A Basic Investigation on Paraffin wax for Energy Efficient Buildings

Greesan R, Vasumathi AM

Department of Civil Engineering, Chendhuran College of Engg & Tech, Pudukkottai
Department of Civil Engineering, Sethu Institute of Technology, Madurai

Received 28 January 2017; Accepted 22 March 2017; Available online 28 April 2017

Address For Correspondence:
Greesan R, Department of Civil Engineering, Chendhuran College of Engg & Tech, Pudukkottai
E-mail: greesan.ram@gmail.com

Copyright © 2017 by authors and American-Eurasian Network for Scientific Information (AENSI Publication).
This work is licensed under the Creative Commons Attribution International License (CC BY).
http://creativecommons.org/licenses/by/4.0/

ABSTRACT

Improvement of energy performance is the prime objective of any research work. Thus in-order to minimize the energy consumption, the implementation of phase change materials is necessary to provide the energy efficient building. Here the most superior Phase Change Material namely; Paraffin wax is suggested because of its reliable nature. Various papers are reviewed and the basic properties are examined to confirm the nature of wax. Energy efficiency and thermal characteristics are studied briefly to control the thermal effect with less energy consumption. Few important tests like CHNS, XRD are conducted to compare the reviewed papers and actual available material. Based on the results attained from the analysis and literature review, the Paraffin wax is suggested to utilize in a building components to reduce the energy consumption by making the comfort room temperature.

KEYWORDS: Energy Efficiency, Paraffin wax, Global Warming, Thermal insulation, PCM.

INTRODUCTION

The construction industry is a chief contributor towards the nation’s economical growth and it also a large consumer of energy. On the view of high volume energy consumption, the industry is always focussed towards the invention of alternate materials with less emission of Co2.

Sustainable environment is the key for every research. The Phase Change Materials are such a kind of material to consume less amount of energy and it leads to sustainable environment.

PCM is nothing but a Material which can change from its one state to another state, either from liquid to solid or solid to liquid or from liquid to gas vice versa. Some of familiar PCM’s are, Paraffin Wax, Fatty Acids, PEG etc.

Phase change materials exhibits thermodynamic property of storing large amount of latent heat during its phase change. PCM solidifies on drop of ambient temperature giving off its latent heat of fusion. As compared to conventional materials PCMs have the property of storing high amount of latent heat giving more heat storage capacity per unit volume. PCMs can be used in building walls, ceilings and floors. In building applications, they have a phase transition close to human comfort. Regarding the types, there are two types of waxes are available namely, Paraffin wax and beeswax.

Energy Efficiency:

Energy Efficiency is nothing but an achieving the desired comfort with the least input of conventional energy. Architects and designers accomplish the task through solar passive design, use of renewable energy technology systems, and/or natural building materials. While designing such buildings, not only new building
stock can be targeted but also existing buildings can be retrofitted with energy efficient and eco-friendly technologies, thereby substantially reducing energy consumption. All put together is Energy Efficient Housing. [6]

**Fig. 1:** Energy Consumption in Canada

In residential sector, size and location are key factors for energy consumption. Small flats needs less energy as there is less conditioned and transfer area, and also less occupation. The amount and type of energy used in dwellings are mainly related to weather, architectural design, energy systems and economic level of occupants. By and large, dwellings in developed countries use more energy than those in emerging economies and it is expected to continue growing due to the installation of new appliances. In USA, dwellings consume 22% of the total final energy use, compared with 26% in the EU. The UK figure is 28%, well above the Spanish 15% mainly due to more severe climate and building type. For example: Predominance of independent houses over blocks. [7]

If we concentrate on energy efficiency, we can’t omit the greenhouse gas emissions. The continuous increase in the level of greenhouse gas emissions and the climb in fuel prices are the main driving forces behind efforts to more effectively utilize various sources of renewable energy. In many parts of the world, direct solar radiation is considered to be one of the most prospective sources of energy. However, the large-scale utilization of this form of energy is possible only if the effective technology for its storage can be developed with acceptable capital and running costs. One of prospective techniques of storing solar energy is the application of phase change materials (PCMs). This paper looks at the current state of research in this particular field, with the main focus being on the assessment of the thermal properties of various PCMs, methods of heat transfer enhancement and design configurations of heat storage facilities to be used as a part of solar passive and active space heating systems, greenhouses and solar cooking. [8]

