Energy Assessment and Optimization of Façade by Using Phase Changing Materials

Jaison Varkey.\textsuperscript{1} & K. Shobana\textsuperscript{2}
\textsuperscript{1}Post Graduate student, ME Construction Engineering and Management, Nehru Institute of Technology, Coimbatore. Tamil Nadu, India
\textsuperscript{2}Assistant Professor, Civil Engineering Department, Nehru Institute of Technology, Kaliyapuram, Coimbatore, Tamil Nadu, India

Abstract: Construction sector is the most prominent sector for several decades after agricultural sector. There will be several kinds of innovative techniques used for construction. The main criterion in construction is to get the durability and to do in economic manner. Several techniques have been used to get these criteria. In the field of construction industry the wall construction incurs more cost & load. Facade is the one of the solution to this problem. To reduce the cost and optimization is the main factor in façade sector. Phase changing material can be incorporated into construction materials and element by direct incorporation, immersion, shape stabilization and encapsulation. Building integrated thermal energy storage systems cover a wide range of techniques and solutions depending on technology applications and aims. In this context, Phase Change Materials (PCMs) fit the above description, since they would allow for mostly isothermal phase change within normal thermal comfort range. Using the phase changing materials as a paraffin when mixed in to the gypsum board as a powder. The idea is to use the phase change materials as a substitute to the thermal inertia of massive walls to obtain a similar effect in lightweight structures. In this project Paraffin wax PCM is used in the suspension and impregnation manually. Due to the organic nature of the PCM with high elasticity and, the adherence is reduced due to the difference between the porosity of the different surface as well as the surface tension difference.

1. Introduction

As the rapid economic growth worldwide, the supply of the overall energy consumption becomes tense gradually and, the building sector’s energy consumption is the dominant around the world with a total of 30% share of the over-all energy consumption. Building energy consumption derives from a variety of sources, such as building envelope and equipment. Solar energy is believed to be very promising which is not only renewable but also non-polluting. There is always a time or space contradiction between energy supply and energy demand, such as peak valley difference of electrical load and intermittent of solar energy source. Thermal energy storage (TES) can solve this contradiction and reduce energy consumption

New technologies in building construction and services are needed in order to reduce the big energy consumption in the building stock from which a major part goes for controlling of indoor climate. On the other hand, performance requirements are growing higher because of both more severe regulations and higher comfort requirements by the users – the wide use of air conditioning systems, also in houses, is just an example of this trend. Integration during the design phase among Architecture, Building Technology and Services is thus much recommended to obtain a more sophisticated “living-environment”, using relatively simple strategies and avoiding extra-costs.

It is possible to tackle the problem of energy consumption with stratified lightweight skins and layers, high performance materials and integration of installations, like heat pumps for example or wind turbines, and enhancing the use of renewable energy sources by using devices like solar photovoltaic panels or solar thermal exchanger or simply by preferring natural ventilation and natural shading or re-interpreting low processing materials and using them in a clever way.
2. Objective of study

The objective of this study is to analyze the potential of application of Phase Change Materials (PCM) in lightweight buildings or rather compounds (salts or paraffins) that undergo a phase change process, involving the storage, or release, of latent heat.

- Assessment of energy consumption in building envelope
- Implementation of PCM in façade
- Producing a new façade envelope by using PCM
- Optimization of energy measured through test

3. Scope of the study

- To arrive a potential method to develop a phase changing material which have less energy consumption and more life time.
- Aims to study potential of application of Phase Change Materials (PCM) in lightweight buildings or rather compounds (salts or paraffins) that undergo a phase change process, involving the storage, or release, of latent heat.

4. Methodology

Methodology is the systematic, theoretical analysis of the methods applied to a field of study. It comprises the theoretical analysis of the body methods and principles associated with a branch of knowledge. It may be understood as a science of studying how research is done scientifically. It will study the various steps that are generally adopted by a researcher in studying the research problem along with the logic behind.

5. Introduction Of Phase Changing Materials

The main property of phase change materials is the storage of heat energy in a latent form, leading to greater heat storage capacity per unit volume than that of conventional building materials. When the ambient temperature rises, the chemical bonds of the material will break up whereby the material will change from solid to liquid. This phase change is an endothermic process and as a result will absorb heat. As the ambient temperature drops again, the PCM will return to the solid state and give off the absorbed heat. This cycle stabilises the interior temperature, cuts off-peak cooling loads and decreases heating loads, not by affecting the thermal resistance of the building envelope but by influencing the (surface) temperatures. Including such phase change materials in building constructions, some specific thermal, physical, kinetic and chemical properties are desired:
i. From a thermal point of view, a suitable phase change temperature range, a high latent heat of fusion and a good heat transfer towards the PCM are desired. The desired phase change temperature will depend on climatic conditions and the desired comfort temperature.

ii. From a physical point of view, a favourable phase equilibrium, i.e. no phase segregation, a high density and small volume changes at the phase change are desired for easy incorporation in existing building materials or structures.

iii. From a kinetic point of view, no supercooling and a sufficient crystallization rate are desired to make optimal use of the properties and possibilities of PCMs. Supercooling, i.e. the process of lowering the temperature of a liquid below its freezing point without becoming a solid, could strongly affect the performance of the PCMs based on the chosen suitable phase change temperature by influencing this temperature.

iv. From a chemical point of view, a long-term chemical stability of the PCM despite cycling, compatibility with construction materials, non-toxicity and no fire hazard is desired.

5.1 Paraffin Wax

Paraffin wax is a white or colourless soft solid derivable from petroleum that consists of a mixture of hydrocarbon molecules. It is solid at room temperature and begins to melt above approximately 37°C. It is an excellent material for storing heat. This property is exploited in modified drywall for home building materials. It is infused in the drywall during manufacture so that it melts during the day by absorbing heat, and solidifies again at night by releasing the heat.

6. Future concept of high-performance building by adopting PCM

- PCM uses the power of phase changing materials to actively absorb and release heat. These “phase changes” help maintain constant, comfortable building temperatures.
- This is a major breakthrough in design which helps to reduce energy consumption, shift peak electricity demand and reduce the cost of energy. Results showed that for most climates a PCM melt temperature of 25°C yielded the largest increase in occupant comfort; however the magnitudes of increase in occupant comfort were highly climate dependent.
- A minimally invasive method of adding the thermal mass to a building is to apply phase change material to the interior of the structure. The future enhances a simulation based approach for informing the integration of PCM in high performance homes without mechanical cooling.

7. Conclusion

This research work aiming the development of a gypsum plaster based in conventional construction techniques had the opportunity to test the system in a real practical environment in order to evaluate and verify its feasibility. Results in test cells allowed stepping with further confidence into the real application.

8. Acknowledgement

I would like to extend my sincere & heartfelt obligation towards all the personages who have helped me in this study. Without their guidance, help, cooperation and encouragement, I would not have made progress in the study.

9. References


