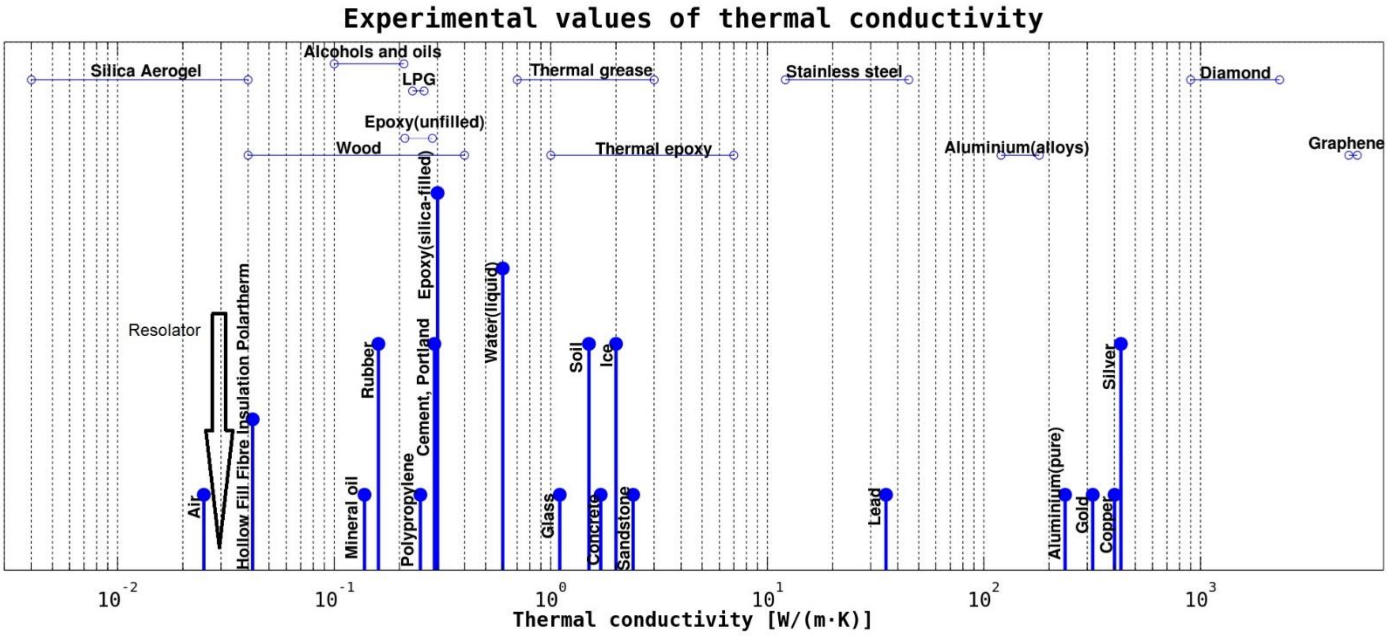

In this image one can see were the Resolator+ fits in the scale of “Experimental values of thermal conductivity”.

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Conclusion:

Throughout this experiment we were able to develop a material that could be able to resist thermal variations. We were able to do so successfully on a small scale, as shown in the graphs above, in comparison to other simple insulations.

The material proved itself to be able to decrease the heat transferred from inside the box to the freezer thanks to the small value of thermal conductivity.

With this experiment we can conclude that anyone is able to create thermal insulation to apply to their homes on a broader scale and thus improve their living conditions, while using eco-friendly and sustainable materials readily available everywhere.

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