DESIGN OF COST EFFICIENT SOLAR AIR CONDITIONER

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Abstract: The conventional air-conditioning system uses refrigerant that harms the environment and depletes the ozone layer. The commonly used refrigerants are CFC’s and HFC’s. Though HFC’s has less effect over the ozone layer as compared to the CFC’s but it still plays a role in depletion of ozone layer. A huge time would be required to make the complete system eco-friendly Moreover the other factors like extra power consumption, maintenance, service etc. lead to find an alternative for existing air-conditioning system. By using the thermoelectric effect we can do solar thermal air-conditioner without creating pollution It is inexpensive to poor people than the conventional air conditioners.

Index Terms: Peltier Module, Peltier Effect, Solar array, Heat Exchanger.

INTRODUCTION:

An environmental control system utilizing solar energy would generally be more cost effective if it were used to provide both heating and cooling requirements in the building it serves. Various solar powered heating and cooling systems have been tested extensively, but solar powered air-conditioners have received little more than short-term demonstration attention. Solar cooling technologies collect the thermal energy from the sun and use this heat to provide cold air for residential, commercial, institutional and manufacturing buildings. These technologies displace the need to use electricity or natural gas. Today, Countries across the globe are at work manufacturing and installing solar heating and cooling systems that significantly reduce our dependence on imported fuels. We need smart policies to expand this fast growing, job producing sector.

A conventional cooling system contains three fundamental parts - the evaporator, compressor and condenser. The evaporator or cold section is the part where the pressurized refrigerant is allowed to expand, boil and evaporate. During this change of state from liquid to gas, energy (heat) is absorbed. The compressor acts as the refrigerant pump and recompresses the gas to a liquid. The condenser expels the heat absorbed in the evaporator plus the heat produced during compression, into the environment or ambient. A thermoelectric has analogous parts. At the cold junction, energy (heat) is absorbed by electrons as they pass from a low energy level in the p-type semiconductor element, to a higher energy level in the n-type semiconductor element. The power supply provides the energy to move the electrons through the system. At the hot junction, energy is expelled to a heat sink as electrons move from a high energy level element (n-type) to a lower energy level element (p-type).

LITERATURE SURVEY:

Matthieu Cosnier et al[1] presented an experimental and numerical study of a thermoelectric air-cooling and air-heating system. They have reached a cooling power of 50W per module, with a COP between 1.5 and 2, by supplying an electrical intensity of 4A and maintaining the 5°C temperature difference between the hot and cold sides.

Suwit Jugsujinda et al[2] conducted a study on analyzing thermoelectric refrigerator performance. The refrigeration system of thermoelectric refrigerator (TER; 25 × 25 × 35 cm3) was fabricated by using a thermoelectric cooler (TEC; 4 × 4 cm2) and applied electrical power of 40 W. The TER was decreased from 30 ºC to 20 ºC for 1 hr and slowly decreasing temperature for 24 hrs. The maximum COP of TEC and TER were 3.0 and 0.65.

BLOCK DIAGRAM:

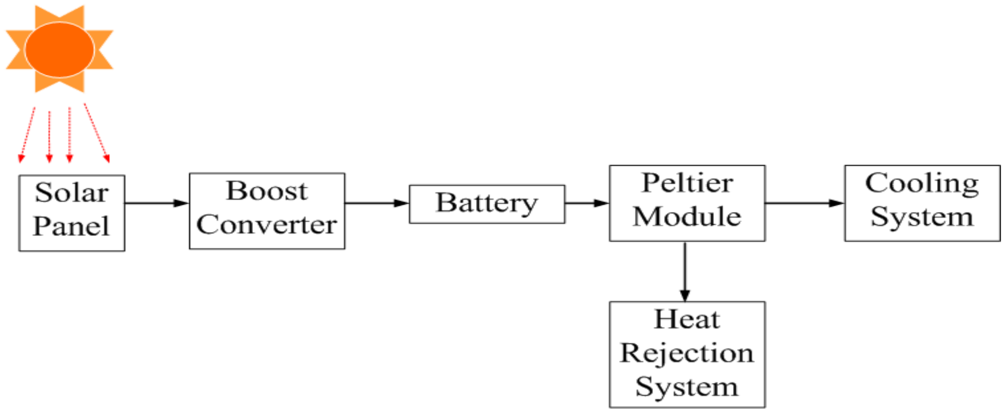

Figure 1: Block Diagram

MATHEMATICAL MODELLING:

