HEAT TRANSFER ENHANCEMENT OF NANO ENHANCED LATENT HEAT THERMAL ENERGY STORAGE SYSTEM

S.Ramanathan
Assistant Professor, Department of Mechanical Engineering, Dr.Sivanthi Aditanar College of Engineering,Tiruchendur
ramnath.mech@gmail.com

ABSTRACT

Latent Heat Storage is one of the most efficient ways of thermal energy storage system because of its compactness in comparison with Sensible TES as well as the operational advantage of a nearly constant storage-cycle temperature. Efficiency of the LHTES system depends on the thermal conductivity of phase change material used. Thermal conductivity of the PCMs is usually very low and its lead to low heat transfer rates during both charging and discharging process. In order to overcome this problem during such processes, ultra fine solid particles (nano particles) are added to the PCM. In this project, CuO nano particles were added to the paraffin wax phase change material to improve the heat transfer rate. It was found that the addition of nano particles enhances the thermal conductivity of the PCM and thus increases the efficiency of the system

Keywords: PCM, Nano PCM, Paraffin wax, Thermal energy storage system

I. INTRODUCTION

Thermal energy storage has attracted increasing interest for thermal applications such as space heating, air-conditioning. TES is useful for addressing the mismatch between the supply and demand of energy. Thermal energy storage also termed as cool storage involves the use of conventional HVAC/refrigeration equipment and storage tank to shift period of chiller operation from on-peak to off-peak periods. Thermal energy storage (TES) is a technology that stocks thermal energy by heating or cooling a storage medium so that the stored energy can be used at a later time for heating and cooling applications and power generation. TES systems are used particularly in buildings and industrial processes. Therefore, TES systems can help balance energy demand and supply on a daily, weekly and even seasonal basis.

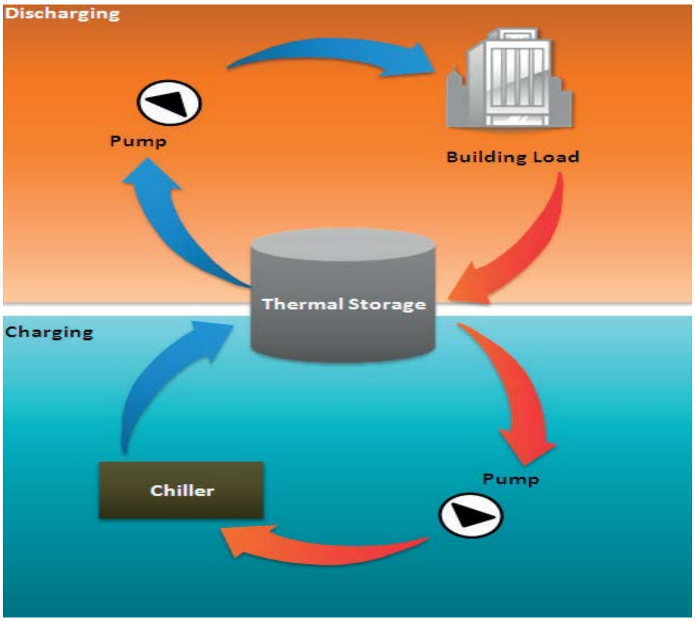


Fig1:Working principle of Thermal energy storage system

The thermal energy transfer occurs when a material changes from solid to liquid or liquid to solid This is called a phase change. Various methods are proposed to enhance the heat transfer in a latent heat thermal energy storage system, such as Metallic fillers, metal matrix structures, and finned tubes were used to improve the thermal conductivity of the phase change materials. Enhancements followed with other techniques are
also listed (i)Active methods of agitators, vibrators, scrapers and slurries (ii)Microencapsulated PCM. (iii) PCM containing dispersed high conductivity particles, Lessing rings. (iv) PCM mixed with graphite

composite material. (v) Extended surfaces such as fins and honeycombs.

