DESIGN AND SIMULAtion of ICE BASED STORAGE FOR SMALL SCALE COLD Room

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INTRODUCTION

The project is focused on the development and experimentation of Latent thermal energy storage for its application in cold storage. The main idea of the project is to understand the working of TES tank using phase change material.

OBJECTIVES

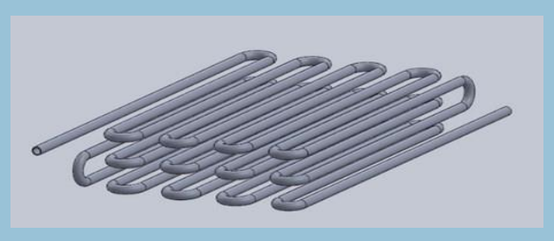
1. To design the discharge coil of Latent heat Energy Storage (LTES) tank for efficient cooling of refrigeration load.
2. To perform a simulation study to understand the dynamics of the discharge coil using COMSOL Multiphysics.

METHODOLOGY

1. A numerical study is done to identify the dimensions of the discharge coil.
2. A three-dimensional CAD model is designed using solidworks to properly align the charging and discharging coils in the TES tank.
3. A section of the discharge coil is simulated using COMSOL Multiphysics. Study parameters are such chosen which can help

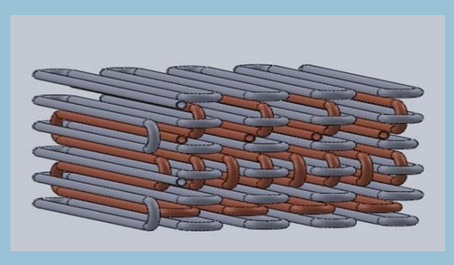
DESIGN

1. The refrigeration load of perishable items consists of sensible heat load, latent heat load, transmission load, infiltration load and miscellaneous loads.
2. The total refrigeration load for 1 Tonne of potato cold storage in the pull-down period and holding period is 0.211 and 0.107 TR respectively.
3. The length of the discharge coil depends on the refrigeration load, the mass flow rate of air and number of coils.
4. The charging coil and discharge coil has a total length of 39.62 and 12.45m respectively.
5. The charging coil and discharge coil are arranged as following.

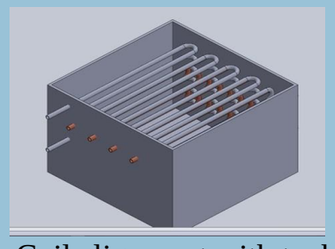


Charging coil

Discharging coil



Coil alignment



Coil alignment with tank

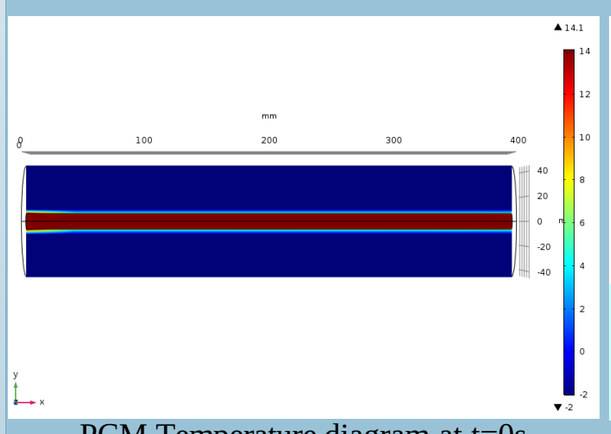
SIMULATION

1. For simplicity and computation a 3D discharge coil of 90mm outer diameter, 12.5mm inner diameter and 400 mm length is constructed using COMSOL geometry function.
2. The diameter and length are interpreted from the original discharge coil with the help of volumetric ratio.
3. Normal mesh is selected and total number of degree of freedom solved is 6726.
4. Heat transfer and laminar functions are used for solving the problem

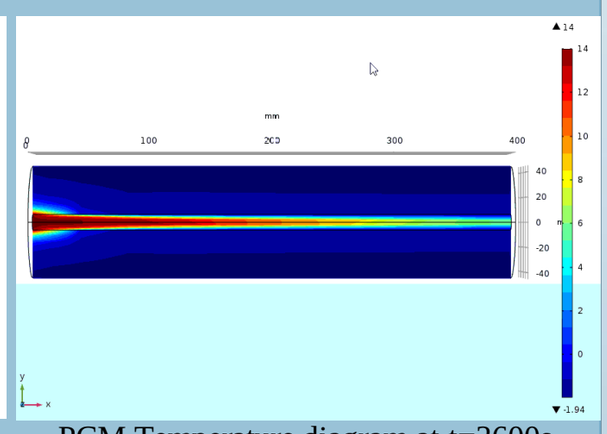
RESULTS AND DISCUSSIONS

1. The results and discussion in holding period are satisfactory. It is assumed that air is entering the discharge coil at 14°C.
2. The temperature vs time graph shows the temperature drop of 8°C at the end of 3600 second.
3. The outlet temperature of 6°C is obtained which is the holding temperature for potatoes recommended by NHB. Following are the some of the results.

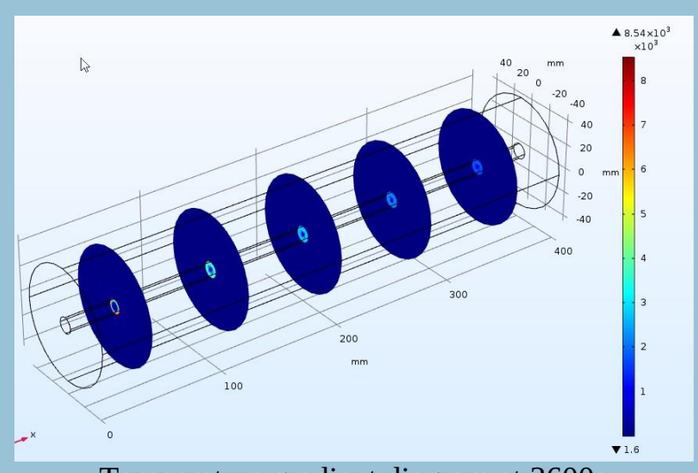
Temperature vs time diagram for the holding period



PCM Temperature diagram at t=0s



PCM Temperature diagram at t=3600s



Temperature gradient diagram at 3600s

CONCLUSIONS

1. LTES system can be economic, reliable and environmental-friendly option for the cold storage.
2. The temperature vs time graph in holding period show that the LTES system can be an effective solution if used during the holding period and power outage conditions.

FUTURE SCOPE

1. The future work includes developing a Latent thermal heat storage with cold storage to experimentally validate the simulation results.
2. Further study also includes an economic analysis of a solar photovoltaic powered LTES-cold storage standalone system for its operation in remote areas.