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NEUST AC-DC SOLAR-POWERED PERSONALIZED AIR COOLER

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ABSTRACT

The improvised AC-DC solar-powered personalized air-cooler was constructed out of locally, less cost, locally available materials to provide comfortable temperature at home or anywhere at any time of the day utilizing solar power as energy source.

The study underwent the following stages: (1) selection and description of the materials used in constructing the project air-cooler; (2) design of the ac-dc solar-powered personalized air-cooler; (3) procedure on the construction of the personalized air cooler; and (4) testing the efficiency of the personalized air cooler.

The improvised AC-DC solar-powered personalized air cooler was tested and found effective, easy to operate, environment friendly, and less expensive personalized air cooler which can be driven efficiently either by AC-DC power adaptor or by Solar Powered Battery; and that if one needs longer period for cooler temperature, greater mass of ice is needed while to produce a more comfortable condition, smaller size of room will suit the need. The battery was fully charged within 8 hours by the 10 watts solar panel and can run the 12V fan for 5 to 6 hours based from the activities done. The cost of putting up a personalized air cooler was found to be Php. 440.00 while the energy of the mighty sun can be harnessed through the solar panel board.

Keywords: ***air cooler, AC-DC adaptor, solar charge controller, solar cells, solar panel.***

INTRODUCTION

As day time temperature is starting to become more and more unbearable, as fans would only constantly stir the hot sticky air around, and as the expenses to finance an expensive air conditioning unit coupled with the cost of electricity to run the unit which is escalating every now and then, it is instinct to find ways and means on how an individual could find comfort at a less cost, easier, and energy saving manners. [1]

Basically, the Philippines as a tropical country have two major climatic conditions or seasons – wet and dry. During wet season, rains pour downright, sometimes hard and other times fair, yet during these instances especially in the city, room temperature is still quite high making children and adult sweat profusely. So much more can be observed during dry season when there is absence of rain and when temperature in and out of the house is highly alarming. For instance, last summer in Cabanatuan City, according to television and radio announcements, the average temperature was found to be fifty two degrees Celsius (52 ºC). Such temperature would not only makes people sweat unsteadily, but would put in danger the health condition of the young, adults and sickly individuals. More so, the adults were prone in experiencing heat stroke, heart attack, and other similar health problems. To solve this problem, the temperature in a confined place has to be cooled down to provide comfort and the device to suit the need is called air cooler.

Air cooler is a device for cooling and controlling the humidity of the air circulating in a confined space. Traditionally, air cooler is powered by electricity from an alternating current. But at today's technology, air cooler can be powered utilizing electricity from solar energy source. A solar powered air cooler makes use of concentrated solar thermal energy to power a thermally driven cooling process.

A research on the development of the evaporative cooling air conditioning standard of utilizing renewable energy dry air cooling was a project of ICBBE in 2010. [2] According to the article, through introducing the foreign countries' evaporative cooling air conditioning standards of utilizing renewable energy dry air cooling, combining with the practical standard application in China, the paper analyzed the developed idea of evaporative cooling air conditioning standard by utilizing renewable energy dry air cooling. The research shows that China is as soon as possible the one currently to develop standards for evaporative cooling air conditioner in which the air conditioner energy consumption accounts for 8.1% - 13.5% of total energy consumption, but through the use of evaporative cooling air conditioning standard of utilizing renewable energy dry air cooling promoted evaporative cooling air conditioning technology which will be able to make the air conditioning energy consumption reduced by 30%-50% or more in China. Moreover, the article said that the use of this technology will play an important role in China's severe energy situation. [2]

CSIRO scientists are developing new technologies which use the natural heat from the sun (solar thermal energy) to provide space cooling, or heating, for buildings, homes and offices, to help reduce greenhouse gas emissions from air conditioning. [3]A solar cooling system according to the research was consists of: (1) solar

thermal collectors which capture the heat from the sun; (2) absorption cooling machine to convert heat to cooling. Depending on the application, this could be an absorption chiller, an adsorption chiller or a desiccant cooler.

