iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** III **Month of publication:** March 2022

DOI: https://doi.org/10.22214/ijraset.2022.40819

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue III Mar 2022- Available at www.ijraset.com

A Review on Peltier Device and Heat Dissipation of It's Hot Surface Using Fins

Tithi Sharma[1], Pratham Jain[2], Smit Patel[3], Nishyank Bhatt[4], Prof. Kunalsinh Kathia[5]
[1, 2, 3, 4]UG Student, [5]Assistant Professor, Department of Mechanical Engineering, Saffrony Institute of Technology, Linch Mehsana, Gujarat, India

Abstract: The branch of thermal science is widely involved in refrigeration theory used at many places like Air Conditioners, Air Cooler, Refrigerator, etc. Refrigeration cycles and their concept were newly introduced in early 1834 and after that in 1913 refrigerators for possible to use for home applications and at various places. When it comes to cooling mainly the refrigeration process comes in mind for the solution, But Peltier effect which is reverse of seebeck effect is also well known for cooling as portable cooling in compact size is possible by TEC Module as Peltier devices generates heating at one side and cooling at other side when there is a voltage difference between two dissimilar metals. TEC Module of various ampere gives various ranges of temperature at different voltages and current. Different models of TEC Module (Peltier device) are mainly varied in terms of current as no. of P-N junctions remains same as voltage and current can be modified. The heat generated in at one side of Peltier device is extremely high and if that heat is not dissipating then TEC module will be damaged and won't be possible to bring back in working conditions. So, in Heat Transfer the theory of extended surface is mainly important for heat dissipation. So different geometry of fins is being used such as rectangular fins, Annular fins, Trapezoidal fins, Inversely Trapezoidal fins, etc. The shape and thickness of fins are the most important factors affects heat dissipation. Another thing needed to be taken in account is analysis on material composition of fins which is affected by the term thermal conductivity of the materials.
Keywords: Peltier Device, Thermoelectric Module, Heat Dissipation, Fins, Peltier Effect, Refrigeration, Heating, Portable cooling, and heating.

I. INTRODUCTION

Peltier Device works on theory of Reverse Seebeck Effect. This Seebeck effect is also known as Baltic German physicist Thomas Johann Seebeck [1], this device is also known as thermoelectric device or module. Refrigeration is available on domestic and industrial uses which is installed in large devices such as Air Conditioners, Coolers, etc. This TEC modules are available of different varieties. The maximum voltage it can handle is up to 12Volts. The variety is based on different capacities of maximum current input. Common and easily available modules in the market are TEC12706, TEC12705. TEC12710, etc. The Figure below describes the standardized acronym for TEC Modules. The following acronym defines that how the TEC module is standardized over the world by the nomenclature such as size of TEC, no. of stages, no. of P-N Junctions/Couples and current rating as per various applications of the users.

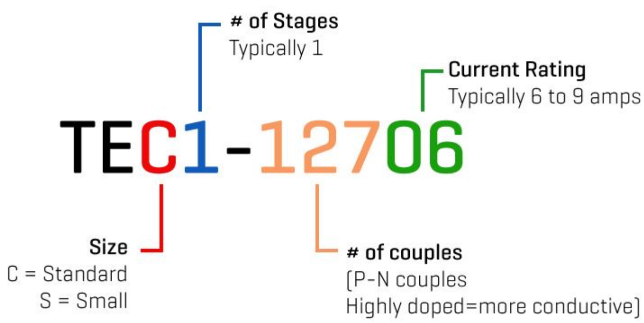


Fig. 1 Standardize acronym for TEC modules

TEC Modules are also available in special varieties like small, Multistage TEC, Current rating more than 9 amps, etc. Commonly used are square TEC Modules of sizes 40mm and 30mm followed by (Length X Width) [2]. TEC module is a well-built energy conversion device as it does not require any additional components as well as it doesn't put any external vibration or friction, or any mechanical stresses and it is portable and need less maintenance as compared to other cooling systems [3].

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue III Mar 2022- Available at www.ijraset.com

II. APPROACH

In order to ensure we review researches of interest only, we pre-set some important criteria. Firstly, the article must be published in year 2014 and later. This is to ensure we get only the most recent researches, so that our study is relevant and not outdated. Secondly, the article must be published in scientific journal or conference. This is to ensure the validity of the content, which have been peer reviewed and approved. Thirdly, the article must use Refrigeration with use of Peltier device and Heat dissipation of hot side of TEC Module using fins. This is our objectivefor this study, so we must work within the scope of our study.

III.PELTIER MODULE

A. Construction of TEC Module

A Peltier Module (thermoelectric module) is a type of thermal control module that has both "heating" and "cooling" properties. It is possible to adjust the surface temperature and maintain it at the target temperature by running an electric current through the module. This both the effects follow the principle of Peltier Effect which is the Reverse Seebeck Effect [3,4].

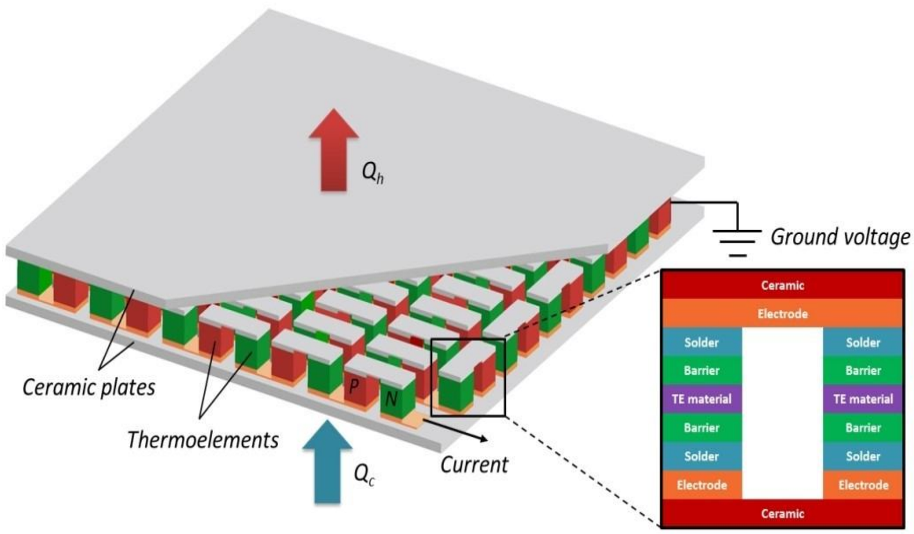


Fig. 2 Constructional cross-sectional view of TEC module

By this effect electricity can also be generated which follow the effect known as Seebeck Effect. Both the effect can be performed by Peltier Module's [5]. The image below represents the actual and cross-sectional view of TEC Module with labelled components.

