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UNDERGROUND SEASONAL SOLAR THERMAL ENERGY STORAGE: A CASE STUDY

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Abstract

Solar thermal technologies are promising, given the fact that solar energy is the cheapest and most widely available of all renewable energy technologies. The recent promotion of solar energy for various applications has received considerable attention from researchers, to improve the overall efficiency of various solar thermal systems. Thermal storage systems are essential to overcome the disadvantage of the intermittent nature of solar energy. One of the methods to effectively utilize solar energy is the integration of a highly efficient storage system, which should enhance the storage capacity to make the system suitable for continuous usage. Further, high stratification is required in the storage system in order to increase the efficiency of the solar collector system. Such stratified storage tanks are also vital for the effective storage and retrieval of energy, intended for various solar thermal applications.

INTRODUCTION:

The purpose of the research described in this document is to simulate, optimize, and evaluate a method for storing the sun's thermal energy during the warm season so it can be harvested later during the cold season. Specifically, the energy harvested during the cold season supplies a single story residential home with space heating via radiant floors [1].There are two different closed loop systems carrying a working fluid that are responsible for transferring thermal energy. The working fluid was modeled as water, but in practice is typically a water-glycol solution to prevent from freezing. By closed loop, the water never leaves the piping system except for when it's in the solar collectors [2-4]. The first loop is the heat addition loop in which solar collectors transfer heat from the sun to the working fluid. The working fluid is then pumped to the SSTES bed where the thermal energy is stored since the bed temperature is much lower than the solar collectors' output temperature. The fluid is then returned to the solar collectors. The second loop is the heat extraction loop which uses the same working fluid to extract thermal energy from the SSTES bed and deliver it to the house. The heat is delivered to the house via radiant floor heat (tubes carrying hot water underneath the floor surface). The SSTES bed is constructed underground to conserve available land space and to help insulate the bed since underground conditions are much more stable and less severe during the winter [5-7]. The top of the bed is buried below the frost line in the ground where temperatures remain fairly constant year round. The outside of the bed is covered with a vapor barrier layer to keep all ground water flow out of the bed. Cold ground water flow through the bed would effectively remove all stored thermal energy. Inside of the vapor barrier, the SSTES bed is lined with insulation to minimize heat transfer to the surrounding ground [8-10]. Sand is used as the bed medium because it is cheap and has a high thermal capacitance. The purpose of the research in this document is to explore the effectiveness and the sizing parameters of the system. Data will be obtained through computer simulations developed in TRNSYS, a software package that specializes in transient thermal energy system simulations. Different sized homes will be explored to see how the size of the SSTES bed and solar collector area should be varied based on different demands [11, 12]. The flow rate of the working fluid in the closed loop connecting the solar collectors to the SSTES bed will also be optimized.

STATEMENT OF RESEARCH ARGUMENT:

In the present work, an experimental investigation was carried out to study the stratification behaviour during the charging process, in a packed bed thermal storage unit, filled with phase change materials (PCM) encapsulated spherical capsules. The configuration used in the experimental investigation was modeled, and analysed for the stratification behaviour, using the commercially available CFD software FLUENT. The results were validated using the experimental analysis. The computational fluid dynamics (CFD) analysis was also performed on a sensible heat storage tank of similar geometrical dimensions. It is concluded that the LHS systems perform better in comparison with SHS systems. The solar thermal collector benefits arising from better stratification in the LHS coupled with the advantageous features of quicker charging, more energy density, and better energy quality, favours the LHS systems.

OBJECTIVE OF THE STUDY:

1. To study the Thermal Energy Storage.

2.To study the Thermal Energy Storage Mechanisms and Concepts.

3.To study the Thermal Energy Storage Methods.

4.To study the Stratification in Thermal Storage.

CONCLUSION:

Solar thermal technologies are promising, given the fact that solar energy is the cheapest and most widely available of all renewable energy technologies. The recent promotion of solar energy for various applications has received considerable attention from researchers, to improve the overall efficiency of various solar thermal systems. Thermal storage systems are essential to overcome the disadvantage of the intermittent nature of solar energy. One of the methods to effectively utilize solar energy is the integration of a highly efficient storage system, which should enhance the storage capacity to make the system suitable for continuous usage. Further, high stratification is required in the storage system in order to increase the efficiency of the solar collector system. Such stratified storage tanks are also vital for the effective storage and retrieval of energy, intended for various solar thermal applications.

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