There were lots of air coolers in the market. There were manually operated and there were electronically and electrically operated ones. The simplest air cooler was called “abaniko fan” but very arm tiring to use and cannot serve the purpose when the user is sleeping. Electrically and electronically operated air coolers were of various forms, capacity, sizes, and brands. The simplest one called “electric fan” cost less than a thousand peso but would only make the air around feel sticky and warm especially at enclosed room. There were of course very expensive air coolers if one would want a real comfort especially while sleeping, such as those air conditioning (air-con) units of various forms and capacity depending on the size of the area to be cooled. Using these air-con units would really make the room or house comfortable in terms of temperature but that would cost high electric bill aside from its high acquisition cost. Great majority of Filipinos could only afford “abaniko” and “electric fan” but not air-con units simply because of its acquisition price and operational expenses.

This is the dilemma which this project tried to deal with and that is providing simple households an easy to construct, simple to operate, less expensive and environment friendly AC-DC solar powered personalized air cooler.

OBJECTIVES OF THE STUDY

The main objective of this project is to come up with an **AC-DC solar-powered personalized air-cooler** out of locally, readily available, less cost materials and environment friendly which can be used to provide comfortable temperature at home or anywhere at any time of the day utilizing solar power as energy source.

Specifically, this study intended to construct a user friendly working design for an AC-DC **solar-powered personalized air cooler** that is safe, efficient, and at very minimal acquisition cost and operational expenses.

METHOD AND PROCEDURE

Research Method

Experimental method of research through improvisation was utilized. Through experimentation, the researchers had the chance making observations, performed accurate measurement, gathered data, tabulated and analyzed important data for the success of the research.

More specifically, the study underwent four stages:

1. Selection and description of the materials used in constructing the ac-dc solar-powered personalized air-cooler
2. Design of the ac-dc solar-powered personalized air-cooler
3. Procedure on the construction of the ac-dc solar-powered personalized air cooler
4. Testing the efficiency of the ac-dc solar-powered personalized air cooler

A. Selection and Description of the Materials Used in Constructing the AC-DC Solar-Powered Personalized Air Cooler

The table below shows the quantities and descriptions of the materials used in constructing the solar-powered personalized air cooler.

Table 1: Quantity, Description and Uses of Materials Needed in Constructing the AC-DC Solar-powered Personalized Air Cooler

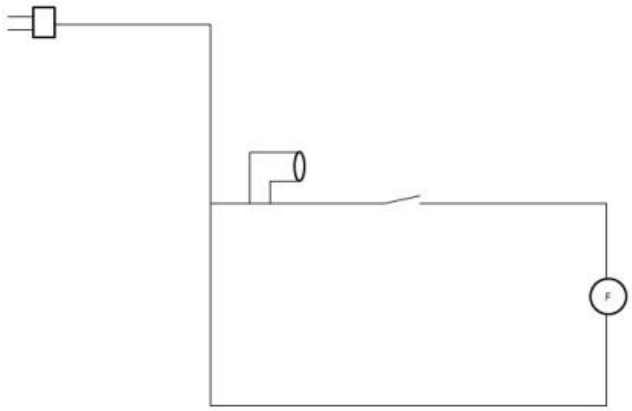
Materials	Description	Quantity	Uses
DC brushless fan	Measures 4"x4", makes used of 12V power supply	1piece	Used to ventilate the temperature of the ice
PVC pipe	Elbow type measures 3" in diameter	1 piece	Used as outward air passage
Digital thermometer	Thermometer with digital meter powered by 1.5V battery	1 piece	Used for monitoring the temperature of the room
Solar Panel	10W, 12V	1 piece	Used to charge the 12V battery within 8 to 10 hours
Solar Charge	A controller with light	1 piece	Used to control the

