 ISSN: 2321-8169
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Review of PCM Technology With Application of Solar Water Heater

Saurabh P. Joshi
Department of Mech Engg
MGI-COET, Shegaon, Maharashtra, India
saurabhj231@gmail.com

Harish L. Nimbalkar
Department of MECH Engg
MGI-COET, Shegaon, Maharashtra, India
nimbalkarhl4922251@gmail.com

Rajatkumar A. Jawlekar
Department of MECHEngg
MGI-COET Shegaon, Maharashtra, India
rajatjawalekar1996@gmail.com

Abstract—The objective of this paper is to review the recent technology of thermal energy storage using phase change materials for various applications. Solar energy is one of the biggest sources of renewable energy. Solar tank is having a great important as a part of solar collector. Collector transform but not store the solar energy, so there is solution of this problem the solar tank particularly filled with PCM. The collector operates at low temperature when the solar tank filled with PCM. TES systems which have paraffin as the PCM are under study here. System absorbs and stores the solar energy during daytime with the help of PCM which can later be used during night-time to heat water. Therefore, in this paper, attempt has been taken to summarize the investigation of the solar water heating system incorporating with phase change materials.

Keywords- *PCM (Phase Change Material), LHTES (Latent Heat Thermal Energy Storage), HTF (Heat Transfer Fluid).*

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I. INTRODUCTION

Energy is one of the most important parts of human life. It is necessary for existence of human life. Population increases day by day due to growth of population; there is tremendous burden on the energy resources. The country's energy demand grown. There is different form of energy resources; renewable energy is one of that. Solar energy is a form of renewable energy. Today India has the highest potential for the effective use of renewable energy sources. Solar energy is simple to use clean, none polluting and inexhaustible has received wide spread attention in the times. Hence, some form of thermal energy storage is necessary for more effective of this energy source.

PCM is one of the techniques to store this thermal energy in the form of latent heat. Phase change material can store energy by melting at a constant temperature. The classifications of PCM are as follows: A number of studies have been reported on using different types of PCMs for LHTES. Those PCMs generally known for thermal storage application include organic compounds, inorganic salts and their eutectics, as categorized in Fig. 1. Organic compounds used for PCM include paraffin waxes, esters, acids and alcohols; inorganic materials include salt hydrates, eutectics of inorganic salts, and metals and their eutectics Those PCMs from organic compounds generally have low melting points and can only be used for room-heating thermal storage. For high temperature thermal storage, molten salts have been widely considered by researchers. Nevertheless, since molten metal and alloys are considered as HTFs in nuclear power plants, they are also viewed as possible HTFs as well as PCMs for thermal energy storage in CSP systems.

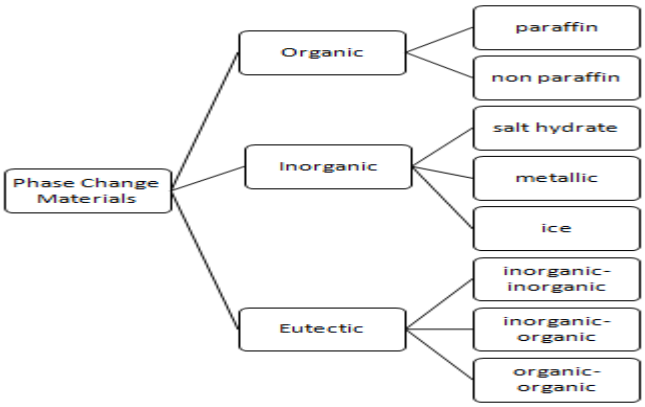

Fig.1 classification of PCM [8]

Paraffin is one of the most reliable and inexpensive phase change materials are being used as a storage material in the thermal storage unit. It is used because of its proper such as a large latent heat and thermal characteristics.

Table: 1 characteristic of paraffin. [5]

Property	Value
Latent heat	145 kJ/kg
Viscosity	1.9 mm2/s
Density	1.412 g/cm3

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Sp. heat capacity-solid	2.1 KJ/kg K
Melting point	50 c
Coefficient of thermal	0.2W/m K
Sp. Heat capacity - liquid	2.4 KJ/kg K

II. Encapsulation of PCM

Encapsulation of PCM has been giving a lot of attention during recent time. If PCM is encapsulated into the large number of capsule either sphere of cylinder increases which offer much better heat transfer when HTF flow through the capsule packed bed. It has been reported that PCM stored in capsule with radius of 10mm offer surface area more than 300square meter per cubic meter. Metallic encapsulation is preferred if high temperature criterion otherwise, plastic encapsulation is commonly used for low temperature.

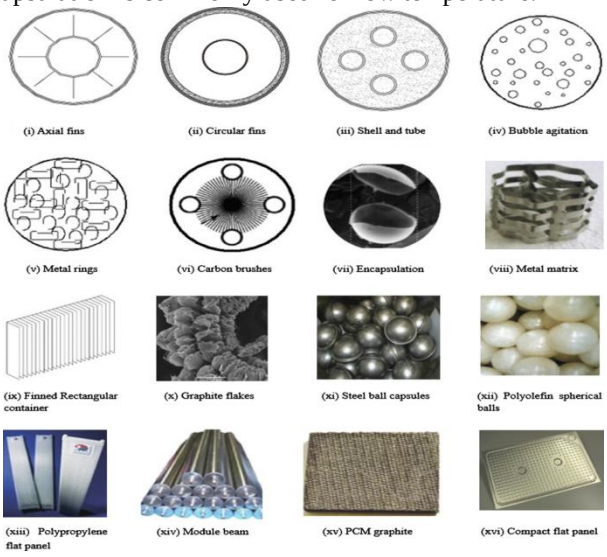

Fig.2 Encapsulation of PCM [8]

