DESIGN AND EXPERIMENTAL PERFOMANCE OF THERMOELECTRIC AIR CONDITIONER

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ABSTRACT

The main aim of our project is to produce the air conditioning effect using peltier effect and eliminating the use of compressor condenser and other refrigerants like Freon and Ammonia which is toxic in nature. Thermoelectric couples are solid state devices capable of generating electrical power from temperature gradient known as seebeck effect or converting electrical energy into a temperature gradient known as peltier effect. We implement this peltier effect by using a series connection of peltier module to cool the air and it will be a better alternative to vapor compression system. We monitor the performance of the thermoelectric air conditioner and various temperature readings have been tabulated and COP is estimated.

Keyword : *Thermoelectric,Compressor,Performance.*

1. INTRODUCTION

In thermoelectric materials, electrical energy can be directly converted into thermal energy and thermal energy into electrical energy. Direct conversion between electrical energy and thermal energy is possible because of two important thermoelectric effects: the seebeck effect and peltier effect. The seebeck effect refers to the existence of the electrical potential across a thermoelectric material subject to the temperature gradient. The peltier effect refers to the absorption of the heat into one end of the thermoelectric material and the release of heat from the opposite end due to the current flow through the material.

1.1 Peltier Effect

It works on the principle that when a current is made to flow through the circuit, heat is evolved at the lower junction and absorbed at the upper junction. Peltier heat is reversible when the direction of current is reversed; the peltier heat is the same but in opposite direction. Peltier coefficient depends on the temperature and material of a junction. This effect will be reversed thereby a change in the direction of electric current flow and reverse the direction of heat flow.

1.2 Seebeck Effect

It is discovered by Thomas Johann seebeck in 1821. He accidentally found that the voltage existed between two ends of a metal bar when there is an electric current. The voltage is proportional to the temperature gradient existed within the bar. The temperature difference causes diffusion of electrons from the hot side to the cold side of a conductor. The motion of electrons creates an electric current the voltage is proportional to the temperature difference as governed by.

$$V = Ch (T2 – T1)$$

Where

T2 = temperature of the hot side of the module
T1 = temperature of the cold side of the module
Ch = coefficient of heat transfer

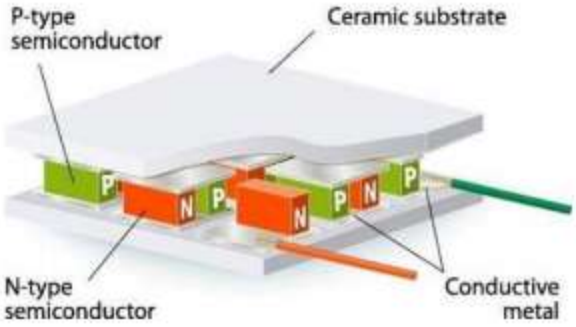

Fig-1: Thermoelectric Module

2. LITERATURE REVIEW

Wei He et al., Theoretical and experimental investigation on a termoelectricheating and cooling system driven by solar applied energy 107, 89-97, (2013) Conducted did Numerical study of Theoretical and experimental investigation of a thermoelectric cooling and heating system driven by solar. In summer, the thermoelectric device works as a Peltier cooler when electrical power supplied by PV/T modules is applied on it. The minimum temperature 17 degree C is achieved, with COP of the thermoelectric device higher than 0.45.Then comparing simulation result and experimental study of comparative investigation of thermoelectric air conditioners versus vapor compression and absorption air conditioners. Three types of domestic air conditioners are compared and compact air conditioner was fabricatedcompared performances of thermoelectric and conventional vapor compression air-conditioners. In this paper analyze the cooling performance of compact thermoelectric air-conditioner. TEC1-12708 typethermoelectric modules used for heating and cooling application. The compact TE air conditioners COP was calculated to its optimum parameters. Results show that the actual COPs of vapor compression and thermoelectric air-conditioners are in the range of 2.6-3.0 and0.38-0.45, respectively. However, thermoelectric air conditioners have several advantageous features compared to theirvapor-compression counterparts.

Astrain, Vian&Domıngu et.al., **Increase of COP in the thermoelectric refrigeration by the optimization of heat dissipation, applied thermal engineering 23, 2183-2200,(2003)** conducted an experimental investigation the COP in the thermoelectricrefrigeration by the optimization of heat dissipation. In thermoelectric refrigeration based on the principle of a thermosyphon with phase change is presented. In the experimental optimization phase, a prototype of thermo siphon with athermal resistance of 0.110 K/W has been developed, dissipating the heat of a Peltier pellet with the size of 40*40*3.9 cm,Experimentally proved that the use of thermo siphon with phase change increases the coefficient of performance up to32%.

Shen, Xiao et al., Investigation of a novel thermoelectric radiant air-conditioning system. Journal of energy and buildings, 59,123 – 132, (2102) investigated a novel thermoelectric radiant air-conditioning system (TE-RAC). The systememploys thermoelectric modules as radiant panels for indoor cooling, as well as for space heating by easily reversing theInput current. Based of a commercial thermoelectric module they have obtained a maximum cooling COP of 1.77 when applying an electric current of 1.2A and maintaining cold side temperature at 20°C.

3. WORKING PRINCIPLE OF AIR CONDITIONER:

In this thermoelectric air conditioners system we eliminate the use of compressor condenser and other gases thus making it eco friendly. To find the alternative for a conventional air condition system we make use of the peltier effect. Our air conditioner mainly runs on two principles, peltier effect and seebeck effect. Our design of air conditioner needs both the current AC supply and battery DC supply for efficient run. Current AC supply is given to the Fan blowers and 12V DC supply is given to the peltier module.

Let us illustrate the working principle with a working process diagram given below

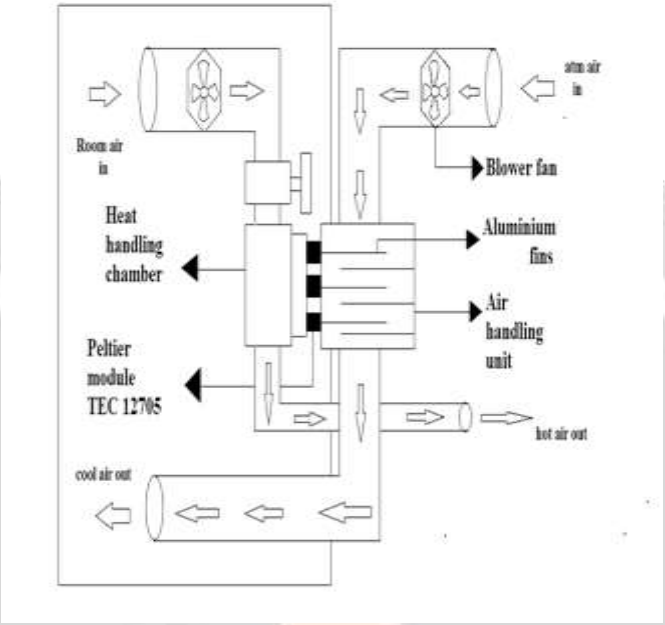

Fig-2: working of a thermoelectric air conditioner

Our Ac setup consists of one big chamber which is made of mild steel and two, small hot and cold chambers. This Ac is insulated in-between the walls. The setup is arranged in such a way that the hot and cold chamber sits inside the big mild steel chamber. Both the hot and cold chamber consists of an inlet and outlet hole where we pass the air through the duct. The Ac setup is clamped and hole is made for duct passage through the chambers. We have chosen peltier module TEC12710 and those peltier modules are made to be placed in-between the hot and cold chambers with the help of thermal paste or otherwise known as hat sink paste. The module wire connections are merged together and it is directed to 12V Dc battery and the blower fan wire connections are directly given to the Ac supply. As we said earlier we use two types of ducts round ducts and tapered ducts. Round duct is fixed to the cold chamber and tapered duct is fixed to the hot chamber.

Cold chamber is made of aluminum sheet metal. It is been cut to four parts and bended and spot welded on its end and thus aluminum box is designed and we also designed fins inside the aluminum chamber. Fins are present in the chamber for a smooth and steady air flow inside the chambers and one input and hole is made with a help of drilling operation and pipes are connected to it which is connected to a duct. A fan is fixed to the end of the duct

Hot chamber is made of stainless steel sheet metal. It is been cut to four parts and bended and spot welded on its end and thus steel box which is also known as het box is designed and we also designed fins inside the hot chamber. Fins are present in the chamber for a smooth and steady air flow inside the chambers and one input and hole is made with a help of drilling operation and pipes are connected to it which is connected to a duct. A fan is fixed to the end of the duct

Firstly the atmosphere air which is in the other side of the room is sucked through the blower fan and pushes it to the cold chamber which is inside the air unit box and fins are present inside the box so the air moves smoothly

throughout the fins and reaches the outlet. While passing through the chamber peltier module reacts with the cold chamber at one end which is cold so when air hits the chamber cool air produced and it's sent out to the room and the amount of air is calculated with the help of the temperature sensor.

Secondly the hot air which is inside the room is sucked through the blower fan and pushes it to the hot chamber which is inside the air unit box and fins is present inside the box so the air moves smoothly throughout the fins and reaches the outlet. While passing through the chamber peltier module reacts with the hot chamber which is made up of mild steel at one end which is hot so when air hits the chamber hot air produced and it's sent out of the room with the help of the exhaust and stops after sometime so that when the room is occupied with cold air the suction of hot air from the room will be stopped and cold air will only be circulated again and again.

4. CONCLUSION

We made this setup to run on two major sources, we operate the fan using Ac current supply and supply electric current to peltier module by means of 12V battery and thus we can save around 75% of power consumption of a conventional Air conditioner we use nowadays. The performance of thermoelectric module depends on the material used for thermoelectric module and we concluded that bismuth telluride is found to be the suitable thermoelectric material in comparison with other thermoelectric materials We conclude that thermoelectric air conditioners are eco friendly and does not emit any toxic gases and by using 10 TEC's we can achieve a better cooling than previous thermo electric air conditioners and increase in performance is achieved. The material also plays a big role in cooling and considering that we conclude hat aluminum is suitable for heat transfer properties as it absorbs heat at a very high rate.

5. REFERENCE

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