

Development of a rigid polyurethane foam incorporating phase change material microencapsulated in a calcium carbonate shell for thermal energy storage

Cláudia Amaral^{1,3}, Romeu Vicente¹, Paula A.A.P. Marques², Ana Barros-Timmons³

The use of phase change materials (PCMs) and rigid polyurethane foams (RPU) in building solutions and components to improve the thermal performance and to enhance the energy efficiency of the building is an up-to-date challenge. These two materials are widely used in buildings for thermal insulation and thermal storage purposes, respectively. Taking the joint advantages of the excellent thermal insulation performance of RPU foams and the thermal energy storage capacity of PCMs, the development of RPU composite foams can be designed to function as a latent heat thermal energy storage (LHTES) system. The major aim of the present study is to improve the thermal characteristics of RPU foams which have been almost exclusively used for thermal insulation purposes but can also find application as potential thermal energy storage components.

To overcome the low thermal conductivity of the RPU foam matrix, a method to prepare PCM microcapsules (mPCMs) based on paraffin core and calcium carbonate

shell (CaCO_3) has been developed to enhance the thermal conductivity and thus achieve a more effective charging and discharging process.

Additionally, a numerical analysis was used to determine the optimal wt% of mPCMs to add to the RPU foams. The determined value was 1.8 wt% of mPCMs and this amount was then incorporated in RPU formulations to yield composite foams. Figure 1 reveals that the morphology of mPCMs was kept intact during the preparation of the composite foams and were well dispersed in the RPU matrix. Comparing the indoor temperature curves results obtained for the RPU foam layer with and without mPCM (see Figure 2), it can be observed that the thermal amplitude reduction attained is about 0.5-1°C for the peak maximum temperature and 0.1-0.3°C for the peak minimum temperature. The indoor curve profile obtained ranges between 18.1°C and 25.2°C for the RPU foam layer without mPCM and 18.3°C and 24.1°C for the RPU foam layer with mPCM.

1 — Department of Civil Engineering & RISCO, University of Aveiro
2 — Department Mechanical Engineering & TEMA, University of Aveiro
3 — Department of Chemistry & CICECO, University of Aveiro

FIGURE 1
SEM images of the RPU foams with mPCMs.

FIGURE 2
Temperature profiles.