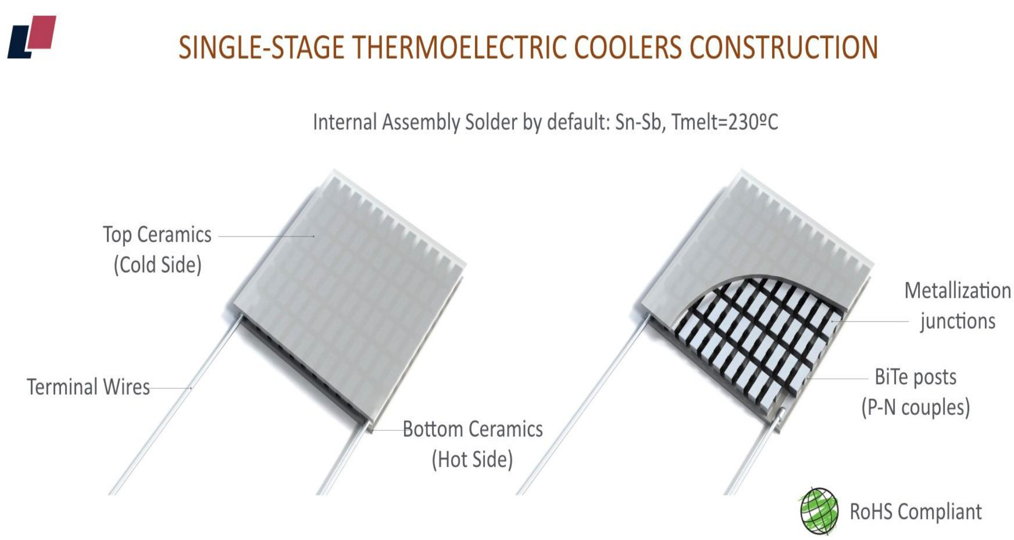


Fig. 3 Constructional cross-sectional view of single-stage TEC module

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue III Mar 2022- Available at www.ijraset.com

B. Working Principle

The TEC module works by transferring the heat from hot side to cold side. During the cooling or heating mode, the direct current passes from n-type to p-type semiconductor material. The principal of the Peltier Effect involves the absorption of thermal energy from one dissimilar metal junction and release the thermal energy to another junction [5].

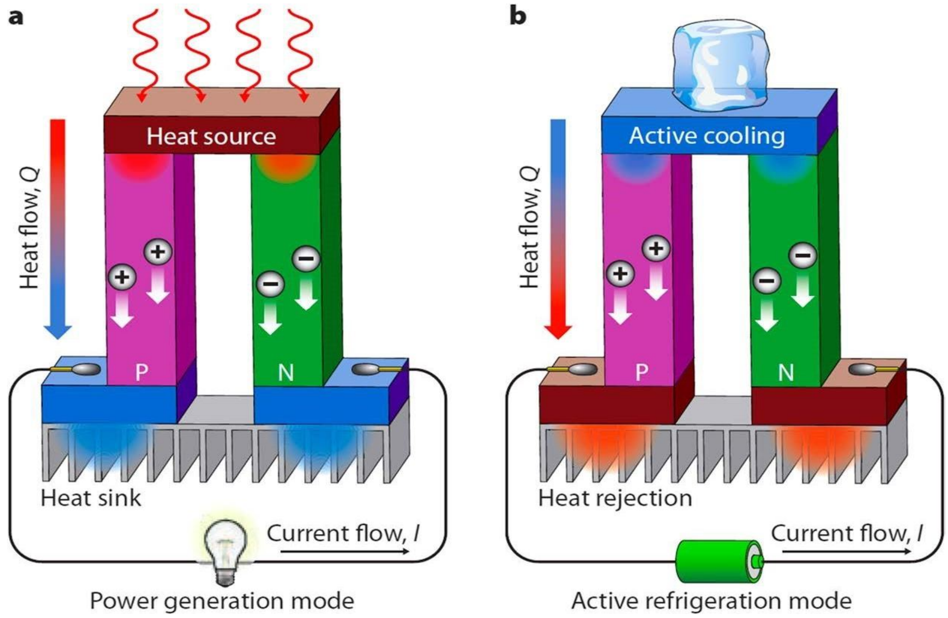


Fig. 4 Working principle of seebeck and peltier effect

C. Material Influence on TEC Module

The quality of a thermoelectric material (TEM) depends on three factors: electrical conductivity, thermal conductivity, and TEM efficiency. Thermal conductivity determines the heat passing through the module due to the decrease in temperature [6]. The efficiency of TEC depends on the quality factor, ZT (Figure of merit), which is the ratio of electricity generated per unit area [5].

$$ZT = S2\sigma/\kappa \; [5]$$

The conflict tracts to develop the evolved ZT and power factor of TEC material are optimized and considered as below

1) ZT about 1 is hamstrung;
2) ZT = 2 is suitable to recover waste heat;
3) ZT = 4/5 is suitable to match the refrigerator

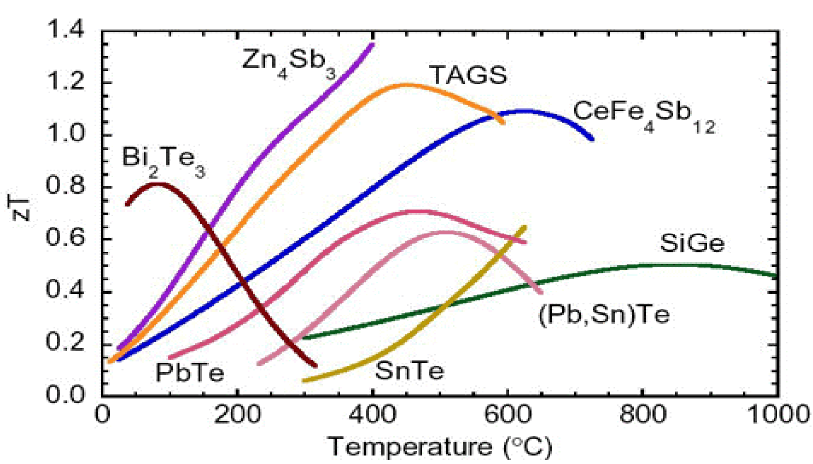


Fig. 5 The TEC figure of merit ZT, depend on the electrical conductivity and the best figure of merit was found in Bismuth Telluride semiconductor [5,8]

Thermoelectric efficiency (TEC) is the ratio of electrical energy produced to the amount of thermal energy received from a heat source [5]. The ZT quality index is a key parameter that can improve the efficiency of TEC modules. High quality elements require low thermal conductivity but high electrical conductivity [7].

