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DESIGN AND THERMAL ANALYSIS OF PORTABLE SOLAR ELECTRIC AIR COOLER

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Abstract: *Air Cooling is the process of removing heat from a substance under controlled conditions. Air Cooler is a reversed heat engine or a heat pump which pumps heat from a cold body and delivers it to a hot body. The substance which works in a heat pump to extract from a cold body and to deliver it to a hot body is called refrigerant. Air Cooling is an accomplished by various methods, such as the vapor compression system, absorption system, and steam jet Air Cooling cycle the vapor compression system of Air Cooling cycle. Thermoelectric couples are solid-state devices capable of generating electrical power from a temperature gradient, known as the* Seebeck effect*, or converting electrical energy into a temperature gradient, known as the* Peltier effect*. To assist the thermal designer in modeling thermoelectric coolers or peltier modules, standard Bismuth Telluride coolers or modules manufactured from alternative semiconductor materials. This module of portable solar electric air cooler is being designed by the modeling software like Catia V5 and thermal analysis is done using Ansys Workbench; the family of TEC routines provides the designer the ability to model single stage or multi-stage coolers, and calculate valuable sizing information regarding cooler performance. Solar electricity is the technology of converting sunlight directly in to electricity. It is based on photo-voltaic or solar modules, which are very reliable and do not require any fuel or servicing. Solar electric systems are suitable for plenty of sun and are ideal when there is no main electricity.*

I- NTRODUCTION

"Faster, mightier & smaller" is still the keyword for every invention and development. In day-to-day world we concentrate on the compactness and efficiency of every product. Keeping this in our thought we have designed an economical and reliable unit known as "Solar Air Cooler".

"Human comfort is that condition of mind, which expresses itself with the thermal environment". In our project two rival properties of cool water and cool air are obtained. This system can be used continuously. By using our system there is no need of going for a separate Air Cooler.

Description of the Project

The field of mechanical engineering has a theme word called "CHANGE" as its backbone. The new technological advancements and the needs of people have made us think about this project. Our project is maiden venture into the field of air temperature controlling and also deals with human comfort.

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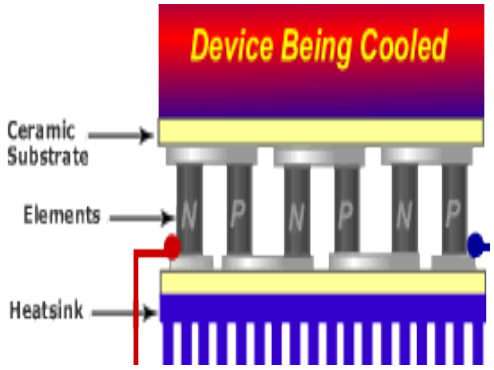

Fig: Cooling process by ceramic substance

Thermoelectric couples are solid-state devices capable of generating electrical power from a temperature gradient, known as the *Seebeck effect*, or converting electrical energy into a temperature gradient, known as the *Peltier effect*.

A typical thermoelectric module is composed of two ceramic substrates that serve as a housing and electrical insulation for P-type and N-type (typically Bismuth Telluride) elements between the substrates. Heat is absorbed at the cold junction by electrons as they pass from a low energy level in the p-type element, to a higher energy level in the n-type element.

Our objective is to design and analyze a system normally **"Solar Air Cooler".** This solar power is used to run the compressor in this system.

II - REVIEW OF LITERATURE

A review on modelling and performance evaluation of solar photovoltaic powered refrigeration system; In the present paper, an attempt has been made to review the performance of various solar powered refrigeration system. The refrigeration is closely related to the demand for cooling commodities. Solar refrigeration is the best alternatives to address this issue and it may be accomplished by using one of the refrigeration system like vapour compression system, thermo electric refrigeration. The simulation model of photovoltaic thermal hybrid system has been created by using TRANSYS and the performance of 1.44kW photovoltaic thermal hybrid system has been evaluated. The results of solar PV has been improved by using plane mirror which was inexpensive and cost effective. The average performance indicator of SPV powered refrigerator i.e. COP varies from 2.02 to 2.41 and maximum value obtained by using Nano refrigerant. Majority of the studies carried out on 40L to 50L direct cool refrigerator.

