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A STUDY ON POWER GENERATION USING THERMO ELECTRIC GENERATOR

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ABSTRACT:
Now a days humans are facing difficult issues, such as increasing power costs, environmental pollution and global warming. In order to reduce their consequences, scientists are concentrating on improving power generators focused on energy harvesting. Thermoelectric generators (TEGs) have demonstrated their capacity to transform thermal energy directly into electric power through the Seebeck effect. Due to the unique advantages they present, thermoelectric systems have emerged during the last decade as a promising alternative among other technologies for green power production. In this regard, thermoelectric device output prediction is important both for determining the future use of this new technology and for specifying the key design parameters of thermoelectric generators and systems. Moreover, TEGs are environmentally safe, work quietly as they do not include mechanical mechanisms or rotating elements and can be manufactured on a broad variety of substrates such as silicon, polymers and ceramics. In addition, TEGs are position-independent, have a long working life and are ideal for bulk and compact applications. Furthermore, Thermoelectric generators have been found as a viable solution for direct generation of electricity from waste heat in industrial processes. This paper presents in-depth analysis of TEGs, beginning with a comprehensive overview of their working principles such as the Seebeck effect, the Peltier effect, the Thomson effect and Joule heating with their applications, materials used, Figure of Merit, improvement techniques including different thermoelectric material arrangements and technologies used and substrate types. Moreover, performance simulation examples such as COMSOL Multiphysics and ANSYS-Computational Fluid Dynamics are investigated.
KEY WORDS :TEG (Thermo Electric Generator),Seebeck Effect,Cooling Fan,Heat Sink

INTRODUCTION:

When generating electricity in power stations, around two thirds of the energy is lost in the form of waste heat that is discharged from cooling towers . The main reason is that the gas or steam-powered turbine systems, that operate to produce most of the electrical power, primarily function by burning fuel to produce energy in the form of heat. This is followed by the conversion of this heat energy into mechanical energy within the turbine, and finally turning the mechanical energy into electrical energy in a generator . As a result, only about 1/3 of the energy released from the fuel actually ends up in the transmission lines leaving the power plant . The ability to collect the heat wasted within these processes and convert it to usable electrical power would enormously increase the efficiency of power generation. Additionally, the reduction of greenhouse emission from the reduced wastage would be beneficial for the environment as less fuel is burned for the same amount of electricity produced. In recent years, thermoelectric generator (TEG) systems have attracted great consideration in the recovery of waste heat due to their incomparable advantages : TEGs provide an opportunity to generate electrical energy from heat energy without the need for moving parts such as turbines, which eliminates extra costs resulting from

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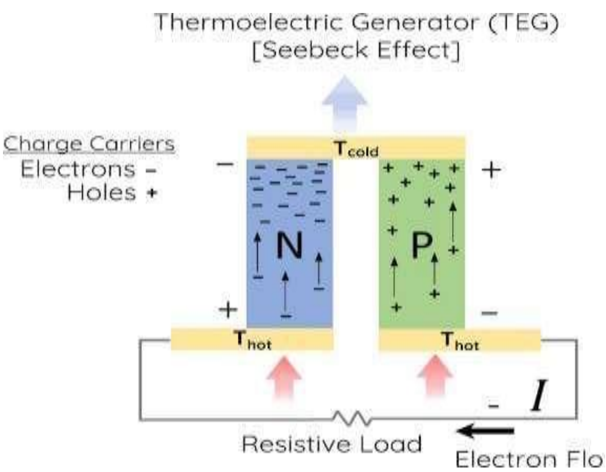
maintenance and replacement. TEGs have no economy scale-of effect and can be utilised for micro generation in a restricted position or can be used to generate kilowatts. TEGs are also environmentally favourable as they operate with no sound pollution . Conversely, TEGs do have a low energy conversion efficiency and require a relatively constant heat source, which are disadvantages. TEGs can be used in numerous applications, such as waste heat recovery and solar energy operation, experimental measurements of solar thermoelectric generatorswith a peak efficiency of 9.6% and a system efficiency of 7.4% are reported by Kraemer et al was introduced in a study . A flexible thermoelectric generator using eutectic gallium indium liquid metal together with a high thermal conductivity elastomer was designed to harvest body heat which can then be used for wearable electronics .A triple micro combustor aimed at portable power generation was designed and developed to enhance heat transmission from hot gases to thermoelectric modules considerably .

1.METHODOLOGY:



In this method we used thermoelectric generator for generating electric generator

The basic model of this study (prototype) as a thermoelectric generator will consist of an fanheat sink and a thermoelectric cooler .Thermoelectric generator used as a generator. There are twosides i.e cold and hot sides . They are two different temperature are used to generate electricity (based on seebeck effect).

The design of the thermoelectric charging circuit consists of three components mainly:

1. Thermo electric generator
2. Heat sink
3. Cooling fan , lithium ion battery , LED light

Each component was tested individually to characterize their performance, and then all of the components were combined into the final circuit

A thermoelectric device converts thermal energy to electrical energy by using an array of thermos couples.Studieshave been done on improving the efficiency of thermos electric incorporating other technologies, like nanotechnology

Mostly, TEG systems consist of three key elements:

1. A heat exchanger (HEX); This absorbs the heat and transfers it into the thermoelectric modules.

2 Thermoelectric modules (TEMs); The TEMs generate electricity when a temperature difference exists between their ends. A TEM contains many pairs of thermoelectric couples, and each couple normally combines a pair of p- and n-type semiconductors.

3 A heat sink; In order to dissipate the additional heat from the thermoelectric modules. The temperature difference between two sides of the generator is what determines the operation of TEGs. Fig. 1 explains the theory behind TEGs. If one side of a piece of metal could be heated while simultaneously cooling the other side, electrons surrounding the metal atoms at the hot side will have more energy than the equivalent electrons at the cooler side, this means the hot electrons will have more kinetic energy than those in the cooler side. Hence, the hot electrons travel more quickly towards the cold side than the

cold electrons move towards the hot side, and eventually the cold end of the thermoelectric generator becomes negatively charged, and the hot end positively charged . A drawback of this technique is that the voltagegenerated is very small and this cannot be overcome simply by linking groups of metal parts together in sequence because, the wires used to connect them, which are also made of metals, would produce a voltage in the wrong direction and oppose the voltages produced in the main metal parts. So the most effective way to address this issue is, to develop a material that can conduct electricity using positively charged

2.SEEBECK EFFECT:

This mechanism, where a temperature differential produces a voltage, is known as the thermoelectric effect or Seebeck effect and it was believed to have been defined for the first time in the 1820s by the German physicist Thomas Johann Seebeck. However, recent evidence shows that Alessandro Volta had also observed the Seebeck effect 27 years before Thomas Seebeck. . During an experiment carried out 1794, Alessandro Volta designed a U-shaped iron pin, in which one end of the rod was heated by dipping it in hot water. During the next step, the unevenly heated rod was electrically attached to a dead frog’s leg. The current went through the frog’s leg, and its muscles contracted. This is considered to be the first example of the Seebeck influence.

3.PETTLIER EFFECT:

As mentioned earlier, in 1821, Thomas Seebeck, a German physicist, carried out numerous tests on electricity and discovered that electricity can function through a circuit comprising two separate conductors, given that the junctions at which these conductors connectedwere kept at different temperatures. Seebeck, though, was unable to clarify the real empirical hypothesis behind this process and wrongly deduced that flowing heat causes the sameresult as flowing energy. Gene Peltier (a French scientist) discovered in 1834, when researching the influence of Seebeck, that heat could be consumed at one junction of dissimilar metals and emitted at the other junction of the same circuit. Then throughout the 1850s, Lord Kelvin (William Thomson), was able to theoretically validate the results of both Seebeck and Peltier and to establish the connection between them. Nevertheless, this result was restricted to being just a laboratory based experiment until 1930, when Russian physicists started to reinvestigate earlier experiments on the thermoelectric effect, which contributed to the development of realistic thermoelectric instruments; the Peltier effect is believed to be the opposite of the Seebeck effect . The electrical current passing across the junction of the two materials produces or absorbs heat per unit time at the junction to offset the gap in the chemical structure capacity of the two materials. Thanks to this influence, an electronic refrigerator, known as the Peltier cooler, can be produced.

4.THOMPSON EFFECT :

Thomson indicated that as the current passes into unequally heated conductors, the thermal energy is either consumed or formed in the metal structure . In other words, the Thomson effect is the generation of reversible heat when an electrical current is passed through a conductive material subjected to a temperature gradient . The Thomson effect therefore describes the heat loss of a substance with a current through it and this transfer of heat is immediately observable. It is different from the effects of Peltier and Seebeck, for which only the net effect of two different materials can be measured.

LITERATURE SURVEY:

Literature survey 1. published patent by Bradley J. Mitchell and William C. Sanford titled Power generation using a thermoelectric generator and a phase change material done on 2010, An energy harvesting device is disclosed that includes a thermoelectric device adapted to produce

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electricity according to a Seebeck effect when a thermal gradient is imposed across first and second major surfaces thereof, a housing enclosing phase change material that is disposed for thermal communication with the first major surface of the thermoelectric device, and a radio transmitter electrically coupled to the thermoelectric device, the radio transmitter capable of transmitting wireless signals. In another aspect, the housing includes a conductive fin therein to provide more uniform distribution ofheat to the phase change material.

Literature survey 2.published patent by bjorn Erik Birkeland, Finn Erik saghus, Erik Rosness on 2009 titled Thermoelectric generator for battery charging and power supply, A portable device for supplying with power of at least one portable electrical load or gadget, wherein the device is adapted to be manually heated and comprises at least one thermoelectric element having one hot or warm side and one cold side, a container attached to the cold side and adapted for holding or keeping a cooling medium or fluid therein, a power converter and a set of cables coming out of the thermoelectric element and connected to the electrical load via the power converter.

3. Literature survey 3:- Jihad G. Haidar, Jamil I. Ghojel, "waste heat recovery from the exhaust of low- power Diesel engine using thermoelectric generators, 20THinternational conference on thermoelectric(2001), p413-417From literature survey 1 we studied how to recover waste heat and how to utilize waste heat from different industries.

4. Literature survey 4:- Mariem SAIDA, Ghada ZAIBI, Mounir SAMET, Abdennaceur KACHOURI, A new design of thermoelectric generator for health monitoring, 2017 International Conference on Smart, Monitored and Controlled Cities (SM2C), Kerkennah, Tunisia, February, 17-19, 2017, p 59-63From literature survey 2 we analysed about thermoelectric generator and its specification.

5. Literature survey 5:- Ahaad Hussein Alladeen, Shanshui Yang, Yazhu Liu, Feng Cao, Thermoelectric waste heat recovery with cooling system for low gradient temperature using power conditioning to supply 28V to a DC bus, 2017 IEEE Transportation Electrification Conference and Expo, Asia-Pacific (ITEC Asia-Pacific), 2017From literature survey 3 we studied different types of cooling system and different types of coolant.

6. Literature survey 6:- Arash Edvin Risseh, Electrical Power Conditioning System for Thermoelectric Waste Heat Recovery in Commercial Vehicles, IEEE Transactions on transportation electrification, 2018, p 2-16From literature survey 4 we got an idea about how to recover the waste heat from automobile application

7. Literature survey 7:- T.J Zhu, Y.Q. Cao, F. Yan And X.B. Zhao, nano structuring and Thermoelectric properties of Semiconductor Tellurides, 2007 International Conference on Thermo electricsFrom literature survey 5 we knew about thermoelectric materials and its properties.

CONCLUSION :

As from the project we can conclude that the electric power is generated by using thermos electric generator. This project is useful for those who are living in remote areas and suffering from lack of electric power. The below graph represents the amount of power generated with respect to the temperature difference between the two plates of TEG . By using more plates of TEGs which are connected in series and parallel combination we can generate more electric power.

In conclusion, this review provides a detailed investigation into thermoelectric generation technology and it begins with an extensive description of their operating theory, forms, utilised components, Fig. of Merit and ways to maximise its

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enhancement strategies such as various configurations of thermoelectric materials and the styles of utilisation of the device substrates. A key obstacle still remains in the design and development of advanced TE materials with acceptable values of Fig. of Merit (zT) and Power Factor, but various methods to achieve a satisfactory efficiency have been analysed.

The functioning of a thermoelectric module is determined by the thermoelectric properties of the n- and p-type materials from which it is composed. High implementation requires both n- and p-type legs to exhibit comparable Fig.s of Merit, although, it was nonetheless discovered that the rigidity of certain compatible materials also places an obstacle to constructing the next generation TEG models.

Flexible contacts can provide a means of alleviating this problem. Furthermore, over the last few decades, major advancements in materials science and nanotechnology have led to a substantial increase in the dimensionless Fig. of Merit, as shown. Although for other applications discussed within the article, where, for example, temperatures of heat sources change and materials also undergo quite long temperature cycles.Thermoelectricgenerators have been found as a viable solution for direct generation of electricity from waste heat in industrial process.

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