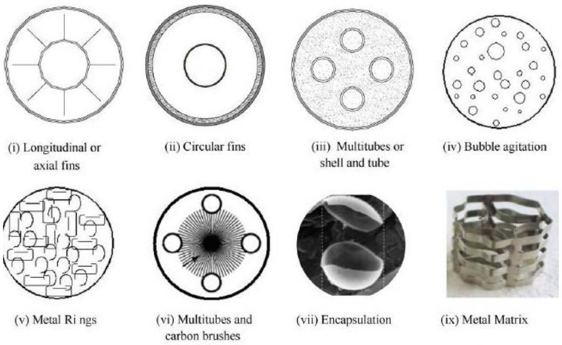


Fig 2: Enhancement Methods Of PCM

II LITERATURE SURVEY

S.D. Sharma (2005) - The use of a latent heat storage system using Phase Change Materials (PCM) is an effective way of storing thermal energy (solar energy, industrial waste heat) and has the advantages of high storage density. This review will help to find a suitable PCM for various purposes a suitable heat exchanger with ways to enhance the heat transfer, and it will also help to provide a variety of designs to store the heat using PCMs for different applications, i.e. space heating & cooling, solar cooking, greenhouses, solar water heating and waste heat recovery systems. The present paper is a compilation of much of practical information on various PCMs and latent heat storage systems. Abduljalil A (2012) - the Latent heat thermal energy storage (LHTES) is more useful than sensible energy storage due to the high storage capacity per unit volume/mass at nearly constant temperatures.It is expected that the design of latent heat thermal energy storage will reduce the cost and the volume of air conditioning systems and networks Many researchers studied the double pipe, and shell and tube heat exchanger configurations due to their high efficiency, whereas other configurations have not been studied seriously and need more work as recommended by researchers. Stella P. Jesumathy (2012) Experiment has been performed for different water flow rates at constant inlet temperature of heat transfer fluid for recovery and use of heat. Time- based variations of the temperature distributions were explained from the results of observations of melting and solidification curves. The experimental results proved that the PCM melts and solidifies congruently, and the melting front moved from the top to the bottom of the PCM container whereas the solidification front moved from bottom to the top along the axial distances in the PCM container. It has a suitable transition temperature range of 58-60°C and a relatively high latent heat of 210kJ/kg. In addition, it does not exhibit any sub cooling. Valan Arasu (2011) - Have numerically investigated Present results show that dispersing nanoparticles in smaller volumetric fractions increase the heat transfer rate. The enhancement in thermal performance of paraffin wax is greater for Al_2O_3 compared with that for CuO nanoparticles. In the present work, a numerical investigation is carried out to estimate the effect on thermal performance of paraffin wax due to the enhancement in thermal conductivity using alumina (Al_2O_3) and copper oxide (CuO) nanoparticles. The effect of volumetric concentration of the nanoparticles on the melting and solidification performance is examined. The numerical simulations were carried out for typical conditions found in PCM thermal energy storage. The base-case conditions together with the physical parameters are listed. In the following, we will examine the effect of nanoparticle suspended in the PCM with respect to the thermo physical properties and heat transfer rate at various volumetric nanoparticle concentrations during charging and discharging. K Karunamurthy (2012) – Time period and more surface area for charging and discharging of thermal energy. To overcome this problem, an attempt was made by dispersing CuO nano particles within the PCM., it was observed that, the thermal conductivity of PCM and the charging and discharging time of LTES has also been reduced significantly by introducing CuO nano-particles. It is also observed that there is almost 50% reduction in charging time and discharging time of the PCM for a volume concentration of 0.16% and for all the three constant heat flux (flow rate of hot water).period and more surface area for charging and discharging of thermal energy. It was observed that, the thermal conductivity of PCM and the charging and discharging time of LTES has also been reduced significantly by introducing CuO nano-particles. This improved thermal conductivity of PCM overcomes the poor rate of heat transfer in the thermal energy storage system. Atul Sharma, C. R. Chen et al this paper summarizes the investigation of the solar water heating system incorporating with Phase Change Materials (PCMs). This paper is focused on the past & current research of energy storage through PCMs for solar water heating systems. Abhay B. Lingayat, Yogesh R. Suple et al this paper present on thermal energy storage using PCM and their applications. Nanoparticles are the simplest form of structures with sizes in the nm range. In principle, any collection of atoms bonded together with a structural radius of < 100 nm can be considered a nanoparticle. Nanoparticles are very common place in nature - for instance proteins exist in almost all biological systems, metal-oxide nanoparticles are easily produced.

