Review On Sensible Heat Storage System Principle, Performance And Analysis

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Abstract

The thermal energy storage it is temporary storage at high or low temperature. An important criterion in selecting a material for sensible heat storage is its (ρ $C_{p)}$ value. A variety of substances have been used in such systems includes liquid like water, heat transfer oil and certain inorganic salts, and solid like rocks, pebble and refractory. The experiments are conducted for continuous discharging and batch wise discharging for both sensible heat storage and combined storage system. In this review we discuss the detailed investigation of availability of SHS techniques for solar thermal application, selection criterion for store material in SHS system, the economic impact on SHS system thermal performance of solar water heating system integrated with SHS system is investigated experimentally and analysis techniques of SHS system.

Keywords :-thermal energy storage , sensible heat storage ,

1. Introduction

Developing efficient and inexpensive energy storage device is as important as developing new source of energy .storage of thermal energy is going to be decisive factor for the future problem of managing energy [1].the sensible heat storage is least complicated e.g. with latent heat storage(LHS) and bong energy storage(BES).in case of sensible heat storage system energy is stored or extracted by heating or cooling a liquid or a solid ,which does not change its phase during this process[2].there are draw-back of cause ,sensible heat storage require e.g. large quantities of material and volumes. The second disadvantages associated with the sensible heat storage system are that cannot store or deliver at constant temperature.

2. Principle of sensible storage.

In sensible heat storage (SHS) thermal energy is stored by raising the temperature of a solid or liquid .SHS system utilizes the heat capacity and the change in temperature of the material during the process of charging and discharging .the amount of heat stored depends on the specific heat of the medium, the temperature change and amount of storage material [3], [2].

$Qs = m C_p \Delta T = V \rho C_p \Delta T.$

Where m is mass, V is volume, C_p is specific heat, ρ is density and T = Tmax -Tmin is maximum temperature difference between maximum and minimum temperatures of the medium.

2.1 Different concept for the storage of sensible heat.

The water displacement state haws a volume of some hundreds liters and is used for hot water supply in houses. The pebble/water reservoir is for the seasonal storage of heat. The couper regenerator is the device used in steel and foundry industry for many years. The solar pond is a special arrangement for an easy store of solar heat. Ground stores, multiple well stores, aquifers & storage reservoirs are seasonal stores. The Ruth accumulator stores hot water under high pressure [2].

2.2 Requirements for effective store of sensible heat on store material.

- Long service life, on-corrosive, non-toxic, on-flammable, long heat storage capacity.
- High thermal diffusivity, heat diffusivity, thermal conductivity and density.
- Capacity to withstand charging /discharging cycles
- Wide availability simple handling, low cost.

3. Thermoeconomic analysis of sensible heat energy storage systems.

This paper [3] considering advantages of employing a thermoeconomic analysis of sensible heat and performing the storage system at the minimum total cost of owning, Maintaining and operating such system. The analysis extended to model the entire process of charging-discharging cycle. the balance of the energy and entropy generation due thermal effect and friction considered in both the process of charging and discharging, the cost of the storage medium as working fluid is air intended in the fixed cost of the storage unit .compared the influence of 'α' charging temperature mass flow rate on the performance of the storage unit at the minimum total price. The advantages of utilizing thermoeconomic aspects such value of'α'flow condition, NTU and low second-low efficiency focused in designing operating thermal energy storage system. The analysis provides an important tool for engineer to select the right storage unit for a given application. In [9] an analytical method for the second-law-based thermoeconomic optimization of a sensible heat-storage system, in which the energy is stored in a large liquid bath from a hot-gas source, is presented. Results are presented in terms of the optimum number of transfer units as a function of a dimensionless unit-cost ratio, charging time, and reduced temperature difference of the storage system.

4. A perturbation solution for heating rectangular sensible heat storage packed bed with a constant temperature at the walls.