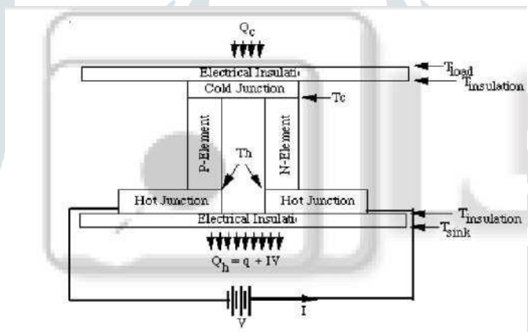

Figure 2: Thermal Network Model of TER

Assumptions:

- No heat loss takes place from or to the system.
- Thermo physical properties such as Resistivity, conductivity etc do not change with temperature.
- Heat transfer takes place only through the P type and N type semiconductor.

When current is passed through the dissimilar material, heat is absorbed or liberated at the junction. This phenomenon is known as Peltier Effect. Thermal network model of TER is given in Figure 1. The various equations used for calculating the parameters under the study are given below.

Cooling and heating due to the thermoelectric effect is given by (peltier effect)

$$Q_c = \propto IT_c$$

$$Q_c = \propto IT_h$$

For the cold junction

$$Q_c + 0.5I^2R + U(T_h - T_c) = \propto IT_c$$

For the hot junction

$$Q_h + U(T_h - T_c) = \propto IT_h + +0.5I^2R$$

Thus the thermoelectric cooling

$$Q_c = \propto IT_c - 0.5I^2R - K(T_h - T_c)$$

And heating is $Q_h = \propto IT_h + 0.5I^2R - K(T_h - T_c)$

Now energy input to the system from outside, as per first law of thermodynamics, is given by

$$\oint \eth Q = Q_{net} = -Q_h - Q_c = \propto I(T_h - T_c) + I^2R$$

Negative sign indicates that energy has to be supplied to the system. Now, $(COP)_C = Q_c$/Energysupplied

$$Q_c = \propto IT_c - 0.5I^2R - U(hT_h - T_c)$$

$$P = \propto I(T_h - T_c) + I^2R$$

Similarly $(COP)_h = Q_h$/Energysupplied

$$\boldsymbol{Q_h = \propto IT_h + 0.5I^2R - K(T_h - T_c)P = \propto I(T_h - T_c) + I^2R}$$

THERMOELECRIC MATERIAL

The common Thermoelctric Material used in Different applications are Bismuth sulfide(Bi_2S_3), Lead Telluride(PbTe), Antimony Telluride(Sb_2Te_3), Cesium Sulfide(CeS), Bismuth telluride(Bi_2Te_3), and Germanium Telluride(GeTe). The seebeck coefficient for different material are given in table 1.

Table 1: Seebeck Coefficient For Different Material

Material	$\alpha(K^{-1})$
Germanium Telluride	1.5×10^{-3}
Cesium Sulfide	1×10^{-3}
Bismuth Telluride	41×0^{-8}
Lead Telluride	1.5×10^{-3}

PROPOSED WORK:

The aim of the project is to investigate experimentally and numerically the COP of the thermo electric air conditioner using Peltier Modules. The details of the experimental set up are as follows

S.No.	DISCRIPTION	DIMENSION/ RANGE
1	Peltier Module	40×40×40 mm
2	Aluminum Block	320×6.5×3.8 cm
3	Rectangular Fin	68×35 cm
4	Fiber Sheet	470×36 cm
5	K-Type Thermocouple with Indicator	$0\text{-}1000^0c$
6	Multimeter	350V ac

FINAL OUTPUT:

CONCLUSION:

The literature regarding the investigation of Thermoelectric air conditioner using different modules has been thoroughly reviewed .From the review of the pertinent literature presented above, it can be inferred that thermoelectric technology using different modules used for cooling as well as heating application has considerable attention. Many researchers try to improve the COP of the thermoelectric air-conditioner using different material. Thermoelectric coolers to be practical and competitive with more traditional forms of technology, the thermoelectric devices must reach a comparable level of efficiency at converting between thermal and electric energy.

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