Isoware

Study of the efficiency of a thermal cup made with recycled material

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Experiment introduction:

Due to the familiarity with the theme and the observation of a growing trend of waste resulting from textile production, our group decided to create a project capable of fighting this trend.
In large textile productions there is a large use of plastics and cardboard. However, our group intends to focus only on the knits and fabrics that end up being wasted.

There are plenty of cheap and common insulation materials available in the market today, like fibreglass, cellulose, mineral wool or even polystyrene. Each of these insulations have their own ups and downs. That is why we tried to combine three aspects of what would be the ideal insulator: low cost, efficient and mainly eco-friendly.

To evaluate the insulator we will compare a thermal cup that you can easily find in the market with a plastic cup coated with our insulator.

Experiment goal:

With *Isoware* we intend to reduce the use of raw materials such as cellulose, normally used for insulation. The project consists in creating a thermal insulator with clay and textile remains that are mostly wasted. This product, besides its low costs, can contribute for a better sustainability of the planet, by reusing material that has an unknown end.

The experimental setup 1:

You need a plastic cup (or a 3D printed cup), a thermal cup (one that you can easily find in the market), a coffee pot (or anything where you can boil some water), knits and fabrics and a thermometer.

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You will start by making the insulator. All you need to do is to mix the clay powder with some water. Then add small pieces of fabric, until you get a great consistency.
When it is ready you coat the cup with the insulator and let it dry.

Now you can do the second part of the experiment and the data collection.

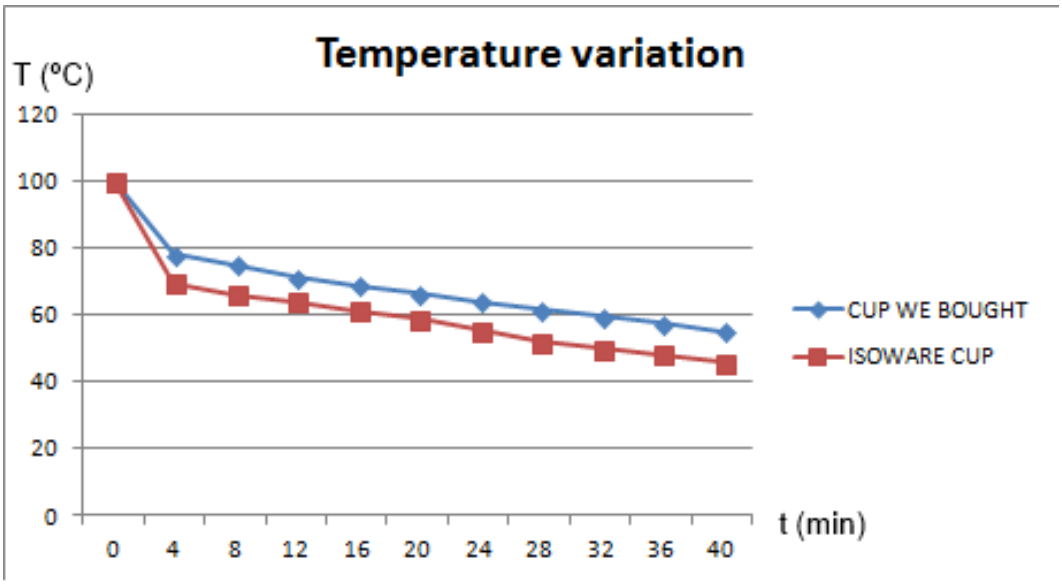
To stop convective power transfers, we thought it would be better to make a lid. To make it, we molded our insulator in the shape of a champagne cork.

Data Collection:

Start boiling 600 ml (the

on the the are a pot. pour

by about of water volume depends size of cups you using) in coffee Then the water in both cups and start taking some notes. You need to measure the temperature of the water in both cups, but do it every 4 minutes. Repeat it for at least 20 minutes.



	CUP WE BOUGHT			ISOWARE CUP		
t(min)	T(ºC)	T(ºC)	T(ºC)	T(ºC)	T(ºC)	T(ºC)
0	100	100	100	100	100	100
4	78,5	77,8	78,1	69,7	69,5	70
8	74,4	75,1	75,4	66,2	66	66,4
12	71,7	71,4	70,9	64,1	63,8	64,3
16	69,1	68,8	68,6	61,3	61,1	61,2
20	66,7	66,4	66,3	58,8	58,2	59,1
24	64,1	64	63,9	55,7	55	55,5
28	62,2	61,5	61,4	52,5	51,7	52,1
32	59,6	59,8	59,7	50,1	49,6	50,2
36	57,8	57,6	57,6	48,3	47,9	48,5
40	55,6	54,8	55,1	46,1	45,5	46.3

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Data Analysis:

After the experiment, you will notice that *Isoware* let the water cool faster. Since you don't know the material used in the cup that you have bought, it is hard to know the exact energy that the water lost, but it's evident that it is lower than the energy lost in *Isoware*.

