Optimization of Stratified Thermal Energy Storage (STES)

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Abstract- *A considerable increase in interest in using thermal energy storage has been observed in recent years. The growing requirement to save energy and to reduce overall environmental impacts, thermal energy storage is one of the best available option which can be used effectively. The presence of stratification is well known to improve the performance of thermal energy storage system, stratified thermal energy storage tanks are superior in thermal performance, exergy content is more in stratified storage when compared to mixed storage.Performance of the stratified thermal energy storage can be increased by the use of baffles. In this project stratified thermal energy storage tank and the effects of baffles are analysed and optimized using ANSYS software and model experiment.*

Keywords- Energy storage, Baffles,Thermal Stratification.

I. INTRODUCTION

Thermal energy storage (TES) is one of the key technologies for energy conservation and therefore it is of great practical importance. One of its main advantage is that it is best suited for heating and cooling thermal applications. TES appears to be an important solution to correcting the mismatch between the supply and demand of energy.TES can contribute significantly to meeting society's needs for more efficient, environmentally benign energy use.authorities every day in anunhygienic manner leading to health issuddcddcfd

The Thermal energy storage technology has only recently been developed to a point where it can have a significant impact on modern technology. In general a coordinated set of actions has to be taken in several sectors of the energy system for the maximum potential benefits of thermal storage to be realized. Thermal energy storage appears to be an important solution to correcting the mismatch between supply and demand of energy. Thermal energy storage can contribute significantly to meeting society's needs for more efficient, environmentally benign energy use. Thermal energy storage is a key component of many successful thermal systems and a good thermal energy storage should allow little thermal losses, leading to energy savings while permitting the highest reasonable extraction efficiency of the stored thermal energy.

The basic principle is the same in all TES applications. Energy is supplied to a storage system for removal and use at a later time. What mainly varies is the scale of the storage and the storage method used. In terms of storage media, a wide variety of choices exists depending on the temperature range and application. For sensible heat storage, water is a common because, among its other positive attributes, it has one of the highest specific heats of any liquid at ambient temperatures.

1] Analysis of latent thermal energy system with embedded heat pipes
Authors: K.Nithyanandham, R.Pitchumani
Published in: International Journal of Heat and Mass transfer (2011).

This project presents an approach to reducing the thermal resistance of LTES through embedding heat pipes to augment the energy transfer from the heat transfer fluid (HTF) to the PCM. Energy transfer rate and effectiveness is increased using a thermal resistance network model of a shell and tube LTES with embedded heat pipes

2] Thermal Energy Storage for Active and Passive cooling
Authors: Abdul Majid, Izzudin Zaman, Nasrul Amri
Published in: MATEC Web of Conference (2018)

This project analyses the performance of stratified thermal energy storage system of a cooling plant, from the observation, it is noted that problem arises when the chilled water scheduling become inconsistent which led to low performance of the tank. And the analysis results in the thermal energy storage tank performance using thermocline thickness.

3] Operation and Performance of Thermal Energy Storage System
Authors: Joko Waluyo, Meseret Nazir, Mohd Amin
Published in: International conference on advances in Energy Engineering (2016).

This project analyses a simulated model of stratified thermal energy storage tank. In this study a simulated model which is capable to simulate the charging phenomenon in the stratified TES tank precisely. The model incorporated chiller in to the charging of stratified TES tank system in a closed system. The model was developed in one dimensional type involve with heat transfer aspect. The model covers the main factors affect to degradiation of temperature distribution namely conduction through the tank wall, conduction between cool and warm water, mixing effect on the initial flow of the charging as well as heat loss to the surroundings. Validation of the simulation model is carried out using observed data obtained from operating stratified TES tank and found increase in overall thermal performance of the system.

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Motivation

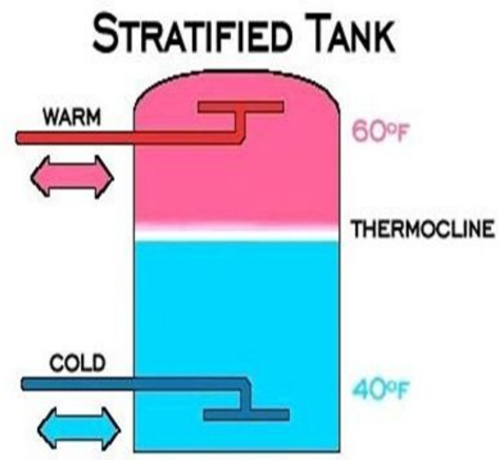
Large thermal energy storage systems have been employed in recent times for numerous applications, ranging from solar hot water storage to building air conditioning systems. Thermal energy storage system appears to be an important solution to correcting the mismatch between supply and demand of energy.

Problem Statement

When using thermal energy storage to save and retrieve energy and to reduce environmental impact, heat losses, exergy, overall available energy, average temperature and overall performance are considerably less, hence by using stratification principle in thermal energy storage systems overall performance of the storage system can be increased effectievely.

II. METHODOLOGY

The term “thermal” storage is used instead of “heat storage because the former states storage of heat or cold and the latter just refers heat. An effective TES tank which uses water as the storage medium. A thermally naturally stratified storage tank has no inside partitions and has the following principle of operation. Warm water has low density and floats to the top of the tank, while cooler water with higher density sinks to the bottom.



The storage volume with this type of system is reduced relative to other systems, because the dead water volume is relatively low and the energy efficiency relatively high. Performance of the stratified thermal storage tank is more effective when compared to mixed storage. To increase the degree of stratification baffles can be used effectively. The performance of the thermally stratified storage tank with baffles and without the use of baffle plate is analysed.

Additionally best placement for the baffle plate inside the tank is analysed and validated coherent with both simulation and experiments. Flat plate baffle is to be used in this experiment. Temperature difference and thermocline thickness plays major role in stratification of the storage tank. Stratification also affected by the flow rates, so constant flow rate is to be used for the experiment. Heat loss from the tank also affects the process, hence the stratified thermal storage tank should be provided with proper insulation around the tank. Better placement of baffle plate, reduce mixing of water with temperature variations inside the stratified thermal storage tank. Hence increase the degree of stratification and the overall performance of the stratified thermal energy storage tank.

III. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

ADVANTAGES

Increase in thermal performance
Increase in exergy
Environmental benign
Increase in utilization of energy
Almost applicable to most of the TES
Applicable to large TES

DISADVANTAGES

- Increase in initial cost
- Increased maintenance

APPLICATIONS

- Sensible TES Systems
- Latent TES Systems
- Solar TES Systems

IV. CONCLUSION

The aim of this project is to increase the overall thermal performance and exergy of the thermal energy storage systemsby using baffles inside the thermal storage tanks. stratification is increased which increases the overall performance. Increase in performance is validated through thermocline thickness and available maximum temperature of the system

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