III. WORKING

When a PCM is in its' solid part it'll absorb heat because the external temperature rises. The temperature of the PCM can mirror the external temperature till the PCM's soften purpose is reached. Once the external temperature reaches the soften purpose of the PCM, the PCM can begin to soften, i.e. "change phase". Throughout the modification process the PCM can absorb giant amounts of warmth with virtually no change in temperature. Throughout this point amount, the PCM is providing a cooling impact. The quantity of your time the PCM can offer a cooling impact is set by the PCM's total heat of melting, conjointly known as the heat of fusion of melting. The total heat varies reckoning on the PCM material itself. Within the case of PCMs, the total heat is usually measured in Joules/gram. The upper the quantity of Joules per gram, the longer the PCM can offer a cooling impact.

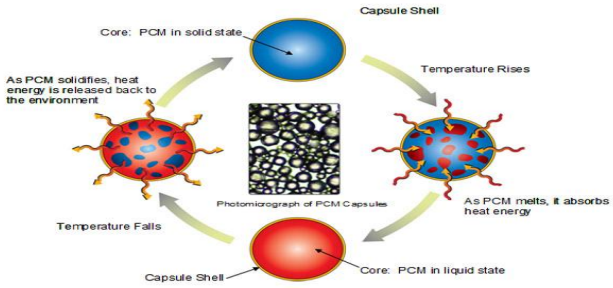

Fig.3 working of PCM

IV. Literature Review

1Nitin M. Morkane et al. [5] has carried out the experiment on solar water heater with PCM. In that researcher has used TES tank 48 liters and concentrate dish collector for absorbing the solar energy. After the study of this paper has found comparative method of the system with PCM and other system without PCM. It has judged of the basis of different parameter like, heat stored energy system with PCM for exceeds that stored in the system without PCM of the same size and volume of storage tank. The heat stored per unit volume, when calculated is, 0.234kJ/kg. For the system without PCM and is 0.1444kJ/kg. The efficiency of system without PCM vary a period and efficiency of system with PCM is constant ad shows higher efficiency.

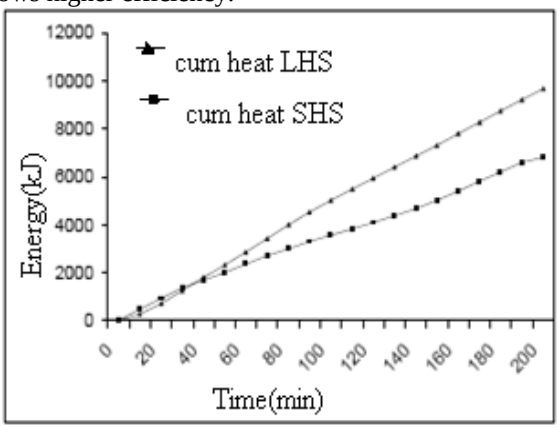

Fig.4 Comparison of Cumulative Heat in Both The System [5]

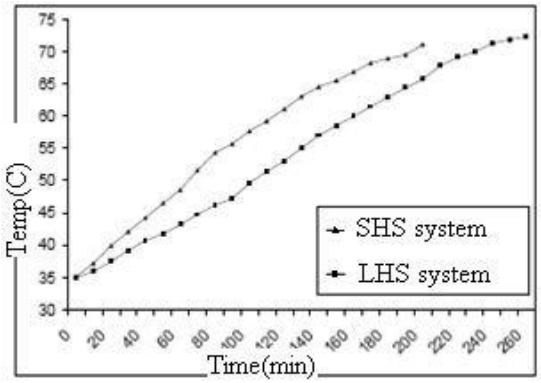

Fig.5 Temperature Histories of Both Systems during Charging [5]

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2. Mr. M. V. Kulkarni et al. [1] has found result with PCM cooling rate during the light decrease and efficiency and heat storage capacity increase. In this research with use of PCM efficiency of solar water heater increases from 31.25% to 44.63% and also heat storage capacity increases from 3260.4kJ to 4656.5 kJ. The use of PCM in solar water, thus in enhance the maximum utilization of solar energy and hence improves efficiency of system.

3. Pascal Henry Biware [9] has proposed that system numerically and to find out the max operating temperature a system can achieve with improve PCM by operate the collector under the temperature 40 degree Celsius for 80 min.

4. Abdul Jabber N. Khalifahas done experiment with impure paraffin as a PCM. In that experiment most important parameter is collector temperature of flat plate collector and researcher has found nearly steady variation in the system useful efficiency is noticed for all months.

5. Zhangywan Wang [6] has carried out experiment and mostly found increase in energy storage density ad efficiency by the use of PCM with different melting temperature.

V. CONCLUSION

In this paper, the review of solar water heater with the PCM has carried out. As per the study of different research method it has found the different types of collectors are observed along with the Numerical study. Also developing new SWS system for integration with PCM, e.g. solar collector.

VI. FUTURESCOPE

Lot of work has already done on thermal energy storage with phase change material. Day by day there is need of solar energy. This technique is more reliable and inexpensive at the same time it is easy to implement. There is huge progress in the field of thermal energy and also scope of further advancement in this field.

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