Advanced building envelope by integrating phase change material into a double-pane window at various orientations

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Abstract

Considering building envelope elements in hot locations, windows contribute to about one-third of the building's total cooling load since heat is transferred effortlessly through transparent elements more than opaque ones. The present work experimentally explores the energy advancements of a phase change material (PCM) loaded in the air gap of a double-pane window. The PCM window was examined under Southern Iraq weather conditions and compared with an identical air–gap double-pane window at various orientations. Numerous energy indicators were analyzed, including the improvement in the average indoor temperature, attenuation coefficient, and time delay to quantify the PCM's usefulness to the built environment at different orientations. Study outcomes depicted remarkable energy improvements for the PCM in all orientations over the reference window in which the indoor temperature was reduced as much as 23 °C, and shifted by up to 50 min over the reference case. Conclusively, the PCM window could notably shave peak temperature when exposed to high solar radiation for a short period, while it could shift peak temperature mostly if oriented towards longtime solar radiation.