Iran school energy storage

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One of the important lines of this research is thermal comfort. Thermal comfort studies have started decades ago, but since 1930, a scientific and engineering approach has been adopted to investigate this issue in buildings with different uses such as; residential37,38,39, office40,41,42 and educational43,44,45,46,47.

There are two methods for evaluating thermal comfort: the predicted mean vote (PMV/PPD) model and the adaptive (ACM) model. The PMV model was introduced by Fanger in the late 1960s, is based on the thermal balance model, measuring six internal environmental variables2. Fanger (1970) has given relation between PMV with PPD(Percent of People Dissatisfed) by, which says even if the PMV is zero 5% of the people feel dissatisfied, When the PMV is in the range of ? 0.5, and then PPD is less than 10%15.

The adaptive model is a relatively new model that determines the acceptable temperature range for buildings that use mixed mode air conditioning (natural ventilation (NV) or air conditioning (AC)) based on the outdoor temperature48. Current thermal comfort standards such as ISO 773049, EN 15,25150, and ASHRAE Standard 551, based on the PMV/PPD and adaptive thermal comfort models, determine the design values for the operative temperature and the comfort equations48. Additionally, thermal comfort and energy consumption in Iran have been studied in various types of built environment such as residential buildings, hospitals, office buildings, markets, gardens, sidewalks, urban spaces, and educational spaces6,32,51.

In order to reduce energy consumption and increase thermal comfort by using nanomaterials such as Aeropan in the wall and nano-PCM in the windows of the educational building, the research method of this paper is divided into two parts which is presented as follows.

Location of the studied case. The maps used in Fig. 1 were obtained from Google Maps and then processed by the authors using Adobe Photoshop 2023 v24.7.4.125161.

Class module and their three arrangement modes.

Aeropan panel is a novel thermal insulator made by nanotechnology and aerogel material. This panel, due to having very low thermal conductivity (0.015 W/mK), needs less thickness (Table 5). With a thickness of only 10 mm, it provides a similar performance to expand polystyrene panel with a thickness of 25 mm. The aerogel-based insulating panel guarantees a longer useful life than traditional insulators in addition to reducing thickness, installation cost and, time62.

The innovation of this research lies in the simultaneous use of two nanomaterials, the nano-PCM and the Aeropan in the window glass of the school, which are used to improve thermal comfort and reduce energy consumption (Table 7).

This paper aims to investigate the performance of two nanomaterials in improving thermal comfort and reducing energy consumption in an educational building. These nanomaterials are the nano-PCM in window glasses and the Aeropan in walls. For this purpose, a mix of simulation and experimental methods was used. In the school building design section, the module and alignment of the classes were presented. Then, the thermal comfort and energy consumption of these alignments were analyzed and compared in two different conditions including with usual building materials (Table 3), and, with the same materials enriched by the nano-PCM window and the Aeropan wall coatings.

Flowchart of different part of this article.

The TESTO 425 device is used to measure thermal comfort parameters.