Design of a heat battery

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Objectives

The objective was to make a small heat battery as a good way for **thermal energy storage**. This had to be done by keeping a reasonable heating time and a as long as possible heat retention time. While also being able to work safely at those high temperatures.
Using a **Phase-Change Material** for extending the heat retention time also was an objective for this project.

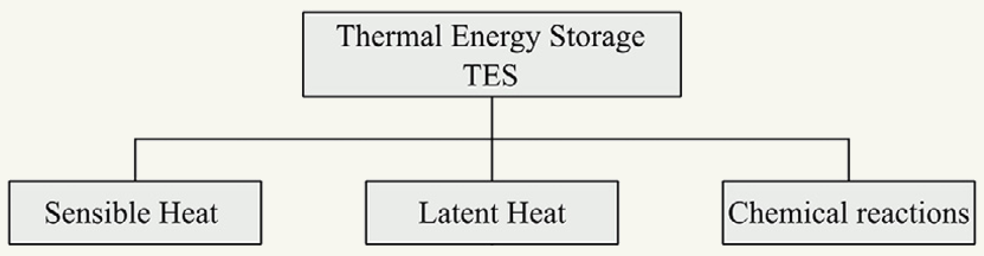

Figure 1: The different types of TES storage (2)

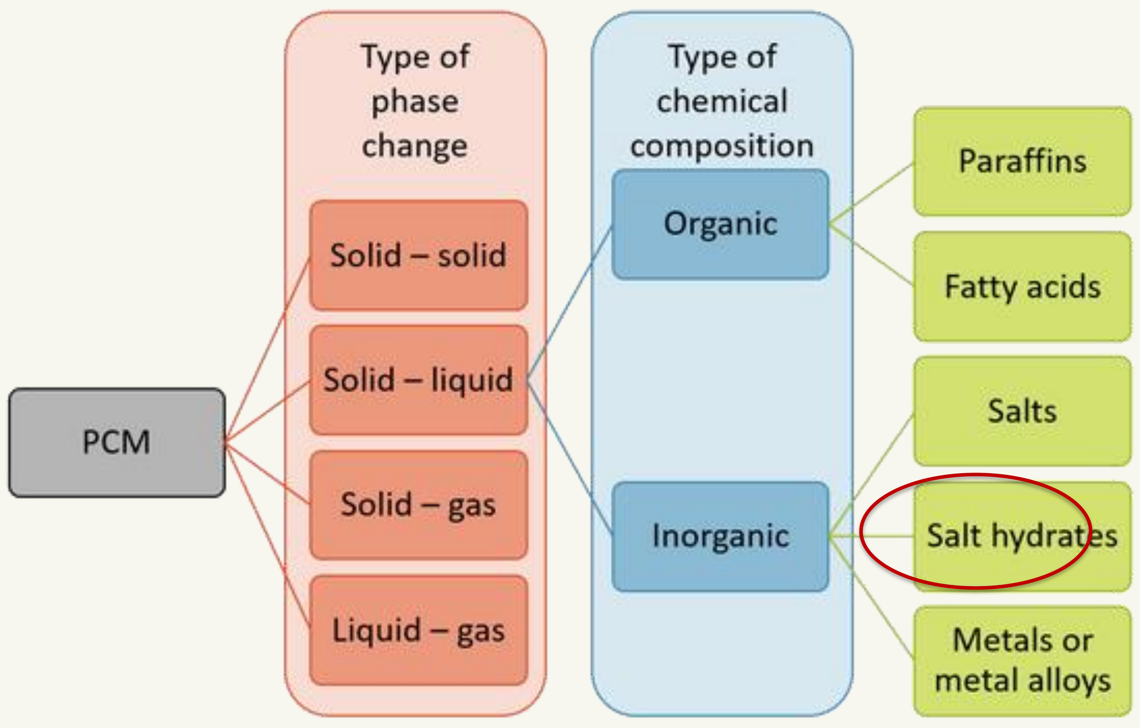

Figure 2: Table of the different types of PCM (1)

Materials and methods

An **industrial heating rod** is used to heat up a barbecue filled with sand, copper rods, a cast iron container, aluminium sheets, stones and a container filled with **sodium acetate trihydrate (SAT)**.