Controller	operated timer mode, load time and displays		solar charging of the battery
Wires	Gage 22	10 m	Used for all the electrical connections needed
Rechargeable Battery	12V, Lead-Acid Battery, 1.2Ah (Ampere henry)	1 piece	Storage of electricity charged by the solar panel
Power Adaptor	1000 mA, multi voltage which converts 220V input to 12V output	I piece	Used as DC power source
Styrofoam ice Box	Measures	1 piece	Used as air-cooler box
Power Switch	See-saw type	1 piece	Used for turning on and off of the device.
Ice	Contained in reusable bottles or plastics	In kilogram	Used as source of cooled air

B. Design of the AC-DC Solar-Powered Air Cooler

Below are the suggested designs of the AC-DC Solar-powered Personalized Air Cooler as product of the researchers' extensive research activities and experimentation.

Figure 1: Schematic Diagram of the AC-DC Powered Personalized Air Cooler



As shown on Figure 1, a very simple diagram can lead an individual in constructing a personalized air cooler unit powered by AC-DC adaptor. That is, one would only need a switch, a 12V fan, and a 1000mA adaptor which can easily be bought from an electronics store

Figure 2: Schematic Diagram of the solar Powered Personalized Air Cooler

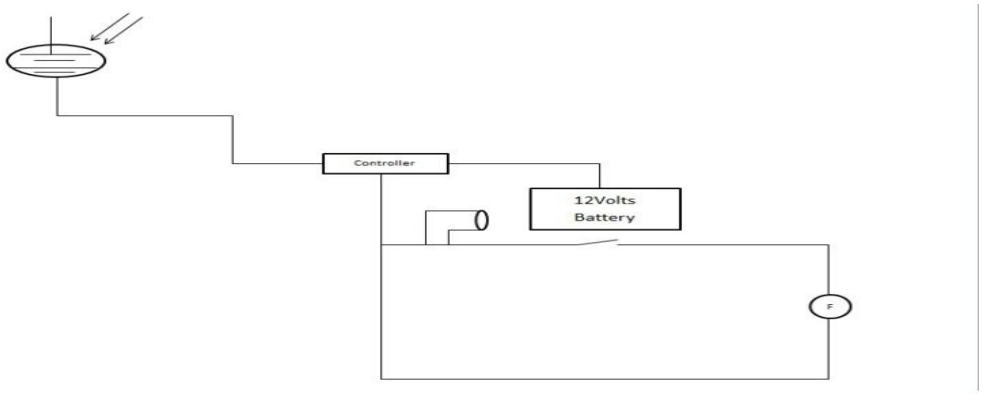


Figure 2 shows the suggested connections where the improvised air cooler, the battery charged by the solar panel met and wired to solar charge controller. The switch shall control the entry of electricity that will drive the fan.

C. Procedure in the Construction of the AC-DC Solar-Powered Personalized Air Cooler

Step 1. Identify the materials to be used. Be familiar with the uses of each of the materials.
Step 2 Mark the Styrofoam according to the size of the brushless fan, switch on and off and elbow PVC pipe.
Step 3. Carefully cut the Styrofoam to fit all the parts that need mounting.
Step 4. Install the brushless fan, switch, the elbow PVC pipe and all wiring connection for 12V adaptor and solar powered connections following the schematic diagrams shown above.

D. Testing the efficiency of the Solar-Powered Personalized Air Cooler

The constructed improvised air cooler was tested utilizing the AC-DC power adaptor and a rechargeable battery charged by solar panel. The testing of the efficiency of the AC-DC solar-powered personalized air cooler was done considering the following variables such as mass of ice, size of the room to be cooled, room temperature, melting time of ice, and **stored electricity in a rechargeable 12V battery**. The testing was done in three consecutive days at around 11:00 o'clock in the morning of each day.
Step 8. Put the desired amount of ice on the Styrofoam ice box.
Step 9. Test the set up utilizing AC-DC adaptor and later on solar power source.
Step 10. Record all data gathered during the testing process.

RESULTS AND DISCUSSION

1. Design of the AC-DC Solar Powered Personalized Air Cooler

The figure below shows the working design of the improvised AC-DC and solar powered personalized air cooler.