Approximately 30% of energy use in Canada in consumed in buildings. The largest component of this energy consumption in multifamily residential buildings in space heating. One of the primary functions of building enclosure is reducing space – heating energy. Although heat flow cannot be completely prevented, it can be controlled to reduce energy consumption, creates a sustainable environment and implement human comfort. However this can be achieved by constructing a thermally resistant building enclosure. [9]

Concrete and Brick walls are coated with Phase Change Materials to make a comfort building environment. Its aim to study the influence of the integration of PCM on the thermal behavior of cells and on the thermal behavior of cells and on the improvement of thermal comfort in buildings under the Algerian climate. [5]

A building faces different kinds of problems due to thermal inefficiency such as condensation on window surfaces; some occur within our wall and roof systems. Condensation problems occur for several reasons like, elevated humidity and stagnation of air. Evaluations of thermal inefficiencies are done using visual observation, tracer smoke testing, infrared thermography and thermal analysis. Along with architectural features such as light shelves and sun shades, we have to considere about structural retrofits for stabilizing the thermal comfort. [10]

**MATERIAL DESCRIPTION:**

**A. Basic terms in heat transfer:**

**Exothermic Reactions:**

It is the reaction that release energy, usually in the form of heat. In this reaction, energy is released because the total energy is less than the total energy of the reactants.

**Endothermic Reactions:**

It is the reaction that absorbs energy, usually in the form of heat. In this reaction, energy is drawn because the total energy is higher than the total energy of the reactants.
Fission & Fusion:
It is the process of division or splitting of the material into two or more parts and the process of joining two or more materials together is referred to as Fusion.

Latent Heat:
If the latent heat of fusion is high, the amount of energy needed to store is less.

B. PCM & Types:
Overview of PCM:
The possible incorporation of phase change materials (PCMs) in building materials has attracted a lot of research interest worldwide due to the concern on global warming and the ability of PCMs to reduce energy consumption in building because of their thermal energy storage abilities. As a substance with a high heat of fusion, PCM is capable of storing and releasing large amounts of energy in the form of heat during its melting and solidifying processes at the specific transition temperature. For the past 20 years, significant research has been undertaken on the potential use of PCMs in concrete. [1]

Why PCM?
The optimum concentration of PCM (30% PCM) wherein the composite material has a specific heat and mechanical properties well suited to the use of PCM in the building. During the summer season, the PCM incorporated building components decrease of 2.5°C in the maximum indoor temperature and reduces the amplitude of the cells indoor temperature by 4°C. The PCM improves the thermal comfort and increases the maximum wall temperature by 4°C in winter period. [5]

Need and Requirements of PCM:
PCMs are more useful because of its nature of storing and releasing heat within a certain temperature range. Phase change materials (PCM) are “latent” thermal storage materials possessing a large amount of heat energy stored during its phase change stage. [2]

Buildings are large consumers of energy in all countries. In regions with harsh climatic conditions, a substantial share of energy goes to heat and cool buildings. The proper use of thermal insulation in buildings does not only contribute in reducing the required air-conditioning system size but also in reducing the annual energy cost. [3]

The various types of PCM are:

1. Organic PCMs:
Organic PCM are stable compounds and are free from super cooling, corrosion and have higher latent heat of fusion. Commercial paraffin waxes are less expensive and have a thermal storage density of 120KJ/Kg to 210KJ/Kg. It is chemically inert and it has various melting points from 20°C to 70°C. They are free from super cooling, volumetric change and have high heat of fusion.

Advantages:
i. Materials can be available in large temperature range and freeze without much super cooling.
ii. It has high heat of fusion.
iii. Compatibility with conventional material of construction and no segregation.
iv. Safe, non-reactive and recyclable.

2. Inorganic PCMs:
Inorganic PCM has good thermal conductivity, affordability and non-flammable. They are corrosive to metals and also undergo super cooling and phase decomposition. Most of them occur at unfavourable temperature ranging from 30°C to 600°C.

Advantages:
i. High volumetric latent heat storage capacity.
ii. Low cost and easily available.
iii. It has high thermal conductivity.
iv. It has high heat of fusion.

3. Eutectics:
Eutectics have low melting point and its volumetric storage density is slightly higher than that of organic compounds. In general its melting point varies from 18°C to 51°C and its freezing point lies between 16°C to 51°C.
**Advantage:**
i. They have sharp melting temperature.
ii. They have high volumetric thermal storage density.