During the heating and cooling processes, the temperature gets measured to determine the ability of the battery to stay warm over prolonged periods.

To test this, the heating rod gets brought to a temperature of **370°C** and keeps this temperature for a duration of one and a half hours until the PCM is **fully melted**. After this, the cooling of three different components get measured.

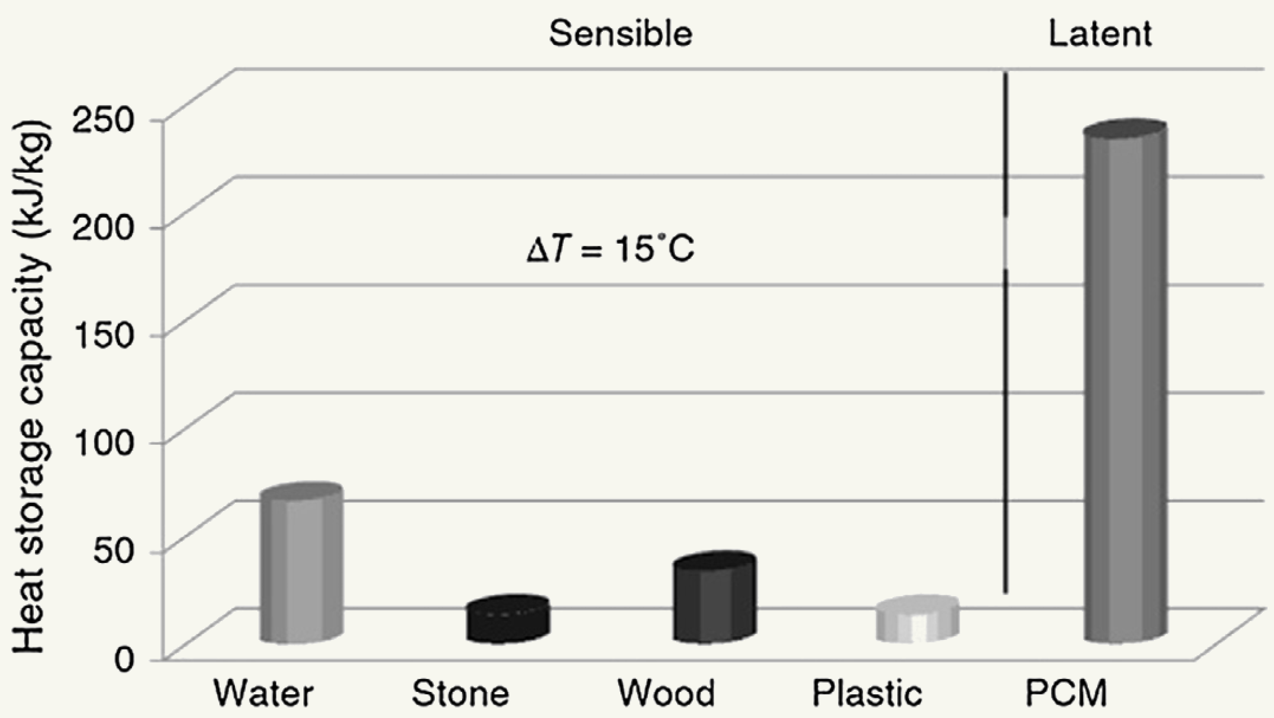

Figure 3: The TES capacity for different materials (2)

The thermal properties of SAT

Property	Symbol	Value	Unit
Salt in liquid state			
Density	ρ_l	1280	kg/m^3
Specific heat	C_{pl}	2570	J/(kg.K)
Thermal conductivity	k_l	0,1	W/(m.K)
Salt in solid state			
Density	ρ_s	1450	kg/m^3
Specific heat	C_{ps}	4880	J/(kg.K)
Thermal conductivity	k_s	0,5	W/(m.K)
Solid ↔ Liquid transition			
Melting temperature	T_f	58,4	°C
Latent heat	Lmf	275,1	kJ/kg

Figure 4: Table with thermal properties for SAT (3)

Results and discussion

The graph is a representation of a small-scale heat battery and its retention time for containing heat. The retention time of the different places shows that there is a possible **future in heat batteries**. In the graph, there is a visible increase of the stone and plate after removing energy and a slower release of the heat.