Figure 3: Working Design for AC-DC Solar Powered Personalized Air Cooler

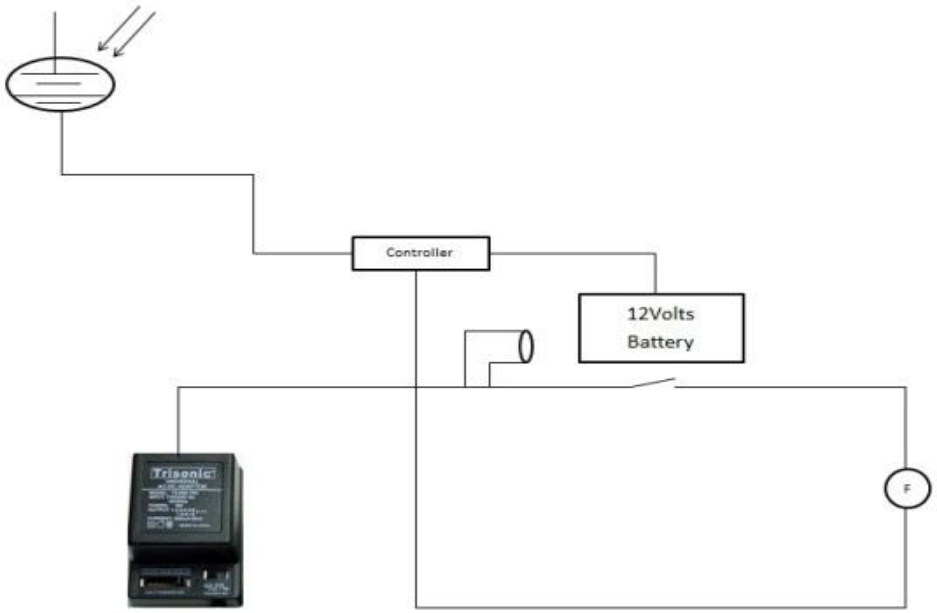
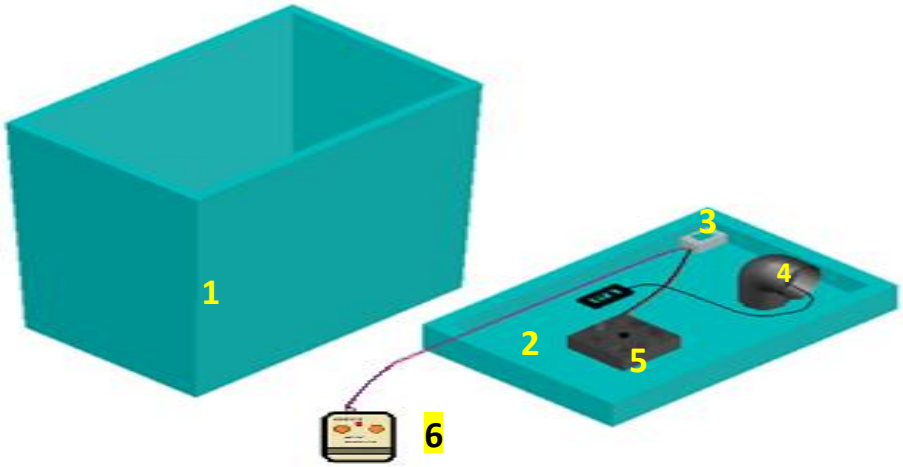


Figure 3 shows the schematic diagram on how to avail the vast energy from the sun. The solar panel and all the implanted solar cells collected the renewable heat energy from the sun, and charged a 12V rechargeable battery. The charging process is controlled by a solar charge controller. The controller stopped the charging as soon as the battery is fully charged. The diagram also shows that once the switch is closed, the 12v fan would rotate. The user has two choices to run the improvised air cooler: AC-DC adaptor and solar power.