Experimental Analysis of Solar Operated Thermo-Electric Heating and Cooling System; The main objective of our project is to design & make analysis of a Heating & Cooling system which utilizes non-conventional energy source (i.e. Solar Energy) with the help of Thermoelectric Module which works on the principle of the Peltier effect. This will be a suitable & affordable system for the people living in remote part of India where load-shading is a

major problem. The major difference between the existing system & our system is that, our project works without use of mechanical device & without refrigerant too. As the module is compact in size one can design (i.e. shape, capacity) the system according to his requirement. In this paper an attempt has been made to conduct an experimental study on small scale solar operated thermoelectric Heating & Cooling system.

& Analysis of Solar Air Cooler cum Heater; The natural increase or decrease in the temperature of the surroundings makes human uncomfortable. So for human comfort the invention of air-conditioner, cooler, heater took place. The present cooling and heating methods require large amount of electricity, which results in excess depletion of Non–renewable resources. Depending completely on electric source for cooling and heating effect is risky as there might be a power short circuit which would in return lead to damage of the device. But completely stopping the use of cooling or heating devices is not feasible. The room occupants also add heat to room since normal body temperature is much higher than Room temperature. So there's need to use such a source which is abundantly available in nature (here solar energy). Solar energy is never ending source as long as there's sun in nature. The effective use of same device for cooling as well as heating is done. This project reviews the solar powered cooler cum heater at domestic level.

Design and Development of Solar Powered Air Cooler; The present air cooling methods are evaporative coolers, air conditioning, fans and dehumidifiers. But running these products need a source called electricity. The producing of electricity is ultimately responsible for hot and humid conditions i.e. global warming. 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 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.

III - WORKING PRINCIPLE

Solar panel is used to charging the lead acid battery. Here we are using 12 volt 10 watts panel for demo purpose. The battery supply is given to the thermo-electric zip cooler. Before that the water is kept inside of the zip cooler. This water is cooled by the principle of see beck effect. In our zip cooler having two option

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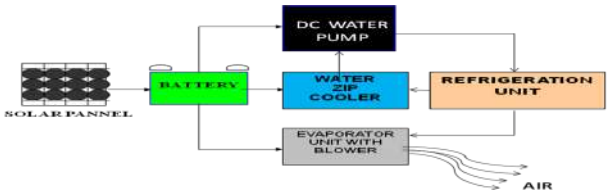

Fig: Working principle

There is a one changeover switch is used to convert the water into those two mode. This water is circulated by the D.C reciprocating water pump to the evaporator unit. The D.C high speed blower is fitted in front of the condenser so that the cooled air is rushed out force.

If electrical contacts are made with the two semiconductor materials and the contacts the connected through an external electrical conductor, the free electrons will flow from the n-type material through the conductor to the p-type material (figure). Here the free electrons will enter the holes and holes and become bound electrons thus both free electrons and hole will be removed. The flow of electrons through the external conductor constitutes an electric current, which will continue as long as move free electrons and holes are being formed by the solar radiation.

