

# Phase Change Analysis of New Backfilling Materials with PCM for Geothermal Wellbores

Uxía Calviño<sup>1,4</sup>, Javier P. Vallejo<sup>2</sup>, S. M. Sohel Murshed<sup>3</sup>, Yulong Ding<sup>4</sup>, Luis Lugo<sup>1</sup>

<sup>1</sup> CINBIO, Universidade de Vigo, Grupo GAME, Departamento de Física Aplicada, 36310 Vigo, Spain  
uxia.calvino.barreiro@uvigo.gal; luis.lugo@uvigo.gal

<sup>2</sup> Centro Universitario de la Defensa en la Escuela Naval Militar, Grupo InTeam, Plaza de España, s/n, 36920 Marín, Spain  
jvallejo@tud.uvigo.es

<sup>3</sup> IDMEC, Department of Mechanical Engineering, Instituto Superior Técnico, University of Lisbon, 1049-001 Lisbon, Portugal  
smurshed@tecnico.ulisboa.pt

<sup>4</sup> Birmingham Centre for Energy Storage, School of Chemical Engineering, University of Birmingham, B15 2TT, Birmingham, United Kingdom  
y.ding@bham.ac.uk

## Extended Abstract

The dependency of fossil fuels in many residential and industrial applications is one of the main causes of global warming. Residential heating and cooling correspond to the 40% of the CO<sub>2</sub> emissions in Europe [1]. To cover the increasing energy demand while protecting the environment, renewable energy systems are being implemented. Among them, geothermal heat pump (GHP) systems are becoming a leading option for building applications.

The main element of a GHP system is the ground heat exchanger (GHE) installed underground, which must be sized depending on demand expectations. The GHE consists of a borehole, usually backfilled with grout, and tubing where a heat transfer fluid flows through. The ground heat is transferred from the soil to the borehole wall and then through the backfilling material to the circulating thermal fluid. Thus, the thermal behaviour of the GHE is highly dependent on the thermal properties of the backfilling material. With the aim of increasing the thermal performance of the GHE, the thermal storage capacity of the backfilling materials should be enhanced. Phase change materials (PCMs) have been proposed as potential candidates for this purpose. They can store or release energy in the form of latent heat multiple times greater than sensible thermal energy storage materials, allowing to reduce the size and cost of the plants [2].

In this study, a slurry formed by microencapsulated organic PCM dispersed in water (MPCM) is incorporated to three of the most common backfilling materials (BM) for geothermal boreholes, water (W), sand (SAND), and bentonite (BNT) at four different MPCM mass concentrations (20, 30, 40, and 50 wt.%). The main phase change characteristics of these materials have been analysed by performing heating and cooling curves at 2, 5 and 10 K·min<sup>-1</sup> heating rates within a temperature range from 243.15 to 303.15 K. All samples show two exothermic events corresponding to crystallization and two exothermic events corresponding to melting. The presence of ultrapure water causes crystallization peaks up to ~250 K while two melting peaks between ~272 and ~279 K are shown in all MPCM/BM samples. The solid-liquid transition temperatures varied with the heating rate from 10 to 2 K·min<sup>-1</sup> finding maximum decreases of the melting temperatures up to 4.8 K and maximum increases of the crystallization temperatures up to 5.1 K for the MPCM/BNT samples. No significant modifications of the latent heat were found with the variation of the heating rate. On the other hand, increases of the latent heat with the addition of MPCM were found for the MPCM/BNT samples, being the latent heat of the highest mass concentration three times higher than that of the 20 wt% MPCM/BNT.

## References

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