In this paper [4] obtained the analytical solution of perturbation for heating a rectangular sensible heat storage packed bed by a non-thermal equilibrium flow of incompressible fluid with a constant temperature at the wall. The physical model consist of the porous packed bed is filled with incompressible fluid at uniform temperature. Initial the temperature of packed bed are kept constant and at instant 't=0' fluid allowed to flow through it at high temperature from the analytical solution it shown that the temperature difference between solid phases and fluid consists of the steady and transient components while the wave propagates downstream the amplitude of the wave quickly decreases.

5. A transient, conjugated, conduction, controlled sensible heat storage.

In this paper [5] the waste energy dissipated during industrial manufacturing process may be stored as sensible heat in a storage system. They have applied the integral method to the specified storage system and obtained closed form solution of the governing equation for a sensible heat storage system with heat conduction .which depends upon only on a non-dimensional parameter 'B' .the schematic of this sensible heat storage system consisting of two semiinfinite plates having different material with uniform but different thermophysical properties. the storage plate stored sensible heat which flows from the hot plate .the result dependence of B is indicate by the closed form solution and hot plate material for $0.0775<B<63$ and the hot plate act as a constant temperature heat reservoir.

6. Experimental investigation on a combined sensible and latent heat storage system integrated with constant/varying (solar) heat source.

In this experimentation [6] the performance is compare with that of conventional SHS system .the water used as heat transfer fluid (HTF) from constant temperature solar collector to the TES tank also act as SHS mater and TES unit contain paraffin as PCM filled in spherical capsules which are packed in an insulated cylindrical storage tank. In this combined storage system employing batchwise discharging of hot water from TES tank is best suited for application where the requirement is intermittent .the experiment are performed to examine the effect of inlet fluid temperature and flow rates on the performance of the TES unit for both constant varying HTF inlet temperature .the uniform rate of charging and discharging is possible for a longer period this is the major advantages of combined storage system. It is seen that in the case of combined storage system the batchwise process gives better performance than the continuous discharging process. In the case of constant inlet HTF temperature the mass flow rate has only a small effect on the rate of charging. It is concluded that the combined storage system gives better performance than the conventional SHS system where there is a direct mixing of the HTF with the hot water in the storage tank.

7. Experimentation study of the dynamic behavior of porous medium submitted to a wall heat flux in view of thermal energy storage by sensible heat.

This study [7] concerns the storage of thermal energy in a porous bed mainly formed by a vertical channel, filled with glass beads, heated on one of the vertical walls by a constant heat flux. The use of glass beads is motivated by the possible use of such a system for storage of solar energy by sensitive heat and its optimization. In this experiment the system efficiency defined as the ratio of stored energy over the energy given to system increases with the discharge time for a fixed channel width and fixed charge duration.

8. Selection and characterization of recycled materials for sensible thermal energy storage

In [8] author has proposed alternative low cost materials are evaluated through the valorization of by-products derived from mining and metallurgical industry for solid sensible heat based energy storage systems. Studied materials have high energy density and medium thermal conductivity. They are compared with other materials using the material's selection methodology. Studied materials are cost effective for STES for an application such as CSP industrial TES. Compressive and flexural strength of different studied thermal energy storage materials at 20 °C. The paper [10] presents thermal stability examinations of Solar Salt and $NaNO_3$ by isothermal lab-scale tests and thermal analysis measurements. Salt analysis in the isothermal test showed a steadily increasing oxide level at a constant nitrite to nitrate ratio. Kinetic differences for nitrite and oxide formation for decomposition identified. Overview of corrosion aspects for steels in molten alkali nitrate salts given. Thermophysical data of Solar Salt reviewed and consistent data identified.. Thermal stability improvement for increased oxygen partial pressure determined.

9. Conclusion

This paper addressed the review on techniques for solar thermal application, selection criterion for store material in SHS system. By considering the thermoeconomic analysis provides an important tool for engineer to choose the right storage unit for a given application. It is concluded from the experimental results that the combined sensible and latent storage concepts reduces the size of the storage tank appreciably compared to conventional storage system. Using perturbation the temperature difference between the fluid and solid phases consist of steady and transient component shown and an analytical solution of problem is obtained.

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