IV - 2D DRAWINGS OF SOLAR-ELECTRIC AIR COOLER

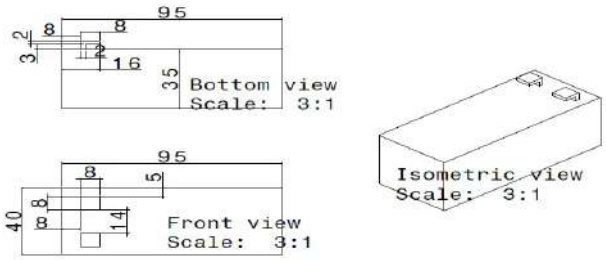

Fig: Battery

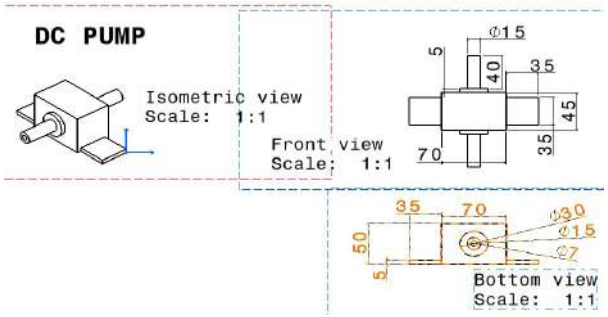

Fig: DC Pump

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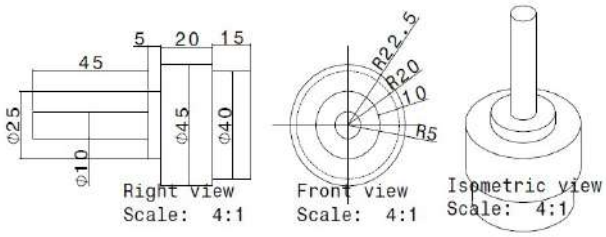

Fig: DC Motor

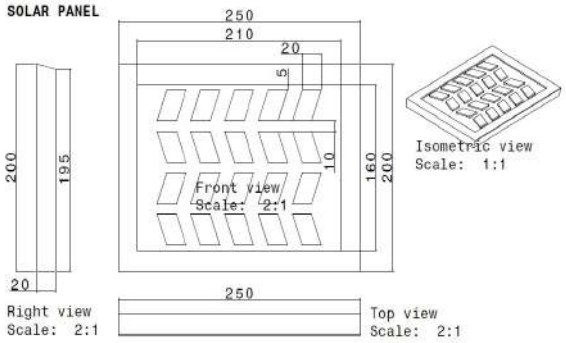

Fig: Solar Panel

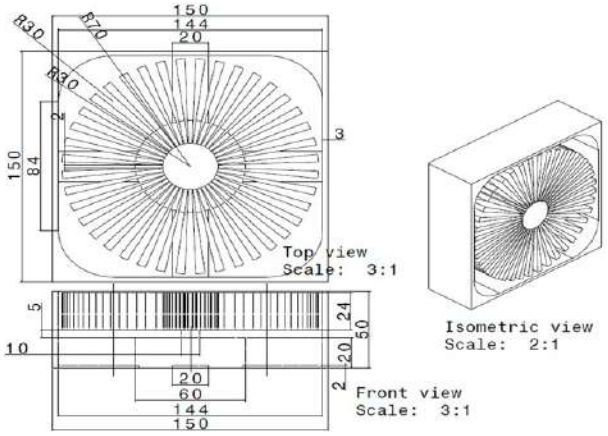

Fig: Blower + Frame

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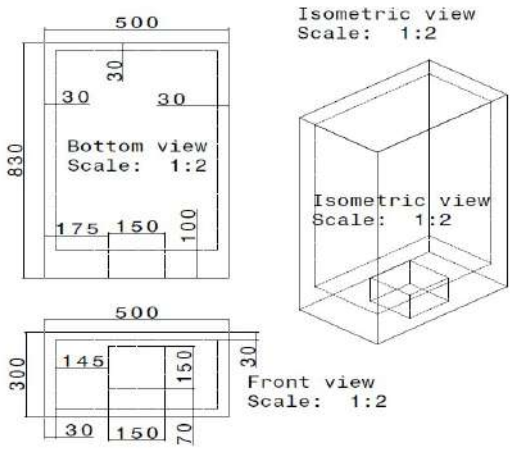

Fig: Air Cooler Body (Approx Size)

Advantages of Solar-Electric Air Cooler

- Simple in design and analysis, and construction
- This system is noiseless in operation
- It is portable, so it can be transferred easily to any place
- Its operate in battery
- Maintenance cost is low
- Solar panel is used. so this project is non-conventional one
- Solar panel, battery is also used as a lighting system.

Disadvantages of Solar-Electric Air Cooler

- It does not purify air.

Applications of Solar-Electric Air Cooler

- Domestic Application
- Office and Bank Application
- It is very much useful in College and Schools

V - DESIGN METHODLOGY OF SOLAR-ELECTRIC AIR COOLER

Modeling of Portable Solar Electric Air Cooler in CATIA V5

This Portable Solar-Electric Air Cooler is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design. The same CATIA V5 R20 3d model and 2d drawing model is shown below for reference. Dimensions are taken from. The design of 3d model is done in CATIA V5 software, and then to do test we are using below mentioned software's.

