ENHANCING BUILDING ENERGY EFFICIENCY WITH INNOVATIVE PARAFFIN-BASED PHASE CHANGE MATERIALS

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ABSTRACT

The demand for more energy-efficient and low-carbon buildings and neighborhoods has intensified due to the significant energy consumption associated with the building sector. This, coupled with the expanding global population and rising standards of human comfort, underscores the urgency of addressing this issue. Integrating highly energy-efficient technologies in buildings is key to tackling this challenge. In this context, thermal energy storage (TES) emerges as a recognized and efficient technology for reducing greenhouse gas emissions and energy consumption in buildings and neighborhoods. A solid example of TES is Phase Change Materials (PCMs), which have emerged as promising agents for improving energy efficiency in buildings by mitigating temperature fluctuations. Based on their physical characteristics, PCMs are mainly categorized in Solid-Solid (SS-PCMs) and Solid-Liquid (SL-PCMs). This paper explores the application of PCMs, with a specific focus on organic paraffin-based SL-PCMs solutions, in enhancing thermal performance and reducing energy consumption in buildings. Paraffin-based PCMs offer advantages such as high thermal storage capacity, compatibility with building materials, and cost-effectiveness. [1] This paper shortly reviews recent advancements in the integration of paraffin based PCMs into building components, including roofs, walls, ceilings, windows, and floors, to regulate indoor temperatures and optimize energy usage. The challenge that arises is that, although progress has been made in the use of PCM materials within different categories separately, there has not been a focus on combinations of PCM materials within a building, such as a combination of PCM in walls, ceilings, and floors. [2] Therefore, this paper explores a use case example in building design, where paraffin based PCM is employed in various combinations of building materials simulated using OpenStudio/EnergyPlus. The thermal conductivity of paraffin-based PCMs, integrated into building elements such as cement or gypsum boards, was determined using the Hot Disc TPS1500, whereas their solar reflectance and infrared emittance were measured using a UV-RIS-NIS spectrophotometer. These laboratory measurements serve as inputs for the OpenStudio/EnergyPlus simulations. Subsequently, energy and carbon emissions savings are quantified for each PCM scenario within various material combinations, allowing for comparative analysis.

KEYWORDS: Phase Change Materials, Paraffin, Energy Efficiency in Buildings, EnergyPlus,

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