SOLAR POWERED COLD STORAGE WITH BRINE CIRCULATION AND PCM STORAGE

Problem statement:

Traditional cold storage systems rely heavily on grid electricity or diesel generators, making them costly, unsustainable, and inaccessible in rural or off-grid areas. This leads to high energy consumption, post-harvest losses, and limited food preservation options for farmers and small businesses. Additionally, inefficient temperature regulation in conventional storage results in uneven cooling and energy wastage.

Objective:

To develop a solar-powered cold storage system using brine circulation and PCMs for energy-efficient cooling. This system ensures sustainable, cost-effective, and automated temperature control, making it ideal for food preservation and off-grid applications. PCMs absorb, store, and release thermal energy by changing phase (solid ⇄ liquid) to maintain a stable temperature.

Methodology:

1. Solar Energy Captures & Stores Power

2. Ice Bank & PCM Act as Thermal Batteries

PCMs in the walls or brine tanks help maintain temperature for longer, reducing energy consumption. This allows the storage to stay cold even if solar power is unavailable for a few days.

3. Brine Circulation Distributes Cooling Efficiently

* Each room receives the required amount of cooling through valves controlled by temperature sensors.
* After absorbing heat, the warmed brine returns to the ice bank, where it gets re-cooled and the cycle continues.

5. Smart Automation for Temperature Control

* IoT sensors in each room monitor temperature.
* A microcontroller (ESP32 / Raspberry Pi) adjusts:
  + Brine flow rates via solenoid valves for zoned cooling.
  + Pump speed based on cooling demand to save energy.

Key features:

* Longer Storage Time: PCMs prevent temperature spikes, protecting stored goods.
* A hybrid water collecting system can be used to utilise water resources efficiently.
* Brine Circulation Cooling – Efficiently distributes cooling across storage rooms.
* PCM-Based Thermal Storage Enhances cooling retention and reduces energy use.
* Sustainable & Eco-Friendly- Solar power minimizes electricity costs

Abstract statement:

This solar-powered cold storage system provides an innovative solution for storing perishable goods in regions where electricity is limited or unreliable. This project aims to develop a solar-powered cold storage system utilizing brine circulation and Phase Change Materials (PCMs) for efficient and sustainable cooling. A brine circulation network efficiently distributes cooling to different storage rooms, with IoT-based automation adjusting temperature based on demand. This solution is ideal for farmers, small businesses, and remote areas.

Expected outcomes:

A more efficient solar powered cold storage system, as it uses PCMs and brine circulation for a well run and longer cold storage that can be functional even during cloudy days and monsoon season. It ensures that farmers and small-scale vendors can store their produce longer, reducing post-harvest losses and increasing their income.

Impact:

Preserves perishable goods for longer, reducing waste and promoting zero hunger. Lowers reliance on fossil fuels and conventional refrigeration. Helps small-scale producers store and sell products more efficiently. By reducing energy consumption and ensuring reliable preservation of perishable goods, this system enhances food security, economic growth, and environmental sustainability.