**C. Wax & its Types:**

**Paraffin Wax:**
Paraffin Wax is generally an organic PCM which is white in colour or colourless. It is a solid based product derived from petroleum having the melting point of 58 to 60°C. Paraffin are chemically inert and stable compounds.

The chemical formula for Paraffin wax is $C_{n}H_{2n+2}$. As a name implies, paraffin exhibits a less affinity to chemical agents and that’s why it is preferable to most of the industries.

![Paraffin Wax Image]

**Bees Wax:**
Beeswax is a natural wax from honey bees. They generally have low melting point from 62°C to 64°C. If beeswax is heated above 85°C, there may be de-coloration occurs.

![Bees Wax Image]

**Applications of bees wax**
1. It acts as lubricating sashes.
2. It helps to remove the ruts in the bolt threads with melted wax.
3. It acts as a waterproof layer.

**TABLE I:** Paraffin Vs Beeswax

<table>
<thead>
<tr>
<th>S.No</th>
<th>Paraffin Wax</th>
<th>Beeswax</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White solid substance</td>
<td>Coloured solid</td>
</tr>
<tr>
<td>2</td>
<td>It is the last product from the petroleum refinery</td>
<td>It is the natural by product from honeycombs.</td>
</tr>
<tr>
<td>3</td>
<td>It is chemically inert and stable</td>
<td>It does not contain harmful chemicals</td>
</tr>
<tr>
<td>4</td>
<td>Melting point may starts from 50°C</td>
<td>Its having low melting point when compare to Paraffin</td>
</tr>
<tr>
<td>5</td>
<td>Non Corrosive in nature</td>
<td>Non Corrosive in nature</td>
</tr>
</tbody>
</table>

**D. Properties of Paraffin wax:**
It is a colourless or White colour nature solid substance. And also it is tasteless and odourless having the density around 900kg/m³. Naturally it is insoluble in water and it may soluble in ether, benzene and in certain ester.
Applications of paraffin wax:

Among the various applications in food and other industries some of the few applications in our construction industry are listed below:
1. Liquid paraffin wax is used in self curing concrete.
2. It acts as a sealant.
3. It also acts as an internal curing agent in the ordinary concrete.
4. While adding this paraffin wax with concrete it retains excess warmth within it.

III. TEST RESULTS:

A. CHNS Analysis:

Any of the compound material is tested to found the ingredients present in it. The paraffin wax is subjected under the CHNS analyser and based on the CHNS analysis, the following results are tabulated to found the components present in the paraffin wax specimen.

<table>
<thead>
<tr>
<th>Chemical Content</th>
<th>% Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>85.51</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>15.69</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.00</td>
</tr>
<tr>
<td>Sulphur</td>
<td>15.69</td>
</tr>
</tbody>
</table>

Fig. 3: Constituents of Paraffin Wax

B. XRD Analysis:
Figure 4&5 shows the XRD patterns of Paraffin wax. XRD patterns are compared with standard JCPDS data and it is found that it is well matched with PDF no 14-0763 (Paraffin wax). From figure 1, can clearly identify the predominant peaks of paraffin wax was found at 21.369 and 23.735°, which shows a very slight shift to the higher angle side compared to corresponding JCPDS file, which is possibly due to the presence of impurities may be improper refining process.

IV. REASONS FOR SUGGESTING PARAFFIN WAX:

Some of the strong reasons are mentioned below for recommending paraffin wax.

- Phase Change Materials are the real solution to provide comfort room temperature.
- Organic PCM are the most suitable one as compare to inorganic PCM
- Paraffin Wax is the type of Organic PCM which exhibits better characteristics as
- Non Corrosive in nature
- High thermal stability
- Higher degree of melting point when compare to beeswax
- No affinity to chemical reactors
- Less Energy Consumption
- Make a structure as thermally insulated one with less energy
- Cost effective technique when compare to other materials and cooling agents.

Conclusions: Based on the literatures studied and the test results obtained for a Paraffin wax, the paper suggest to incorporate the Paraffin wax as a successful PCM to make a structure as a thermally insulated one by providing the comfort room temperature. Further research works are in progress to conclude the results for the Paraffin wax.

REFERENCES