

INNOSTORAGE IRSES-610692		Deliverable number:	D7.2
		Title:	Report on Staff Exchange

INNOSTORAGE – USE OF INNOVATIVE THERMAL ENERGY STORAGE FOR MARKED ENERGY SAVINGS AND SIGNIFICANT LOWERING CO₂ EMISSIONS

Beneficiaries:



Partners:



D7.2 - Report on Staff Exchanges

	Name and Institution	Date
Prepared by:	Sleiman Farah University of South Australia	20/03/2017
Checked by:		
Approved by:	Prof. Dr. Luisa F. Cabeza University of Lleida	20/05/2017

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1 Objectives

The objective of this secondment is to investigate the use of phase change material (PCM) to reduce energy usage for space heating. To achieve this objective, the research conducted during the secondment investigates the integration of PCM into a building envelope. The secondment also aimed at continuing the previously established research collaboration on thermal storage between the University of South Australian and the University of Lleida.

2 Introduction

Thermal storage is one of the promising technologies to reduce energy requirements for space heating and cooling. However, thermal storage systems are usually large and aesthetically unacceptable. Researchers have investigated the integration of PCM energy storage into the buildings components, such as façade and structure (de Gracia et al. 2013c; Navarro et al. 2015). This integration allows reducing the size of the required thermal storage as well as providing an aesthetically acceptable system. The experimental results demonstrate that this type of thermal energy storage systems can significantly reduce energy requirements (de Gracia et al. 2013b). To test this type of thermal energy storage under different conditions and configurations, a numerical model for cooling has been developed (de Gracia et al. 2013a). The work presented here complement the model for cooling by developing a numerical model for heating applications.

3 Description of work

The research work conducted during the secondment consists of developing a computer model of a macro-encapsulated PCM integrated in a double skin ventilated façade for space heating. This double skin facade not only reduces space requirements and provides aesthetically acceptable design of the thermal storage system, but also improves the thermal characteristics of the building envelope. During the PCM charging stage, the façade air inlets and outlets are closed until the PCM is melted. During the discharging stage, relatively cold air from indoor space enters the façade and absorbs energy from the PCM and then enters the indoor space as warm air.

4 Methodology

The thermal performance of the facade has been modelled numerically using a control volume approach; maintaining a balance between the required computational resources and results accuracy. The numerical model considered 1D and 2D heat transfer inside the different components of the façade. The use of C-programming language for the modelling allows calculating the façade thermal performance in a short period (a few seconds). The use of C-programming language will also allow integrating the model into other simulation software, such as TRNSYS.

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5 Results

Efforts are still continuing to validate the numerical model experimentally using monitoring data from the facade built at Puigverd de Lleida, Spain. The model validation includes both phases of charging and discharging the PCM inside the façade. The discharge phase considered both with and without availability of solar radiation. When solar radiation is available, the charging and discharging can happen simultaneously.

6 Outcomes or future work

Once the numerical model is validated, it can be used for thermal performance optimization considering main design parameters such as PCM melting and solidification temperatures and air flow rate. The numerical model can also be used to investigate different schedules for charging and discharging the PCM based on weather forecast. The presented model can provide a reliable tool to investigate the energy savings provided by a double skin façade with PCM in the building envelope. The work conducted during the secondment can eventually lead to a couple of conference and journal publications.

In addition, the modelling of the façade thermal performance has identified two potential research topics. The first topic is the behaviour of PCM under partial charging and discharging conditions; when the PCM is not fully melted or solidified. The second topic is the investigation of natural ventilation on partially heated vertical plate.

7 References

de Gracia, A, Navarro, L, Castell, A & Cabeza, LF 2013a, 'Numerical study on the thermal performance of a ventilated facade with PCM', *Applied Thermal Engineering*, vol. 61, no. 2, 11/3/, pp. 372-380.

de Gracia, A, Navarro, L, Castell, A, Ruiz-Pardo, Á, Álvarez, S & Cabeza, LF 2013b, 'Experimental study of a ventilated facade with PCM during winter period', *Energy and Buildings*, vol. 58, 3//, pp. 324-332.

de Gracia, A, Navarro, L, Castell, A, Ruiz-Pardo, Á, Álvarez, S & Cabeza, LF 2013c, 'Thermal analysis of a ventilated facade with PCM for cooling applications', *Energy and Buildings*, vol. 65, 10//, pp. 508-515.

Navarro, L, de Gracia, A, Castell, A, Álvarez, S & Cabeza, LF 2015, 'PCM incorporation in a concrete core slab as a thermal storage and supply system: Proof of concept', *Energy and Buildings*, vol. 103, 9/15/, pp. 70-82.

8 Assessment

The secondment has been an exciting and successful part of my PhD experience. During the research stay at the University of Lleida, I had the chance to meet and work with other researchers; discussing research ideas and exchanging knowledge. I also had the chance to participate in the Training School which covered

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an interesting range of topics. The secondment allowed me to participate in the EuroSun conference in Palma de Mallorca and the IRSEC conference in Marrakesh.