Selection of Nano particle - CuO

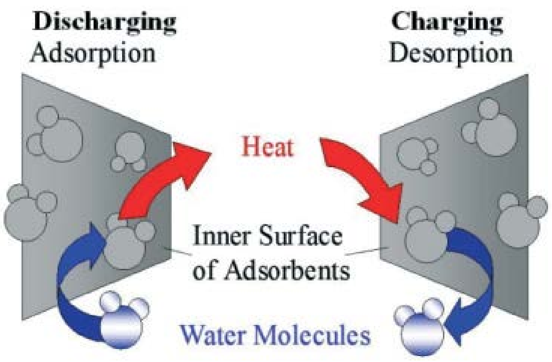
The dynamic viscosity is greater for CuO nanoparticles compared with Al_2O_3 nanoparticles in paraffin wax. The enhancement in the dynamic viscosity for the nanoPCM may play a key role in the natural convection dominated melting of nanoPCM. CuO nanoparticle is much cheaper than silver corbide nanoparticle

THERMO PHYSICAL PROPERTIES OF CuO NANOPARTICLE

III EXPERIMENTAL METHODALOGY

Charging process

The charging process to maintaining the inlet(hot water) temperature we should take the nano copper with paraffin wax melting temperature at two different locations and outlet temperature also will be find out charging process.



Discharging process

The Discharging process to maintaining the inlet(cold water) temperature we should take the nano PCM solidification temperature at two different locations and outlet temperature& inner PCM and wall temperature also will be find out.

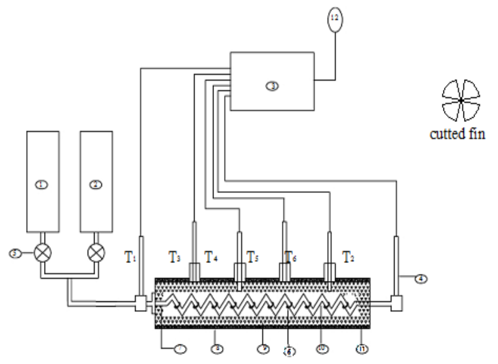
Preparation Method of Nanopcm

Properties	Values
Specific heat capacity of cuo	540kJ/kgk
Thermal conductivity of cuo	18w/mk
Density of cuo	6.31kg/cm^3
Diameter of cuo	25-30nm
Weight of cuo	30grams