The experimental setup and data collection 2:

To understand what wasn't right with the material, we decided to make a second experiment.
We used the same *Isoware* however, it would be now compared with a normal cup, one that was like the cup we coated.
To do that, we used the same procedures that we used in the experience 1.

Data Analysis 2:

t(min)	ISOWARE	UNCOATED CUP
4	77,5ºC	81,5ºC
8	69,2ºC	74,3ºC
12	65,0ºC	68,2ºC
16	60,5ºC	63,8ºC
20	57,6ºC	59,4ºC

You can notice that the water in the cup we coated was still getting cooler than the water inside the uncoated cup. That was when we realized that the problem could be in the amount of clay we were using.

The experimental setup and data collection 3:

For the third experiment, we decided to improve *Isoware*, decreasing the amount of clay we used. To make the new cup, we followed the same procedure in the first experiment. However, we reduced the size of the shredded fabrics and used less clay, just enough to group the fabrics.
Once again, we let it dry and compared it with the cup we had bought.

Data Analysis 3:

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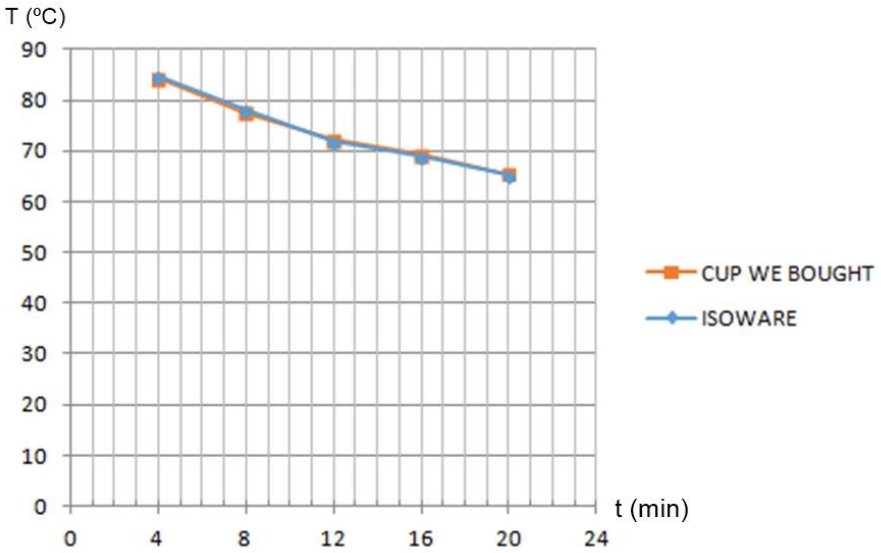
t(min)	ISOWARE	CUP BOUGHT
4	84,9ºC	84,3ºC
8	78,1ºC	77,5ºC
12	72,0ºC	72,1ºC
16	68,9ºC	69,2ºC
20	65,2ºC	65,4ºC



Observations:

$$\frac{Q}{\Delta t} = \mathrm{K} \times \mathrm{A} \times \frac{\Delta T}{L}$$

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A- $0{,}0114m^2$
L- 0,004

At the beginning of the first experience we made an insulator that had 50% clay and 50% cotton fabrics. By doing so, we ended up with an insulator that has a thermal conductivity of approximately 0,12 W/(m K).

In the third experience we decided to make a new insulator with 80% fabrics and 20% clay. Making an insulator that has a thermal conductivity of approximately 0,072 W/(m K).

Those values could be improved by replacing the clay with other material.

Conclusions:

After the last experiment we noticed that Isoware had the same performance as the cup we bought. However, we could get even better results by replacing the powder clay for glue or resin since we struggled a bit with fixing all the materials.

Questions:

- Why did we use clay to make the insulator?

We needed something capable of grouping the fabrics into one single material. The ideal material would be a resin or glue that has a lower Thermal Conductivity and that is waterproof.

- Why did we use fabrics?

Our main point was to recycle and decrease the use of raw materials. The knits and fabrics that we used were manly made of cotton, which has a low thermal conductivity.

- Would it be good for big applications?

Although *Isoware* is a cheaper and easier alternative, the fabrics in its constitution are not able to endure high temperatures, the same happens with the clay.
This idea would work great in the coating of small surfaces or to improve other insulations.

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