FABRICATION AND ANALYSIS OF SOLAR AIR COOLER

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ABSTRACT

The predominant source of energy which is obtained from the nature is solar energy. There are many non-conventional sources of energy like Solar, Hydel, Wind, Geothermal, biomass energy and so on. In this paper an attempt has been made to fabricate solar air cooler by extracting energy from sun - which helps to reduce the power consumption. The main reason to choose this solar energy is its availability and cost of the solar panels is less compared to the others. A comparison has been made to identify the variation in the power consumption if it is for an air cooler running with electrical energy and for the solar powered air cooler. To determine the temperature rise by using a solar panel a case study has been carried out for a week, by taking the maximum and minimum temperatures during day light that is from 10 am to 4 pm and the result obtained from the observation is at 1 pm recorded as the maximum temperature, these readings has been compared with the weather reports also.

keywords: Solar panel, battery, solar charge controller, fan, cooling pads.

I.INTRODUCTION

Non-conventional energy is the energy that is collected from renewable resources which are naturally replenished on a human time scale, such as sunlight, wind, rain, tides etc. There are many non-conventional energy sources like solar energy, wind energy, biomass tidal energy etc. Renewable energy often provides energy in three important areas. They are electricity generation, air and water heating or cooling, transportation. Based on a report renewable contributed 19.2% to humans global energy consumption. Rapid deployment of renewable energy is resulting in significant energy security, climate change mitigation and economic benefits. Usage of this energy also reduces greenhouse gases emissions. At least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply. Out of all the renewable resources solar energy is widely available so, it is mostly used. Out of all the non-conventional energy sources solar energy is predominantly used since the availability is more and using of this solar energy is also more economic than others.

II. FABRICATED MODEL OF SOLAR AIR COOLER AND ITS ASSEMBLY

2.1 SOLAR PANEL:

It is composed of 36 mono crystalline silicon solar cells of similar performance. They are interconnected in series to obtain 12volt output. It is laminated by a 3mm tempered glass which protects against moisture penetrating into the module. The cells are embedded in a sheet.

2.2 CHARGE CONTROLLER:

A charge controller is basically a voltage regulator to keep batteries from overcharging. There is no requirement for a charge controller with small maintenance of 1 to 5 watt panels, but for higher capacity panels the charge controller is required.

2.3 BATTERY:

A battery is electrochemical cell, which store chemical energy and make available as electric current. Two types of batteries were used, primary and secondary types. Primary batteries can only be used once because they use up their chemicals in an irreversible reaction. Secondary batteries can be recharged because the chemical reactions they use are reversible. They are recharged by running a charging current through the battery but in opposite direction of the discharge current. They can be charged and discharged as many times as possible before wearing out. After wearing out some batteries can be recycled.

2.4 FAN:

A fan is a machine used to create flow within a fluid. A fan consists of rotating arrangement of vanes or blades which act on the fluid. The rotating assembly of blades and hub is known as an impeller, a rotor or a runner, contained in the form of housing or case. This may direct the airflow or increase safety by preventing objects from contacting the fan blades.

2.5 DC PUMP:

A pump is a device used to move gases, liquids or slurries. A pump moves liquids or gases from low pressure to high pressure. Pumps work by using mechanical forces to push the material either by physically lifting or by the force of compression. A positive displacement pump causes a liquid or a gas to move by trapping a fixed amount of fluid or gas and then forcing that trapped volume into discharge pipe. They are relatively less inexpensive and are extensively for pumping water out of bunds, or pumping low volumes of reactants out of storage drums.

2.6 GALVANIZED IRON BODY:

Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered. Sheet metal is available in flat pieces or coiled strips. There are many different metals that can be made into sheet metal, such as aluminum, brass, copper, steel, tin, nickel and titanium. Sheet metal is used in automobile and truck bodies, airplane fuselages and wings, medical tables, roofs for buildings and many other applications. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines. Galvanized iron and steel's resistance to corrosion depends largely on the type and thickness of the protective zinc coating and the type of corrosive environment.

2.7 FINAL ASSEMBLY:

The body of the air cooler is made up of GI sheet with a thickness of about 1.2 mm. Fan and cooling pads are fitted to the body. A pump is used to supply water to the cooling pads. Separate switches are used for the fan and pump. All these units together forms the body. Solar panel is placed in such a way that sunlight directly falls on it. Charge controller has 3 pairs of terminals both positive and negative. One is for solar panel, second is for battery and the last is for the load. The terminals of the solar panel are connected to the terminals given for the solar panel on the charge controller. The terminals for batter on the charge controller are connected to the battery. Before starting the cooler pump is started first which makes the pads wet. Then the fan is started and due to wet pads cool air is received from the fan. Hence, it is called as water cooler. The figure 1.1 below shows the assembly of the solar air cooler.

