A review on latent heat based solar energy storage

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***Abstract-* Solar energy is a very large, inexhaustible source of energy and it is time depending energy source with a discontinuous character. This energy is utilizing as directly or indirectly. The direct methods include photovoltaic and thermal while indirect includes water power, ocean temperature difference, wind, Biomass. This Paper deals with the storage of solar energy by thermally (Latent Heat).**

***Index Terms*—Latent Heat, Phase change Materials**

I. INTRODUCTION:

Every day, the sun radiates a huge amount of energy called solar energy. The sun emits more energy in one day that equivalent to energy utilized by world in one year. The sun is the source for this energy. The degree and significance of solar energy are well known. Solar energy is free, environmentally clean, and therefore it is considered as one of the most auspicious alternative source of energy. The total value of available energy depends upon season and atmospheric condition of that location. Since the solar energy during day time is flexible and at night it is Zero, considerable amount of solar energy should be stored during the daytime to meet the demands at night. Because of inconsistency in solar energy, two components are required to have a functional solar energy system. Those are solar collectors and storage units. The function of collector is to simply collect the radiation that falls on it and coverts fraction of it into other forms. The storage unit is required because of the non-constant nature of solar energy for this purpose; latent heat of fusion of Phase Change Material (PCM) is of great interest on account of high storage concentration and its isothermal nature of the storage process. Solar energy can be stored by thermal, electrical, chemical, and mechanical methods.

II. LATENT HEAT:

The heat energy released or stored based on phase change of storage material from solid to liquid or liquid to gas or vice versa. The use of a latent heat storage system using phase change materials (PCMs) is an effective way of storing thermal energy and has the advantages of high-energy storage density and the isothermal nature of the storage process. The storage capacity of the LHS system with a PCM medium is given by

$$\boldsymbol{Q = \int_{Ti}^{Tm} mCpdT + ma_m \Delta h_m + \int_{Tm}^{Tf} mCpdT \ldots\ldots\ldots (1)}$$

III. PHASE CHANGE MATERIALS (PCM):

Phase change material is a substance which absorbed or released heat during a phase change from solid to liquid or liquid to gas or vice versa. *The PCM are Latent heat storage materials.* The phase change used for PCMs is the solid-liquid or liquid-solid change. Liquid –gas phase change are not practical for use as a thermal storage due to their large volume or high pressure required to store the materials when they are in gas phase. Initially, these solid–liquid PCMs perform like conventional storage materials; their temperature rises as they absorb heat. Unlike conventional (sensible) storage materials, PCM absorbs and release heat at a nearly constant temperature. They store 5–14 times more heat per unit volume than sensible storage materials. The PCM to be used in the design of thermal-storage systems should passes desirable thermo physical, kinetics and chemical properties.

III. METHODS TO STORE SOLAR ENERGY BY LATENT HEAT:

For storing a solar energy two components are required. These two components are storage unit and Collector unit. The collector unit simply collects the solar radiation falls on it and converts fraction of it into an other forms of energy (either heat or electricity). The storage unit is needed because non constant nature of solar energy, and at certain times small amount of radiation will be received (At night or during cloud cover).

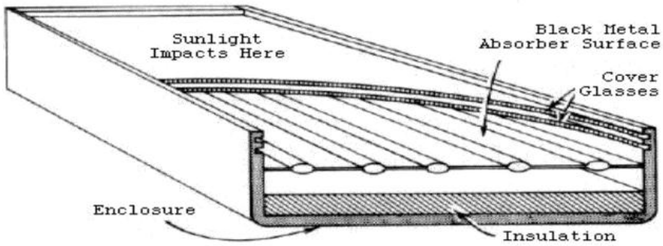
IV. SOLAR COLLECTORS:

In general, there are three types of collectors they are flat-plate collectors, focusing collectors, and passive collectors.

Flat-plate collectors:

These types of collectors are most commonly used. They are arrays of solar panels arranged in a simple plane. Their output is directly relates to few variables such as size, facing, and cleanliness. These variables all affect the amount of radiation that falls on the collector. Frequently these collector panels have automated systems that keep them facing towards sun.

