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Investigation of heat transfer of wall with and without using phase change material

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Abstract

As part of reducing energy use for building application like cooling and heating, the phase change material (PCM) plays a vital role, it be incorporated into building structure and materials in an effective manner. In this research concentrated to find the effect of heat transfer of PCM filled hollow block (wall) and unfilled one, tested in a natural climatic condition of Chennai. In this regard Organic Material OM29 PCM is chosen based on average temperature persists on the selected location, it acts as thermal barrier also minimize the heat entering to the room. Heat gain of the building wall is respective to seasonal variations based on that the selected OM29 is to be effective only where the clear sunny days, over the period the PCM performance is to be optimized. The result shows that temperature drop of 5.7% and heat gain reduction of 33% are observed across the dimensions of the hollow block in the indoor surface, the temperature at various points in a surface is similar. The results showed the selected PCM have great influence in reduction of heat transmission from external face to internal face in hot climates, however for a moderate climate, the solar intensity differs from day to day so cooling transmission loads it varies, so employability of PCM influenced by ambient factors. The

numerical simulations were performed thus the results are validated with experimental, in the incorporated PCM was effective in the months of April to July.

Introduction

Thermal solace is critical for unsteady atmospheric conditions and beyond. The solace implies the degree of comforts of an individual depends on the environment. It can just accomplish once air temperature, moistness, and air circulation volume unit among as far as possible. The significant purpose of building is to shield the human from changes in atmospheric condition.

For maintaining indoor thermal comfort conditions to ensure the indoor temperature below from outdoor temperature in summer where as vice versa in winter. Besides, to scale back the price of electrical energy and adverse impact on the setting to seek out different strategies for reduction of energy use. In the last two decades, introducing various types of energy storage system for cooling applications, in that thermal energy storage systems play a significant role, combined with phase transition material is an attractive approach as result of such a system has stable thermal behavior and high storage density.

The main aim to analyze the thermal viability of PCM to build up a perfect energy storage device for free cooling. The goal is to increase the thermal consolation without utilizing power. The thermal efficacy of the proposed brick-PCM system is assess by contrast the swing of temperature and heat flux at the indoor surface of a wall with unfilled PCM wall on proposed boundary conditions. As this research is concentrated on temperature and heat transfer, we found that OM29 (which is made of organic acid and Monocarboxylic acid) was the most suitable one for our temperature range. Building blocks or other building materials impregnated with a PCM used in constructing the building, leading in a structure with large thermal inertia without the large mass related to it.

Hawes, D.W., Feldman, D. [1] The selection of PCM for Building applications depends on mass and energy rates, more preferred high latent heat storage material with smaller mass volume. Kenisarin and Mahkamov [2] investigated the cutting edge on incorporation of PCM into building structures for their latent warm control. The consequences of relative tests on fifteen full-scale structures containing components with PCMs were abridged.

Ravikumar et al. [3], [4] analyzed the heat resistance capacity of PCM for cooling of structures. The capacity is conceivable because of the low heat conductivity of PCMs and these materials can go about as self-protectors. Zhang, et al. [6] dissected the thermal exchange of the wall loaded up with PCM under a dynamic mode of air temperature. The outcomes demonstrated that PCM incorporated wall has reduced the heat flow to indoor. If increasing the mass rate, the thermal interactions could be reduced. N. Zhu et al. [7] The fuse of phase change materials guarantees to be one of the most progressive innovative patterns to expand the energy performance thus, resulting manageability of the building stock. The greatest benefits of PCM is that they can stores up to twenty percentage energy than the normal building materials by idle warmth limit.

F. Kuznik et al. [8] describe the phase transition happens when the forced temperature is more than the blending temperature of the PCM, so the PCM stores energy in latent form amid the stage change from liquid and among the same during PCM discharge the stored energy where the forced temperature is less than the blending temperature [8], [9], [10], [11]. The points of interest in the utilization of microencapsulated PCM are: i) the simple joining into ordinary building materials; ii) Enhance the heat exchange territory among the PCM and the encompassing material. iii) steady volume could be maintained during any phase transformations.

To the extent hollow block is concerned, the design advancement [12], [13], [14], [15], [16] depends on evolving the arrangement of the centers, either by adjusting the gaps to be increased and in some ongoing cases, by filling the gaps with protection materials [17].

a) Phase change material serves as latent thermal storage relatively low mass and high density

b) The thermo physical properties have varies the organic, inorganic, eutectic PCMs

c) Based on average ambient temperature (27 °C) the organic acid and monocarboxylic acid (PCM) are selected

Section snippets

Proposed system

Based on the difference in temperatures and climatic condition of the region the PCM is selected. The PCM works in such a way that during night time it absorbs the cold and turns back to a solid state and release it during daytime. Hollow block is divided into three segments first one is solid part, second is hollow part and third is solid part. The hollow part inside the brick of the wall can be filled with PCM. Thus, PCM plays an important role as a thermal energy storage device by utilizing…

Results and discussion

The construction of the prototype can be done with help of hollow blocks. The hollow blocks are arranged to build a wall in four sides. The one side of the wall is constructed with help of nine hollow blocks and the wall is of dimension 1200 × 600 mm. This is done for sides for East, West, North and South. The top side of the construction is covered. Then the temperature sensor is placed inside the hollow block and surface of both side of the hollow block. This is done for different iteration…

Conclusion

In the present project, a detailed study on PCM incorporation in Building material is done. It is quite evident from the preceding reviews that the thermal improvements in a building due to the inclusion of PCMs depend on the melting temperature of the PCM, the type of PCM, the percentage of PCM

mixed with conventional material, the climate, design and orientation of the construction of the building. Being site specific, a detailed study is required for the selection of material and to…

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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...While comparing the performance of n-octadecane, natural paraffin, n-eicosane, and P116, Alawadhi [20] recorded a comparative outcome. Arunkumar et al. [179] carried out a numerical and experimental analysis on the walls with and without PCM bricks. They used commercially available organic PCM, OM 29, with phase transition temperature at 29°C suitable for the location selected....

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...Although there are substitutes being employed for a more non-conventional and inexhaustible sources of energy, the fact remains that the most viable way for sustenance is to cut down the energy consumption. Phase change materials could be used as a suitable latent heat storage system to reduce temperature fluctuations by storing the solar radiations via passive solar energy storage [1–3]. Two or more fatty acids, which are easily available and economical in usage could be combined together in order to form a eutectic mixture....

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