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Identification and Analysis of Thermal Storage System Using Inorganic Material for Phase Change Material for Application of Refrigeration

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Abstract*: In this we are mainly dealing the interrelation of temperatures at hot and cold the experimental analysis of thermal energy storage. We are implementing the new technique of adding the hydrated salts and increasing the solidification of the storage system .The phase change material which helps in the storage of energy. LHS in a phase change material (PCM) is very attractive because of its high storage density. Hydrated salts are attractive materials for use in thermal energy storage due to their high volumetric storage density, relatively high thermal conductivity and moderate costs compared to paraffin waxes, with few exceptions. The high storage density of salt hydrate materials is difficult to maintain and usually decreases with cycling. The salts such as* $Na_2SO_{4.}10H_2O$*and water is mixed in the correct proportions to intimate the change temperature in the material.The changes make the helpful range in saving the food preservation and environmental cooling and the main thing is we can save the renewable resources. The cooling effect will with stands for longer period and the energy can be save.*
Keywords: *Phase Change Material, Thermal Energy Storage, Inorganic Material*

I. Introduction

The use of renewable energy sources and increased energy efficiency are the main strategies to achieve better thermal energy storage. In both strategies, heat and cold storage will play an important role. Refrigerators, space heating, and domestic ho t water are a part of every household. Thermal energy storage (TES), which is heat and cold storage, plays an important role in many energy systems, not only households but also industrial processes. Even though storage itself will never save energy, it is often abl e t o improve a system in a way that it is more energy or cost efficient. Thermal energy can be stored in the form of sensible heat in which the temperature of the storage material varies with the amount of energy stored. Water or rock can be the best example.

Alternatively, thermal energy can be stored as latent heat in which energy is stored when a substance changes from one phase to another by eith er melting or freezing. Thus the temperature of the substance remains constant during phase *change.* The energy used can have different sources, which are renewable and non-renewable. Especially solar energy is not continuous and thus heat storage is necessary to supply heat reliably. When solar collectors are used to heat domestic hot water, the storage also matches the different powe rs of the solar collector field, which collects the energy over many hours of the day, to meet the demand of a hot bath that is filled in only several minutes. Sensible heat storage is used for example in hot water heat storages or in the floor structure in under floor heating.

An alternative method is changing the phase of a material. The best -known examples are ice and snow storage. The storage of thermal energy in the form of latent heat in phase change materials (PCMs) represents an attractive option of r low and medium temperature range energy applications. Wide ranges of PCMs have been investigated, such as paraffin wax, salt hydrates and non -paraffin organic compounds. The economic feasibility of employing a latent heat storage material in a system deep ends on the life span and cost of the storage materials. In other words, there should not be major changes in the melt ing point and the latent heat of fusion with time, due to thermal cycles of the storage materials. For latent heat storage, commercial grade PCMs is preferred due to various reasons, such as low cost and easy availability.

The matching of transition temperature range for the PCMs is to deliver the energy at a suitable temperature for a given application. This is one of the important aspects for a PCM-based energy storage system. Eliminating the problems of super cooling, phase separation and stability over a long period of application is an important criterion for the successful application of suitable PCMs for thermal energy storage systems. The latent heat over the sensible heat is clear from the comparison of the volume and mass of the storage unit required for storing a certain amount of heat. It shows that inorganic compounds, such as hydrated salts, have a higher volumetric thermal storage density than the most of the organic compounds du e to their higher latent heat and density. The various PCMs are generally divided into three main groups: organic, inorganic and eutectics of organic and/or inorganic compounds. Organic compounds present several advantages such as no corrosiveness, low or no under cooling, possess chemical and thermal stability, ability of congruent melt ing, self-nucleating properties and compatibility with conventional materials of construction.

The use of phase change materials (PCMs) in energy storage has the advantage of high energy de*nsity* and isothermal operation. Although the use of only non-segregating PCMs is a good commercial approach, some *desirable* PCM melting points do not seem attainable with non-segregating salt hydrates at a reasonable price. The inorganic mixtures would show a similar thermal behavior as the salt hydrate, with the same melting point and an enthalpy decreases depending on the type and amount of material use

1.1 Thermal Energy Storage

Thermal energy storage (TES), also commonly called heat and cold storage, allows the storage of heat or cold to be used later. To be able to retrieve the heat or cold after some time, the method of storage needs to be reversible. Sensible heat By far the most common way of thermal energy storage is as sensible heat. The phase change solid-liquid by melting and solidification can store large amounts of heat or cold.

