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INNOSTORAGE – USE OF INNOVATIVE THERMAL ENERGY STORAGE FOR MARKED ENERGY SAVINGS AND SIGNIFICANT LOWERING CO_2 EMISSIONS

Beneficiaries:

UNIVERSITAT DE BARCELONA

Universitat de Lleida

UNIVERSITÉ DE LYON

Ben-Gurion University of the Negev

Partners:

THE UNIVERSITY OF AUCKLAND NEW ZEALAND Te Whare Wananga o Tamaki Makaurau

University of South Australia

AUBURN UNIVERSITY

D7.2 - Report on Staff Exchanges

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1 Objectives

The main objective of the secondment was to continue the joint research in the field of nanofluids for thermal energy storage that University of Lleida and University of South Australia started within this project.

The secondment also allowed the ability to enhance the collaboration between the University of Lleida and the University of South Australia and to grow ideas to apply for further joint projects.

2 Introduction

Three different laboratories recently reported that the effect of adding silica (SiO_2) nanoparticles to the so-called solar salt ($NaNO_3$-KNO_3 (60:40 ratio)) produces an increase on its specific heat (Cp) of around 25 % in the liquid phase [1-3]. This can lead to costs savings in a concentrated solar power (CSP) plant which is very attractive for the industry.

3 Description of work

Until now all the manufacturing of nanofluids for CSP plants is being done only up to 200 mg samples scale [1-3]. Therefore, to ensure to the industry that this process is scalable and reproducible, the objective of the present study is to **synthetize** the nanofluid in **larger scale (250 times higher)**.

4 Materials and Methodology

The nanofluid under study is based on the **Solar salt,** $NaNO_3$-KNO_3 (60:40), and **SiO_2** nanoparticles (own synthetized and commercial) which were produced in **two different batches** of around **50 g.** This nanofluid is characterized before and after being 200 and 400 h in an oven at 450 ºC, which simulates the CSP behaviour, to see if there are significant changes in its thermophysical properties**,** mainly Cp and degradation temperature.

Table 1 shows the methodology that is being carried out to characterize the nanofluid. All these techniques (SEM, TGA, DSC), except DLS, are used to characterize the nanofluid before and after being placed in the oven, and also to characterize the solar salt without nanoparticles, as a reference, as well as for both types of nanoparticles themselves.

Table 1. Methodology to analyse all the developed nanofluids, with commercial and own synthetized silica nanoparticles

		Before and after 200 and 400 hours in the oven			
	Quantity prepared	SEM (Morphology)	DSC (Specific heat)	TGA (Maximum working temperature)	DLS (Particle size distribution)
Salt (eutectic)	Little	1 sample several pictures	2 samples, 2 runs	Yes	No
Nanoparticles own synthesis, size 80 nm	Little	1 sample several pictures (better TEM)	no	No	Yes
Commercial nanoparticles 250 nm	purchased	1 sample several pictures	no	no	yes
SAMPLE 1 1st batch own synthetized nanoparticles size 80-200 nm	50 g	1 sample several pictures	3 samples, 3 runs	Yes	Yes
SAMPLE 2 2nd batch own synthetized nanoparticles size 80-200 nm	50 g	1 sample several pictures.	3 samples, 3 runs	Yes	Yes
SAMPLE 3 1st batch commercial nanoparticles size 250 nm	50 g	1 sample several pictures	3 samples, 3 runs	Yes	Yes
SAMPLE 4 2nd batch commercial nanoparticles size 250 nm	50 g	1 sample several pictures	3 samples, 3 runs	yes	Yes

By following this methodology, 2 batches and 3 samples of each batch, repeatability and reproducibility of the results and thus of the manufacturing process will be ensured. This will be the first time that larger scale molten salt based nanofluid is being manufactured which provides a step forward for the industrial processing of this potential material for high temperature applications.

5 Results

During the secondment several important results were found:

- The synthetized nanoparticles in the lab were successfully developed and their particle size is around 200 nm observed by TEM (see Figure 1). Now, the sample will be anylized by dynamic light scattering (DLS) to know the particle size distribution.

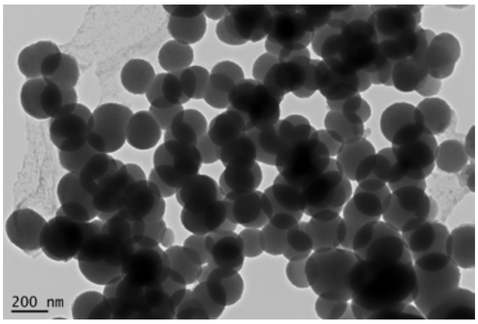

Figure 1. TEM image of own synthetised SiO_2

- 50 g of the nanofluid can be produced in two days with laboratory equipment as shown in Figure 2.

Figure 2. Pictures of the ultrasonic bath and samples when synthetizing nanoparticles and the nanofluid at the lab

- SEM images of samples 1 and 2 (see Table 1), batch 1 and 2, respectively, of own synthetized nanofluid, clearly show that they contain nanoparticles. Nanoparticles have been successfully dispersed in the solar salt and show some clusters formation.

- As observed in the case of the nanofluid with the own synthetized silica nanoparticles, some clusters of the nanoparticles are observed at 2 µm scale. It can be seen that nanoparticles still preserve its spherical shape and uniformity in particle size.
- No results are available at this point regarding the Cp of the developed nanofluids.

6 Outcomes or future work

If the results are as expected, they will lead to the production of at least one journal paper and a conference presentation.

7 References

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3. P. Andreu-Cabedo, R. Mondragon, L. Hernandez, R. Martinez-Cuenca, L. Cabedo, J. E. Julia. Increment of specific heat capacity of solar salt with SiO_2 nanoparticles. Nanoscale Research Letters 2014 9:582. doi:10.1186/1556-276X-9-582.

8 Assessment

The secondment was successfully developed and interesting research and experimental tests were possible to be performed during these three months. The nanoparticles were synthetized in the lab of the University of South Australia, as well as the nanofluid. However, once all the samples were synthetized and characterized by SEM or TEM, they were sent to the University of Lleida to finish the experimental part since it was not possible to be finished due to lack of time. The secondment was by far a success since the objectives were fulfilled during the timeframe. Also, I had the opportunity to attend a material conference (SIF2016) held in Adelaide and be in contact with experts from other institutions.