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Experimental study of a novel finned and tube phase change material storage for low-temperature applications

Giorgio Besagni[1], Lorenzo Croci[1]

1 Ricerca sul Sistema Energetico - RSE S.p.A., Power System Development Department, via Rubattino 54, 20134 Milano (Italy)

**Corresponding author: giorgio.besagni@rse-web.it*

Highlights

- A pilot-scale phase change material storage is build and tested.
- The effect of operating parameters have been evaluated.
- The energy stored is 80% higher compared with a water storage.

1. Introduction

Thermal energy storage is a matter of intense discussion, to decouple the demand-side and the supply-sided. Such field of study is particularly interesting in the residential sector, to support the large-scale deployment of renewable energy-based technology to support the decarbonistaion pathways. An example regards solar-assisted systems (i.e., solar assisted heat pumps, *SAHPs*) as a technical solution to reduce the primary energy consumption at the household scale. This paper contributes to the existing discussion by proposing a novel finned and tube phase change material storage for low-temperature applications (viz., storage temperatures in the range of 20 - 30 °C, accordingly with the experimental outcomes of Besagni et al. [1])

2. Methods

A novel a pilot-scale phase change materials storage for is proposed, designed and tested).A laboratory test facility has been designed and build, to test the variations of flow rate, inlet/outlet temperatures, charging/discharging times (Figure 1, see Table 1 for the details of the instrumentation). Given the application in this study and, following the discussion of Palomba et al. [2], a fin-and-tube heat exchanger is selected). The phase change material used is pure paraffin RT26 and is contained inside a tank with finned-tube heat exchanger.

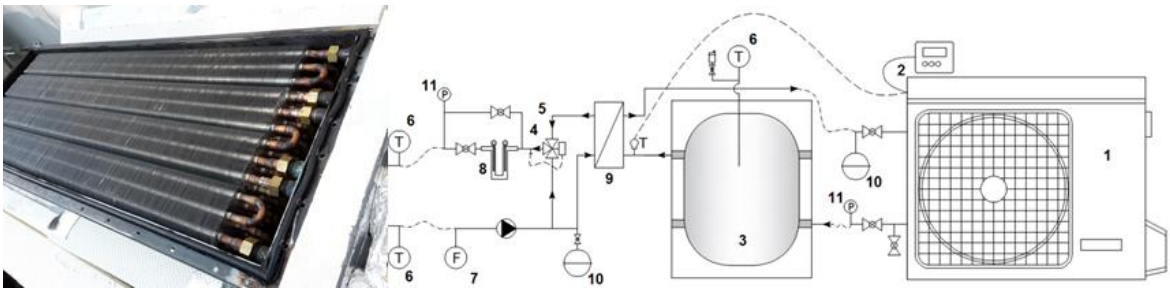

Figure 1. Test facility.

Figure 1. *Details of the experimental system is Table 1*

Code name (Figure 1a)	Equipment and details
1	Reversibile heat pump (MAXA, i-HWAK//V4 06, R410A)
2	Remote control system for the reversible heat pump
3	Buffer storage tanks for heat pumps; 51l, water storage
4	Deviation valve
5	Variable speed circulation pump
6	Temperature probe - RTD Pt100 (1/5DIN)
7	Electromagnetic flow meter
8	Two electrical resistances (1500 W each)
9	Plate heat exchanger
10	$8dm^3$ expansion tank
11	Pressure Transducer

Figure 1. The phase change material storage.

3. Results and discussion

the heat exchanger was tested in two different configurations, series and parallel, to investigate the impact of the non-uniformity of the heat exchange on the dynamic behavior of the storage unit. the experimental runs were conducted simulating a real charge/discharge thermal energy cycle I risultati della campagna sperimentale, riassunti nella Figura 46, indicano che lo scambiatore nella configurazione in parallelo (quella più performante) con materiale a cambiamento di fase ha accumulato circa l'80 % in più di energia termica rispetto allo stesso serbatoio con acqua nell'intervallo di temperatura tra 15°C e 40°C. Tale incremento è superiore rispetto a quanto evidenziato in studi di letteratura [2]. L'incremento di energia accumulata comprende sia il calore sensibile dovuto all'aumento della temperatura sia quello latente di fusione del PCM. In particolare l'incremento percentuale di energia accumulata dal serbatoio con PCM è dovuto al calore latente e pertanto risulterebbe più elevato riducendo l'intervallo di temperatura considerato, come evidenziato nel seguito.

4. Conclusions

The data obtained, besides allowing to evaluate the efficacy of accumulation systems with PCM, can also be used to calibrate and validate a numerical model to be used to extend the simulations to tanks with PCM of different sizes and several purposes, to be used in the air conditioning sector of buildings. Le caratteristica di un serbatoio con PCM di poter accumulare molta energia in un ristretto campo di temperatura può avere un risvolto pratico importante e rende l'impiego di un serbatoio con PCM ideale per il suo accoppiamento con pompe di calore elio assistite dual-source. Infatti il fatto che con PCM il processo di cambiamento di fase avviene a temperatura quasi costante, unito al periodo di tempo in cui questo processo avviene, rendono l'utilizzo di un serbatoio con PCM interessante come supporto all'evaporatore di una pompa di calore

References [Calibri 10]

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