Energy Mechanisms Of A Phase Change Material Solar Wall

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Abstract - Solar walls are one of the cleanest, effective, and reliable ways to harvest and use solar energy. Solar walls use phase change materials to store and release energy into buildings to create heating, cooling, and electricity. Solar walls use a unique configuration of double glazing that has a ventilative gap between the layers and then a strong thick base. Out of the three types of thermal energy storage techniques, latent heat storage is most used. During the heating and cooling periods, two different mechanisms are used. Ventilation is used for cooling and auxiliary is used for heating.

Keywords— Solar wall, renewable resource, phase change material, ventilation, auxiliary, latent heat storage, Higgs boson electro-quantum field, solar photons.

I. Introduction

Wind, solar energy, hydroelectric energy, geothermal energy, and tidal waves are 5 of the most abundant renewable sources on planet Earth [1]. Solar energy can be used to heat and cool houses, solar water heaters, create indoor lighting, and be converted into electricity. Solar energy is effective, reliable, and does not cause pollution [2]. With solar energy being renewable, solar walls are one of the most effective ways of harvesting energy with no pollution. With today's growing concern for environmental sustainability, solar walls are becoming more prominent. Solar walls or Tombe walls are structured systems that create a wall to harvest solar energy and convert it into electricity for the building to use. Trombe walls are relatively easy to incorporate into the design of buildings. Incorporating solar walls into budlings helps reduce pollution such as greenhouse gas emissions. These also assist in greater energy savings and reducing electricity consumption. Solar walls use phase change materials to capture, store, and release solar energy [3]. The phase change materials used in solar walls are typically liquid-solid. They are relatively easy to incorporate due to being light and inexpensive. These phase change materials allow for solar energy to be collected, stores, and later released as electricity, heat, and air conditioning to be used in the building.

II. Phase change materials

Phase change materials are considered one of the most sustainable ways to harvest energy from renewable resources like the sun. Phase change materials absorb a large amount of heat that can later be released to turn into heat or electricity. Inorganic phase change materials are inexpensive and nonflammable. Most solar walls use solid to liquid phase change materials. These materials generally have low volume changes which allow for little space difference between the states. They also have low enthalpy changes. This means they lose very little heat as they change phases [4]. A phase change material that has low enthalpy and low volume changes creates a solar wall that can generate maximum energy while taking up minimal space.

III. Energy conservation and storage techniques

Thermal energy storage occurs in three phases: absorption, storage, and discharge. There are three different types of thermal energy storage. Sensible heat storage is the simplest form of thermal energy storage. Energy is stored in a solid or liquid medium for smaller applications of energy release. When using sensible heat storage, the amount of heat that can be stored is based on the rise in temperature. To supply a large amount of energy, the rise in temperature would need to be very large. Due to the need for rise in temperature to create large amounts of energy, this storage technique is not commonly used in solar walls. The next storage technique is latent heat storage. This is done with phase change materials such as solid-solid, solid-liquid, liquid-gas, and solid-gas. These release the stored energy during phase changes at a consistent temperature. The phase change materials used in these have a high energy storage density, meaning they can hold large amounts of energy. Latent heat storage is commonly used in solar walls for several different reasons. They are low cost, available for different temperature ranges, and are easy to incorporate into buildings. The final type of heat storage technique is thermo-chemical energy storage. These are done by sorption and chemical reactions. Sorption is storing energy within chemical or physical bonds. It uses endothermic and exothermic reactions to store energy long term with minimal loss. This storage technique allows for the use of small storage systems, low temperature reactions, and minimal heat loss. These are not commonly used in solar walls due to their low stability, high cost, and poor heat transfer [5].

