

Studying The Role of Phase Change Materials in Improving the Thermal Performance Efficiency of Adaptive Building Envelopes

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Abstract:

In the context of unsustainable approaches, buildings are increasingly dependent on mechanical systems to ensure quality requirements of thermal indoor environment, which causes the need for more energy as well as rising the associated greenhouse gas emissions rates. This requires increased awareness towards energy conservation and reduction of energy consumption in conjunction with enhancing buildings sustainability. In this regard, we find that the building envelope plays a crucial role in reducing energy consumption; as well as its role in raising the performance of buildings as the regulating mediator in the reciprocal relationship between the internal and external environment, especially when applying appropriate technical solutions and energy-saving materials within the structure of the envelope, which enhances the concept of passive adaptation to the simultaneous environmental changes. So, Improving the efficiency of energy performance during the operational phases of the building envelope is a vigorous area of research; Organizations and responsible authorities are always seeking to come up with advanced technologies based on renewable energy sources in order to reduce buildings' dependence on fossil fuels and provide cooling and/or heating energy requirements, as well as improve indoor thermal comfort in a more sustainable and cost-effective manner.

In this regard, Thermal Energy Storage Systems (TES) are discussed as one of the most effective advanced technologies in managing the thermal performance of the building envelope with a particular focus on studying the role of Phase Change Materials (PCMs) in raising the efficiency of the building's thermal performance. This study sheds light on the importance of applying

phase-changing materials in the building envelope and its role in activating the principle of thermal adaptation to daily fluctuations. by discussing the nature of that category of materials, their types, and their distinctive properties in addition to studying its main working principle, then studying criteria for choosing the most appropriate. focusing on current studies and future scenarios for these materials to monitor their thermal behavior and examine their role in raising the efficiency of the building envelopes performance. The main results indicated that the phase change materials have a significant effect on reducing the cooling/heating load, saving energy and gaining thermal comfort.

Keywords:

Phase change Materials (**PCMs**) - Thermal Energy Storage Systems (**TESSs**) - Thermal indoor environment quality (Thermal Comfort) - Adaptive Building Envelopes – Passive Cooling - Energy Saving.