The different design for holding the coil made a huge difference in spreading the energy evenly. The best design for spreading was the **aluminium**, but due to certain problems was a bit unsafe for the coil.

The main problem of this project finding a good discharge mechanism for the collected energy.

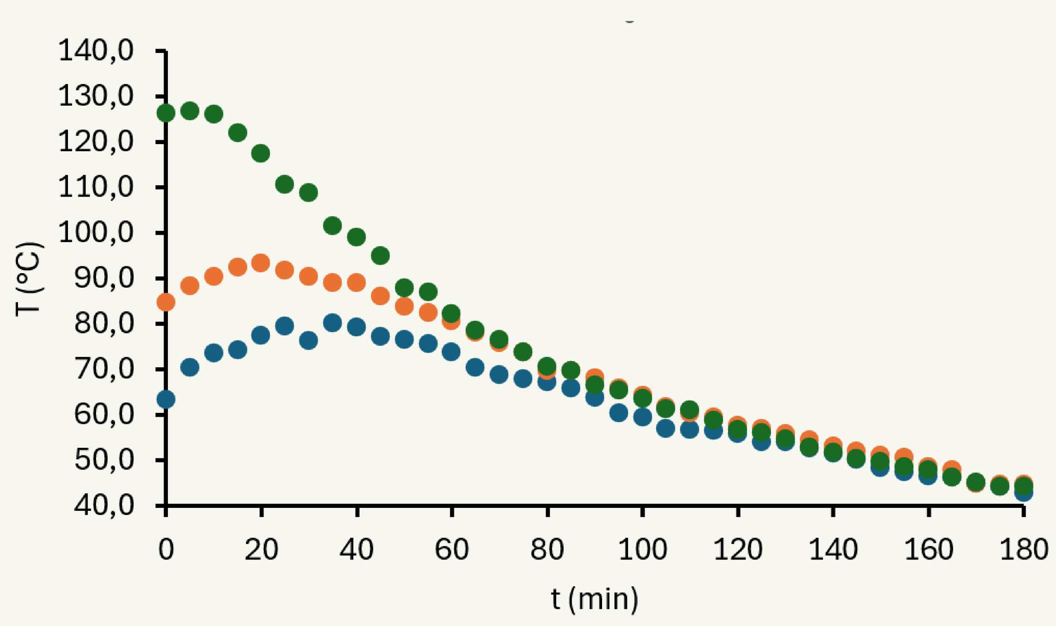

Figure 5: graph of the retention time

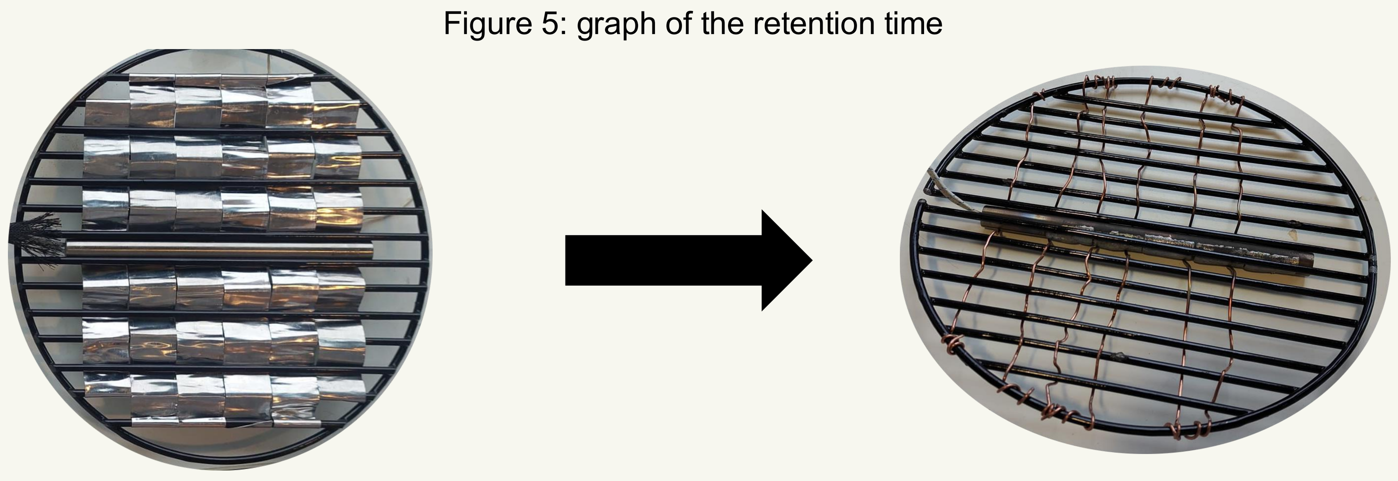

Figure 6: The change of the design for the heating element

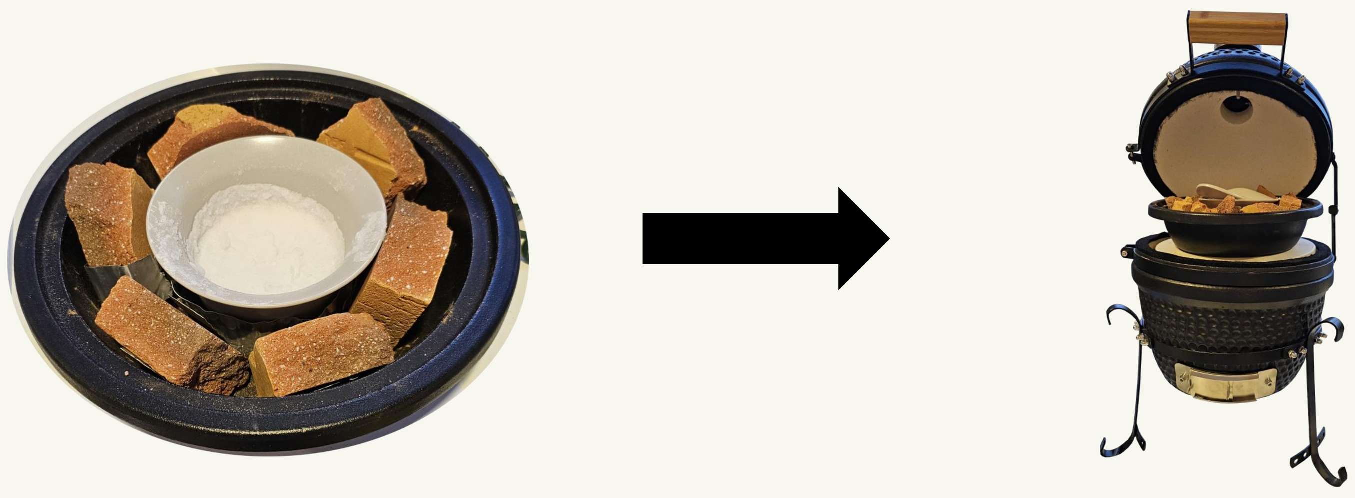

Figure 7: A lab design of the heat battery

Conclusion

In conclusion, we successfully made a working design for a heat battery of which energy could be harvested. It had quite a **good heat retention**, but the warm-up time was a bit slow.
Future research should focus on using a **better dispersion mechanism** like using a wooden stove fan. Something like a CPU cooler from a computer could also be used, but instead of dissipating the heat it would warm up the fluid. In future research, we also recommend using **more insulation** so that the heat escapes less through small crevices.

References

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