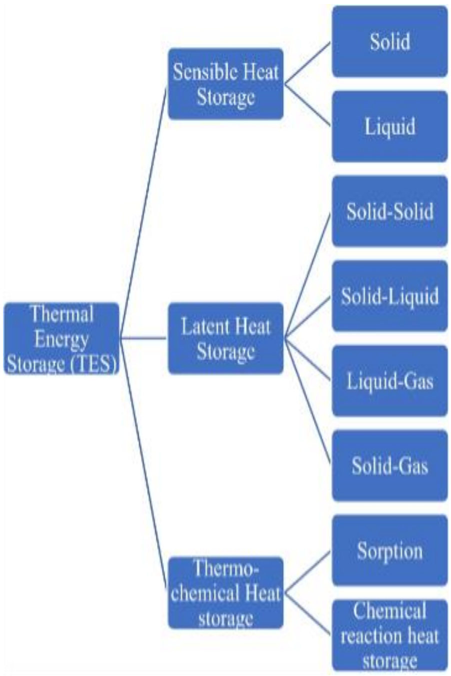

Figure 1. *A flow chart of different types of thermal energy storage [5].*

IV. SOLAR WALL DESIGN

There have been many studies on the design and layout of solar walls. Each experiment uses a vertical and horizontal section. These walls traditionally consist of a double exterior glazing that is exposed to the sun with a gap in between to allow for ventilation. The main base of the wall is often made of adobe, brick, concrete, or stone. The energy is transmitted through the glazing and stored in the phase change material [2],[3]. As time elapses from when the energy was harvested, it heats up as it is transmitted from the energy holding material to the ventilation layer [2].

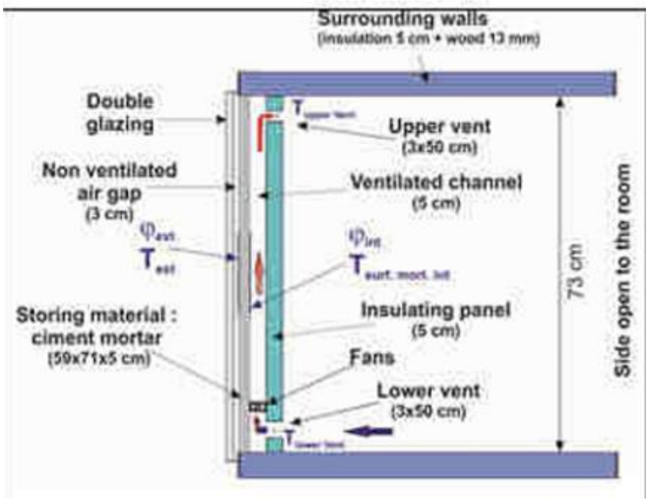

Figure 2. *Schematic of a traditional vertical solar wall mechanism [2].*

V. HEATING AND COOLING MECHANISMS OF SOLAR WALLS

During summer and warmer months, solar walls use ventilation mode. Ventilation mode is used to reduce the indoor temperature while keeping out excess heat from outdoors. While the solar wall is absorbing solar energy, it is also keeping the inside of the building cooler due to it absorbing the heat and not allowing it to pass through the foundation [6]. The solar irradiance that is being absorbed is being transformed into cooling-state photons. This is done by introducing helium into the metal frame of the wall. When this happens, the structure of the waveguide becomes deformed by helium mixing with solar photons creating a cooling-state photon [7]. In the winter and cooler seasons, solar walls use auxiliary mode. This is where solar energy is converted into heat to be used as a space heater. Solar energy is absorbed by the glazing and heated by the phase change material allowing for the heat to be distributed through the building [6]. To heat the building, the electric field must be formed into a semiconductor. When this happens, the cooling photons are deformed into heating photons by generating a Higgs boson electro-quantum field. The generation of the Higgs boson electro-quantum field happens when the solar light splits the field symmetry [7].

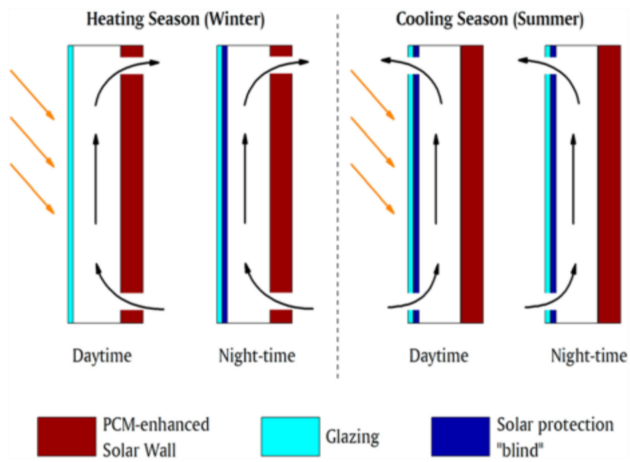

Figure 3. *Schematic of the heating and cooling mechanism of a solar wall during the heating and cooling periods [3].*

VI. CONCLUSION

In conclusion, solar walls are one of the cleanest, inexpensive, and reliable ways to supply energy to a building. They are configured of a double glaze with a ventilation layer to allow for energy to be transferred and converted into heating, cooling, and electricity. They use liquid to solid phase change materials due to their high storage density, inexpensiveness, and low temperature changes. Solar walls use latent thermal storage to ensure the least amount of heat loss possible. In the summer and warmer months, they use ventilation mode to cool the building, while in the winter and cooler months they use auxiliary mode to heat the building.

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