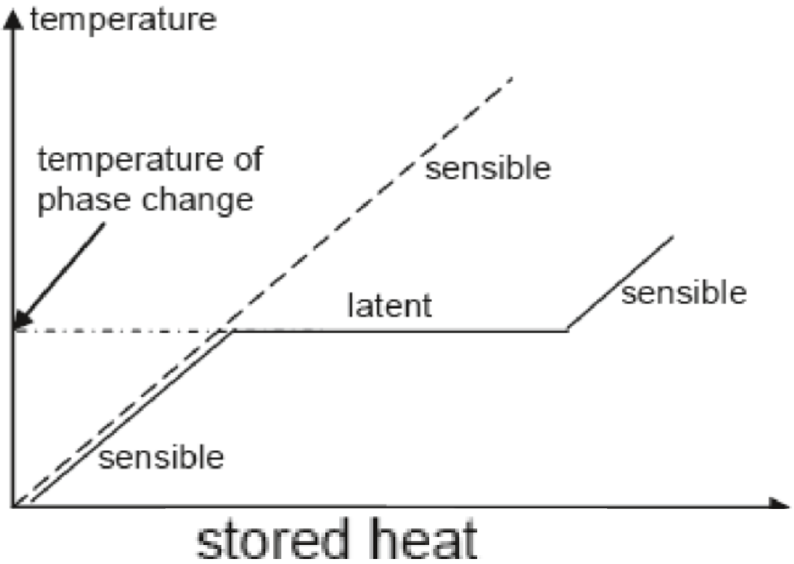

Fig 1 Latent And Sensible Heat

1.2 Phase Change Material

Phase change material (PCM) is very attractive because of its high storage density with small temperature swing. It has been demonstrated that for the development of a latent heat storage system in a building fabric, the choice of PCM plays an important role in addition to heat transfer mechanism in the PCM.

Inorganic phase changes of materials are a perspective way of thermal energy storage. Big latent heat, good thermal conductivity and inflammability are the main advantages of inorganic materials. But they cause corrosion and suffer from loss of H_2O. Incongruent melting and super cooling are the biggest problem with their exploitation. During melting and freezing there are precipitations of other phases which do not take part in next process of charging and discharging.

High latent heat of fusion per unit mass, so that a lesser amount of material stores a given amount of energy. High specific heat that provides additional sensible heat storage effect and also avoid sub cooling. High thermal conductivity so that the temperature gradient required for charging the storage material is small.

II. Selection Criteria Of Pcm

- Thermal properties:-
  (i) Suitable phase-transition temperature.
  (ii) High latent heat of transition
  (iii) Good heat transfer.
- Physical properties:-
  (i) Favorable phase equilibrium.

(ii) High density
- Kinetic properties:-
(i) No supercooling.
(ii) Sufficient crystallization rate

III. Literature Review

- **OZGUL GOK, (2003)** The aim of this study is to find effective gelling agent for Glauber's salt ($Na_2SO_4.10H_2O$) to prevent incongruent melting and phase separation for latent heat storage. Polyacrylamide and gelatin gels are used as gelling agent in this study

- **SUBHASH KAMAL(2005)** It was found that after 10 cycles Crack has been initiated in the scale and it isclearly visible in the presence of NaCl salt. On subsequent cycles, crack propagates perpendicular to surface andas it encounters inclusions, intermetallics it starts propagating parallel to surface. Through cracks, molten saltsattack the substrate and cause hot corrosion. But extent of corrosion is less as the thickness of scale formed after50 cycles is not more than 50 µm even in most severe environment (Na2SO4 + 60% V2O5). XRD, SEM and FESEM/EDAX, and X-ray mapping were used to characterize the corrosion products in order to render an insightin to the corrosion mechanisms.

- **KIRSTEN LINNOW et.al,(2013)** It is well known that salt crystals often clump together during a hydration which leads to a lowering of the air flow rate through a heat storage tank, thus, severely hindering the release of the stored heat. To overcome this problem, experiments were carried out with salts dispersed in porous host materials , but the influence of the confinement on the hydration reaction is poorly investigated. In the present work, first investigations covering a broad range of pore sizes (1.7 µm to 7 nm in diameter) were carried out at 85 %*RH* and room temperature and the influence of the confinement is discussed.

