A Review on Thermal Heat Storage Technology

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Abstract- *Thermal energy is the energy that is stored in the form of heat. Today energy is one of the basic requirements of our life. Thermal energy is one of the cleanest and cheapest sources of energy. In order to store that energy different types of storage are required. This articles discusses the ways in these energy can be stored and the requirement of the materials of these energy storage.*

Keywords- ambient temperature, nanofluid,thermal energy storage.

I. INTRODUCTION

We live in a world where the industrial development is taking place in a rapid speed and with the growth of industrialization; the demand of energy is growing daily. In order to meet this demand we are using the nonrenewable resources, which is not the solution as it can be exhausted. So alternate method such as renewable resources must use. Solar energy is one of the best source of energy .To store such types of heat energy we use thermal heat storage. A thermal heat storage is made up of various different types of material depending on the storage requirement .It can be in the form of fluid, solid or gas . Different methods such as using nanofluid, phase change slurry or phase change material can be used to meet the requirement of the application. These methods are studied and listed in this review. Following is the review of such method.

II. THERMAL ENERGY STORAGE

❖ Definition

Thermal energy storage (TES) systems have the potential of increasing the effective use of thermal energy equipment and of facilitating large-scale switching. They are normally useful for correcting the mismatch between the supply and demand of energy. There are mainly two types of TES systems, sensible storage systems and latent storage systems. As the temperature of a substance increases, its energy content also increases. The energy released (or absorbed) by a material as its temperature is reduced (or increased) is called sensible heat. On the other hand, the energy required to convert a solid material in a liquid material, or a liquid material in a gas (phase change of a material) is called heat of fusion at the melting point (solid to liquid) and heat of vaporization (liquid to gas), respectively. Latent heat is associated with these changes of phase. The other category of storing heat is using reversible endothermic chemical reactions. Chemical heat is associated to these reversible chemical reactions where heat is to need to dissociate a chemical product. All this heat (or almost all will be recuperated later, when synthesis reaction takes place. A complete storage process involves at least three steps: charging, storing and discharging. In practical systems, some of the steps may occur simultaneously, and each step can happen more than once in each storage cycle. In terms of storage media, a wide variety of choices exists depending on the temperature range and application. [1]

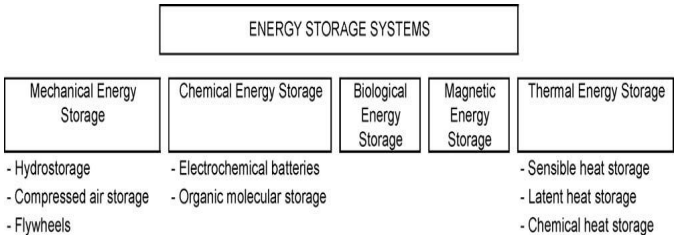

Fig.1 Classification of energy storage systems [1]

III. DIFFERENT TECHNIQUES

A. Fatty Acids and Their Mixture as Phase Change Material.

Fatty acids and their binary mixtures can be used as a storage medium as they has a low melting range of about 30^0C to 65^0C freezing range is 28-64^0C and latent heat ranges from about 160 to 185J/g [2] which is suitable for most of the thermal storage applications. Fatty acids are commercially available and the raw materials for their manufacture consist of renewable vegetable and animal sources. This assures a Continuing source of supply, independent of the world's dwindling reserve of mineral and fossil fuel supplies.

B. Phase change slurry

By using phase change slurry the thermal storage volume can be reduced .The fusible material in the slurry can

be chosen in such a way that the melting point (or corresponding phase-change temperature) lie between the intended source and the sink temperatures [3]. Using phase-change slurries in thermal systems rather than Single-phase sensible heat fluids can have the following benefits

a) It increases fluid/solid surface heat-transfer coefficients resulting from several mechanisms, reducing the temperature difference required for a given amount of heat transfer and allowing reductions in heat-transfer surface area.
b) It increases heat capacity of the heat-transfer fluid, due to the latent heat of the fusible material in suspension. This will results in reduction of flow rate hence, reduced pumping power.
c) It improves quality of usable thermal energy. The working fluid end-use temperature will be closer to the heat source temperature.

C. Latent Heat Storage

The latent heat storage will increase by increasing the surface area of the flux concentration on the surface of the material where the phase change material is stored. For Latent Heat Storage for Solar Steam Systems - Solar steam generation for power plants requires latent heat storage systems for a saturation temperature range between 200°C and 320°C [4]. Various segments of phase change material or composite materials are tested in laboratory with different types of arrangements to increase the latent heat storage.

In a latent heat thermal storage (LHTS) system during phase, change the solid-liquid interface moves away from the heat transfer surface. At this time, the surface heat flux decreases due to internal thermal resistance of the growing layer of the molten or solidified medium that decreases the heat transfer rate. These can overcome by inserting a matrix into the phase change material (PCM) using PCM dispersed with high conductivity particles and micro-encapsulation of PCM.[5] The enhancement in heat transfer can be possible with fin configuration for storage tubes and by using Lessing rings in storage tank.

Fig.2 A photographic view of Lessing rings [5]

D. Low temperature use of Phase Change Material

For domestic use, the phase change material having lower cost can use. Thermal energy storage systems, which keep warm and cold water, separated by means of gravitational stratification. This system stores sensible heat in water for short-term applications. Adding PCM (phase change material) modules at the top of the water tank would give the system a higher storage density and compensate heat loss in the top layer because of the latent heat of PCM.[6] Three kilograms with 80:20 weight percent ratio mixtures of paraffin and different fatty acids were prepared and experiment was conduct with PCM. The experiment was conduct in a solar domestic hot water tank and the result shows that the cooling curve of water with PCM had a sharp drop. The PCM discussed in this paper were stearic acid (PS), palmitic acid (PP), myristic acid (SM).

E. Low temperature use of Phase Change Material

High temperature material that are used for thermal storage can be in the form of sensible heat, latent heat and chemical energy

The diagram shows different types of materials that can be used for thermal heat storage [1]. The type of material used is further divided into organic and inorganic .These materials have different operating range so it is important to check whether the material and its properties for the required application.

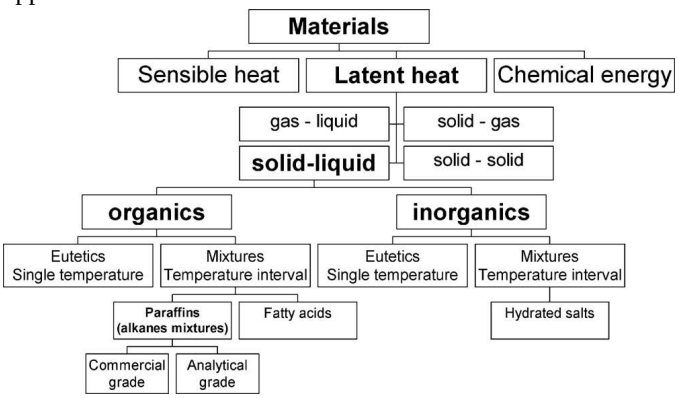

Fig.3 Classification of latent heat materials, with phase change solid–liquid [1]

F. Use of Nano fluid to increase the heat capacity for thermal energy storage

Solvents doped with stable suspensions of nanoparticles at minute concentrations are termed as ‘‘nanofluids’’ [7]. Using nano fluid can enhance the thermal conductivity of the fluid. For a comparison between the specific heat, capacity of pure eutectic and nanofluid with

temperature, it was find that, the specific heat of nano fluid was more in comparison to the pure eutectic. It is finding that the nano particles have propensity to agglomerate and precipitate if the liquid properties are not control within close tolerance hence it is necessary to examine whether or not nanoparticles are well dispersed and non-agglomerated before and after thermal cycling. This is needed to be done specially at high temperature as the nanofluid materials are subjected to rapid melting/solidification.

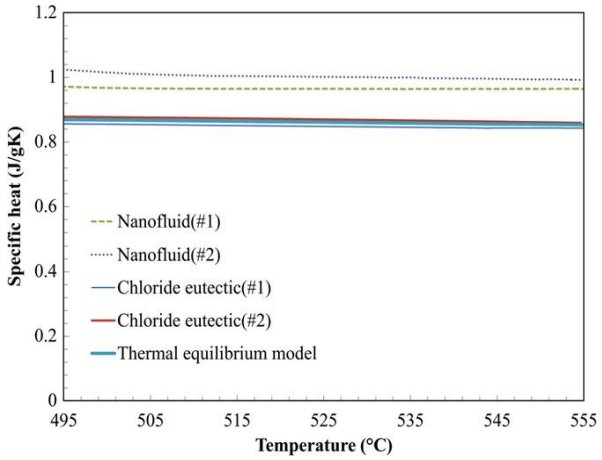

Fig.4Variation of the specific heat capacity of pure eutectic and nanofluid withtemperature.[6]

G. Industrial need for thermal energy storage

Thermal energy storage is a key element for effective thermal management in the sectors of process heat and power generation, and it is indispensable for solar thermal applications. Important applications for high temperature heat storage can be obtain in the industrial process heat sector. A vast amount of energy (in Germany about 5–6% of the total annual energy consumption) in the temperature range of 100–300^{0}C is needed to generate process steam at low or intermediate pressure for applications in food processing, production of cardboard and paper, in the textile industry, manufacturing of construction materials, rubber and other commodities.[8]

Three major types of solar thermal power systems that is commercially used and/or are close to commercialization are the central receiver, parabolic dish and parabolic trough [7]. These technologies are use in power industries for commercially generating power. However, they are not cost competitive, a cheaper alternative method could be found, and the capital cost can be reduced.

IV. CONCLUSION

The review shows that great efforts are made by the researchers to develop different types of thermal heat storage materials. There are a many technologies related to PCM for the storage of thermal energy. This review will help to develop better thermal heat storage and a broader idea about the present technique used for heat storage.

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