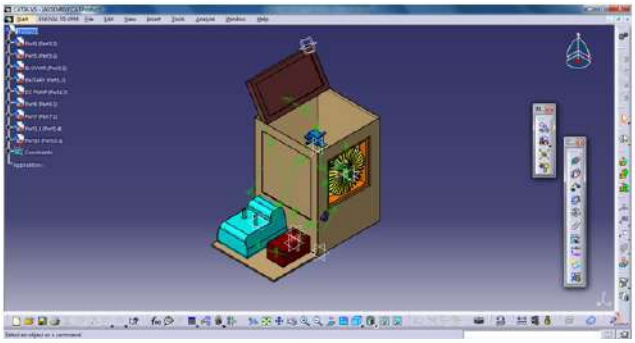

Fig: Model design of PSEAC in CATIA-V5

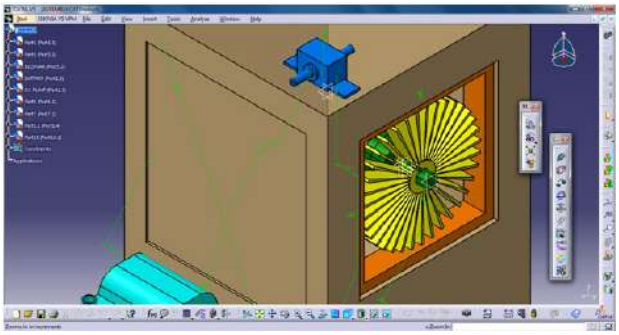

Fig: Model arrangement of working mechanism in CATIA-V5

VI - ANALYSIS OF PORTABLE SOLAR ELECTRIC AIR COOLER

Procedure for FE Analysis Using ANSYS:

The analyses of the blower, pump, pipes, sq. frame, condenser, air out port are done using ANSYS. For compete assembly is not required, motor and attached gear system is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of assembly of machine.

Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

  File Menu > Import> STEP > Click ok for the popped up dialog box > Click

  Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

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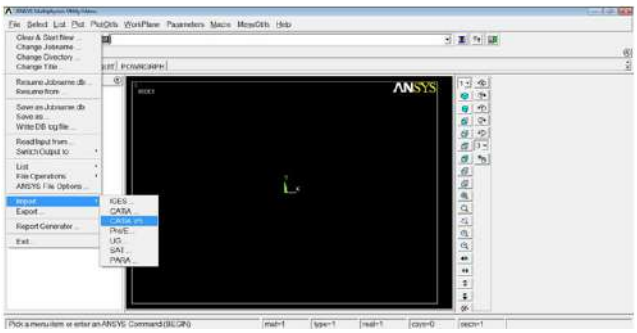

Fig: Import panel in Ansys.

VII - DISCUSSION ON ANALYSYS RESULT

Thermal Analysis Results:

