Latent Heat Thermal Energy Storage Using PCM

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Abstract— The final goal of this study is to implement and to test a thermal energy storage (TES) system using different phase Change materials (PCM) for solar cooling and refrigeration applications. Thermal energy storage has always been one of the most critical components in residential solar water heating applications. Solar radiation is a time-dependent energy source with an intermittent character. It is used as a bridge to cross the gap between the energy source, the sun, the application and the building. So, thermal energy storage is essential in the solar heating system. Therefore, in this paper, an attempt has been taken to summarize the investigation of the solar water heating system incorporating with Phase Change Materials (PCMs).

Key words: Heat Thermal Energy, PCM

I. INTRODUCTION

Nowadays, due to increase in energy consumption, a great deal of fossil fuels is being used. This latter is a consequence of the present environmental problems, such as global warming, acid rain, etc. In order to decrease these problems, the use of renewable energy sources is being promoted. But the renewable energy sources, particularly solar energy, present the drawback that there is a mismatch between the energy demand and supply. To cover this mismatch, the use of phase change thermal energy storage systems is required.

Increasing energy consumption, shrinking resources and rising energy costs will have significant impact on our standard of living for future generations. In this situation, the development of alternative, cost effective sources of energy for residential housing has to be a priority. Scientists all over the world are in search of new and renewable energy sources. One of the options is to develop energy storage devices, which are as important as developing new sources of energy. Solar thermal power generation could be feasible as a source of base load power in arid countries, but due to its intermittent and variable nature, an energy storage system is required.

Thermal energy storage (TES) proves to be an attractive and economical alternative for large- scale use. Energy is accumulated in a storage medium, and the storage mechanism can be classified as sensible heat, latent heat, or chemical storage. Considering a review paper by Medrano. It is clear that almost all operational solar thermal power stations use sensible heat thermal storage. The most popular sensible thermal storage systems use molten salts. Thermal energy storage systems provide the potential to attain energy savings, which in turn reduce the environment impact related to energy use.

Latent heat storage is a relatively new area of study and it received much attention during the energy crisis of late 1970's and early 1980's where it was extensively

Researched for use in solar heating systems. When the energy crisis subsided, much less emphasis was put on latent heat storage. Although research into latent heat storage for solar heating systems continues, recently it is increasingly being considered for waste heat recovery, load leveling for power generation, building energy conservation and air conditioning applications.

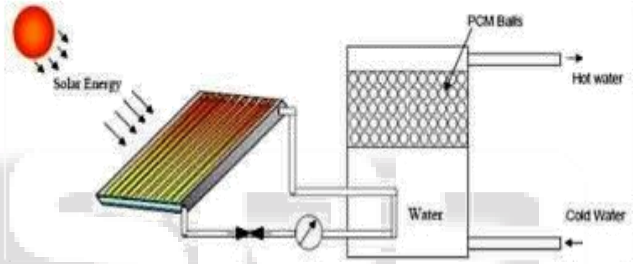
Thermal Energy Storage (TES) is the temporary storage of high or low temperature energy for later use. It bridges the time gap between energy requirement and energy use. Most TES Applications involve a 24 hour storage cycle and a typical TES load shifting strategy can be seen below,

While the output of the TES is always thermal energy, the input energy may be Thermal or electrical. A solar thermal power plant could have four elements:

Solar field, heat transfer fluid (HTF), thermal storage system and finally power generation system. The thermal storage system allows use the excess of energy at night and/or cloudy days to increase plant performance.

Types Ofthermal Energy Storage (TES):

- Latent Heattes
- Sensible Heattes



In sensible heat storage, the temperature of the storage material varies with the amount of energy stored. The amount of thermal energy that is stored depends on its specific heat and on the temperature variation. It has been implemented in thermal solar power plants through thermo cline or two tanks systems using molten salt as storage medium.

Latent heat thermal energy storages attractive due to its high energy storage density. When compared to conventional sensible heat energy storage systems, latent heat energy storage system requires a smaller weight and volume of material for a given amount of energy. Furthermore, latent heat storage stores fusion heat at a constant or near constant temperature which correspond to the phase transition temperature of the PCMs. In practice, solid-liquid phase change is preferred because of simultaneous slight volume variation and high enthalpy variation. The last approach for thermal storage is based on thermo chemical reactions. This storage method could allow long-term storage but its technical complexity and high costs is not easily compatible with cost-effective solar electricity product.

II. ADVANTAGES OF THERMAL ENERGY STORAGE

- Cheap electricity rates
- Lower ambient operation
- Smaller chiller/running at full load
- Large short term load
- Future/expansion additional capacity
- Full stand-by capacity

- Envirmental friendly option

III. Application of TES

- The time delay and available power between production or availability of energy and its consumption in receiving systems (solar energy, cogeneration, etc.)
- Security of energy supply (hospitals, computer centers, etc.)
- Thermal inertia and thermal protection

IV. General Principles for Material Selection and Corrosion Protection

Material selection shall be optimized, considering investment and operational costs, such that Life Cycle Costs (LCC) is minimized while providing acceptable safety and reliability.

V. The Following Key Factors Apply to Materials Selection

- Primary consideration shall be given to materials with good market availability and documented fabrication and service performance.
- The number of different material types shall be minimized considering costs, interchange ability and availability of relevant spare parts.
- Design life
- Operating condition
- System availability requirement
- Weight reduction
- Inspection and corrosion monitoring possibilities
- Effect of external and internal envirment, including compatibility of different material.

VI. Experiment Setup

VII. Phase Change Material

Bridging the gap between a Thermal Paste and Solid filler pad a phase change material is an ideal material. At room temperature it is a solid filler pad but when its transition temperature is reached it softens or melts and behaves more like a paste/grease.

There are two types of materials, waxed based type and elastomeric type. The wax based material has good wetting characteristics and low viscosity the material is ideal to fill any microscopic surface irregularities resulting in very low thermal resistance.

It does not dry out, separate or settle. The elastomer type has good compressibility, and is available with single sided adhesive.

It is also ideal where re-workability is required. Due to the physical characteristics of phase change material it is easier to handle and process than paste/grease and yet still offer good thermal conductivity with low thermal resistance.

Can be supplied Die cut to customers specification. Phase change materials (PCM) provide an effective way of accumulating thermal energy, due to their high capacity to store heat at a constant or near to constant.

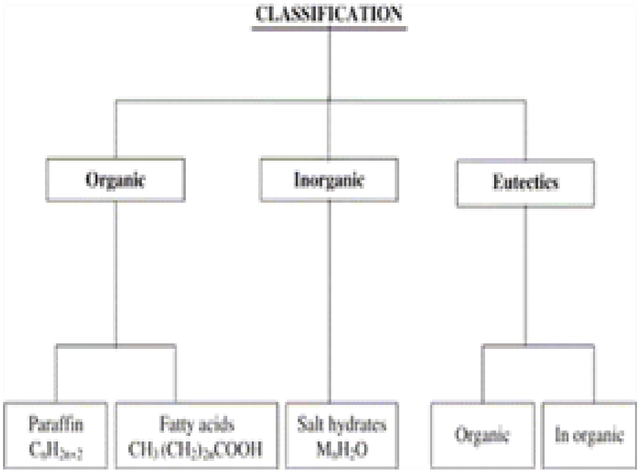


Fig: Types

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