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# Fabrication and Result Obtained Of Portable Thermoelectric Air Cooler System

**Swapnil S. Khode, Abhilash Arsod , Kushal Turankar, Krunal Waghmare**

***Abstract*— In present scenario, water cooler and air conditioner system are widely used for air cooling purpose. Besides that, it has some demerits and Environment related problems. It has been observed during last two decades that O3 layer is slowly destroyed because of refrigerant (CFC,HFC) used for refrigeration and air-conditioning system. So our objectives is to give the middle option between these technology which works on peltier module technology. In our previous paper, we have discussed The Design of portable Thermoelectric air cooler system. The purpose of this paper is to developed Prototype Assembly and Fabrication of ours project and also discussed the Temperature measurements with Power supply testing and troubleshooting .**

***Index Terms*— Thermoelectric, Peltier Effect, Thermoelectric module, Applications.**

## I. INTRODUCTION

The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice-versa. A thermoelectric device creates a voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. At the atomic scale, an applied temperature gradient causes charge carriers in the material to diffuse from the hot side to the cold side, similar to a classical gas that expands when heated; hence inducing a thermal current.

This effect can be used to generate electricity, measure temperature or change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices are efficient temperature controllers.

The term "thermoelectric effect" encompasses three separately identified effects: the Seebeck effect, Peltier effect and Thomson effect. Textbooks may refer to it as the Peltier–Seebeck effect. This separation derives from the independent discoveries of French physicist Jean Charles Athanase Peltier and Estonian-German physicist Thomas Johann Seebeck.Joule heating, the heat that is generated whenever a voltage is applied across a resistive material, is related though it is not generally termed a thermoelectric effect. The Peltier–Seebeck and Thomson effects are thermodynamically reversible whereas Joule heating is not.

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**wapnil S. khode,** B.E (Final year mechanical) .J.D.I.E.T, Amravati University. City -Yavatmal, Country -India, Mobile No:9763183670,
**Abhilash Arsod,** B.E (Final year mechanical). J.D.I.E.T, Amravati University City -Yavatmal, Country -India, Mobile No: 9552880341
**Kushal Turankar,** B.E (Final year mechanical ).J.D.I.E.T, , Amravati University City -Yavatmal, Country -India,
**Krunal Waghmare,** B.E (Final year mechanical ).J.D.I.E.T, , Amravati University City -Yavatmal, Country -India

## II. THERMOELECTRIC COOLING

Thermoelectric cooling uses the Peltier effect to create a heat flux between the junctions of two different types of materials. A Peltier cooler, heater, or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other side against the temperature gradient (from cold to hot), with consumption of electrical energy. Such an instrument is also called a Peltier device, Peltier heat pump, solid state refrigerator, or thermoelectric cooler (TEC). The Peltier device is a heat pump: when direct current runs through it, heat is moved from one side to the other. Therefore it can be used either for heating or for cooling (refrigeration), although in practice the main application is cooling. It can also be used as a temperature controller that either heats or cools.