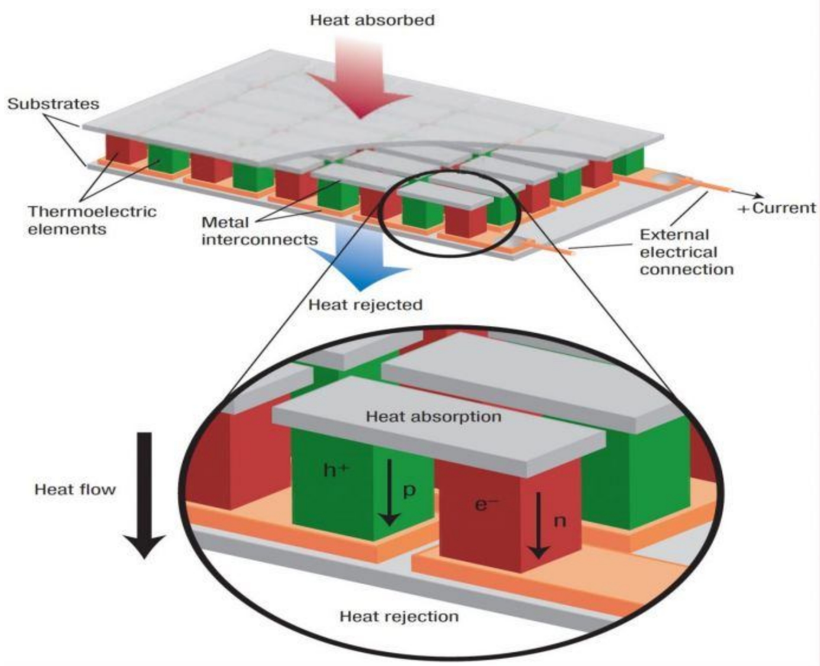


Fig. 6 Enlarged view of P-N junctions

The overall heat decrement and external thermal resistance are established along the consistence of module and the most TEM efficiency. Thermal conductivity determines the heat passing through the module due to the decrease in temperature [6]. The efficiency of TEC depends on the quality factor, ZT (Figure of merit), which is the ratio of electricity generated per unit area [5]

D. Efficiency of TEC Module

Figures the word "efficiency" refers to the ratio of the work a person gets to the amount of power a machine utilizes. For thermoelectric modules, it is standard to use the term "efficiency" rather than "efficiency". COP is the amount of heat transferred divided by the amount of electricity supplied [9]. The COP depends on the heat payload, input power, and the desired temperature differential. usually, the COP is between0.3 and 0.7 for single-stage usages. Still, COPs higher than1.0 can be achieved especially when the module is pumping against a positive temperature difference (that is, when the module is removing heat from an object that's warmer than the environment) [10]. The figure below shows a regularized graph of COP versus I/ Imax (the proportion of input current to the module's Imax specification). Each line corresponds with a constant DT/ DTmax (the proportion of the needed temperature difference to the module's DTmax specification).

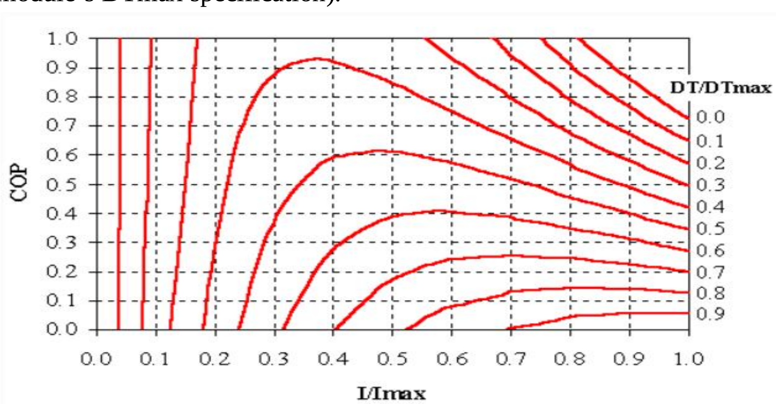


Fig.7 Graphical image of I/Imax current output ratio by DT/DTmax

E. Reliability of TEC Module

All thermoelectric modules experience the same loads during operation, but how to withstand these loads is a matter of build quality. A "point of failure" depends on operating temperature, number of thermal cycles, and the degree of degradation a particular system can tolerate before performance becomes unacceptable [11].

To improve reliability, exposure to high temperatures must be minimized. All modules, regardless of manufacturer, are exposed to high temperatures. Standard modules have a maximum temperature of 80 °C, while high temperature modules can reach 200 °C [11].

F. Benefits of Tec Module Over Conventional Refrigeration System

Tables must be numbered using uppercase Roman numerals. Table captions must be centred and in 8 pt Regular font with Small While maximum conventional refrigeration system uses designs primarily based totally on compressors and refrigerants; an increasing number of applications are turning to thermoelectric cooling as an opportunity to standard refrigeration technology [12]. While thermoelectric cooling isn`t feasible for each refrigeration, thermoelectric modules can appreciably outperform conventional refrigerant-primarily based totally cooling system in sure applications. TEC Technology have following benefits mention below: -

Table I
Benefits Over Traditional Systems

Sr No.	Benefits	Features
1.	Solid state design	✓ No moving components.
		✓ Integrated chip design.
		✓ Noiseless operation.
		✓ Integrated chip design
2.	Accurate temperature stability	✓ Tolerances of better than +/- 0.1°C.
		✓ Accurate and reproducible ramp and dwell times.
3.	Rapid response times	✓ Instantaneous and rapid temperature change.
		✓ Reduced power consumption.
4.	Compact and lightweight	✓ Low profile.
		✓ Sizes to match your component footprint.
		✓ No bulky compressor units.
		✓ Excellent for benchtop application.
5.	Cooling/heating mode options	✓ Fully reversible system with switch in polarity.
		✓ Supports rapid temperature cycling.
6.	Low DC voltage designs	✓ It utilizes only up to 12 Volts
7.	Localized Cooling	✓ Spot cooling for parts or scientific applications.
		✓ Perfect for temperature calibration in precision detection systems.
8.	High reliability	✓ 100,000 hours + MTBF
9.	Dehumidification	✓ Efficient condensation of atmospheric water vapor

G. Configuration for P-N Junctions/No. of Couples

However, notice at the sides of an opened/unsealed thermoelectric device. Each individual column is a pellet. (Observe side view of the TEC Module) These thermoelectric pellets do the effective heat pumping work of a TE device. A thermoelectric device contains both P and N semiconductor pellets arranged in duos called Couples, so mostly there are double as multiple pellets as there are couples. For illustration, a single 127 couple TEC will actually contain 254 pellets (127 N and 127 P). Each of these pellets will have two solder connections making for a sum total of 508 solder joints!

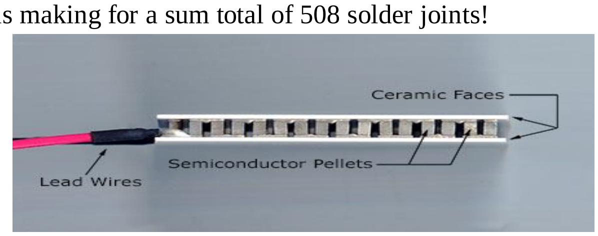


Fig. 8 Side view of an unsealed TEC module

Have a look from the side view of the Peltier and opposite the side from the wires. (See the image below) Count the no. of pellets that you see. It's generally an even number.
Use the following formula Couples = ((Count2)/ 2)-1
For sample, you count 12 pellets;
therefore (122/2)-1 = 71 couples.

Similarly**,** some commonly calculated values are given in the Table below: **-**

Table III
Calculation for Different No. of Pellets

Pellet Counts	*Couples in TEC*
4	7
6	17
8	31
10	49
12	71
14	97
16	127
18	161
20	199
22	241
24	287

IV. HEAT DISSIPATION USING FINS

A. Heat Sink Consideration

Instead of being a heat absorber that consumes heat by magic, a thermoelectric cooler is a heat pump which moves heat from one location to another. When electric power is applied to a TE module, one face becomes cold while the other is heated. In accordance with the laws of thermodynamics, heat from the (warmer) area being cooled will pass from the cold face to the hot face [14]. To complete the thermal system, the hot face of the TE cooler must be attached to a suitable heat sink that is capable of dissipating both the heat pumped by the module and Joule heat created as a result of supplying electrical power to the module. A warmth sink is an imperative a part of a thermoelectric cooling machine and its significance to overall machine overall performance need to be emphasized. Since all operational traits of TE gadgets are associated with warmth sink temperature, warmth sink choice and layout have to be taken into consideration carefully [15].
Several forms of heat sinks are available consist of natural convection, forced convection, and liquid-cooled. Natural convection heat sinks may prove satisfactory for very low power applications especially when using small TE devices operating at 2 amperes or less. A natural convection heat sink should be positioned so that (a) the long dimension of the fins is in the direction of normal air flow and (b) there are no significant physical obstructions to impede air flow. It is important to consider that other heat generating components located near the heat sink may increase the ambient air temperature, thereby affecting overall performance [15].

B. Fins and it's Effectiveness on Heat Transfer

Heat sink having various profiles namely Rectangular, Trapezoidal and inverted Trapezoidal also called as dovetail fin which are the commonly used devices for enhancing heat transfer in electronic components. The temperature along the inverted trapezoidal fins has the best performance (108%) with uniform distribution, while the temperature in the trapezoid fins increased in the positions near the base plate surface because of the complication in moving the heated air. Heat transfer coefficient from of the rectangular fins is higher by (89%) than the heat transfer coefficient of the trapezoidal fins [16].
The shape of the fins is important as they play a major role in the cooling system due to the passage of the air flow into the fins those parameters should be taking in consideration carefully when choosing or designing a heat sink. The number of fins should be optimized because it should be noted that adding more fins also decrease the distance between the adjacent fins [16].

The heat flows through the fins having the same base thickness increase as the values of the length become larger, so that the tapered fin has the lowest heat flow and the dovetail (inverted trapezoidal) fin the largest. It's concluded that the air flow through the inverted trapezoidal fins is much faster due to its geometrical shape that also implies that it is less heated as shown in figure. The inverted trapezoidal fins are also known as Dovetail Fins [17].

The analysis performed in fig. below is CFD Analysis (Computational fluid dynamics) which shows the flow of air & area of contact of air with fins. Researchers have shown that the trapezoid fins can improve heat transfer performance by at least 14% as compared to the rectangular fins, and it is expected that 20% or more improvements can be achieved through further acquisition of data. The SolidWorks Flow Simulation and the experimental data indicate that this could lead to significant improvements in overall performance. The heat transfer coefficient characteristics of rectangular, trapezoidal and inverted trapezoidal pin fin heat sinks subject to the influence of orientation are examined under natural convection [16].

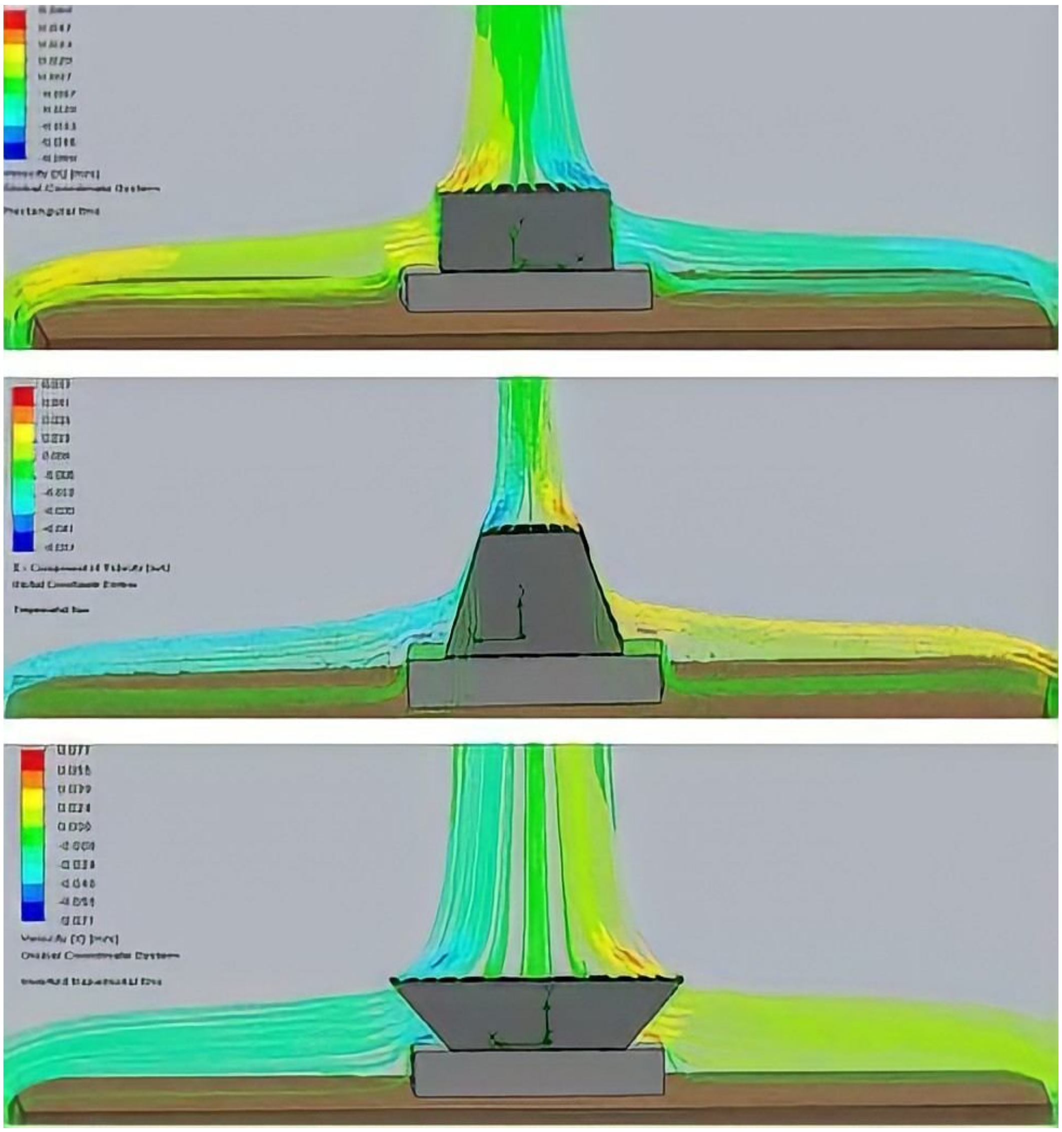


Fig. 9 Air flow simulation on various geometries of fins [16]

The results shows that there is improvement over the other by more than 20%. The heat transfer decreases with increase in length but is insensitive regarding fin thickness and fin height [16]. From fig.10 the heat transfer coefficient of the inverted Trapezoidal fins was way greater than original design which are the rectangular fins. This is because of its height and the smaller edges expose to the ambient air, and required some time to cool down the device. The trapezoidal design was more heated due to its wide part exposing to the air [16].

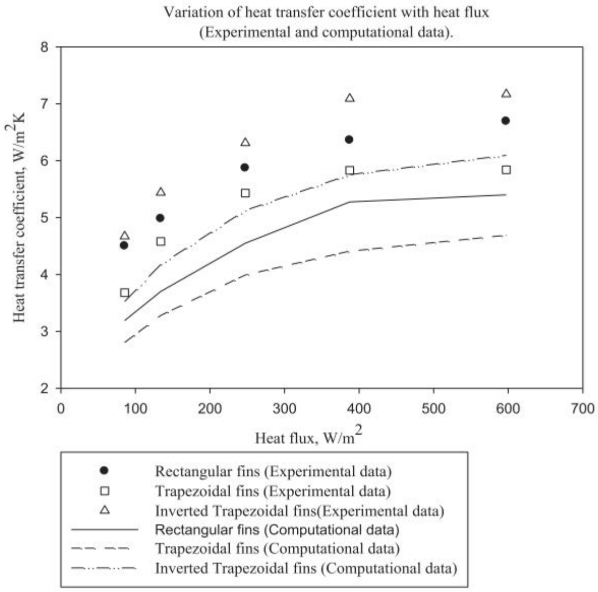


Fig. 10 Efficiency of the heat transfer coefficient with comparison to the heat flux [16]

From figure above (fig.10) the heat transfer coefficient of the inverted Trapezoidal fins was way greater than original design which are the rectangular fins. This is because of its height and the smaller edges expose to the ambient air, and required some time to cool down the device. The trapezoidal design was more heated due to its wide part exposing to the air [16].

V. LITERATURE VIEW

Thermoelectric system is determined by two major factor the material properties and the system. TEC work on material, module, construction, and application. Thermoelectric coolers can be used as power generation using low intensity energy sources if consideration is made for effects of exposure to high temperatures. They are fabricated in tec form the high-performance material available for that temperature range in tec module. Two TEC cooler are experimental test that this type of cooling mechanism has two main problem (1) providing negligible surface contact (2) the natural convection from taking place. they have a positive result to improve material properties and improving module shape and structure such as reducing thermal conductivity. Thermoelectric module has been used many areas such as automobiles, aerospace, and domestic sector. TEC would be an effective cooling and heating device with the proper design system. The proper mathematical model of tec need to obtain for more effectiveness performance of cooling and heating. And the thermal performance actual working environment. they provide the high conversion thermoelectric can provide at below temperatures. Power supply in tec module is D.C. and 12 voltages and 5A. further the new tec module when implementing new material with the higher thermal conductivity in fabricates of TEC device [18].

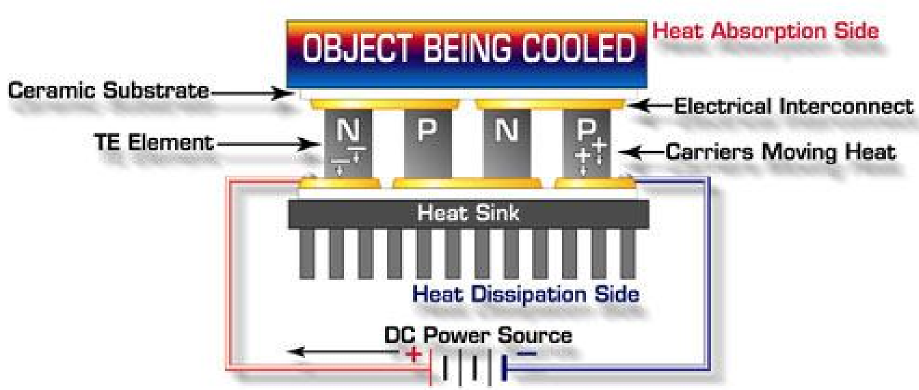


Fig. 11 **S**chematic diagram of cooling and heating of TEC module

Radiation is relatively in more case. Comparing Peltier module to different conventional heating/cooling devices, Peltier module has better power saving capability. Also, it is possible to control the output of a Peltier module by adjusting the voltage supply which is requirement in case human use. Peltier module are less bulky are portable and user friendly [19]. Although Peltier module have a reliability it overcome of most of the conventional heating/cooling devices such as a power consumption and portability and the same module. Since Peltier cooling is not efficient comparatively and due to its small size application, it is not widely used. It found its application only in electronics cooling etc. researcher are working on reducing irreversibility's in the systems because which we can see from the vast difference between value of the first law efficiency and second law. A tec cooling system has been designed and developed to effectively provide active cooling to the head without any element of safety [20]. A single 12-volt tec module was used which provide adequate cooling but less than 2 amp of currant from the power system. Cooling of the head is established the most efficient method of cooling of the body material should be studied to get better performance of tec module.

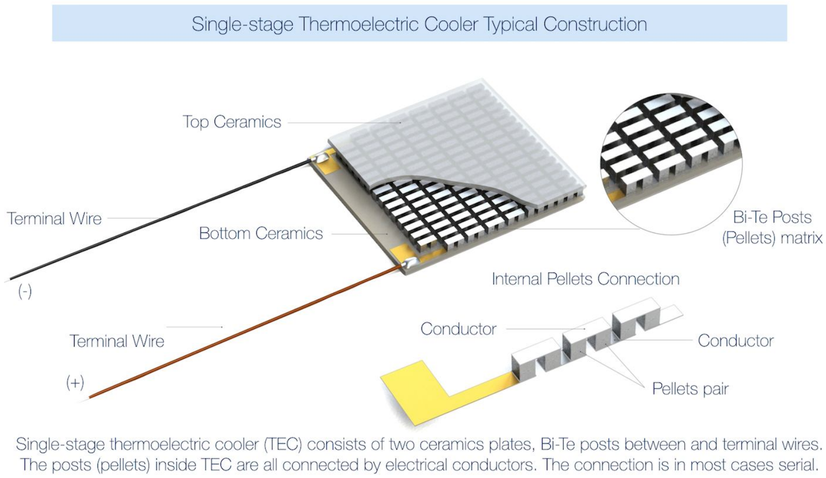


Fig. 12 Single stage module of TEC device

TEC would be an effective cooling and heating device with the proper design system. Thermoelectric devices involve tec and thermoelectric generation. This work focus on tec that generates a temperatures difference when it is supplied with electrical power due to the Peltier effect. Tec is preferable and has been used frequently in recent years because of its small weight, low cost, and environmental friendliness. Tec can work without being connected to a grid, and it has low noise and vibration. It is also easy maintain. The properties of thermo-elements and the main parameter such as cop and cooling capacity, were discussed separately [21]. The results showed that increasing the size and reducing the contact resistance improve parameter. This review mentioned the application used for this purpose. A limited application range was noted due to the low cop of tec improvement of this parameter was discussed together with tec application. Such as refrigerator, cooling for electronic components and as a sensor. In the use of thermoelectric device in power generation was presented. Tec device have the same structure as tec and could have a high potential for use as a future power generation green source.

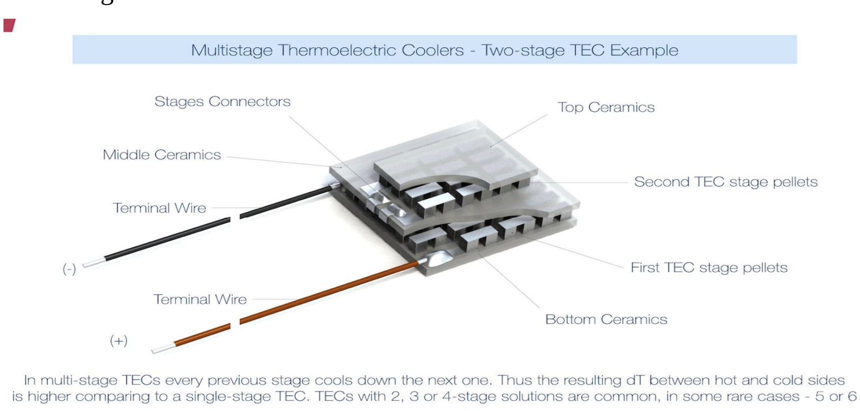


Fig. 13 Multistage module of thermoelectric cooler

The development of a homemade high voltages power supply enabled to gratings in the dispersion of turning point of thermoelectric cooler. Tec provide of automatically controlling the power of a thermoelectric cooler system to maximum net cooling for heat sink performance can quick as testing individual single stage of tec module. The experimental optimum power level was very complicated because it was not only dependent on the hot side of the tec module but also on the air flow rate. It can also provide the tec material can be used in an effective of tec module to the determined the cooling performance of the any thermal and electric condition. It is suggested that the thermoelectric module be tested to determine its physical properties and the performance curves, especially when the manufacturer is not able to provide the basic data of a thermoelectric module [22]. The test facility can be simple if time or budget is limited. Basically, the results from a simple thermal conduction. thermoelectric will not be a serious candidate for high performance electronic cooling application. It is hoped that the work that is being done on development of imploded thermoelectric materials and thin film thermoelectric will ultimately alter this situation. The cooling used in the present study can be replaced by a high-performance heat sink with a DC cooling.

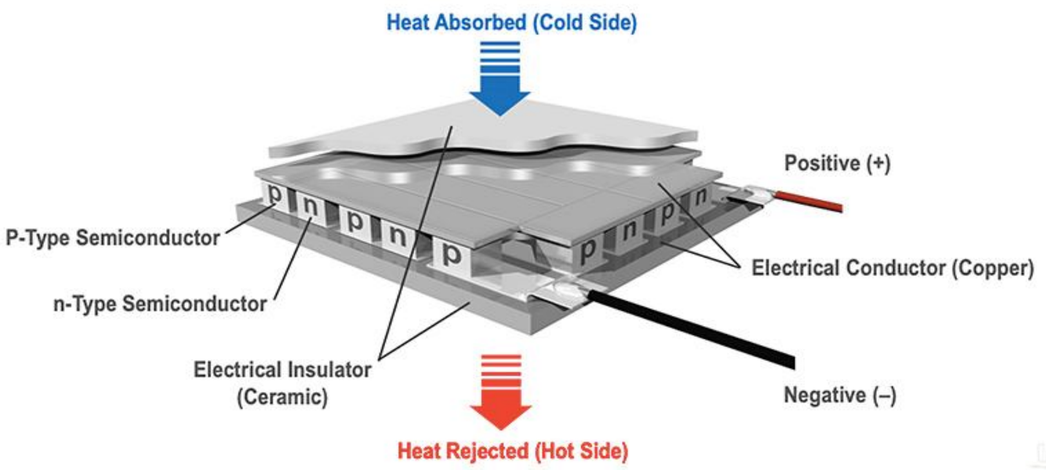


Fig. 14 A diagram of a TEC when electric current passed through a join two ceramic insulators.

TEC module was used as an alternative method to reduce the operating temperature. TEC component is important because it affects the entire application that uses it thermoelectric coolers are usually controlled by varying the voltage/current. Thermal electricity is a phenomenon that produces heat from a DC power supply and vice versa by using the Peltier effect. Heat with low efficiency can generate tec quality depending on parameters. The present air conditioning system produces cooling effect by refrigerants like Freon, Ammonia, etc. Using these refrigerants can get maximum output but one of the major disadvantages is harmful gas emission and global warming. This problem can be overcome by using thermoelectric modules (Peltier effect) air-conditioner and they're by protecting the environment. Thermoelectric air conditioner using different modules is discussed. Peltier cooling module which works on thermoelectric refrigeration to provide cooling by using thermoelectric effects. There are three types of thermoelectric effects. See back effect, politer effect, Thomson effect. From these three effects on Peltier cooler works on Peltier effect. Which seats that when voltages applied to junction of dissimilar electric conductor, heat absorbers from one junction and heat are rejected at another junction [23].

A thermoelectric device created voltage when there is a different temperature on each side. Thermoelectric coolers can be used effectively as power generators. TEC module to convert heat flow to DC power with the highest level of performance thermoelectric can provided. TEC modules normally designed for cooling are the best choice for these applications because they are manufactured form materials of highest efficiency at these nominal temperatures. Thermoelectric module (TEM) is a device that environmentally friendly utilizing for cooling and heating application such as heat pump and power generation. The understanding of relation between electrical conductivity and heat conductivity of the TEC material is essentially to improve the coefficient of performance. Thermoelectric modules are solid state heat pumps that utilize the Peltier effect. During operation DC current flows through the thermoelectric module causing heat to be transferred from one side of the thermoelectric device to other creating a cold and hot side. A thermoelectric cooling system I am power source to provide a direct current through the electrical circuit a thermoelectric module with at least one heat sink and at least one heat source and a control assembly. This section a basic understanding of the performance of a thermoelectric module [24].

VI. CONCLUSIONS

In this work Peltier cooling is not efficient comparatively and due to its small size application, it is not widely used. It found its application only in electronic cooling but we have seen that there is huge scope of research in this field about thermoelectric material its fabrication, heat sink design etc. researcher is working on reducing irreversibleness in system because of Peltier cooler has more potential which we can see from vast difference between the value.

VII. ACKNOWLEDGMENT

A. This review paper was supported by (Prof. Kunalsinh Kathia), who provide insight and expertise knowledge that greatly assisted the review paper.

B. We thank to our (Design Engineering team) for assistance with all new techniques like methodology literature review etc. that we learn from them and improve our knowledge.

C. We would also like to show our Gratitude to (Prof. Kunalsinh Kathia) professor in (mechanical engineering department) of (saffron institute of technology) for sharing their pearls of wisdom with us during the course of review paper.

REFERENCES

[1] Ankur Mishra, Manoj Kumar, Peltier Thermoelectric Cooling Module, Global Journal for Research Analysis: Volume-7, Issue-2, February-2018.

[2] E. K. Viegas, A. O. Santin, and L. S. Oliveira, “Toward a reliable anomaly-based intrusion detection in real-world environments,” Compute. Networks, vol. 127, pp. 200–216, 2017.

[3] Che M.H. Elsheikh, D. Shnawah, M. Sabri, S. Said, M. H. Hassan, M.A. Bashir and M. Mohamad, Renew. Sust. Energ. Rev., **30**, 337-355, (2014).

[4] S. Sharma, V.K. Dwivedi, S.N. Pandit, Int J. of Green Energy, 11, 899–909, (2014).

[5] Aqilah Che Sulaiman, Nasrul Amri Mohd Amin, Mohd Hafif Basha, Mohd Shukry Abdul Majid, Nashrul Fazli bin Mohd Nasir and Izzuddin Zaman, MATEC Web Conf. of Volume 225, 2018, UTP-UMP-VIT Symposium on Energy Systems, https://doi.org/10.1051/matecconf/201822503021.

[6] *Chem.Rev.* 2020, 120, 15, 7399–7515, https://doi.org/10.1021/acs.chemrev.0c00026.

[7] S. Twaha, J. Zhu, Y. Yan, B.Li, Renew. Sust. Energ. Rev., 65, 698-726, (2016).

[8] *D. Enescu, E. O. Virjoghe, Renew. Sust. Energ. Rev., 38 903–916, (2014).*

[9] Lv, Song, Zuoqin Qian, Dengyun Hu, Xiaoyuan Li, and Wei He. 2020. "A Comprehensive Review of Strategies and Approaches for Enhancing the Performance of Thermoelectric Module" *Energies* 13, no. 12: 3142. https://doi.org/10.3390/en13123142.

[10] Wan Iman Wan Mohd Nazi, Yaodong Wang, Haisheng Chen, Xinjing Zhang, Anthony Paul Roskilly, Energy Procedia, Volume 142, 2017, https://doi.org/10.1016/j.egypro.2017.12.632.

[11] Yu, J. J., Xing, Y. F., Hu, C. L., Huang, Z. J., Qiu, Q. Y., Wang, C., Xia, K. Y., Wang, Z. Y., Bai, S. Q., Zhao, X. B., Chen, L. D., Zhu, T. J., Half-Heusler Thermoelectric Module with High Conversion Efficiency and High-Power Density. *Adv. Energy Mater.* 2020, 10, 2000888. https://doi.org/10.1002/aenm.202000888.

[12] Nagesh Kudva, Veeresha R K, & Muralidhara (2020). A Review on Thermoelectric (Peltier) Module. International Journal of Progressive Research in Science and Engineering, 1(4), 212-216. https://www.journals.grdpublications.com/index.php/ijprse/article/view/134.

[13] V. Deshmukh, A. Dharme, M. Gaikwad, C. H. Moghe and C. Patil, “Air Conditioning System in Car Using Thermoelectric Effect” International Journal for Research in Applied Science & Engineering Technology, Vol. 5 Issue VI, pp. 89-95, June 2017.

[14] Xia, G.; Zhao, H.; Zhang, J.; Yang, H.; Feng, B.; Zhang, Q.; Song, X. Study on Performance of the Thermoelectric Cooling Device with Novel Subchannel Finned Heat Sink. *Energies* 2022, *15*, 145. https://doi.org/10.3390/en15010145.

[15] Mark Baldry, Victoria Timchenko, Chris Menictas, Optimal design of a natural convection heat sink for small thermoelectric cooling modules, Applied Thermal Engineering, Volume 160, 2019, https://doi.org/10.1016/j.applthermaleng.2019.114062.

[16] R. Charles and C. Wang, "An optimized heat dissipation fin design applicable for natural convection augmentation (IMPACT 2014)," 2014 9th International Microsystems, Packaging, Assembly and Circuits Technology Conference (IMPACT), 2014, doi: 10.1109/IMPACT.2014.7048391.

[17] S B J Gireesha *et al* 2021 *Phys. Scr.* 96 125209 doi: 10.1088/1402-4896/ac1e5d/meta.

[18] B.N Dulnev, E.M. Semyashkin, “Heat exchange in radioelectrics devices” Energiya, Leningrad, in Russian.

[19] B.J. Huang, C.J. Chin, C.L Duang “A design method of thermoelectric cooler", international journal of Refrigeration 23(20C.218).

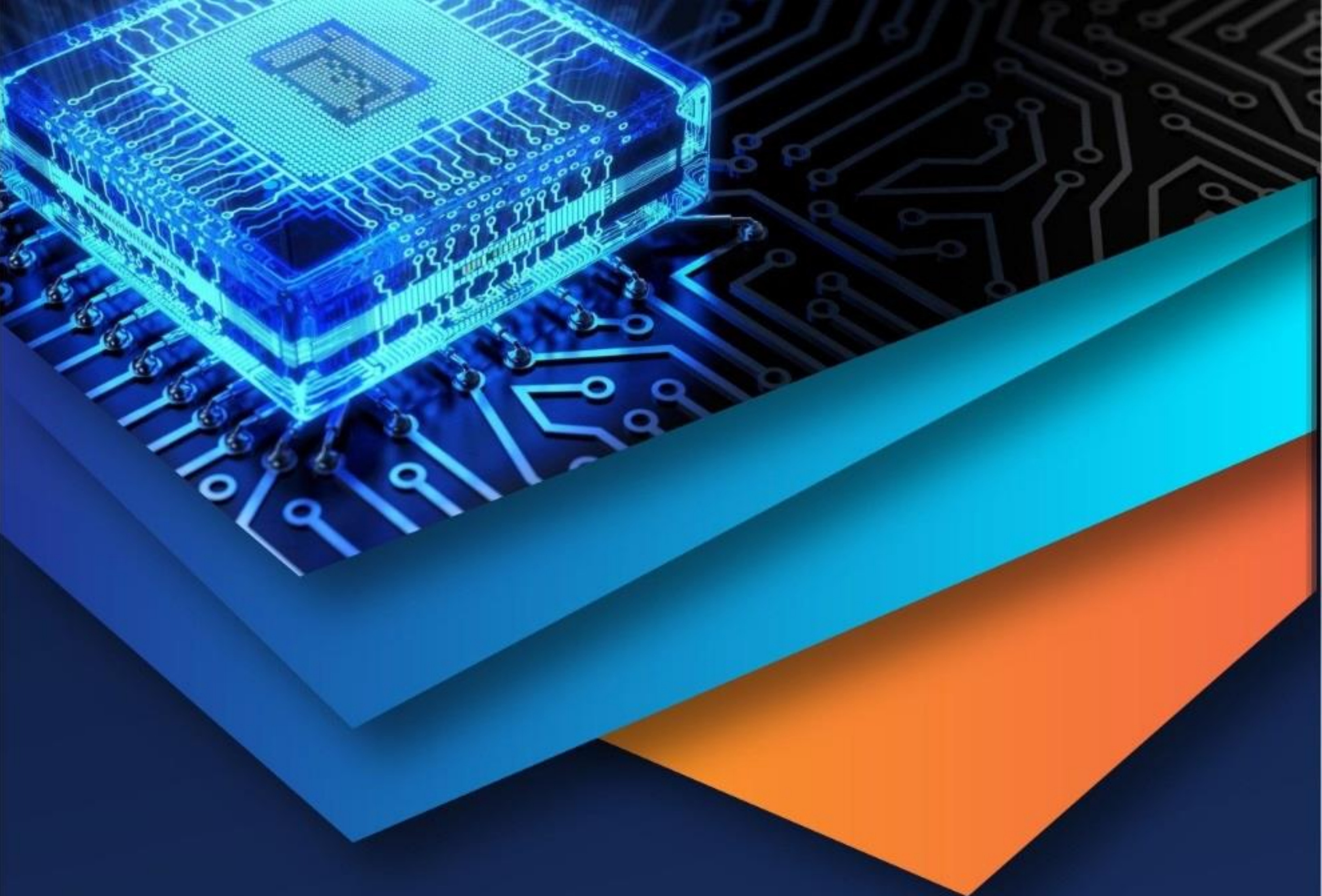
[20] U pau and p. Adour, Energy conversion and management (140,167-181,2017).

[21] Kolander, W.L, and Lyon, H.B, “Thermoclcctric cooler Utility for Electronic Applications”, ASME HTD- vol. (239).

[22] P.J. patil and prof A.M. Patil “Review on thermoelectric devices, IJETAE, vol,3, issue (10,2013).

[23] Benziger B, Anu nair P& Balakrishan P, review paper on thermoelectric airconditioner using peltier module IJME, volBa9,56, (2015).

[24] R.J. Buist “A new method for testing thermoelectric materials and devices”, Proceeding of the XI international Conference on thermoelectrics, October (7-9 1992) Arlington TX U.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY