Thermophysical characterization of commercial paraffin-based PCMs for low temperature thermal energy storage applications

Telma Matias[1], Nelson Soares[2,3], Isabel Campos-Gonçalves[1], José J. Costa[2], Pedro N. Simões[1] and Luisa Durães[1*]

[1] CIEPQPF, Dept. Chem. Eng., University of Coimbra, Rua Sílvio Lima, 3030-790 Coimbra, Portugal
[2] ADAI, LAETA, Dept. Mech. Eng., University of Coimbra, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal
[3] ISISE, Dept. Civil Eng., University of Coimbra, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal

*Correspondent author: Telma Matias, tmatias@eq.uc.pt; Luísa Durães, luisa@eq.uc.pt

· U C ·

Seminar - PCMs4Buildings

PCMs: Thermophysical characterization and buildings' applications

Motivation and Goals

Data on thermophysical properties of commercial phase change materials (PCMs) is fundamental for the design and modelling of low temperature thermal energy storage applications. However, the data provided by manufacturers are frequently insufficient and/or uncertain.

- ❑ Evaluation of thermal conductivity of free and microencapsulated PCMs at several temperatures (0-50ºC) including the phase change range;
- ❑ Evaluation of latent heat of fusion, specific heat and melting/solidification temperatures of commercial PCMs.

Methodology

Table 1. Commercial PCMs used in this work and their specifications (ME - microencapsulated) .

PCM	Type	Manufacturer	$T_{melting}$ (°C)	$\Delta H_{melting}$ (J/g)
MPCM 18D	ME	Microtek laboratories	18	180 - 190
MPCM 24D	ME	Microtek laboratories	24	154-164
MPCM 28D	ME	Microtek laboratories	28	180-190
DS 5001 X	ME	BASF	26	110
PCM 18P	Bulk	Microtek laboratories	18	205-215
PCM 24P	Bulk	Microtek laboratories	24	165-175
PCM 28P	Bulk	Microtek laboratories	28	195-205
RT 25 HC	Bulk	Rubitherm	25	230
RT 28 HC	Bulk	Rubitherm	28	250

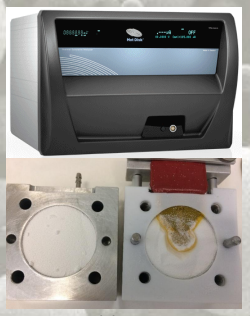

Figure 1. Hot Disk TPS 2500 S and liquids' sample holder full with PCM DS 5001 X.

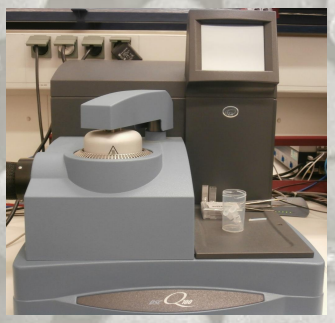

Figure 2. MDSC from TA instruments, model Q100.

Results

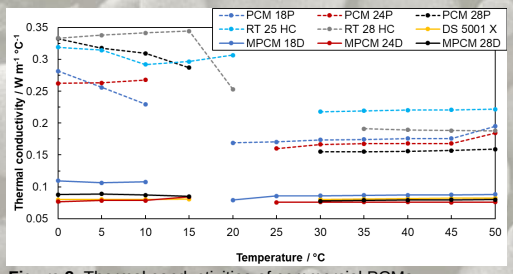

Figure 2. Thermal conductivities of commercial PCMs measured by the TPS method (Hot Disk).

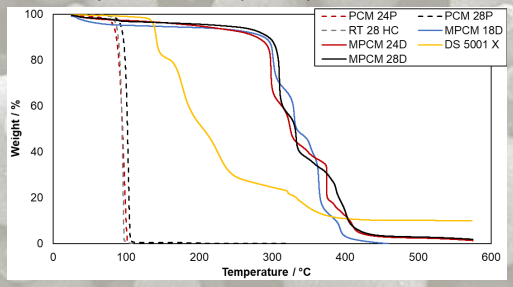

Figure 3. HiRes-TGA of commercial PCMs (rate: 2 ºC min^{-1}).