Cuo nanoparticle

paraffin wax

IV SCHEMATIC DIAGRAM OF LHTES DEVICE SYSTEM

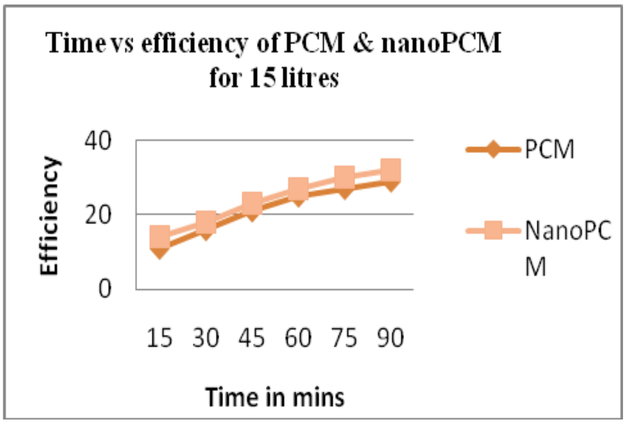


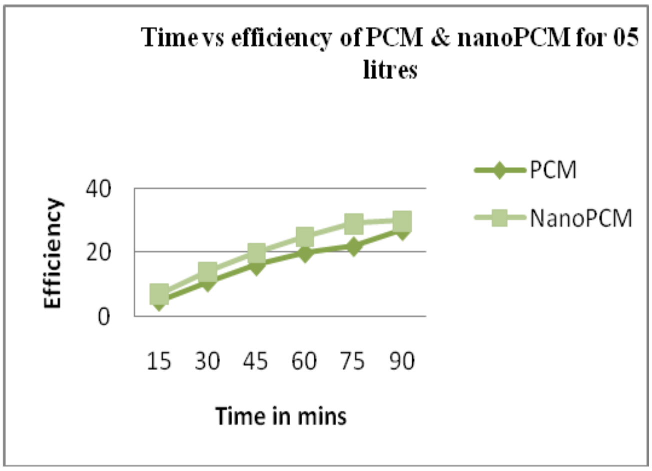
1.Hot water tank
2.Normal water tank
3.Temperature indicator
4.Thermocouple
5.Gate valve
6.Cutted fin
7.Copper tube
8.Asbestos rope
9.Paraffin wax
10.zigzag coil with circular cutted fin
11.Mild steel
12.Power supply

V RESULTS & DISCUSSION

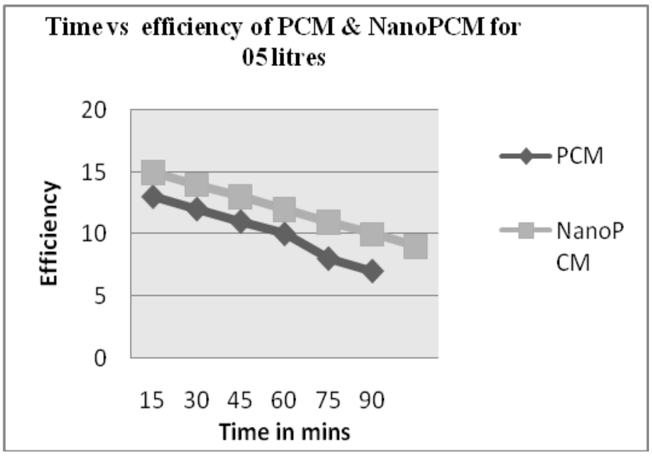
In the experimental analysis on the Latent heat thermal energy storage system has been done using CuO nanoparticle. The effect of 0.46% volumetric concentration of the Nanoparticles on the melting and solidification performance is examined and compared between NanoPCM and pure paraffin wax. The readings were tabulated for PCM as well as for NanoPCM. From the experimental results, it is found that the use of Nanoparticles with paraffin wax reduces the melting and solidification time. It is also observed that there is almost 50% reduction in charging time and discharging time of the PCM for a volume concentration of 0.46%.

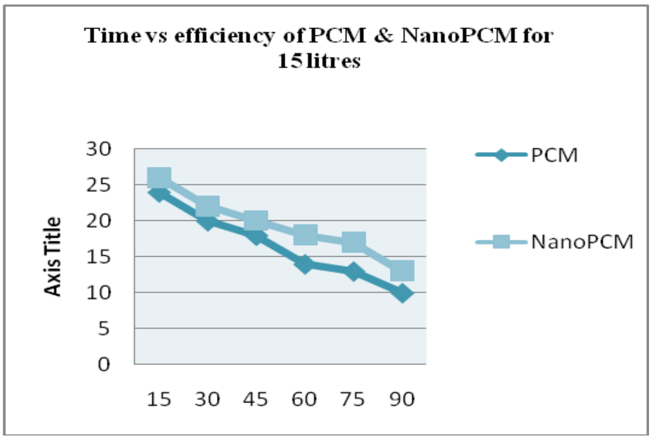
GRAFICAL REPRESENTATION CHARGING PROCESS FOR PCM VS NANOPCM (5L/hr, 15L/hr)





DISCHARGING PROCESS FOR PCM VS NANOPCM (5L/hr, 15L/hr)





VI CONCLUSION

In this project work, the performance enhancement in Zig zag coil with cutter fins is observed with paraffin wax and Nano (CuO) particles in a concentric heat exchanger has been carried out experimentally. Experimental analysis indicates that the charging and discharging rates of thermal energy can be greatly enhanced while using NEPCM, as compared with simple PCM. The charging efficiency of the system is enhanced by 5%

while using NEPCM as compared with simple PCM whereas the discharging efficiency is increased by 3 %. From the results obtained, it is understood that the use of NEPCM in LHTES significantly enhances the efficiency of charging and discharging processes.

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