



Innovation Type:
Technology

Development stage:
Lab scale demonstration

*Remaining uncertainties at current stage: **Few***

TRL: 4-5

Status: Finished 2021-05

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HighEFF Overall Goals		
	Energy use & emissions	
	New solutions	X
	New methods and tools	

Relevant Sectors	
Oil, Gas and Energy	Metal and Material
Food and Chemical	Industry Clusters

Cold thermal energy storage (CTES)

Large-scale cold TES for the food industry to balance between high cooling demand and varying availability of low-cost electricity from renewable sources

Challenge

The electricity consumption in the food processing industry is characterised by peaks and valleys due to the throughput of products in energy-intensive refrigeration processes. Refrigeration equipment must be dimensioned according to the maximum load on the warmest day. This strategy results in refrigeration systems that operate on part load for most of the hours.

Solution

A novel CTES unit based on a pillow plate heat exchanger combined with latent thermal energy storage in a phase change material to achieve peak shifting of the refrigeration load. The developed CTES unit can be integrated directly into the refrigeration circuit and can handle the working pressures of CO₂ refrigeration systems (> 70 bar). The temperature which the energy is stored can be varied by changing the phase change material used in the CTES unit. The unit can operate as a thermal battery to store thermal energy at low temperatures (< 0 °C) using the excess refrigeration capacity during the night. During daytime operation, the stored cold thermal energy can be used to unload the compressors and thereby achieve peak shaving of the power consumption. When implementing this technology the refrigeration system can be designed closer to the mean load rather than the peak load, reducing the investment costs of the plant.

Potential

The flexible design of the CTES unit enables dimensioning of the storage to a variety of load profiles in refrigeration systems, shaving peaks with a duration from less than 1 hour up to 5-6 hours. The storage capacity and discharging rate of the CTES unit can be increased by installing more units in parallel and increasing the size of the pillow plate heat exchanger.

Further related HighEFF work

- Demonstrating the use of the CTES unit through pilots at relevant partner industries in HighEFF and KSP PCM-Store (spin-off from HighEFF)
- Simulation studies of CTES design alternatives for commercial and industrial CO₂ refrigeration systems

References

- Selvnes, H., Allouche, Y. and Hafner, A., 2021. Experimental characterisation of a cold thermal energy storage unit with a pillow-plate heat exchanger design. *Applied Thermal Engineering*, p.117507.
- Selvnes, H., Hafner, A. and Kauko, H., 2019. Design of a cold thermal energy storage unit for industrial applications using CO₂ as refrigerant. In *25th IIR International Congress of Refrigeration Proceedings*. IIR.

