ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 12, December 2017

Electricity Generation from Heat

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ABSTRACT: Equipment which produces heat during operation can be used for other purposes, electricity can be generated through this heat with the help of a generator called a thermoelectric generator (TEG). Heating devices like automobiles, stoves, heaters, and boiler ovens produce large amounts of waste heat. Heat dissipated through these equipment goes unused, because of the waste heat of the device their efficiency is reduced day by day. This paper relates how waste heat of the equipment can be used in a proper way, for making this possible use of a thermoelectric generator (TEG). Application of the heat evolved during any process can be taken in use for generating electricity and supplying it with the help of substation. Thermoelectric generators are used to generate electricity with the help of heat and its application in future is very much as heat is produced from many places such as vehicles, any industrial process, and thermal power stations etc. so heat is evolving from those used to produce electricity.

KEYWORDS*:* Efficiency, Heat, Thermoelectric Generator, Global Warming, Transformer, Thermal Power Plant, Waste-Heat Recovery

I. INTRODUCTION

It has been seen that 20 to 50% of the total energy goes waste in the form of heat. Reduction in the efficiency of equipment day by day heating problem of the device is one of the problems for reduction in efficiency and increment in maintenance cost [1]. Thermoelectric generator is in use nowadays for resolving the problem because of heat. Thermoelectric generators are devices which convert heat energy into electrical energy also electric energy to heat energy. Conversion of solar energy to electricity is nowadays very big in demand lots of inventions and experiments were performed to increase the efficiency of the solar panel, so if photovoltaic and thermoelectric effect combine together then chances of good efficiency from a device. PV absorbs around 58% of solar energy between 200 and 800 nm, while the rest of the solar energy in the range of 800 nm up to about 2500 nm can be converted by the thermoelectric effect [2].

Thermoelectric generator:

Thermoelectric generators are made up of semiconductors which works on the principle of thermoelectric effect. Thermoelectric effect allows devices to convert heat energy into electricity or electric power, this effect involves the process by which heat is transformed to electrical energy [3]. If the heat conversion process is thermodynamically reversible then this effect is known as see beck effect which is achieved in thermoelectric generation. One example of thermoelectric effect in commercial wrist watches in which it will take advantage of the heat difference between the human body and environment. Conversion of solar energy to electricity is nowadays very big in demand. Lots of inventions and experiments were performed to increase the efficiency of the solar panel, so if photovoltaic and thermoelectric effect combine together then chances of good efficiency from a device. PV absorbs around 58% of solar energy between 200 and 800 nm, while the rest of the solar energy in the range of 800 nm up to about 2500 nm can be converted by the thermoelectric effect. Performance of thermoelectric material is defined by this formula:

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

σ = Electrical conductivity
S = Thermoelectric power
K = Thermal conductivity of material
T = Absolute temperature

Thermoelectric generator construction is very simple, its efficiency can be calculated in sinusoidal form also varying or oscillation in temperature can vary the efficiency of the thermoelectric generator [2]. Thermoelectric generator is a solid semiconductor device which measures the difference in temperature of the two bodies and heat flow into DC

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power as shown in Fig. 1. As per knowledge thermoelectric generators used to produce electric energy, the ability of thermoelectric generators to produce power is about 1 to 125W. When use of the thermoelectric generator increases then it will increase the power up to 5kW and in that case $\Delta T_{max\ increases}$ to 70 degree Celsius. Heat source, for example, a heat pipe system (the TEG devices and the heat pipe system can be used together in waste heat recovery systems) [4].
If thermoelectric generation is reversible in nature, then known as see beck effect has been achieved in thermoelectric generation. In Fig. 2 clearly shown there are two materials Material A and Materiel B have different heat energy so these bodies create heat differences due to which particle in a semiconductor material starts moving or conducting, movement of the charge carrier produces potential difference in the body which directly relates to the temperature difference of the body [5].
Process by which a thermoelectric generator works. Thermoelectric generator works on the principle of see beck effect, when two different materials 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 [6]. Selection of the material by their properties like melting point, boiling point, conductivity, resistivity and see beck constant etc.

II. LITERATURE REVIEW

There has been many paper published in the field of thermoelectric generator application and its advantage disadvantage, among various papers a paper titled "Theoretical limits of thermoelectric power generation from exhaust gases Robert J. Stevens a, Steven J. Weinstein b, Karuna S. Koppula disclose about the amount of heat which is wasted in day today life, only 34% of the total heat is usable rest of 66% of heat produces due to automobile, boiler, furnace are waste. Heat energy can be converted into useful power by the conversion of heat energy to electrical energy, this can happen by using thermoelectric generators. Thermoelectric generator works on the principle of see beck effect wherein direct conversion of heat to electrical energy while conversion of the energy there are some factors which come into notice that type of material should be used in thermoelectric generators because higher conductive material will be able to move its charge particle more. Conductivity of the particle is directly proportional to the heat of the body. Also discussed about the see back effect, Peltier effect and Thomson effect and its formula, also give an idea about the joules effect and formula associated with it. There are different structures of thermoelectric generators (TEG) such as three dimension representation of compressive operation of thermoelectric generators. Also shown 1-D, 2-D and 3-D operation of thermoelectric generators and their different diagrams and circuit diagrams. Different networks such as electrical network resistance and thermal network resistance. Theoretical model and analysis of thermoelectric generator and performance expression, performance simulation example of thermoelectric generator also shown different graphical representation of thermoelectric behavior [7].
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 components used in thermoelectric generators. Different formula and derivation used to derive and find the formula by which efficiency of thermoelectric generator decided, there is different material used to make 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 generators. Thermoelectric generator works on the principle of seebeck effect wherein direct conversion of heat to electrical energy while conversion of the energy there are some factors which come into notice that type of material should be used in thermoelectric generators because higher conductive material will be able to move its charge particle more. Conductivity of the particle is directly proportional to the heat of the body [8-10].

III. 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

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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.

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