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Development and design of solar air cooler with water cooling and storage system

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ABSTRACT

In present during the summer season temperature of environment is very high, for observing cooling effect it requires higher cost and electricity, refrigerators and air conditioners are to be very costly and also environmental pollution developed during electricity generation. Resulting increasing global warming and pollution. The design and development of cooler is consist of solar penal, storage box, water cooling system, pipe, air blowing fan and cooling pads. Which provide the cool drinking and storage system for stored regular food items, vegetables and fruit etc.

Keywords: Solar air cooler, water cooling

I. INTRODUCTION

In the 21th century, the world is facing a problem of global warming due rapid industrialization. In India, during summer season the temperature is about 41°C to 45°C. It reaches up to 46°C to 50°C in the month of may-June. To obtain comfortable condition in the summer season. Various types of appliances are used such as 'Air Conditioner', 'Coolers', etc. These are easily available in the market. In India, the average income of common man is not so high, common man cannot afford these appliances because of their high cost. Another problem is scarcity of electricity, especially in villages; the load shading is 12 to 14 hours a day. This paper gives a solution for the above problem.

Solar power systems being considered as one of the path 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. Despite increasing performance and mandatory energy efficiency requirements, peak electricity demand is growing and there is currently no prevalent solar air cooling technology suited to residential application especially for villages, schools and offices. This project reviews solar powered air cooler for residential and industrial applications. It is the modification of the desert cooler by attaching it with some extra items. With the help of these modifications we have achieved the following goals,

1) To replace existing costlier cooling methods.
2) To make aware of non conventional energy sources to reduce environmental pollution.
3) Filtered Cool water for drinking purpose.
4) Storage space for regular food items

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II. DESCRIPTION OF MODIFIED SOLAR AIR COOLER --

The assembly of modified solar air cooler is consist of following components

1. Air cooler assembled with storage box (lower position of air blower)
2. Solar penal, charge controller, battery, inverter
3. Connecting tubes or pipes
4. Two simple size of water pot

The fig.1 shows the assembly of the project in which the solar air cooler is connected with a new innovative cooling system with the help of connecting pipes. The cold water is circulated around storage box with the help of other connecting pipes. The system is so assembled that the flow of water takes place on the principle of gravity. Thus for circulating water around the box & into the water tank.

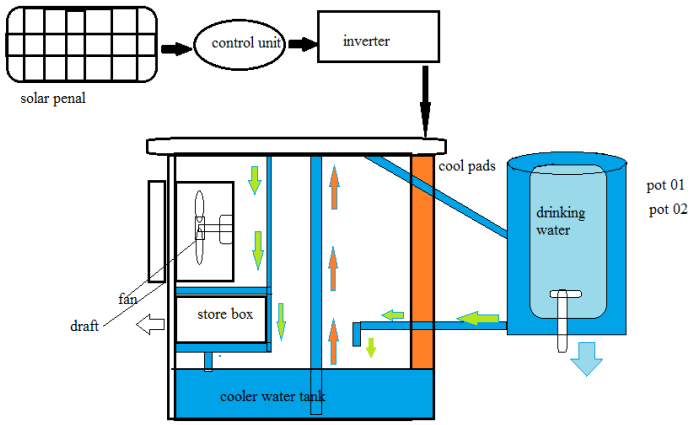

Fig.1 Solar air cooler with water cooling system

Working methodology of solar air cooler

The project is consist of two section

1) Solar energy conversion system

Solar energy is basic non conventional sources of energy which is operated with the help of charge controller and inverter, energy is stored in battery as sun light fall in the solar plate which convert into electrical energy by photoelectric effect. Electrical energy is stored in battery, controlling system connected between the solar penal and battery. There are inverter is required for change energy DC to AC.

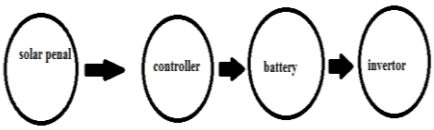

Fig.2 Solar energy conversion system

Capacity of Solar Panel and Battery required

Hence Blower (Fan) Specification: 230v, 50Hz, 35W so to run 35W blower on for 1 hour will take 35 x1=35Wh from the battery (Battery capacity is measured in Amp hours)

For 10Ah, 12v battery the watt hours is given by

$P = V \times I$

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V=12v and I=40Ah

P= 40 x12=480Wh

So, the 35W centrifugal fan runs for

120/35=13.71≈14h

This means the battery could supply 35W blower for 14 hours.

Capacity of the fan required

With the supply of water through the cooling pads.

So, heat transfer between water and the air is given by following equation

$$M_w \times (T_1-T_2) = (V/Vs_1)\,((ha_1-ha_2)-(w_1-w_2)\,T_2) \ldots\ldots\ldots\ldots\ldots \quad (i)$$