IV. Experimental Setup

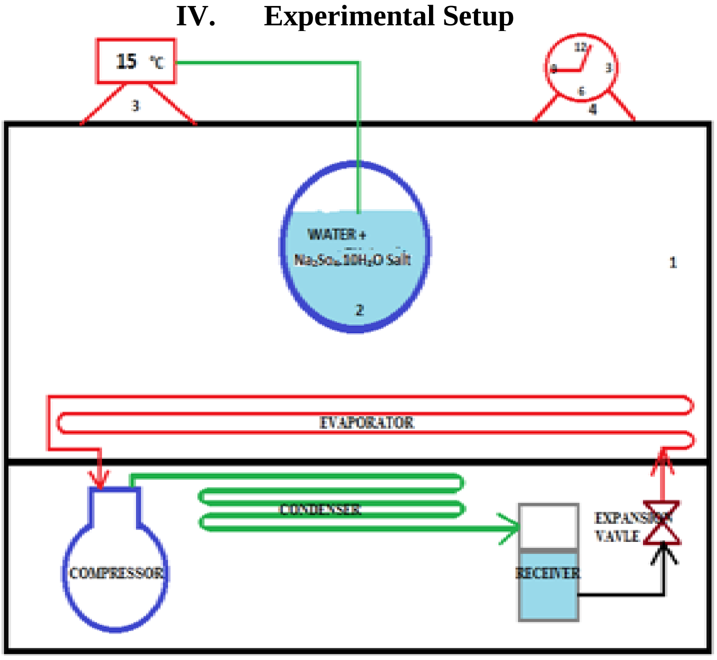

Figure 2.Experimental set up

- Deep freezer
- Shperical ball filled with PCM
- PCM temperature indicator
- Stop watch (or) Clock

V. Result & Discussion

The graph shows that, when time increases, correspondingly temperature will start to increase initially. For a certain time period, there will be a constant value in temperature. The constant value will be suddenly tends to increase, due to increase in time and there will be gradual increase in temperature. Increase in temperature. Again, the temperature will start to decrease and attains a constant temperature, even there will be an increase in time. Then, there will be gradual decrease in temperature.

Result Testing 1

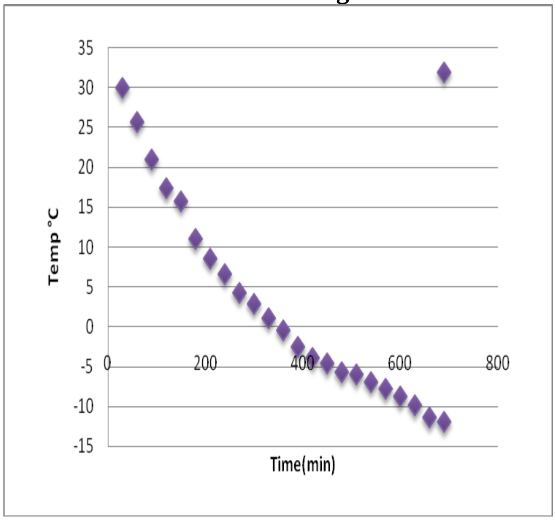

Fig 3.Freezing cure (80%water + salt 20%)

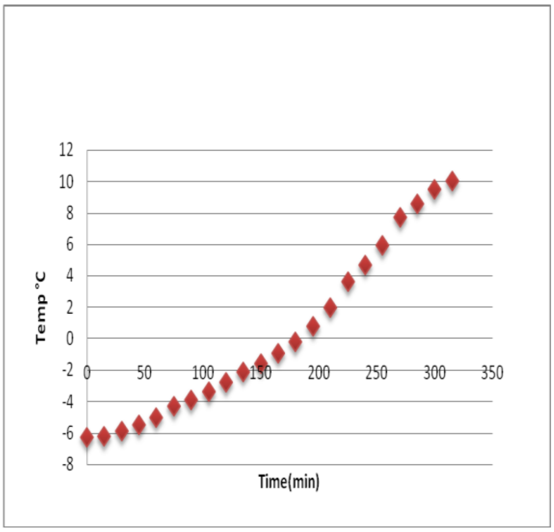

Fig 4.Thawing curve (80%water + 20%salt)

Result Testing 2

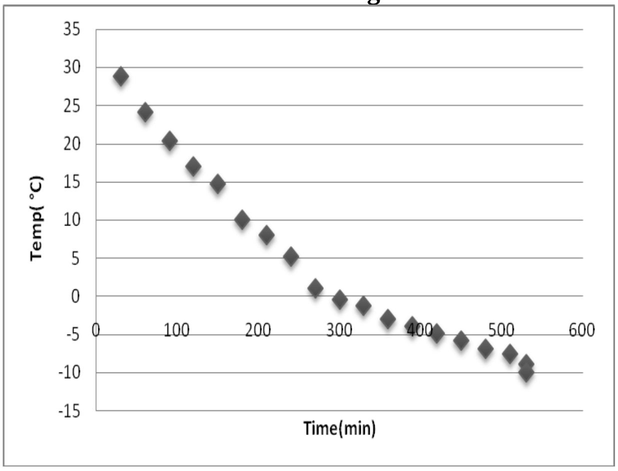

Fig 5.Freezing curve (75%water + 25%salt)

