To Increase The Thermal Conductivity Of Paraffin Wax Using Nano Particles

Gaurav Prakash Arya[1], Atul Lanjewar[2], Rajesh purohit[3]

[1]M.Tech Scholar, Department Of Mechanical Engineering, MANIT Bhopal
[2] Assistant Professor, Department Of Mechanical Engineering, MANIT Bhopal
[3] Associate Professor, Department Of Mechanical Engineering, MANIT Bhopal ---

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Abstract – our aim is *to increase the thermal conductivity of organic phase change material paraffin wax for doing so , one of the effective technique of doing is by adding nano particles in paraffin wax by ultra sonic vibrations, presently many different nano particles in different mass fractions have added in different phase change materials and experimental and mathematical formulations have been studied. This paper has been focused on the different nano particles, setup geometries and various mathematical formulations . Based on the correlation that are obtained, by different studies on the composite phase change materials and pure phase change materials , which is then compared with the experimental and standard data. This paper is an attempt for the comparison of thermal conductivity performance of phase change materials with different nano particles used in different mass fractions .*

Key Words: **phase change materials, nano particles ,thermal conductivity, paraffin wax .**

1. INTRODUCTION

There is always been demand for new technologies to tackle the growing concern for the environment problems. These are the problems in future like energy shortage and the high cost of energy and new power plants has always been considered as a scientific concern for the last three decades. Root of problem is how to store excess energy that will otherwise be wasted and also to fill the gap between energy generation and Consumption. Systems that can store heat as latent heat energy are considered an attractive scheme because it provides a high energy storage densities. When we compare it to the conventional sensible heat energy storage systems, latent heat storage systems require a small weight and small volume of material for the given amount of energy. In the additional to this latent heat storage system has capacity to store fusion heat at temperature being constant of materials having phase changing properties. The process of phase changing materials like conversion from solid to liquid or from liquid to solid . These phase changing materials have the capacity to absorb energy or release it by keeping the temperature at nearly constant.

1.1 Nano particles

Organic phase change material such as paraffin wax has capacity of absorbing large amount of latent heat. Thus it can be used to store both conventional and non-conventional forms of energy by using it as a medium of storing energy. And it starts melting at temperature in the range of 57 to 60 degree centigrade. Thus it can be used for domestic usages. But paraffin wax has low thermal conductivity that result in the lower heat transfer rate. One of the method to sought the problem is by adding nano particles. Therefore increasing its thermal conductivity hence increasing its rate of heat transfer.

2.1 paraffin melting and solidification in a shell-and-tube latent heat storing energy system

Anica Trp experimentally investigated on transient forced convective heat transfer coefficient between HTF with medium Prandtl number (Pr) and the tube wall, heat conduction through the wall and solid to liquid the change of phase PCM. The comparison between numerical predictions and experimentation revile better accord together for paraffin non-isothermal melting and isothermal solidification. The author finds that an experimental and numerical investigation of transient heat transfer phenomenon during paraffin solidification and melting in a shell and tube arrangement LHTS unit, with the HTF circulating inside the tube and the Phase change material which is filled in the shell portion. Experimentation shows that melting of Phase Change Material occurs with change in temperature within the zone of melting, but on different side solidification occurs isothermally

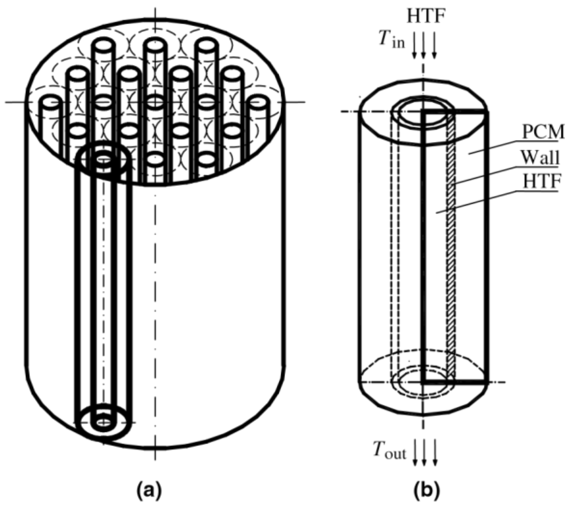


Fig.1 latent heat storage system

2.2 Thermal conductivity enhancement in a latent heat storage system

Eman-Bellah S. Mettawee , Ghazy M.R. Assassa latent heat storage systems particularly those utilizing natural materials have been accounted for to display a low rate of heat transfer rate. This is because of the generally low thermal conductivity of natural latent heat materials. In this study, tests were completed to explore a technique for improving the thermal conductivity of paraffin wax by inserting aluminum powder in it. The extent of the aluminum powder particles was 80 lm. The tried mass divisions in the Phase Change Material i.e. mixed with alumina composite material were 1%, 3%, 4%, and 5% of phase change material . The utilized mass division as a part of the exploratory work was 5%

