The Study of the Applications of the Thermoelectric Generator

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ABSTRACT: ***Equipment which create heat during operation their heat may be utilized for other purpose, electricity can be produced via this heat with the aid of generator called thermoelectric generator (TEG). Heating equipment like car, stoves, heater, boiler ovens generate significant quantity of waste heat. Heat disperse via these equipment's goes underutilized, due of the waste heat of gadget their efficiency decreased day by day. This article discusses how waste heat of the equipment may can utilized in appropriate manner, for making this feasible usage of TEG. Application of the heat develop throughout any process may be take in use for producing electricity and provide it with the assistance of substation. Thermoelectric generator use to create electricity with the aid of heat and its use in future is very much as heat is generated from many locations such as car, any industrial operation, and thermal power station etc. thus heat developing from those used to make electricity.***

KEYWORDS: ***Heat, Global Warming, Thermoelectric Generator, Transformer, Thermal Power Plant.***

1. INTRODUCTION

A thermoelectric generator (TEG), sometimes termed a See beck generator, is a solid state device that transforms heat flow (temperature differential) directly into electrical energy via a phenomena called the See beck effect (a type of thermoelectric effect) (a form of thermoelectric effect). Thermoelectric generators operate like heat engines, but are less bulky and have no mechanical components. However, TEGs are usually more costly and less efficient. Thermoelectric generators may be used in power plants to convert waste heat into extra electrical power and in cars as automotive thermoelectric generators (ATGs) to improve fuel economy. Radioisotope thermoelectric generators utilize radioisotopes to create the necessary heat difference to power space missions.

It has been seen that 20 to 50 percent of the amount of energy goes wastage of heat. Decrease in the efficiency of hardware day by day heating issue of the device is among the troubles for decrease in effectiveness and percentage increase in maintenance cost[1]. Thermoelectric generator take in use nowadays with resolving the problem because of heat. Thermoelectric devices are devices which transform heat energy into electricity also electric energy to heat energy[2]. Conversion of solar energy to electricity is today very large in demand lots of invention and experiment were done to improve the efficiency of the solar panel, therefore if photovoltaic and thermoelectric effect join together then possibilities of high efficiency from a device. PV absorbs approximately 58 percent of solar energy between 200 and 800 nm, while the remainder of the solar energy in the region of 800 nm up to around 2500 nm may be transformed by the thermoelectric effect [3] .

1.1 Thermoelectric generator:

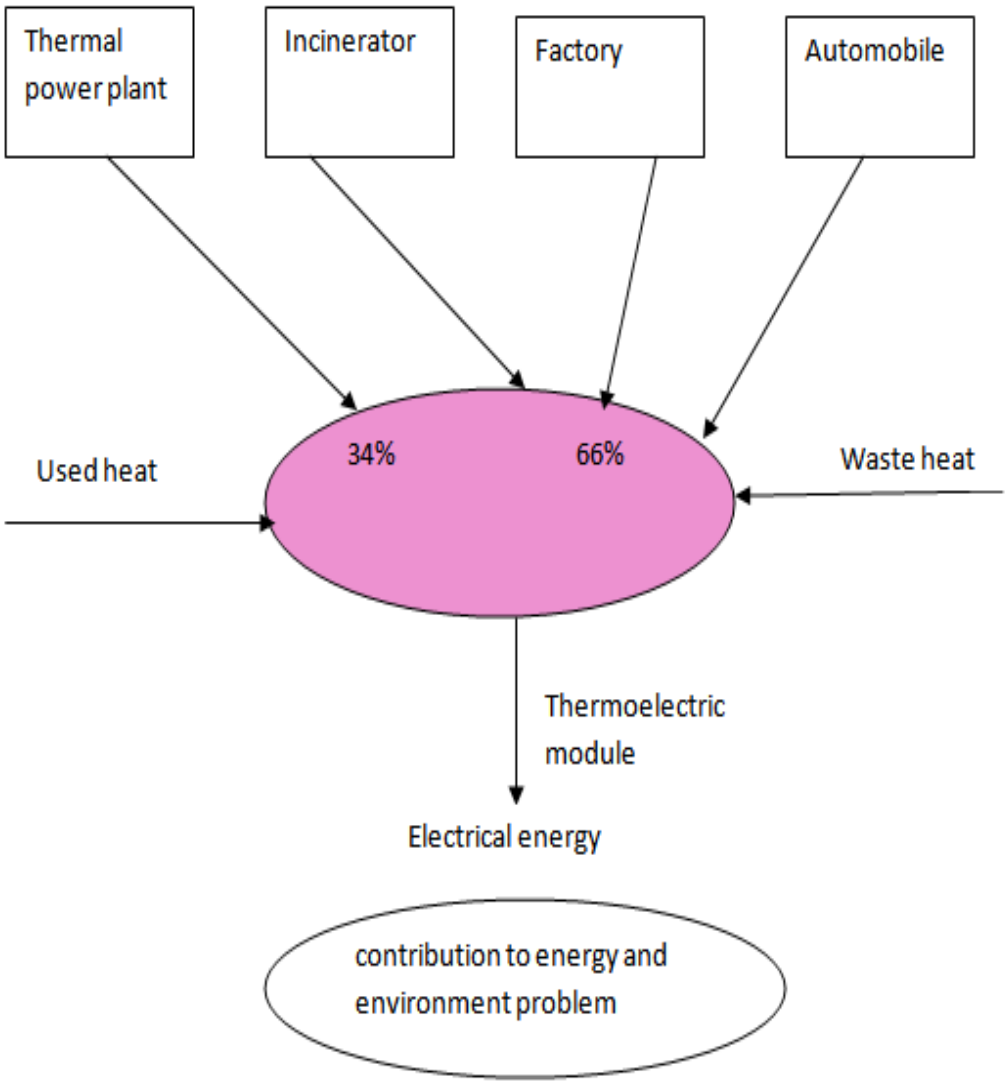
Thermoelectric generators are built out of semiconductors which operates on the basis of thermoelectric effect. Thermoelectric effect enables equipment to convert thermal energy into electrical energy or electric power, this effect includes the process by which heat is converted to electrical energy [4]. If the heat conversion process is thermodynamically reversible then this phenomenon called as see beck effect which accomplished in thermoelectric production. One of example of thermoelectric effect is commercial wrist watch in which it will take advantage of the heat differential between the human body and surroundings. Conversion of solar energy to electricity is today very large in demand lots of innovation and experiment were done to improve the efficiency of the solar panel, therefore if photovoltaic and thermoelectric effect join together then possibilities of high efficiency from a device. PV absorbs approximately 58 percent of solar energy between 200 and 800 nm, while the remainder of the solar energy in the region of 800 nm up to around 2500 nm may be transformed by the thermoelectric effect [3]. Fig. 1 energy conversion from various sources using TEG device. Efficiency of thermoelectric material is determined by this formula:

$$ZT=\sigma S2T/\kappa$$

σ = Electrical conductivity

S = Thermoelectric power

K = Thermal



conductivity of material

T = Absolute temperature

Fig 1: Overview of Energy Conversion from Various Sources Using TEG Device.

Thermoelectric generator construction is relatively easy, its efficiency can be measured in sinusoidal form furthermore changing or oscillation in temperature may change the efficiency of the thermoelectric generator[5]. Conversion of solar energy to electricity is in high demand these days, and many inventions and experiments have been carried out to improve the efficiency of solar panels. When the photovoltaic and thermoelectric effects combine, there is a strong probability that a device will have a high efficiency. PV absorbs about 58 percent of solar energy between 200 and 800 nm, whereas the thermoelectric effect converts the remaining solar energy between 800 nm and 2500 nm[6].

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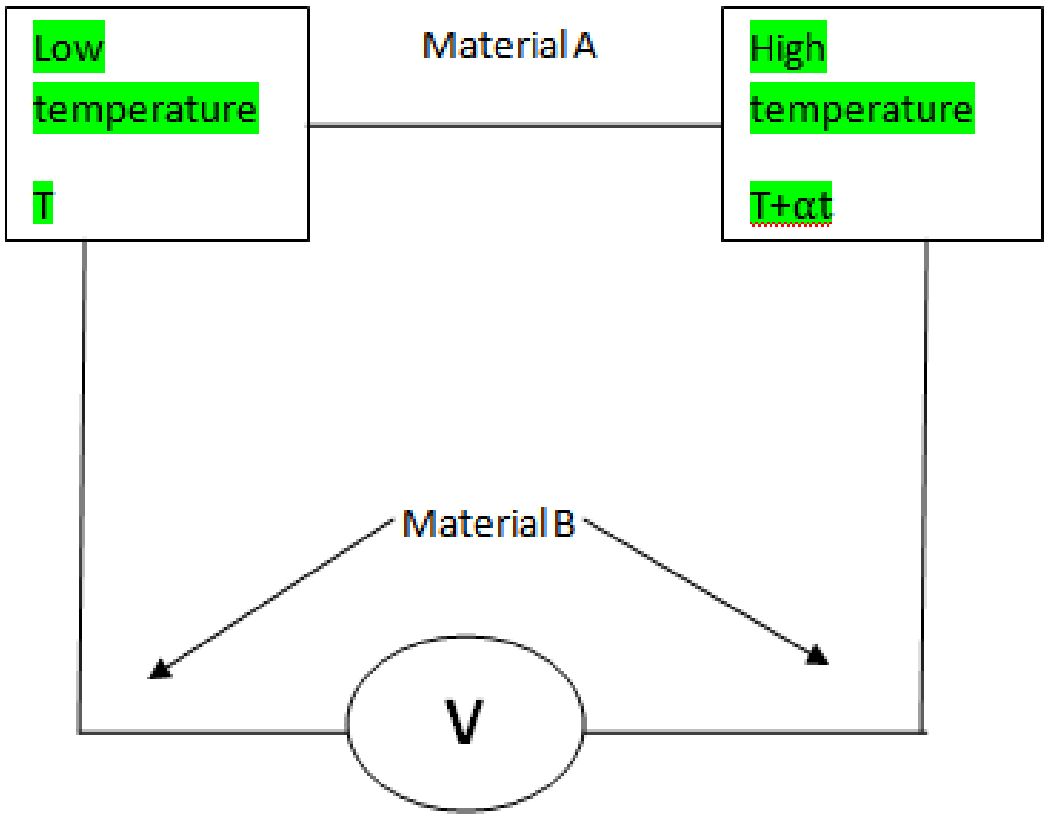

Fig 2: See beck effect In Thermoelectric Generator.

The see beck effect has been accomplished in thermoelectric generation if thermoelectric production is reversible in nature. There are two materials clearly illustrated in Fig. 2. Because Material A and Material B have different heat energies, these bodies generate heat differences, causing particles in semiconductor materials to move or conduct. The movement of the charge carrier causes a potential difference in the body, which is proportional to the temperature difference [7].

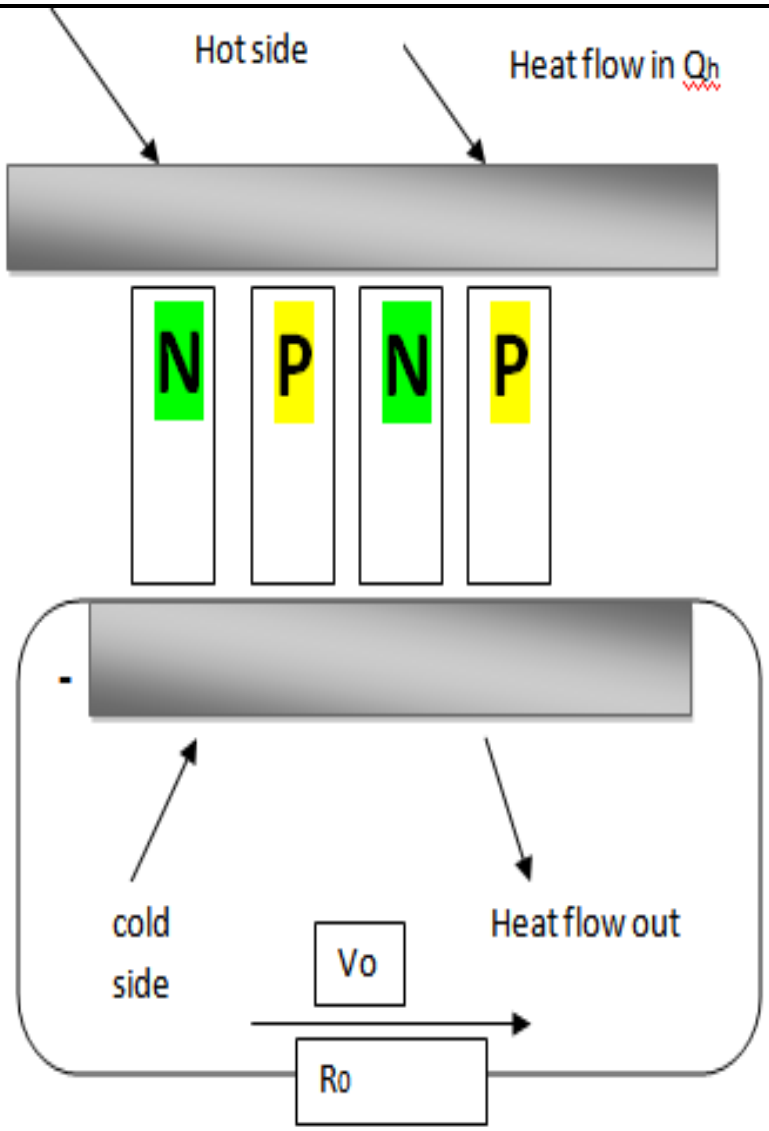

Fig. 3: Process of Thermoelectric Generator through which Thermoelectric Generator Operates.

Fig. 3 illustrates the method through which thermoelectric generator operates. Thermoelectric generator works on the principle of see beck effect, when two different material joined together with different heat then due to difference in heat of the bodies there potential generated in micro (V/K) and the material used in the thermoelectric generator known as thermoelectric material. Selection of the material by its characteristics like melting point, boiling temperature, conductivity, resistivity and see beck constant etc. [8].

2. LITERATURE REVIEW

Many papers have been published in the field of thermoelectric generator application and its advantages and disadvantages. Among the various papers, a paper titled "Modelling of thermoelectric generator device" by G. Rohit, et al. discloses the amount of heat that is wasted in modern life, with only 34% of total heat being usable and the remaining 66 percent being produced due to a variety of factors. The conversion of heat energy to electrical energy, which may be accomplished with a thermoelectric generator, can be used to convert heat energy into useable electricity. Thermoelectric generators are a type of seebeck effect that involves the direct conversion of heat to electric power. While converting energy, there appear to be some variables to consider, such as the type of material that should be used in thermoelectric generators, despite the fact that a larger material will be capable of moving its charge particle further. The heat of the body is exactly proportional to the conductivity of a particle. Also discussed were the see-back effect, the Peltier effect, and the Thomson effect, as well as their formulas, as well as the joules effect and its formula. Thermoelectric generators (TEG) have a variety of structures, such as a three-dimensional representation of compressive thermoelectric generator operation. The functioning of thermoelectric generators in 1-D, 2-D, and 3-D, as well as their different schematic and circuit diagrams, were also shown. Electrical resistance

and thermal network resistance are examples of many networks. Theoretical foundation and analysis of thermoelectric production and perform expressions, as well as performance simulation examples of thermoelectric generators, were also shown, along with different visual representations of thermoelectric behavior [9].

In a research paper titled "Thermoelectric Power Generation Using Waste-Heat Energy as an Alternative" by Wael H. Ahmed discusses the green energy method wherein generation of the electricity by using waste heat is one of the best solutions for utilizing the waste heat into a proper way. Discuss the basic theory of thermoelectric power generator, examples of application of thermoelectric generator and its composition specification with a schematic diagram and also shows different component used in thermoelectric generator. Different formula and derivation used to derive and find the formula by which efficiency of thermoelectric generator decided, there is different material used to made thermoelectric generator, shows different thermoelectric material used to made thermoelectric generator. Heat energy can be converted into useful power by the conversion of heat energy to electrical energy, this can happen by using thermoelectric generator. Thermoelectric generator works on the principle of see beck effect wherein direct conversion of heat to electrical energy while conversion of the energy there is some factors which comes into notice that type of material should use in thermoelectric generator because higher conductive material will be able to move its charge particle more. Conductivity of the particle directly proportional to the heat of the body[10].

3. DISCUSSION

This paper discusses about the Thermoelectric generators are constructed out of semiconductors which works on the basis of thermoelectric effect. Thermoelectric effect allows equipment to convert thermal energy into electrical energy or electric power, this effect comprises the mechanism by which heat is converted to electrical energy. The design of a thermoelectric generator is very simple, and its efficiency may be evaluated in sinusoidal form. Furthermore, temperature changes or oscillations can affect the thermoelectric generator's performance. Solar energy conversion to electricity is in great demand these days, and numerous innovations and experiments have been conducted to increase solar panel efficiency. When the photovoltaic and thermoelectric effects are combined, a device's efficiency is very likely to be high. Thermoelectric generator is a type of see beck effect, once two different substance joined together along with different heat after which due to differing in heat of a bodies here anyway potential produced in micro (V/K) and the content used in the thermoelectric generator recognized as thermoelectric material. Choice of the material by its properties like melting point, boiling temp, conductance, resistivity and see beck constant etc

4. CONCLUSION

This paper describes the basic concepts of power generation by thermoelectric generators and its relevant applications in the waste heat recovery systems. The study is useful in power generation by using Bismuth-Telluride TEG where availability of waste heat is high like engine exhaust, furnaces, heaters, stoves etc. This study shows that the power produced is directly proportional to the temperature of the hot surface. Maximum power output obtained was 650mW and further experiments are being conducted to improve the performance by using an effective heat exchanger. Conversion of solar energy to electricity is in great demand these days, and numerous innovations and experiments have been carried out to increase the efficiency of solar panels. When the photovoltaic and thermoelectric effects combine, there is a significant chance that a device will have a high efficiency. PV absorbs approximately 58 percent of solar energy between 200 and 800 nm, while the thermoelectric effect transforms the remaining energy from the sun between 800 nm and 2500 nm.

REFERENCES

[1] D. M. Rowe, "Thermoelectrics, an environmentally-friendly source of electrical power," *Renewable Energy*. 1999, doi: 10.1016/s0960-1481(98)00512-6.

[2] A. R. M. Siddique, S. Mahmud, and B. Van Heyst, "A review of the state of the science on wearable thermoelectric power generators (TEGs) and their existing challenges," *Renewable and Sustainable Energy Reviews*. 2017, doi: 10.1016/j.rser.2017.01.177.

[3] W. He, G. Zhang, X. Zhang, J. Ji, G. Li, and X. Zhao, "Recent development and application of thermoelectric generator and cooler," *Applied Energy*. 2015, doi: 10.1016/j.apenergy.2014.12.075.

[4] E. Kanimba and Z. Tian, "Modeling of a Thermoelectric Generator Device," *Thermoelectr. Power Gener. - A Look Trends Technol.*, no. February, 2016, doi: 10.5772/65741.

[5] P. Meibom, J. Kiviluoma, R. Barth, H. Brand, C. Weber, and H. V. Larsen, "Value of electric heat boilers and heat pumps for wind power integration," *Wind Energy*, 2007, doi: 10.1002/we.224.

[6] J. Yan, X. Liao, D. Yan, and Y. Chen, "Review of Micro Thermoelectric Generator," *Journal of Microelectromechanical Systems*. 2018, doi: 10.1109/JMEMS.2017.2782748.

[7] U. Lachish, "Thermoelectric Effect Peltier Seebeck and Thomson," *Guma Sci.*, no. April, pp. 1–11, 2016, doi: 10.13140/EG.2.1.2722.3443.

[8] M. Buscema, M. Barkelid, V. Zwiller, H. S. J. Van Der Zant, G. A. Steele, and A. Castellanos-Gomez, "Large and tunable photothermoelectric effect in single-layer MoS 2," *Nano Lett.*, 2013, doi: 10.1021/nl303321g.

[9] G. Rohit, D. Manaswini, V. Kotebavi, and S. R. Nagaraja, "Performance study of thermo-electric generator," *AIP Conf. Proc.*, vol. 1859, no. July 2017, 2017, doi: 10.1063/1.4990247.

[10] B. I. Ismail and W. H. Ahmed, "Thermoelectric power generation using waste-heat energy as an alternative green technology," *Recent Patents Electr. Eng.*, vol. 2, no. 1, pp. 27–39, 2009, doi: 10.2174/1874476110902010027.