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Design, Construction and Testing of Evaporative Cooling Facility for Storing Vegetables and Fruits

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ABSTRACT

A solar powered evaporative cooling system designed and constructed to increase the shelf life of stored vegetables and fruits. The equipment operates on the principle of evaporative cooling and increasing the relative humidity (RH) in the preservation chamber. The quality and storage life of fruits and vegetables may be seriously compromised within a few hours of harvest unless the crop has been cooled promptly to control deterioration. The major problem during storage is the change in the quality parameters of the produce especially the physical characteristics such as the color, texture, and freshness in which the price sometimes depends on. In order to extend the shelf life, fruits and vegetables need to be properly stored. Proper storage means controlling both the temperature and relative humidity of the storage area. Although, refrigeration is very popular but it has been observed that several fruits and vegetables, for example banana, plantain, tomato etc. cannot be stored in the domestic refrigerator for a long period as they are susceptible to chilling injury. Apart from this, the power supply and low income of farmers in the rural communities makes refrigeration expensive. Evaporative cooling occurs when air, that is not too humid, passes over a wet surface the faster the rate of evaporation the greater the cooling. The efficiency of an evaporative cooling structure depends on the humidity of the surrounding air.An Evaporative cooler reduces the storage temperature and also increases the relative humidity within the optimum level of the storage thereby keeping the fruits and vegetables fresh. It can be use for short term preservation after harvested. Thus, an evaporative cooling is a low cost technology for storage of fruits and vegetables. The Technology of evaporative cooling is cost effective and could be used to prolong the shelf-life.

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INTRODUCTION

India is the second largest producer of fruits and vegetables in the world after Brazil and China respectively. Due to their high moisture content, fruits and vegetables have very short life and are liable to spoil. Moreover, they are living entities and carry out transpiration, respiration and ripening even after harvest.Vegetables and fruits are important food items that are widely consumed because they form an essential part of a balanced diet, they are important sources of minerals and vitamins especially vitamin A and C. They also provide carbohydrates and protein, which are needed for normal healthy growth.

In order to extend the shelf life of fruits and vegetables, they need to be properly stored. Proper storage means controlling both the temperature and relative humidity of the storage area. The essence of storage is of great importance because not all the harvested vegetables or crops in general will be used immediately after harvest so, measures of preserving the vegetables before it exceeds its shelf life is of great importance.Evaporative cooling occurs when air, that is not too humid, passes over a wet surface the faster the rate of evaporation the greater a cooling.

The efficiency of an evaporative cooler depends on the humidity of the surrounding air very dry air can absorb a lot of moisture so greater cooling occurs. An evaporative cooling structure is made of a porous material that is fed with water. Hot dry air is drawn over the material. The water evaporates into the air raising its humidity and at the same time reducing the temperature of the air. Low temperature prolongs storage life by reducing respiration rate as well as reducing growth of spoilage microorganisms.

Vegetables should be consumed in the fresh state because they are usually perishable. In their fresh form most fruits and vegetables contain 80% water with some varieties such as cucumber, lettuce and melons containing about 95% When vegetables are harvested the moisture in them reduces partly due to respiration that occurs and since there is no replenishment and loss to the atmosphere.Farmers and traders still practice their age-old storage methods leading to large-scale wastage during storage and transportation. Traditionally, after harvest, most of the fruits and vegetables are kept in temporary wooden/bamboo huts constructed near the residential buildings or production catchment. In the warm plains of India, fruits and vegetables are stored in pits or cool dry rooms with proper ventilation on the floor or on bamboo racks. Inside the hut, fruits and vegetables are kept on floor or over racks and covered are with plant leaves to avoid exposure to the atmosphere.

LITERATURE SURVEY

Timothy Adeoye Adekanye, Kunle Olufemi Babaremu

An active evaporative cooling device for storage of fruits and vegetables was developed and evaluated. The cooling device was developed to improve the shelf life of fruits and vegetables. It consists of an inner wall (aluminium of 0.6 mm thickness), external wall (galvanized steel of 1mm thickness), one suction fan, water pump and three trays. The walls were lagged by polyurethane, and three trays. Water distribution network contains two water tanks of 20 litres capacity each, a PVC pipe was used for circulating water from the tank to the overhead reservoir and a floated switch for controlling the pump. Water is discharged from the overhead tank through a tap and drains through a jute bag which serves as a cooling pad material. The cooler reduced the ambient temperature of 29.5 oC to 22.8 oC and increased ambient relative humidity to 95.7%.

Zakari M. D, Y. S. Abubakar, Y. B. Muhammad.etall

A solar powered evaporative cooling system was constructed to increase the shelf life of stored vegetables. The evaporative cooler was tested and evaluated using tomato. The equipment operates on the principle of evaporative cooling and increasing the relative humidity (RH) in the preservation chamber. The storage system was made up of aluminium sheets side of the system is made of jute pad which get moist by water flowing through a series of perforated pipe from the reservoir located at the top of the storage system. The water flows with the influence of gravity. The average cooling efficiency was found to be 83%. The temperature in the system dropped drastically when compared to the ambient condition which ranges from 6 to 10°C and the relative humidity in the cooling chamber increased considerably to 85%.