Where

M_w – Mass of water entering into the cooling pads per minute

V- Volume of air (m^3) entering into the room per minute

Vs_1- Specific volume of air entering into the cooling room

ha_1 - Enthalpy per kg of dry air at T_1

ha_2 - Enthalpy per kg of dry air at T_2

w_1 - Mass of vapor per kg of dry air at T_1

w_2 - Mass of vapor per kg of dry air at T_2

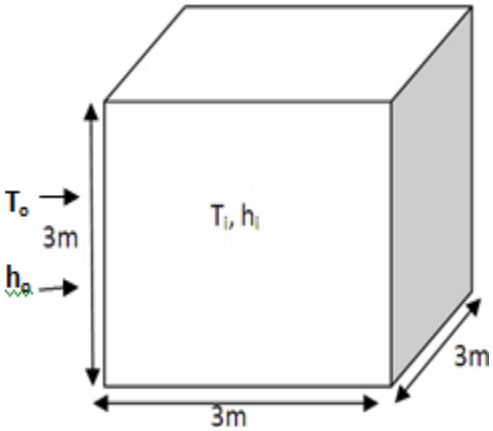

Fig.3 Room considered

Considered conditions,

T1=30°C & T2=25°C

Relative humidity= 60%

M_w=2kg of water per minute (assume)

From: Psychometric chart

ha1 =71.5 KJ/Kg of dry air

= 16.31kcal/kg

ha2 =56 KJ/Kg of dry air

= 13.37 kcal/kg

w1=0.016grams/kg of dry air

w2=0.012 grams/kg of dry air

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$Vs1=0.880m^3/kg$

Substituting above mentioned values in equation (i)

$2X(30-25) = (V/Vs_1)((16.31-13.37)-(0.016-0.012)x25)$

$V=2.26m3/min \approx 2.5m^3/min$

So the fan capacity of $2.5m^3/min$ is selected.

2) Refrigeration system.

- When we start the cooler, cooler will take energy from battery and submersible pump start working and deliver the water through pipes. In solar air cooler many of pipe arrangements is there, one of pipe which is directly connected between lower tank and upper tank of the air cooler and other pipe connected between upper tank and circulated of wall of storage box which make cooling effect of storage box and create a suitable atmosphere inside the storage box for store regular foods item.
- Another pipe is connected between the upper tank of the air cooler and external pot. In external pot also one other pot is situated and make 2- 3cm gap between wall where cool water make circulation of pot and absorb the temperature of inner pot and make desired refrigeration effect and provide cool drinking water.
- Some of whole arrangements are also design for allowing water flow from tank to wood wool pads or khus pad of the air cooler.

Observation table :-

Table-1

Sr. No.	Particulars	Temperature	Energy
1.	Room temperature	35°C	-
2.	Water Temperature in lower tank	35°C	-
3.	Temperature in storage tank	32°C	-
4.	Power generation	-	40 Wh

Table-2 Comparison between normal cooler & solar air cooler

S.No.	Time (in Min.)	Normal cooler (Room Temp. in ° C)	Solar Air Cooler (Room Temp. in ° C)
1.	0	35	35
2.	60	31	31
3.	120	28	27
4.	180	27	27
5.	240	27	27

In observation of 240 minutes there is no change in temperature between conventional cooler solar air cooler.

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Table-3 Comparison between normal cooler & solar air cooler

S No.	Time (in Min.)	Temp. (in ° C) of water in normal Matka	Temperature in modified water pot (in ° C)	Temp. in storage box
1.	0	35	35	35
2.	30	30	30	30
3.	60	29	29	29
4.	90	27	25	24
5.	120	27	25	24
6.	150	27	25	24

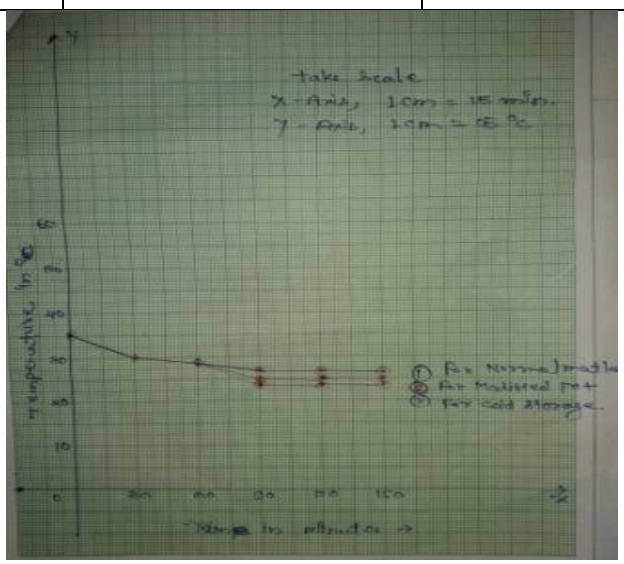

Fig.4 Temperature variation graph

The above graph shows that the temperature variation between normal matka, modified pot and storage box.

III. RESULT AND DISCUSSION

The output of solar air cooler are

1) Cold water for drinking purpose
2) Fall in room temperature
3) No power cut problem
4) Cold Storage system for regular food item

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Table-4 Cost Estimation

S No.	Component	Cost in Rs.
1.	Solar panel set	3000/-
2.	Cooler	2500/-
3.	Internal & external pot	400/-
4.	Pureit water filter	1000/-
5.	Connecting pipes	200/-
6.	Aspen pad	200/-
	Total	7300/-

IV. CONCLUSION

In market the cost of air conditioner is approximately 25000/- or above and cost of refrigerator is about 6000/- which are quite expensive. Electricity consumption of these products is also very high, due to this reason it is not affordable for the middle class families. From the above work we find that the cost of the solar cooler with water cooling and storage system is 7300 /- and its performance is also good with zero electricity consumption. It gives human comfort with water cooling and storage space at cheapest price. It is a multi-functional product which is affordable for everyone. For these reasons it better option for all of us.

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