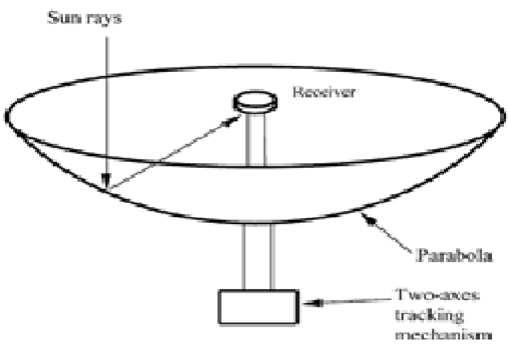
Flat Plate Collector



Focusing collectors:

Focusing collectors are essentially flat-plane collectors with optical devices arranged to maximize the radiation dropping on the focus of the collector. These are currently used only in a few distributed areas. Solar furnaces are examples of this type of collector. Although they can produce far larger amounts of energy at a single point than the flat-plane collectors, they drop some of the radiation that the flat-plane panels don't. Radiation reflected off the ground will be used by flat-plane panels but usually will be ignored by focusing collectors (in snow covered regions, this reflected radiation can be significant). One of the common problems with focusing collector is due to temperature, the fragile silicon components lose efficiency at higher temperature, and if they get too hot they may damage permanently. The focusing collectors can create much higher temperature therefore need to protect their silicon components.

Focussing Collector



Passive collectors:

These are completely different from other two types of collectors. The passive collectors absorb radiation and convert it to heat unsurprisingly, without being designed and built to do so. All objects have this property to some amount, but only some objects (like walls) will be able to produce enough heat to make it valuable. Often their natural ability to convert radiation to heat is boosted in some way or another (by being painted black, for example) and a system for conveying the heat to a different location is generally added.

V. STORAGE UNITS (A CASE STUDY):

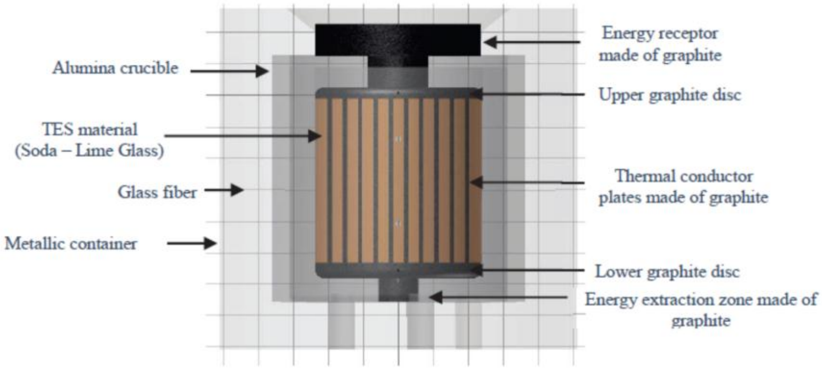


Fig: Thermal Energy Storage Prototype

The Thermal Energy Storage unit consists of an energy storage material, receptor-transmitter assembly of energy, Container for a storage material, thermal insulation to reduce heat losses and a steel container to give a structural support to a unit. It is desired that the TES has the following characteristics: chemically stable, no toxic, no risk of chemical reactions, slight deviation in the volume as the TES material receives or release energy, high value of latent heat or sensible heat per unit of mass or volume, high thermal conductivity, easy to acquire, abundant, low cost, long time service and well-suited with the TES container.

The receptor and transmitter needs to have a high thermal conductivity, good solar radiation absorption coefficient, chemically stable at high temperature and in contact to the atmosphere. The above prototype uses soda lime glass as a thermal energy storage material. Receptor-Transmitter as a Graphite, Storage container as an Alumina and thermal insulation is made up of ceramic fiber. The above mentioned parts are confined in a steel container. The TES prototype has a capacity of 60 litter of soda lime glass and a working temperature of 1000°C or more.

The thermal storage unit has able to store at least 64KWh in order to maintain the engine in operating condition for 16 hours without utilization of solar radiation. The storage unit prototype will contain a total 60 L of solid material (approximately 150 kg) which is sufficient to secure a 24 hour system operation plus an extra 20% to compensate for heat losses and to prevent cloudy Periods.

VI. CONCLUSION:

For Storing the thermal energy which received from collectors it is necessary to choose an appropriate storage media it is necessary to evaluate several properties of the material: melting temperature which must be in the range of required temperature of the application, high latent heat of fusion, good thermal conductivity, thermal diffusivity and overall heat capacity, moreover other factors such as non-flammability, chemical stability, cost and commercial availability.

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