Results obtained are:-

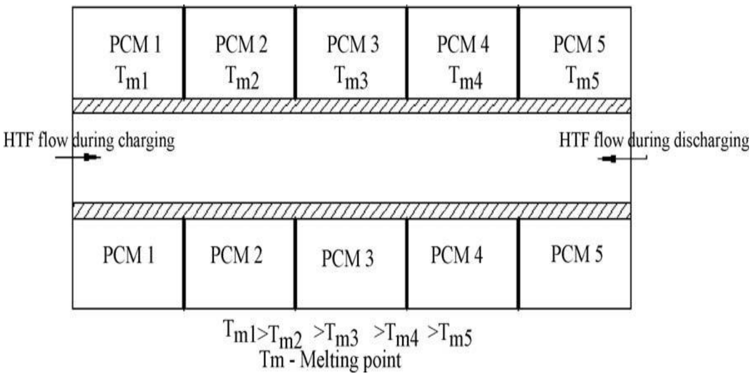
1. The charging time diminished by 60% for composite than as compare to pure paraffin wax
2. The valuable thermal heat picked up expansions as the aluminum powder is added to the paraffin wax

2.3 Influence of operating conditions and geometric parameters on heat transfer in water-paraffin shell-and-tube

Anica Trp *, Kristian Lenic, Bernard Frankovic latent heat storage systems arrangement of the shell-and tube sort, with paraffin as the PCM filling the shell side and water as HTF circling inside the tube. A value of 0.03 meter/sec has been considered as the velocity of the heat transfer fluid and the mass flow rate of 0.026 kg/s and. The total unit charging as well as discharging time has been 3 h. For melting process calculations, PCM was initially in the solid phase with the value of inlet temperature is 20 °C. The Heat Transfer Fluid inlet temperature was 70 °C.

2.4 Performance enhancement in latent heat thermal storing set up

S. Jegadheeswaran *, Sanjay D. Pohekar employing concept of multiple employing of PCMs in Latent Heat Storage system has been investigate and its performance enhancement technique is discussed in this literature. Using the idea of multiple Phase change materials is that, the Latent heat storage system is filled with multiple number of PCMS of temperature having different temperature of melting. The rate of heat transfer in Latent heat storage systems unit and thus the performance of the system during charging (melting) and process of solidifying is primary function of the difference between the HTF temperature and the melting point of PCM.



2.4 Numerical analysis of latent heat thermal energy storage system

N.R. Vyshak, G. Jilani This paper is based on the study of the time required of complete melting of PCM packed in different geometries such as rectangular, cylindrical and cylindrical shell enclosed having the similar volume, surface area and area. Assumed an average heat transfer coefficient over the heat transfer surface, the total time required for complete melting of the PCM stored in the containers of various size and geometry are used to compare among them so to obtain the best shape amongst them . In addition, the effects of the inlet temperature of the HTF and the mass of the PCM on the total melting time of PCM packed in cylindrical shell containers are analyzed. On the basis of the result we have obtained, it is concluded that for the same mass of the PCM and surface area of heat transfer, shell and tube container take the minimum time for same amounts of thermal energy storage, and this geometric effect is more enhanced with an increase in the mass of the phase change materials. It is concluded that for shell and tube container having cylindrical geometry, with the increase in temperature of inlet of the HTF from its lower values results in a rapid reduction in energy storage rate, while this effect of inlet temperature of the HTF diminishes sharply at its higher and higher values. Further, it is observed that as the mass of the PCM in the cylindrical shell container having fixed surface area of heat transfer increases, the reduction in total melting time due to the increase in the inlet temperature of the HTF becomes more and more better.

2.5 A nano-graphite/paraffin phase change material with high thermal

Min Li this study investigated the improvement in the thermal conductivity of PCMs with Nano Graphite. Paraffin and Nano Graphite their combination results in the nano scale compound, and nano-layers of Nano particles with graphite are dispersed in paraffin and results random orientation. The distributed Nano Graphite enhanced in the rate of heat transmission and improved in the performance of energy storage technologies in term of efficiency in the performance of Phase change material. In addition, Nano graphite can be prepared easily from exfoliated graphite and expanded graphite. The price of NG is also comparatively low, while the improved effects of Nano Graphite to the thermal conductivity is outstanding. The phase change temperature of paraffin was slightly enhanced by Nano Graphite combination. The phase change temperature of Nano Graphite/paraffin composite Phase Change Material was relatively less than case compare of paraffin. As the Nano Graphite ratio increased, the thermal conductivity of the Nano Graphite/paraffin composite increased while the effect on the latent heat capacity quite decrease. This is an important consideration that should be noted in the application.