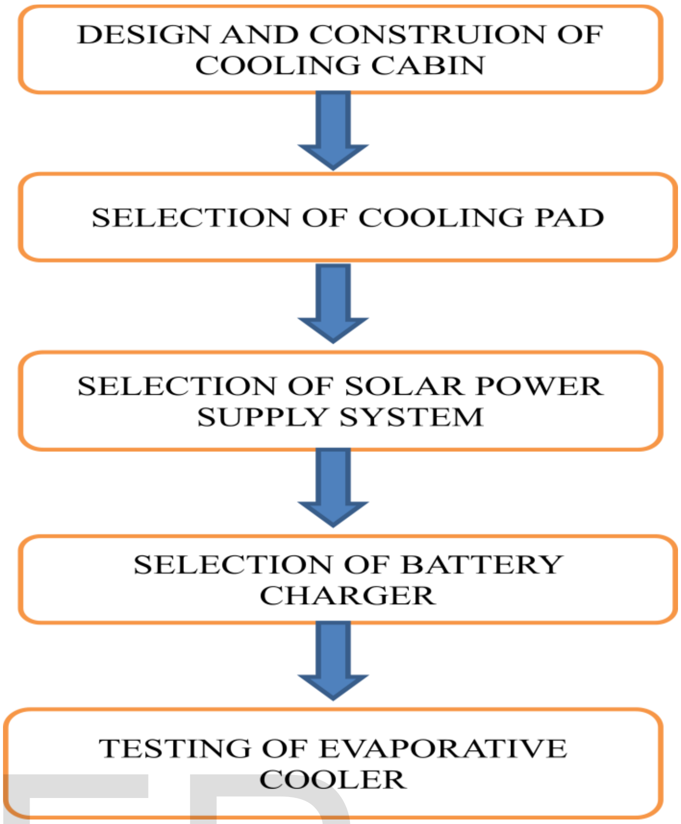
Prof. R. D. Gorle, Prof. M. M. Wandhare, etal.

In hot and humid conditions the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of systems like air-conditioning and refrigeration has increased rapidly. These systems are most of the time not suitable for villages due to longer power cut durations and high cost of products. Solar power systems being considered as one of the paths towards more sustainable energy systems, considering solar-cooling systems in villages would comprise of many attractive features. This technology can efficiently serve large latent loads and greatly improve indoor air quality by allowing more ventilation while tightly controlling humidity.

Sushmita et al., (2008)

He conducted a research on Comparative Study on Storage of Fruits and Vegetables in Evaporative Cool Chamber and in Ambient. An evaporative cool chamber was constructed with the help of baked bricks and riverbed sand. It was recorded that weight loss of fruits and vegetables kept inside the chamber was lower than those stored outside the chamber. The fruits and vegetables were fresh up to 3 to 5 days more inside the chamber than outside.

METHODOLOGY



Selection of cooling pad:

As a part of general requirement, the efficiency of an active evaporative cooler depends on the rate and amount of evaporation of water from the cooling pad. This is dependent upon air velocity through the fan pad thickness and degree of saturation of pad, which is the function of water flow rate wetting the cooling pad.

Selection of solar power supply system:

The installed suction fans on the evaporative cooling system have the following specifications (voltage ratings), 0.5amp current and these specifications where considered in the selection of the solar power source that will ensure the continuous functioning of charger.

Design of the battery charger:

The battery charger was designed so that it can step down the voltage rating from the solar panel, in order to charge the battery adequately.

Determination of battery capacity and selection of battery:

The battery capacity was determined with reference to the suction fan specifications.

Construction of the evaporative cooler:

Hallow rectangular aluminium pipes and sheets were measured. Cut and assemble to form a rectangular storage sticks with the left-hand side open for the insertion of jute pad and mesh wire according to specifications of the design. The pipes and sheets were assembled with the aid of screws, three circular openings were made in the opposite to the jute pad where suction fans were fitted. The storage chamber was divided into two shelve using mesh wire. And opening was near the bottom of reservoir tank. A PVC pipe was inserted in opening.

EXPERIMENTAL WORK

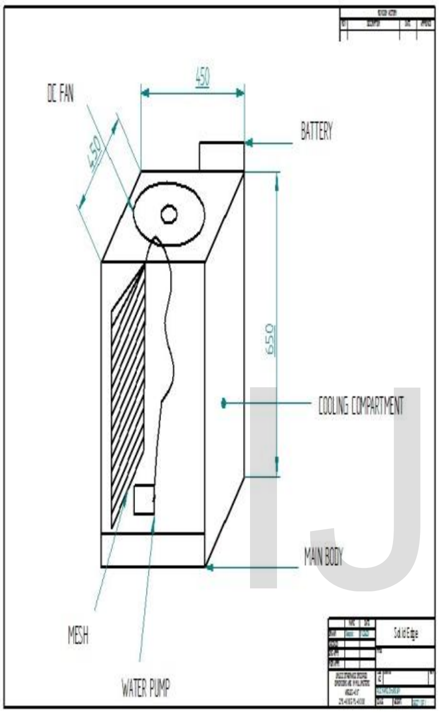
MATERIALS USED:

Material used for outer frame is mild steel Fabrication is carried out using arc welding A suction fan is fixed on top with 60 w power & 2000 rpm speed.

DESIGN AND CALCULATIONS:

Fig. Design of cooling system using solid edge

Calculations



Selections of suction fan based on the calculation are:

Floor area :

A = L * B

A= 1.48ft*1.48ft =2.19ftsq

Fan capacity:

C = 8*2.19 = 17.52 cfm

Required fan capacity:

17.52+10% of fan capacity = 17.52+1.75 = 19.27 cfm = 20 cfm

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