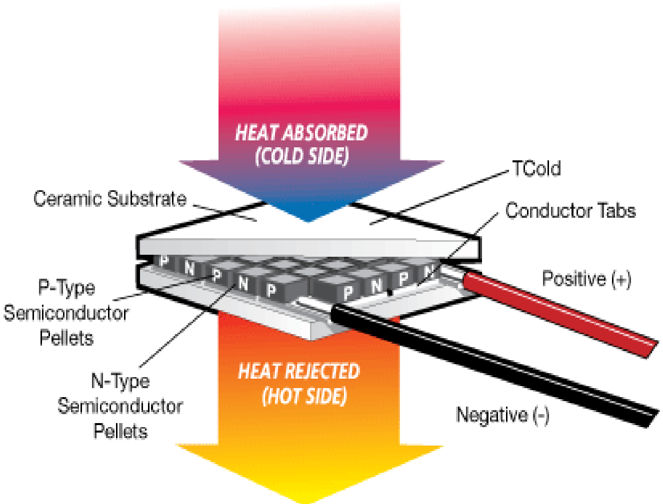



Fig:1 working of peltier module

This technology is far less commonly applied to refrigeration than vapor-compression refrigeration is. The main advantages of a Peltier cooler (compared to a vapor-compression refrigerator) are its lack of moving parts or circulating liquid, and its small size and flexible shape (form factor). Its main disadvantage is that it cannot simultaneously have low cost and high power efficiency. Many researchers and companies are trying to develop Peltier coolers that are both cheap and efficient. (See Thermoelectric materials.)

A Peltier cooler is the opposite of a thermoelectric generator. In a Peltier cooler, electric power is used to generate a temperature difference between the two sides of the device, while in a thermoelectric generator, a temperature difference between the two sides is used to generate electric power. The operation of both is closely related (both are manifestations of the thermoelectric effect), and therefore the devices are generally constructed from similar materials using similar designs.

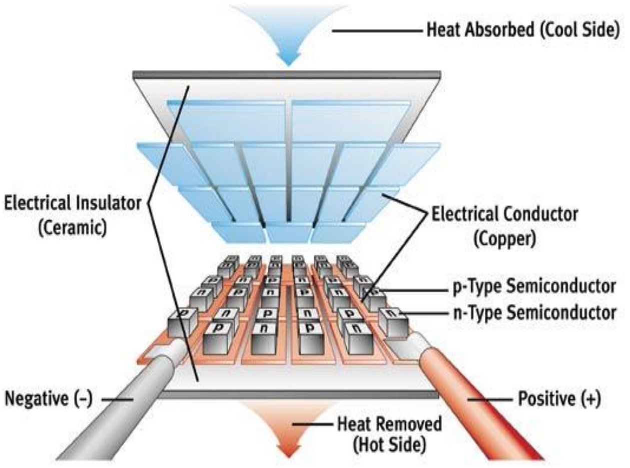



Fig.2 TEC Construction

## III. CONSTRUCTION DESIGN OF THE PROJECT

The portable thermoelectric cooler design was preformed based on certain Thermal and electrical calculations. The cooler was compromised on the availability of parts in the market and budget of the project. The prototype assembly starts with a main cooler which is used to blow the ambient air through a circular duct .The duct is attached to the blower fan and leads towards the heat sinks. The air which is passed through the duct goes into the heat sink which is at bottom side. This heat sinks acts as a channel for the air to pass through. There are six TECs that are sandwiched between a two portable aluminum heat sinks. TEC cold side and other Hot side rests in two heat sinks. The hot side or the cold sides of the TECs are fastened together with the portable heat sink. The TECs were installed between the heat sinks using Mechanical arrangement, which increases the thermal conductivity and cooling effects by removing the air gap for the surface of heat sinks.In this project we used plywood,sunmica with mechanical fasterns for constructing the frame.

| Parameters | Value |
|---|---|
| Outside Dimension (mm) | Length (w) 40cm<br>width(d) 35cm<br>Height (h) 25cm |
| Inside Dimension (mm) | Length(L)30cm<br>Width (w) 25cm<br>Height (h) 25cm |
| Machine Compartment | Diameter (D)16cm |

Table1: Specification of Frame work

**TECs arrangement**

TECs arrangement in our project,here we are using the six TEC of module type TEC12706having the specification given below Six TECs are electrically connected in parallel in network, it is because to give equal voltage to all the TECs i.e 12volt. The control supply is given by the circuit arrangement which uses 12-3-12 Transformer

All small blowers mounted on Heat sink are also connected parallel in network.it takes 12volt Voltage and 0.28Amps current The controle supply is same that of TECs