2.6 Numerical study on melting of paraffin wax with Al_2O_3 in a square enclosure

A. Valan Arasu , Arun S. Mujumdar The melting of paraffin wax dispersed with Al_2O_3 that is heated from one side of a square enclosure with dimensions of 25 mm×25 mm is investigated numerically. Emulsifying the aluminum oxide nano particles in paraffin ends up in relative increase of the dynamic viscosity compared thereupon of the pure paraffin, so much bigger than that of effective thermal conductivity, therefore considerably degrading its natural-convection heat transfer effectively with the concentration of nano particles across the dissolved region. Further, the melting rate and energy hold on are bigger for vertical wall heating than for horizontal bottom wall heating in a very sq. enclosure as a result of increased natural convection result. supported this study, it will be all over that the effective thermal conductivity of a paraffin heat storage medium will be considerably enhanced by using smaller volume concentration of alumina particles in paraffin and therefore the nano Phase Change Material have nice potential for demanding thermal energy storage applications.

2.7 Heat Transfer Enhancement by adding Al_2O_3 nano-material in Paraffin wax for Solar-Thermal Application

A V Waghmare, A T Pise in order to ascertain thermal behavior of the PCM, many experiments were performed at numerous initial temperatures and constant mass rate of flow of the HTF. just some temperature knowledge, that exhibit clearly the melting behaviors, area unit thought-about here. as a result of symmetrical geometry and symmetrical boundary conditions, symmetrical temperature distributions within the PCM has been thought-about. Experiments area unit conducted for the concentric cylinder geometry. For this geometry, it's discovered that PCM within the lower outer region of the annulus take for much longer times than the opposite regions to soften. Therefore, the whole melting time of the total PCM prolongs. Melting starts within the lower region of the storage container near the inner wall and, then, liquified PCM ascends to the highest a part of the storage container as a results of natural convection currents. The soften region extends radial upward (i.e) With a rise in time, PCM goes through heating of the solid matrix as a result of physical phenomenon, melting, and heating of the liquified PCM to temperatures higher than its temperature. As seen and expected, higher temperatures area unit discovered close to the HTF tube surface as a results of immediate melting of the PCM. Flow within the soften region is driven by buoyancy forces. With addition of a nano alumina by mass concentration in PCM and at constant rate of flow of HTF an improved read on the melting characteristic of the PCM the axial and radial variation of the temperature. The melting (Charging) rate of nano-particle increased paraffin is examined for numerous mass concentrations viz. 1,2,3,4 and five capitalize on Al2O3 nanoparticles. the whole melting time is outlined because the time needed for all the points within the PCM to succeed in the higher limit price of melting temperature vary from the identical solid state temperature. It is expected that extra nano particle into paraffin enhances the heat transfer performance; this can be so the case for low nano-particle concentration of a hundred and twenty fifth, as is inferred from the preceding analysis, it's found that a pair of concentration of nano particle enhances the performance of paraffin compared to higher concentrations. Intuitively, adding larger quantity of nano particle within the PCM enhances thermal conduction.

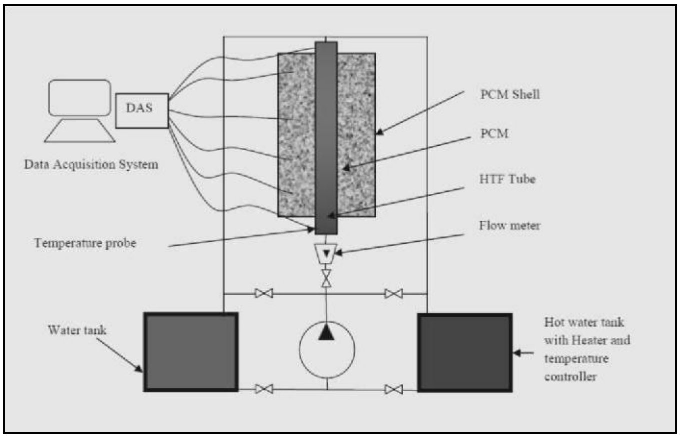


Fig. setup of experiment

3. CONCLUSIONS

The conclusion of the review of the paper is that low thermal conductivity of phase change material such as paraffin wax can be increased by adding different nano particles in different mass fractions and can be analyzed by experimentation and mathematical modelling on various geometries and various phase change materials along with various nano particles.

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BIOGRAPHIES

Gaurav Prakash Arya holds a Bachelor's Degree in Mechanical Engineering from RGPV Bhopal and pursuing M.Tech in Mechanical Engineering (Thermal Engineering) from Maulana Azad National Institute of Technology, Bhopal, Madhya Pradesh.

Dr. Atul Lanjewar working as assistant professor in Mechanical Engineering department MANIT Bhopal. His research interest are mainly heat transfer, solar air heater, solar water heater, energy storage using PCM.

Dr. Rajesh purohit working as associate professor in Mechanical Engineering department MANIT Bhopal. His research interest are mainly Metal and Polymer Matrix Nano Composites for AutomotiveApplications, Forming behaviour of Nano Composites, Unconventional Machining, Rapid Prototyping, Testing of Materials.