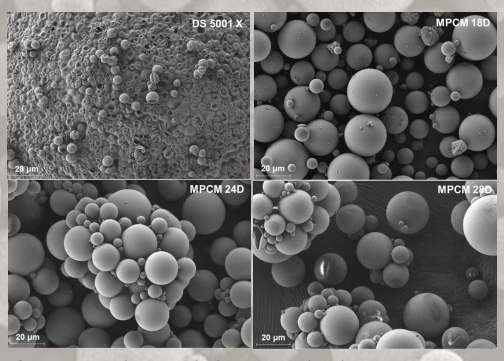

Figure 4. SEM images of Microencapsulated PCMs.

Table 2. Melting/solidification temperature, *Cp* and latent heat of the commercial PCMs.

PCM	$T_{melting}$ (°C)	$T_{solidification}$ (°C)	Cp_{solid} (J/g °C)	Cp_{liquid} (J/g °C)	$\Delta H_{melting}$ (J/g)	$\Delta H_{solidification}$ (J/g)
MPCM 18D	16.74	14.04	2.52	2.09	99.18	86.30
MPCM 24D	21.82	20.95	2.77	2.25	171.81	179.26
MPCM 28D	25.76	24.38	1.92	2.08	147.42	142.88
DS 5001 X	24.91	22.49	2.25	2.02	84.24	62.57
PCM 18P	16.18	14.40	1.49	1.60	116.06	109.15
PCM 24P	22.13	21.71	2.05	1.74	133.13	132.48
PCM 28P	26.32	25.33	1.92	2.13	164.74	129.68
RT 25 HC	25.53	24.22	1.29	1.37	88.62	82.38
RT 28 HC	27.82	25.89	1.45	1.88	89.84	53.81

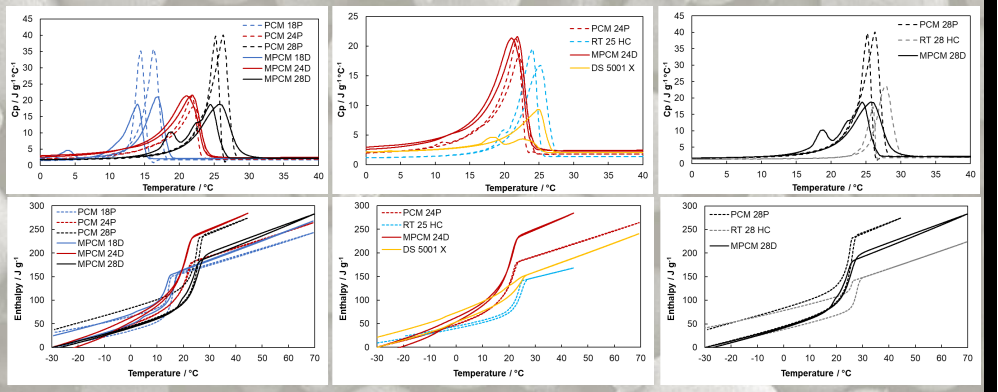

Figure 5. Specific heat and enthalpy curves of commercial PCMs measured by MDSC (rate: 2 ºC min^{-1})

Conclusions

- Thermal conductivity of free PCMs is higher and more discriminated than that of microencapsulated PCMs;
- Lower conductivity of the polymer shell in microencapsulated PCMs may lower the efficiency of this kind of PCMs, since it hinders the heat transfer;
- The position of the *Cp* peaks is consistent with the temperature indicated by the supplier for the phase change temperature, but usually some degrees lower;
- The latent heat provided by the supplier is normally higher than the evaluated by MDSC;
- Residual leak of PCM material during heating/cooling stages occurs at low temperatures, as confirmed by HiRes-TGA.

14-15 June, 2018
Department of Chemical Engineering
University of Coimbra

This project is supported by FEDER funds through COMPETE 2020 - POCI, and by Portuguese funds through FCT in the framework of the project POCI-01-0145-FEDER-016750 | PTDC/EMS-ENE/6079/2014.

Cofinanciado por: