IJARSCT ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Impact Factor: 6.252 Volume 2, Issue 8, June 2022

Design and Manufacturing of Automotive Air Conditioning System to Remove the Fog using TEG/TEC Effect

Prof. S. A. Gurav[1], Mr. Shailesh S. Dongardive[2], Mr. Prathmesh A. Potdar[3], Mr. Manthan A. Wadkar[4], Mr. Saurabh Y. Pasalkar[5]

Assistant Professor, Mechanical Engineering, NBNSSOE, Pune, India[1]

UG Student, Mechanical Engineering, NBNSSOE, Pune, India[2,3,4,5]

Abstract: *Fog is a natural weather condition that can cause visibility to become zero. It can cause vehicle accidents. Nowadays the air conditioners are very efficient and reliable but it has some demerits. According to the International Institute of Refrigeration, air conditioning and refrigeration consumes around 15% of the total worldwide electricity and also contributes to the emission of CFCs, HCFCs, and CO2 etc. Due to the use of such refrigerants it leads to many harmful effects to our environment i.e., global warming. For air conditioning use of fuel also increases and all these are affecting the car efficiency. To overcome the problem of emission and fulfil the mismatch between the demand and supply of energy consumption the thermoelectric Air conditioning can be used. This system is not going to be noisy, there will be no hazardous emission to the environment so the system is totally eco-friendly. As the Peltier module is quite compact in size the design can be easily acquired according to space and need.*

Keywords: Refrigeration, Peltier Plate, Peltier Effect, Seebeck effect, etc.

I. INTRODUCTION

A thermoelectric module is an electrical module, which produces a temperature difference with current flow. The emergence of the temperature difference is depending on the Peltier effect designated after Jean Peltier. The thermoelectric module is a heat pump and has similar function as a refrigerator. It gets along however without mechanically small construction units (pump, compressor) and without cooling fluids. The heat flow can be turned by reversal of the direction of current. Thermoelectric cooling provides an alternative solution to the common compressor and absorber cooler. Thermoelectric coolers are used especially if small cooling power is required up to 500 W.

II. LITERATURE SURVEY

Akshay Thalkar, Pranav Vaidya, Sagar Nikam; Study of Thermoelectric Air Conditioning for Automobiles. Air conditioning systems is used in many automobile applications. The conventional process using refrigerant can cause serious problems to the environment. In this study we developed the air conditioning system based on thermoelectric properties. In this air conditioning, there is no use of compressor and pump for the refrigeration. Thermoelectric module is an electrical module, which produces a temperature difference while current flow. The emergence of the temperature difference is based on Peltier effect.

The thermoelectric module is a heat pump and has the same function as a refrigerator. The heat flow can be turned by reversal of the direction of the current. Our aim is to introduce the new HVAC system using thermoelectric module which shall overcome all the disadvantages of existing HVAC system. Santosh Doifode Prof. A. M. Patil; Review of Thermoelectric Air to Air Cooling for Cars today, an automobile is a necessity for everyone.

For a long or short journey people need car regard to the safety, environment and most important comfort. Owing to these reasons, many vehicles are equipped with heating, ventilating and air conditioning system. In today's world, no one feel comfortable in a vehicle without HVAC system. Therefore, HVAC becomes an integral part of human life. Today's present HVAC system is very efficient and reliable but it has some demerits. It has been observed during the last two decades that the O3 layer is slowly destroyed because of the refrigerant (CFC and HFC) leakage to atmosphere. Other demerits include. The compressor is driven by the crankshaft of the engine. So, it consumes about 5 to10% power of the engine.

The cost of present HVAC system is very high; Maintenance and repairing cost of this system is very high. to overcome these demerits by replacing the existing HVAC system by newly emerging thermoelectric couple or cooler. This works on peltier and seebeck effect. Thermoelectric cooling can be considered as one of the major applications of thermoelectric modules (TEM) or thermoelectric coolers (TEC). The main objective of this project is to design a cooling system installed on a conventional blower of car AC. The idea of cooling is based on Peltier effect, as when a dc current flows through TE modules it generates a heat transfer and temperature difference across the ceramic substrates causing one side of the module to be cold and the other side to be hot. The purpose of the project is to make use of the cold side to cool the ambient air to a lower temperature, so that it can be used as a personal cooler. Testing and measurements will be performed using on car (Maruti 800). The fact is the TE cooling for car can lower the ambient temperature by 7 degrees Celsius.

Manoj S. Raut, Dr. P. V. Walke; Thermoelectric Air Cooling for Cars As a mechanical engineer I am trying to overcome these demerits by replacing the existing HVAC system by newly emerging thermoelectric couple or cooler which works on peltier and seebeck effect. Thermoelectric cooling can be considered as one of the major applications of thermoelectric modules (TEM) or thermoelectric coolers (TEC). The main objective of this project is to design a cooling system installed on a conventional blower of car AC. The idea of cooling is based on Peltier effect, as when a dc current flows through TE modules it generates a heat transfer and temperature difference across the ceramic substrates causing one side of the module to be cold and the other side to be hot. The purpose of the project is to make use of the cold side to cool the ambient air to a lower temperature, so that it can be used as a personal cooler. Testing and measurements are also performed using on car (Maruti Suzuki Zen). A simple temperature controller to interface with the cooling system has also been incorporated. Based on an analysis of sizing and design of the TEC air cooling for car, it can be deduced that the cooling system is indeed feasible. Readings taken during testing also testify to the fact that the TE cooling for car can lower the ambient temperature by 7 degrees Celsius.

Ssennoga Twaha, Jie Zhu, Yuying Yan, Bo Li; A Comprehensive Review of Thermoelectric Technology: Materials, Applications, Modelling and Performance Improvement The drastic changes in climate have driven the need for increasing research into alternative sources of energy. Those rapid changes in climate are mainly attributed to the use of fossil fuels for transport and energy generation. Due to climatic challenges, several countries around the world have pledged to reduce primary energy consumption through an increase of efficiency in production, distribution and end-use, limit carbon dioxide emissions and increase the utilization of renewable energy sources. The rapid development of power electronics technologies has enabled the realization of high energy-efficient systems such as electric vehicles.

The U.S. Energy Administration in 2011 estimated that almost two-thirds of total demand for petroleum is from the transportation sector. With an assumption that daily production of petroleum holds steady at 63.5 million barrels, global oil reserves are conventionally predicted to last approximately fifty years. In the French industry, 75% of the final energy is used for thermal purposes such as furnaces, reactors, boilers and dryers. However, around 30% of this heat is assumed to be wasted in form of discharged hot exhaust gas, cooling water and heated product. Therefore, the recovery and utilization of the waste heat is believed to contribute some amount of energy to the energy needs of the society.

Research and development have been promoted on thermoelectric (TE) modules which convert heat energy directly into electrical energy. TE devices are semiconductor devices that have the ability to either generate a voltage when exposed to a temperature gradient, exploiting the Seebeck effect, or produce a temperature gradient when supplied by electricity, exploiting the Peltier effect. A number of currently available and applicable low-grade waste heat recovery methods include plant/district/water heating, direct power generation (TE and piezoelectric), absorption cooling, indirect power generation (steam and organic Rankine cycle), desalination/clean water and biomass colocation.
TE technology is seen as one of the most promising direct power generation techniques used to recover waste heat energy because of the direct conversion from thermal energy to electrical energy, unlike the organic Rankine cycle, believed to have been discovered more than 150 years ago. Heat energy can be harvested or recovered using two direct electricity generation strategies: thermoelectricity and pyro electricity. Whereas thermoelectricity is the generation of electricity using thermoelectric harvesting systems which exploit the Seebeck effect for conversion of heat energy i.e., generation of electricity due to difference in temperature of two dissimilar conductors or semiconductors connected together at two junctions, pyro electricity exploits specific materials whose structures are modified when heat is applied on them and in turn the polarization of the material is changed, thus creating electric potential.

Khaled Teffah, Youtong Zhang and Xiao-long Mou; Modeling and Experimentation of New Thermoelectric Cooler–Thermoelectric Generator Module In this work, a modeling and experimental study of a new thermoelectric cooler–thermoelectric generator (TEC-TEG) module is investigated. The studied module is composed of TEC, TEG and total system heat sink, all connected thermally in series. An input voltage (1–5 V) passes through the TEC where the electrons by means of Peltier effect entrain the heat from the upper side of the module to the lower one creating temperature difference; TEG plays the role of a partial heat sink for the TEC by transferring this waste heat to the total system heat sink and converting an amount of this heat into electricity by a phenomenon called Seebeck effect, of the thermoelectric modules. The performance of the TEG as partial heat sink of TEC at different input voltages is demonstrated theoretically using the modeling software COMSOL Multiphysics. Moreover, the experiment validates the simulation result which smooths the path for a new manufacturing thermoelectric cascade model for the cooling and the immediate electric power generation.

F Susanto, A T A Salim, N Romandoni1, N Wahyudi1, B Indarto, Z M A Junaedi1, K A Basyar1, J A Furqan1, G A B Putra1; Application of Thermoelectric Generator TEG Type Parallel Series Electric Circuit Produces Electricity from Heat Rocket Stove In rocket stove, wood is burned in a simple combustion chamber. This combustion chamber is connected by chimneys and air holes. Several studies have been carried out to utilize the heat generated by combustion of rocket stove, namely thermoelectric generators. Thermoelectric generators are electrical generator devices that convert heat energy or temperature differences into electrical energy using a phenomenon called the seebeck effect.
The thermoelectric generator used in this study is TEG SP1848. How this tool works is a compilation of combustion occurs on a rocket stove then the copper pipe which is wrapped around a rocket stove flowed by water also rises in temperature, and the circulation of water from the chamber passes through a copper pipe, within 30 minutes the water in the chamber reaches 90ºC ± then it is done from the power generated by the TEG connection then the test is done by loading a resistor of 1kΩ-10kΩ. the highest generator efficiency values obtained at the 5k ohm resistor reached 5.38% of the left TEG. For TEG the right side of generator efficiency tends to be stable. The highest value of the right-side TEG generator efficiency is obtained at 0.48% at 2k ohm resistance. Rocket stove is a stove that uses small size/diameter wood as fuel. On a rocket stove, wood is burned in a simple combustion chamber.

This combustion chamber is connected with a chimney and air holes. Thermoelectric generator (TEG) is a type of energy generator that is based on the Seebeck effect, which in essence in the existing system in a thermoelectric generator is, if there are two metal materials (generally semiconductors) which then continue to exist in an environment with different temperatures then in this material an electric current or electric motion will flow [2]. In previous research on using a thermoelectric generator by considering the difference in temperature and the resistance variable. The heat used in this study, from the heat source of rocket stove combustion and heat sink cooler, the results obtained in this study are the highest voltage value = 12.62 V and the highest current value = 0.087 A so that the power value is 0.00209 Watt with 10 TEG in series, the obstacles faced by this research are the electric current produced is too small and the chamber water overflows when using the test. ICIASGA 2020 Journal of Physics: Conference Series 1845 (2021) 012036 IOP Publishing doi:10.1088/1742-6596/1845/1/012036 2 From previous research, we did assembly for chamber design and by adding TEG and parallel circuits to deliver the current generated from the TEG test. The heat source used is from the heat of the combustion chamber in the rocket stove. In this study, the heat sink size was enlarged so that the cooling on the cold side of the TEG was maximized so that a high temperature difference was obtained.

Zhe Zhang, Yuqi Zhang, Xiaomei Sui, Wenbin Li and Daochun Xu; Performance of Thermoelectric Power-Generation System for Sufficient Recovery and Reuse of Heat Accumulated at Cold Side of TEG with Water-Cooling Energy Exchange Circuit Aiming to reduce thermal energy loss at the cold side of a thermoelectric generator (TEG) module during thermoelectric conversion, a thermoelectric energy conversion system for heat recovery with a water-cooling energy exchange circuit was devised. The water-cooling energy exchange circuit realized sufficient recovery and reuse of heat accumulated at the cold side of the TEG, reduced the danger of heat accumulation, improved the stability and output capacity of thermoelectric conversion, and provided a low-cost and high-yield energy conversion strategy in energy conversion and utilization.

Through the control variable method to adjust the heat generation of the heat source in the thermoelectric conversion, critical parameters (e.g., inner resistance of the TEG, temperatures of thermoelectric modules, temperature differences, output current, voltage, power, and efficiency of thermoelectric conversion) were analyzed and discussed. After using the control variable method to change the ratio of load resistance and internal resistance, the impacts of the ratio of load resistance to inner resistance of the TEG on the entire energy conversion process were elaborated. The results showed that the maximum value of output reached 397.47 mV with a current of 105.56 mA, power of 41.96 mW, and energy conversion efficiency of 1.16%. The power density of the TEG module is 26.225 W/m2.

The stability and practicality of the system with a water-cooling energy exchange circuit were demonstrated, providing an effective strategy for the recovery and utilization of heat energy loss in the thermoelectric conversion process. motivated by the broad prospects of thermoelectric conversion technology, such as thermoelectric conversion, the thermoelectric recovery of heat in industry, and thermoelectric energy supply for microelectronic systems, the principles and applications of thermoelectric energy conversion have been widely researched. Unlike the conversion of the kinetic energy of hydropower or wind power into mechanical kinetic energy, which is then converted into electrical energy, thermoelectric conversion technology directly converts thermal energy into electrical energy without requiring another energy transfer process.

Thermoelectric conversion technology, therefore, has obvious advantages over other energy conversion technologies, such as a long service life, no noise, low cost, and environmental protection. On this basis, thermoelectric conversion technology has been widely adopted in energy conversion processes in the aerospace, aviation, and civil industries.

Seyed Mohsen Pourkiaei, Mohammad Hossein Ahmadi, Milad Sadeghzadeh, Soroush Moosavi, Fathollah Pourfayaz, Lingen Chen, Mohammad Arab Pour Yazdi, Ravinder Kumar; Thermoelectric cooler and thermoelectric generator devices: A review of present and potential applications, modeling and materials

Increasing the production of energy in line with industry development, transportation, and life quality improvement is an interesting topic needs to be addressed. Energy policymakers and researchers have aimed at energy management, particularly by improving energy systems performance. This review paper explains the rising interest of thermoelectric technology and applications. Nowadays, thermoelectric technology such as thermoelectric generators (TEGs) and thermoelectric cooling systems (TECs) provide heat loss recovery of thermodynamic units for power production of remote areas. Unlimited solar energy can also be employed for thermoelectric power production.

This paper describes the principles of thermoelectricity and presents an explanation of current and upcoming materials. Developed models and various performed optimization of thermoelectric applications by using non-equilibrium thermodynamics and finite time thermodynamics are discussed as well. Additionally, a number of topical applications and energy resources are introduced. The main goal of this study is to give a clear overview of thermoelectric technology and applications.

III. IMPLEMENTATION

After the study of thermoelectric refrigeration system, we could demonstrate the cooling ability of the Peltier module and its use as an alternative to refrigerant-based cooling systems. The study concludes that there is a no. of places where TEC can play a more promising role than the conventional ACs with the added advantage of not using the refrigerants and hence protecting the ozone layer. With its reliable cooling and precise temperature control, this solid-state cooling technology can replace conventional cooling in a multitude of applications. Also, with the advancements in material technology, there shall be a drastic rise in the cooling performance. This project was just an effort to demonstrate the need and means of replacing the conventional systems due to their adverse environmental effects and to highlight the future scope of the Thermoelectric Cooling Devices.

IV. CONCLUSION AND DISCUSSION

With its reliable cooling and precise temperature control, this solid-state cooling technology can replace conventional cooling in a multitude of applications. Also, with the advancements in material technology, there shall be a drastic rise in the cooling performance.

REFERENCES

1. Akshay Thalkar, Pranav Vaidya, Sagar Nikam; "Study of Thermoelectric Air Conditioning for Automobiles", Volume: 05 Issue: 01 | Jan-2018
2. Santosh Doifode Prof. A. M. Patil; "Review of Thermoelectric Air to Air Cooling for Cars", Volume 3, Issue 4, April 2014
3. Manoj S. Raut, Dr.P. V. Walke; "Thermoelectric Air Cooling for Cars", Vol. 4 No.05 May 2012
4. Ssennoga Twaha, Jie Zhu, Yuying Yan, Bo Li; "A Comprehensive Review of Thermoelectric Technology: Materials, Applications, Modelling and Performance Improvement", July 2016
5. Khaled Teffah, Youtong Zhang and Xiao-long Mou; "Modeling and Experimentation of New Thermoelectric Cooler–Thermoelectric Generator Module", March 2018 F Susanto, A T A Salim, N Romandoni1, N Wahyudi1, B Indarto, Z M A Junaedi1,
6. K A Basyar1, J A Furqan1, G A B Putra1; "Application of Thermoelectric Generator TEG Type Parallel Series Electric Circuit Produces Electricity from Heat Rocket Stove", ICIASGA 2020
7. Zhe Zhang, Yuqi Zhang, Xiaomei Sui, Wenbin Li and Daochun Xu; "Performance of Thermoelectric Power-Generation System for Sufficient
8. Recovery and Reuse of Heat Accumulated at Cold Side of TEG with WaterCooling Energy Exchange Circuit", October 2020
9. Seyed Mohsen Pourkiaei, Mohammad Hossein Ahmadi, Milad Sadeghzadeh, Soroush Moosavi, Fathollah Pourfayaz, Lingen Chen, Mohammad Arab Pour

10. Yazdi, Ravinder Kumar; "Thermoelectric cooler and thermoelectric generator devices: A review of present and potential applications, modeling and materials", vol. 186, November 2019
11. Dongliang Zhao, Gang Tan; "A review of thermoelectric cooling: Materials, modelling and applications", INIS volume 46, Issue 9, 2014
12. Bao Yang, Herwin Ahuja, Thanh N. Tran; "Thermoelectric Technology Assessment: Application to Air Conditioning and Refrigeration", Volume 14, Issue 5, February 2011
13. Aklilu Tesfamichael Baheta, Kar Kin Looi, Ahmed Nurye Oumer, Khairul Habib; "Thermoelectric Air-Conditioning System: Building Applications and Enhancement Techniques", Volume 27, No. 2, June 2019.