## IV. CALCULATION'S

**Computation of cooling power**

The amount of heat removed or the cooling power was determined before selection of the TEC. *Qc* which is the amount of heat absorbed was calculated using the equation (***Qc* = ΔT**). Mass flow rate **()** of air and is the product of density of air (ρ) and volume flow rate (*Q*). Density of air at 32 *°C* was taken as1.164 *kg* / *m*3. *Q* was obtained by multiplying velocity of air pass through the rectangular duct of heat sinks and the cross section area of a heat sink. It is denoted by the equation (*Q* =*V* × *A*). Velocity of the air passing through the duct was measured using an anemometer and resulted in a reading of 5.2 *m* / *s*2. Cross sectional area of the rectangular duct (*W* ×*H*) was calculated as 0.0042 *m*2 and the volume flow rate was 0.02184 *m*3 / *s* . Specific heat of air (*Cp* ) at 32 °*C* was taken as 1005 *J* / *kgK* . As discussed that the system ΔT is the difference between the ambient temperature and the temperature of the load to be cooled. It had been targeted to attain a temp of 25°*C* form the ambient temperature (32 °*C*). In other words the input temperature from the blower fan is 32 °*C* and the expected output is 25°*C*

$(T\ in - T\ out) = 32^0 - 25^0 = 7^0$

The amount of heat load for cooling the air through the rectangular duct was calculated as :

$Q_c = mc_p\ (\Delta T)_{system} = 1.164*1005*7 = 204.36W.$

No. of module=$Q_c/Q_p$=204.36/51.4=4.08

Conduction from peltier module to aluminium surface is given by formula

Q=KA(T1-T2),

from this formula we get T2=60c.

Heat Transfer through Fins

Qfin = (PhKAcs) ½(to-ta)

from this formula we get Qfin =18.80watt .

Convection From fins To air

Q=hA(to-ta)

from this formula we get ta=$24^0$c

| Parameters | Symbol | Value |
|---|---|---|
| Thermal conductivity of aluminum | K | 225kj/kg$^0$k |
| Convective heat transfer coefficient | h | 1kj/kg$^0$k |
| perimeter | P=2(b+y) | 0.136m |
| Cross sectional area | Acs=b*y | 0.00067m$^2$ |

| | | |
|---|---|---|
| Temprtature of cold side of module | T1 | $5^0$c |
| Temprtature of aluminium surface contact with module | T2 | $6^0$c |

Table:2 Specification of calculation work

## V. CAD IMAGE'S OF PROPOSED PROJECT

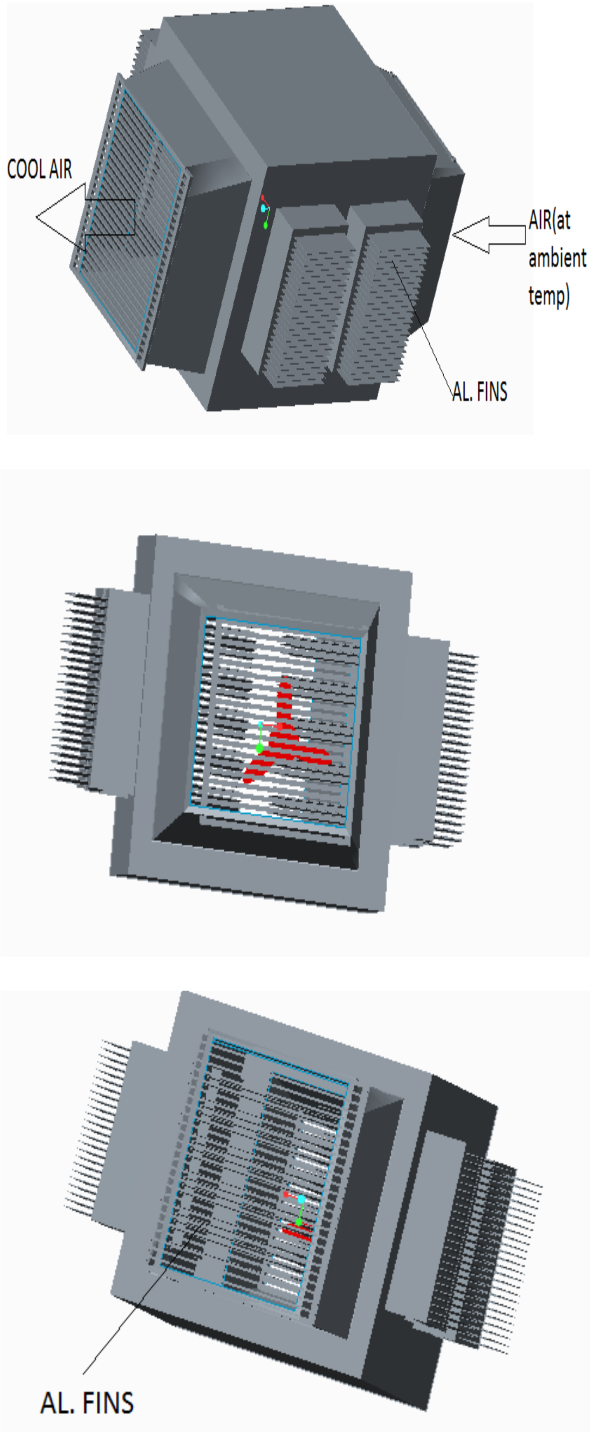


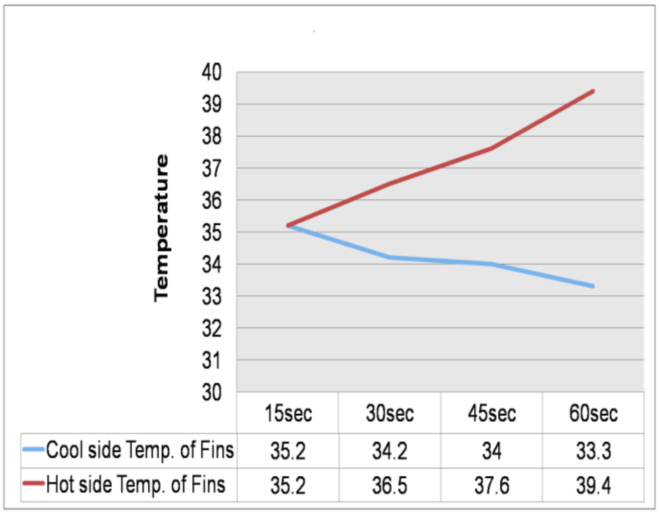

Figure3. Prototype images of the project

| Time(in sec) | Temperature of air just coming out from inside fins (in$^0$c) | Temperature of air just coming out from outside fins (in$^0$c) |
|---|---|---|
| 15 | 36.8 | 36.8 |
| 30 | 36.5 | 37 |
| 45 | 36.3 | 37.2 |
| 60 | 36.2 | 37.9 |
| 75 | 36 | 38.3 |
| 90 | 36.8 | 38.9 |