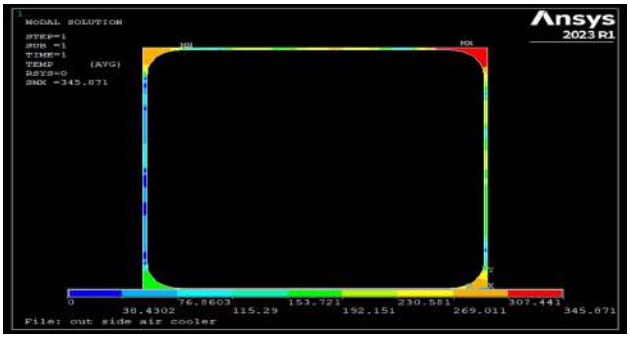

Fig: Thermal Analysis of Air Cooler Frame

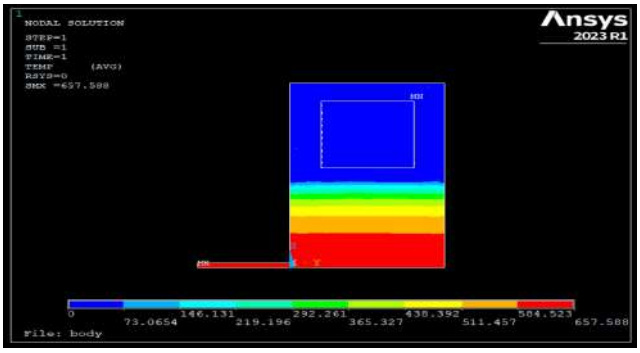

Fig: Thermal Analysis of Body

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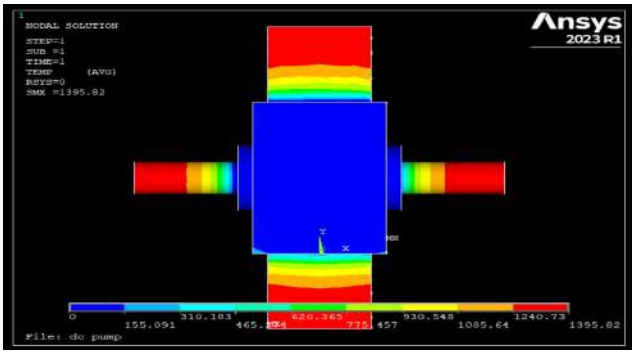

Fig: Thermal Analysis of DC Pump

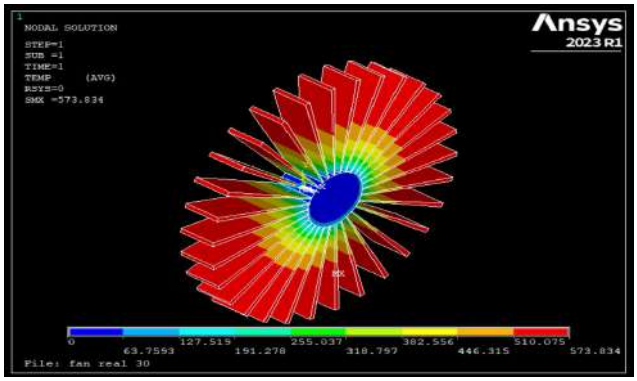

Fig: Thermal Analysis of Fan/Blower

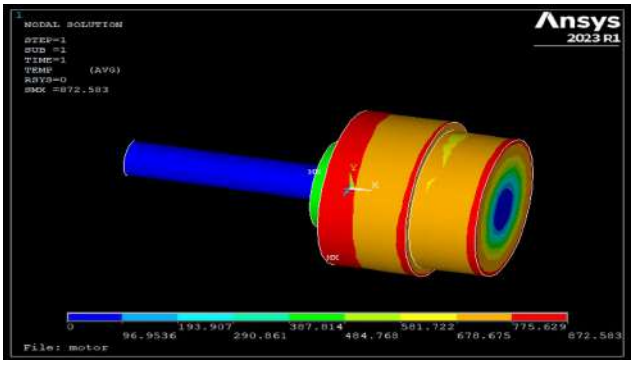

Fig: Displacement of Motor

VIII - CONCLUSION

As shown above figures of the temperature of the meshed and solved using Ansys is very less. This is showing us that clearly each component in assembly is having minor temperature values. Boundary Conditions is at the fixing location (Minimum Stress which is acceptable), value of Nodal Temperature of the blower is 7.5171 ºC.

So we can conclude our design parameters are approximately correct. The final result positive manner .There is no problem with the design assembly of the machine.

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To assist the thermal designer in modeling thermoelectric coolers or Peltier modules, C&R Technologies' tool suite provides built in routines for modeling either standard Bismuth Telluride coolers or modules manufactured from alternative semiconductor materials. The family of TEC routines provides the designer the ability to model single stage or multi-stage coolers, and calculate valuable sizing information regarding cooler performance.

In this changing modern world every day there is a new discovery in all fields of science and technology, benefiting the mankind. In this work the design of solar Air Cooler is slightly modified with an addition air cooler. If one utilizes energy which goes as waste even more useful things can be made.

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