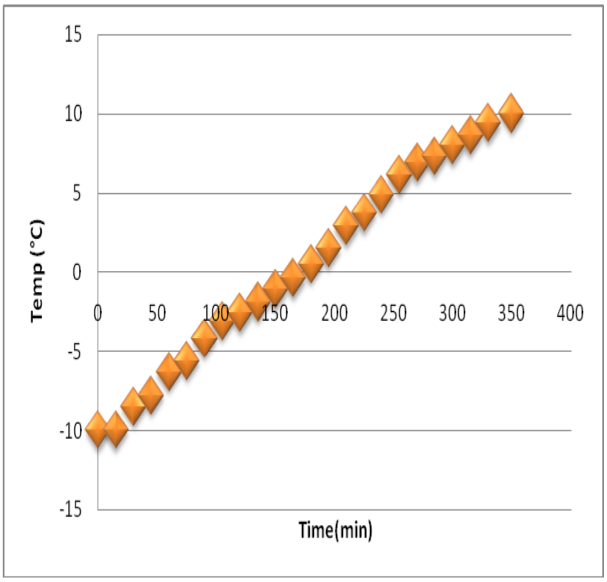

Fig 6. Thawing curve (75%Water + 25%Salt)

Result Testing 3

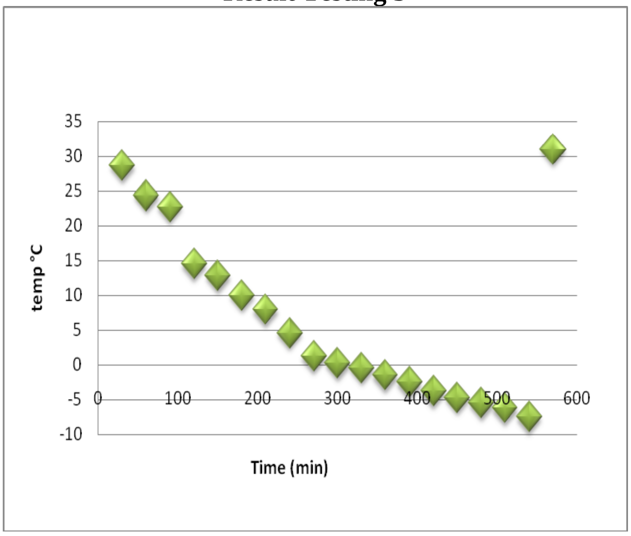

Fig 7. Freezing Curve (70%water + 30%salt)

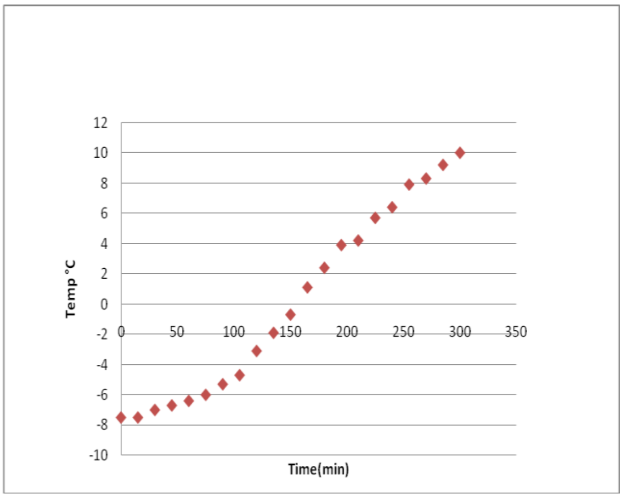

Fig 8.Thawing Curve (70%water+30%salt)

VI. Conclusion

The PCM sodium sulfate decahydrate has been used for cold storage application because of its low cost and conventional temperature of melting, soluble water to cool, which make it suitable for refrigeration application. Experimentation was performed to estimate the solidification and melting time water 80% and salt 20%. As a result, the higher thermal performances of the PCMs have proved its potential as substitute for conventional sodium sulfate PCMs in refrigeration applications.

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