## VI. READING OBTAINED

Condition 1: When both Fans are OFF.
When ambient temperature=35.2$^0$c

Table 3. Reading obtained in case1



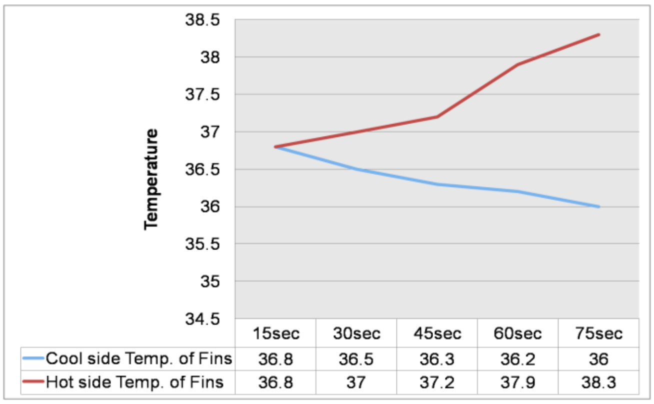

Case1:When both Fans are OFF

Figure 4: Graph for condition 1

Condition 2: When small Fans are ON.
When ambient temperature=36.8$^0$c

| Time (in sec) | Temperature of air just coming out from inside fins (in$^0$c) | Temperature of air just coming out from outside fins (in$^0$c) |
|---|---|---|
| 15 | 36.2 | 36.2 |
| 30 | 35.8 | 36.2 |
| 45 | 35.3 | 36.7 |
| 60 | 35 | 37.4 |
| 75 | 35 | 38 |
| 90 | 34.9 | 38.4 |

Table 4. Reading obtained in case2 Time(in sec)



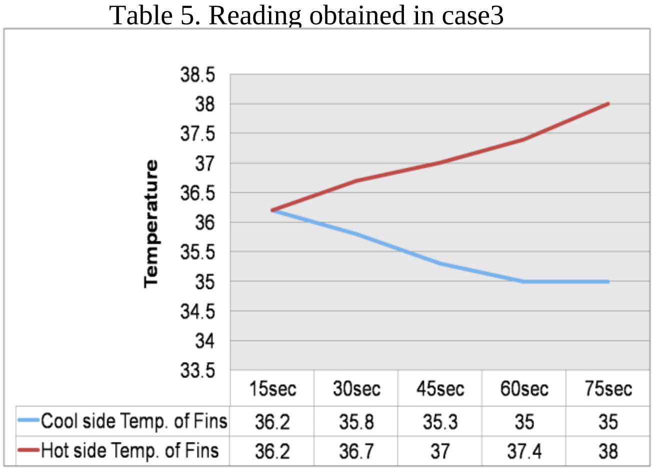

Case2: When small Fans are On

Fig.5: Graph for condition 2

**Condition 3: When both Fans are ON.**
**When ambient temperature=36.2$^0$c**

| Time (in sec) | Temperature of air just coming out from inside fins (in$^0$c) | Temperature of air just coming out from outside fins (in$^0$c) |
|---|---|---|
| 15 | 36.2 | 36.2 |
| 30 | 35.8 | 36.2 |
| 45 | 35.3 | 36.7 |
| 60 | 35 | 37.4 |
| 75 | 35 | 38 |
| 90 | 34.9 | 38.4 |

Table 5. Reading obtained in case3




Case3:When both Fans are On

Fig.6: Graph for condition 3

## VII. CONCLUSIONS

A Portable Thermoelectric Air cooler prototype was designed and built which can be used for personal cooling . Six TECs were used for achieving the cooling with a DC power supply through car battery. It had been shown from testing results that the cooling system is capable of cooling the air when circulating the air inside the encloser with the help of blower. TEC cooling designed was able to cool an ambient air temperature from 32°C to 25.8°C. Cooling stabilizes within four to five minutes once the blower is turned ON. The system can attain a temperature difference of set target which was 7°C. Accomplishing the set target establish the success of the project. All the components in the project had been tested individually and the results were found to be positive.

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**Swapnil S. khode,** B.E (Final year mechanical) .J.D.I.E.T, Amravati University. City -Yavatmal, Country -India, Mobile No:9763183670,

Research work in portable thermoelectric air cooler system, as an alternative for conventional HVAC system.

**Abhilash Arsod,** B.E (Final year mechanical). J.D.I.E.T, Amravati University City -Yavatmal, Country -India, Mobile No: 9552880341

**Kushal Turankar,** B.E (Final year mechanical ) .J.D.I.E.T, , Amravati University City -Yavatmal, Country -India,

**Krunal Waghmare,** B.E (Final year mechanical ) .J.D.I.E.T, , Amravati University City -Yavatmal, Country -India