Fig 1.1 FABRICATION ASSEMBLY OF SOLAR AIR COOLER

III.PERFORMANCE ANALYSIS OF SOLAR AIR COOLER:

The solar air cooler as discussed in the above chapters is reviewed and the main purpose of this paper is mainly to reduce the power consumption by using the solar panels. Since the analysis required to determine the cooling effect produced from the solar air cooler. Based on the theoretical and practical observations performance analysis and a case study have been conducted to check the temperature rise of solar energy which helps to determine the maximum and minimum temperature. The theoretical and practical observations, formulations required to determine the cooling effect followed by the graphs is presented below.

3.1 THEORITICAL CALCULATIONS:

1. The capacity of the battery used is 12volt, 7.2ah has been used in the paper. With this battery, the running capacity of the fan which is observed.

$\boldsymbol{Power} = \boldsymbol{Voltage} \times \boldsymbol{Current}$

Power = 12 x 7.2 = 86.4 watt hours

2. The capacity of the D.C fan used is 12 volts 21 watts. The battery backup with the fan is observed.

Battery backup $= \boldsymbol{Capacity\ of\ battery\ capacity\ of\ fan}$ 86.4/21= 4.11hours by using the battery Hence the battery supplies power for 4.11 hours.

3. To charge the 86.4 watt hour battery, a 12volt 20watts solar panel is used. The time required for charging the battery can be found in the following manner Battery=7.2ah Solar panel 12volt 20watts.

1.66 amps of current will be obtained from the solar panel and the battery capacity is 7.2 ah. So, 7.2 ah, 1.66a = 4.33 hours.

3.2 PRACTICAL OBSERVATIONS RECORDED WHILE RUNNING THE SOLAR AIR COOLER:

When checked practically, some loss of energy has been observed. According to the first law of thermodynamics, energy neither be converted nor destroyed, energy given to a system cannot be converted completely into work. In the same way due to some losses almost 40% of the energy coming from the battery is lost. As per theoretical calculations it is observed that the fan should run for 4 hours. But practically it is observed that the fan worked for only 2 hours 30 minutes. It is observed that almost 40% of energy is lost. The time taken to charge the battery is about 4 hours, to recharge the battery fully by the solar panel. At peak temperatures 42℃, it took half an hour less than the normal 30℃ to recharge the battery. To prevent over charging of the battery a charge controller is used.

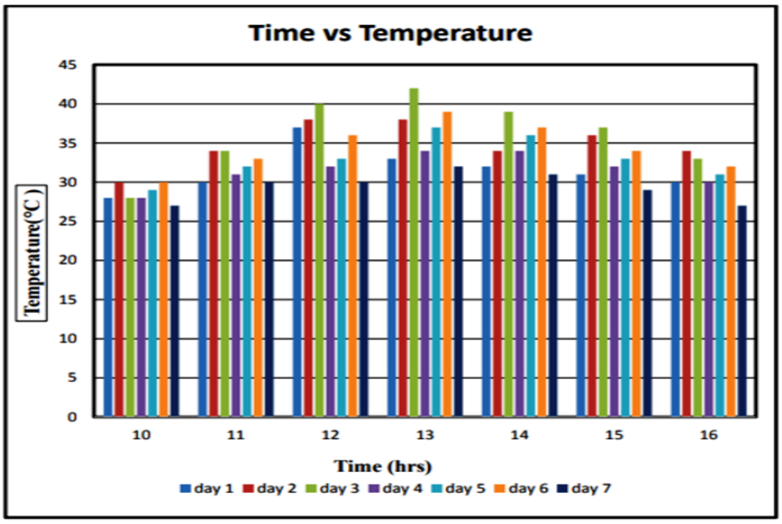
3.3 CASE STUDY:

The main aim to conduct the case study is to determine the maximum and minimum temperatures received from the sun energy in a day around 10 am to 4 pm and select suitable time for charging the battery. The temperature readings from the weather forecast also taken to compare practical temperature readings. As the paper is based entirely on solar energy, it is important to consider the maximum and minimum temperatures obtained from the sun during the day time. It is observed that during day time the peak temperature is attained around 13 hrs.which is considered as the maximum temperature where the solar panel gets more energy which gives more output from the panel.

Time (hrs.)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day7
10	28	30	28	28	29	30	27
11	30	34	34	31	32	33	30
12	37	38	40	32	33	36	30
13	33	38	42	34	37	39	32
14	32	34	39	34	36	37	31
15	31	36	37	32	33	34	29
16	30	34	33	30	31	32	27

TABLE 1.1 TIME (hrs.)-TEMPERATURE (℃)

THE TEMPERATURES OBTAINED DURING THAT ONE WEEK IS REPRESENTED IN A GRAPH AS FOLLOWS:



GRAPH 1.1 TIME (days) Vs TEMPERATURE (℃)

From the above graph 1.1, it is observed that almost every day maximum temperature was recorded from 12 hrs. to 13 hrs. A maximum of 42°C was attained on day 3 at 1pm. Minimum of 27°C was attained on the seventh day at 16hrs. Everyday temperature gradually increased from 10am to 1pm and then decreased from1 to

16hrs. The main objective in performing this case study is to know the variations in temperature during a day and to select a suitable time charging the battery.