The succeeding figures showed the perspective designs of the personalized air cooler. Figure 4 shown below is the perspective view of the ice container with the pvc pipe, switch and fan mounted on the container made of Styrofoam and connected with the AC-DC power adaptor.

Figure 4: The AC-DC Powered Personalized Air Cooler

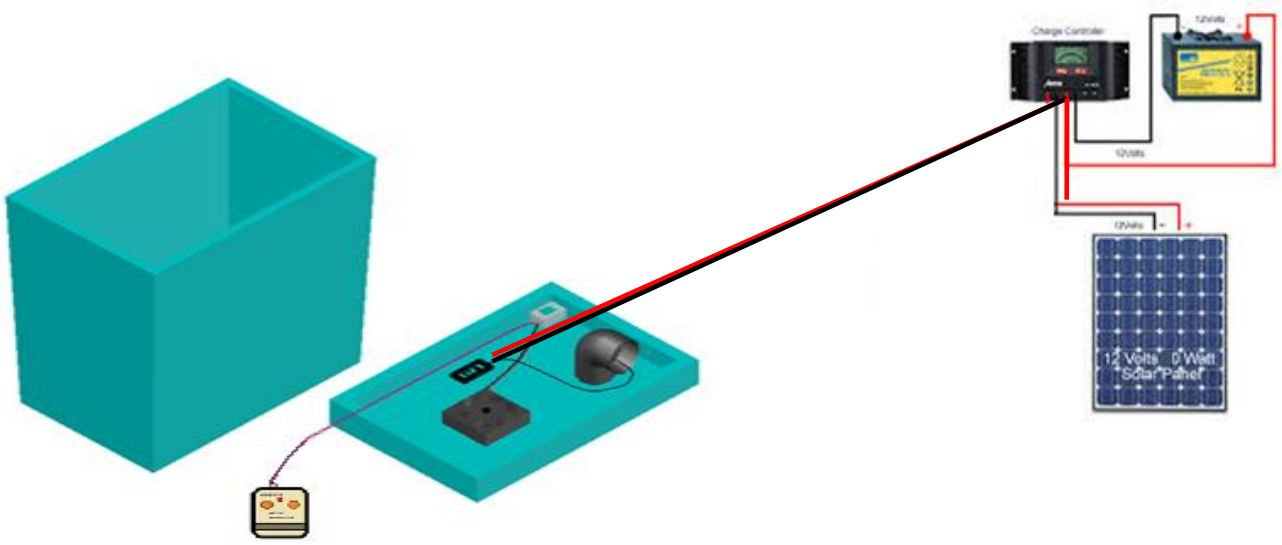


On Figure 4, marked as (1) was the Styrofoam box, (2) Styrofoam cover, (3) switch, (4) pvc pipe, (5) 12V fan, and (6) 1000mA adaptor.

Figure 5 shows the perspective view of the Solar-Powered Personalized Air Cooler wherein, the first set-up shown on Figure 4 was connected with the 12V rechargeable battery, a solar controller and the solar panel board instead of the AC-DC adaptor.

Figure 5 shows the perspective view of the Solar-Powered Personalized Air Cooler wherein, the first set-up shown on Figure 4 was connected with the 12V rechargeable battery, a solar controller and the solar panel board instead of the AC-DC adaptor.

Figure 5: The AC-DC Solar-Powered Personalized Air Cooler



2. Efficiency of the NEUST AC-DC Solar Powered Personalized Air Cooler in terms of Amount of Ice, Time, Temperature, and Room Measurement

The testing of the efficiency of the set up was done utilizing AC-DC adaptor and the solar powered sources. A digital room thermometer was secured to note the initial room temperature and to monitor the room temperature while the improvised air cooler cools a room as the venue for the activity.

In using the AC-DC adaptor as source of power for the improvised air cooler, the researchers simply plugged the adaptor to an AC source while in using the solar powered air cooler, the rechargeable battery was charged up to 8 hours the previous day using the solar panel and brought inside the room. It is important to note that direct connection following Figure 3 can also be done.

Table 2.1: Efficiency in terms of Melting Time of Ice, Temperature Reach at Constant Room Measurement and Mass of Ice (2m x 4m x 2.5m room measurement and 5kg ice)

Trial No.	220V Input-12V Output Power Source		Solar Panel Power Source	
	Melting Time of Ice	Measured Temperature	Melting Time of Ice	Measured Temperature
1	2 hours and 45 minutes	21.4°C	2 hours and 42 minutes	21.1°C
2	2 hours and 38 minutes	22.4°C	2 hours and 52 minutes	21.8°C
3	2 hours and 50 minutes	20.3°C	2 hours and 49 minutes	21.2°C
Ave.	**2 hours and 44 minutes**	**21.37°C**	**2 hours and 47 minutes**	**21.36°C**

Table 2.1 showed the results of the testing done. At constant room measurement of 2m x 4m x 2.5m and 5 kilogram mass of ice, the average melting time of the 5 kilogram ice was 2 hours and 44 minutes producing an average temperature of 21.37°C using AC-DC adaptor power source. On the other hand, using the solar powered air cooler, the average melting time of the 5kilogram ice was found at 2 hours and 47 minutes with an average temperature of 21.36°C. The testing was done starting at 11AM when the noted average room temperature was 26.8°C.

It can be deduced from these data that a 5 kilogram mass of ice can cool down a room which measures 2m x 4m x 2.5m at an average of 21.36°C from its initial room temperature of 26.8°C. Furthermore, the improvised air cooler performed similarly efficient utilizing AC-DC power adaptor and solar power as power sources.

Table 2.2: Efficiency in terms of Mass of Ice, Melting Time, and Measured Temperature at Constant Room Measurement (2m x 4m x 2.5m room measurement)

Trial No.	220V Input-12V Output Power Source			Solar Panel Power Source		
	Amount of Ice (in kg)	Melting Time of Ice	Measured Temperature	Amount of Ice (in kg)	Melting Time of Ice	Measured temperature
1	5	2 hours and 45 minutes	21.4°C	5	2 hours and 42 minutes	21.1°C
2	8	4 hours and 24 minutes	21.7°C	8	4 hours and 32 minutes	21.2°C
3	10	5 hours and 30 minutes	21.2°C	10	5 hours and 35 minutes	20.9°C

At constant room measurement of 2m x 4m x 2.5m but at varying amount of ice, the melting time of ice and the resulting room temperature were noted. Results showed that when the improvised air cooler was driven by AC-DC adaptor, the 5 kg ice was melted within 2 hours and 45 minutes cooling down the room from 27.1°C to 21.4°C while the solar powered air cooler took 2 hours and 42 minutes to melt the same mass of ice and cooled down the temperature to 21.1°C. The 8kg mass of ice was melted in 4 hours and 24 minutes and cooled the room at 21.7°C while the solar powered air cooler melted the 8 kg mass of ice within 4 hours and 32 minutes cooling down the room to 21.2°C. Lastly, a 10 kg mass of ice was set for trial and results showed that the AC-DC powered air cooler melted the mass within 5 hours and 30 minutes and cooled down the room from 27.5°C to 21.2°C. When the solar powered air cooler was used, the 10 kg mass of ice melted within 5 hours and 35 minutes reducing the room temperature from 27.3°C to 20.9°C.

It can be deduced from the data that at constant room size and either using AC-DC powered air cooler or Solar powered air cooler, the greater the mass of ice as source of cooled air the longer the melting time, therefore the longer the period when the room temperature is cooler. Consequently, the more comfortable for the occupant to enjoy.

Table 2.3: Efficiency in terms of Room Measurement, Melting Time, and Measured Temperature at Constant Amount of Ice (5 kg)

Trial No.	220V Input-12V Output Power Source			Solar Panel Power Source		
	Room Measurement	Melting Time of Ice	Measured Temperature	Room Measurement	Melting Time of Ice	Measured temperature
1	2m x 4m x 2.5m	2 hours and 45 minutes	21.4°C	2m x 4m x 2.5m	2 hours and 42 minutes	21.1°C
2	2m x 2.5m x 2.5m	2 hours and 42 minutes	19.5°C	2m x 2.5m x 2.5m	2 hours and 39 minutes	19.3°C

At constant mass of ice of 5 kg., the efficiency of the improvised air cooler was tested at two different room sizes and the results are shown under Table 2.3.

It can be deduced that the smaller the size of the room, the cooler it can be. It is also important to note that the temperature of the air at the mouth of the pvc pipe ranges from 16.2 to 17.4°C. The temperature gets higher as the cooled air leaves the pipe and spread throughout the room.

Efficiency of the Battery Charged by the Solar Panel. The battery was fully charged within 8 hours by the 10 watts solar panel and this was used unconnected with the solar panel due to the inconvenience and distance of the location where the solar panel was posted. A full charged battery of this kind can run the 12V fan for 5 to 6 hours based from the activities done.

3. Cost of the Improvised AC-DC Solar Powered Personalized Air Cooler

The cost of putting up a personalized air cooler powered by an AC-DC adaptor was found to be Php. 440.00. For an amount of Php. 10.00 cost of a 5kg ice, a 2 hours and 45 minutes sleeping time in a room with only 21.4°C temperature is surely a kind of comfort one can enjoy. It is more important to note that the improvised AC-DC personalized air cooler can be used repeatedly for as long as an alternating current is available. The cost of operation is very, very minimal compared to commercially available air cooler units.

In case that there is absence of AC supply to power the adaptor, the energy of the mighty sun can be harnessed through the solar panel board but one would need a total of Php. 2,285.00. The cost got high because of the costly solar panel board, solar charge controller and rechargeable battery but said cost can be compensated

since the service of the improvised solar powered air cooler can be availed anytime and anywhere since the charging of the battery can be done as long as there is the heat from the sun without any operational expenses. In the long run, the cost is still friendly.

Table 3 shows the amount needed in constructing an AC-DC Solar Powered Personalized Air Cooler

Table 3.1: Cost of the Improvised AC-DC Solar Powered Personalized Air

Materials	Quantity	Cost
Styrofoam	1 piece	Php. 220.00
PVC pipe	1 piece	25.00
DC brushless fan	1 piece	45.00
Wires		5.00
AC-DC power adaptor	1 piece	120.00
Ice	In packs	10.00
Switch	1 piece	15.00
Total cost for AC-DC Air Cooler		**440.00**
Solar Panel	1 piece	500.00
Solar charger controller	1 piece	950.00
Rechargeable battery	1 piece	480.00
Connecting wires	10m	35.00
Solar-Powered Air Cooler		**1,965.00**
Total cost of AC-DC Solar Powered Personalized Air Cooler		**Php. 2,285.00**

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. That it is possible to construct a simple, easy to operate, environment friendly, and less expensive personalized air cooler utilizing commonly available materials;
2. That the improvised AC-DC Solar Powered Personalized Air Cooler can be driven either by AC-DC power adaptor or by Solar Powered Battery;
3. That the performance efficiency of the improvised Personalized Air Cooler powered either by AC-DC adaptor or the solar powered battery has no significant difference in producing and maintaining cooled air.

4. That if one needs longer period for cooler temperature, greater mass of ice is needed while to produce a more comfortable condition, smaller size of room will suit the need.

Recommendations

1. The improvised AC-DC Solar Powered Personalized Air Cooler was powered by a 1000mA AC-DC power adaptor. This ampere capacity of the adaptor can be increased in order for the fan to rotate faster. Faster fan rotation will lower the temperature of cooled air to be produced.
2. The size of the container box can be increased to accommodate more pieces or higher mass of ice for longer period of producing cooled air.
3. In case that the size of the container box will be increased, another fan can be installed. This is expected to hasten the production of cooled air from the ice.

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