3.4 DETERMINATION OF COOLING EFFECT FOR SOLAR AIR COOLER

In order to determine the cooling effect attained by the cooler, it is important to know the inlet and outlet air temperatures of the cooler. Heat capacity and mass flow rate value of air is important in finding the cooling effect. The mass flow rate for a volume of 0.04356 m^3 is taken as 0.0023 kg/s. In the same way mass flow rate of a volume of 0.175 m^3 will be 0.0092 kg/s. The standard value of heat capacity of air at constant pressure is 1005 J/kg. K. The cooling effect is calculated by using the values in the following table 1.2.

Table 1.2 Determination of Cooling Effect

Cooling water temperature (°C)	Voltage(Volts)	Current (Amps)	Inlet temperature(°C) ambient temperature	Outlet temperature (°C) cool air temperature	Cooling effect (W)	Coefficient of performance
25° C	18	0.7	31.2	29.6	14.78	1.173
20° C	18	0.7	30.2	26.8	31.4	2.49

The cooling effect can be calculated by using the formula = m x C x ΔT

Where m = mass flow rate

C = Specific heat capacity value

Cooling effect= [0.0092 x 1005 x (31.2-29.6)] = 14.78 watts (water at 25°C)

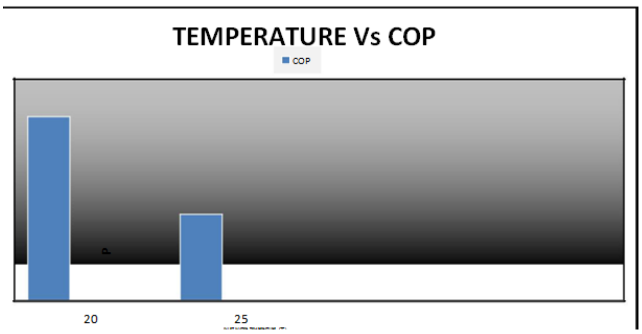
Cooling effect= [0.0092 x 1005 x (30.2-26.8)] = 31.4 watts (water at 20°C)

Coefficient of performance,

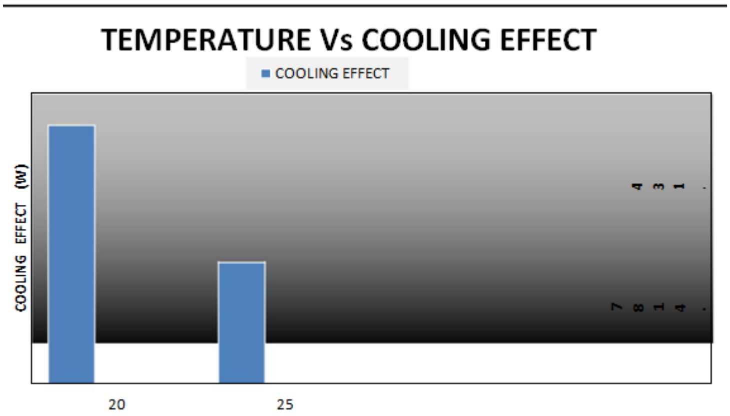
COP = 14.78 / 12.6 = 1.173 (water at 25°C)

COP = 31.4 / 12.6 = 2.49 (water at 20°C)

It is observed that cooling effect and COP are doubled when the water temperature is decreased by 5 °C.



GRAPH 1.2 TEMPERATURE (℃) Vs COP



GRAPH 1.3 TEMPERATURE (℃) Vs COOLING EFFECT

IV CONCLUSION:

There are many nonconventional sources which are available in the nature, among these solar energy is highlighted in this paper since of its abundant availability and its ability to reduce the pollution, and electric consumption. This paper concludes that by using the solar energy, there is a possibility to save energy by reducing the electricity consumption, cost, and by using the solar flat plate collectors cooling effect can be produced. From the review of the work, the solar air cooler can be installed in the rural areas as well as urban areas where the electric consumption is high. After conducting the experimental analysis, it is proved that the cooling effect produced at water temperature is 14.78 watts, and 31.4 watts. The experimental analysis highlights that there is a variation in water temperature is observed that is if the temperature reduces, the cooling effect and the coefficient of performance are doubled respectively which proves that a good cooling effect can be produced if the temperature of cooling water is reduced. Hence from it is concluded that the Solar Air Cooler is one of the most important equipment to produce the cooling effect which helps to reduce the electric charges, and also the annual cost of the unit. Although the initial cost of the Solar Air Cooler is higher, still there is a need to use this cooler for sustainable energy and to reduce the demand of the electricity.

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