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Review on Energy Harvesting Techniques

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Abstract: In the present era, Power Generation and conservation is the main important issue for every country in the world. Power generation is the main priority of every country in spite of its cost and shortage facing a major power crisis. Power generation and transmission is mainly depended upon natural resources. In India power is generated through both conventional and natural resources. Power generation is having a major threat from both natural (wind, water, solar) & conventional (oil, coal, nuclear) resources. Several energy generation harvesting techniques are invented and implemented in various fields depending upon the rated capacity of power. The energy harvesting techniques basically depend upon the storage property of different types of capacitors, Inductor and accordingly can be classified as piezoelectric, triboelectric, thermoelectric, electromagnetic and many more. This paper focuses on the different energy harvesting techniques and finding out the best energy harvesting techniques on the basis of its independence of natural resource, technical expertise, cost effective and many more parameters.

Keywords: Energy Harvesting, Peltier effect, Piezoelectric Effect, Seebeck effect, Thermoelectric effect, Thomson effect

Introduction

In today's world the demand of energy is increasing day by day and the availability of resources is decreasing day by day. To fill the gap between demand and supply the various energy harvesting techniques are invented and implemented very successfully in different applications. Energy harvesting techniques are basically defined as technology to convert the energy that is present in environment or the energy that is wasted out in the form of heat to electrical energy and can be further store in the batteries also. The energy obtained from energy harvesting techniques can be used to power wireless devices where the conventional charging methods are difficult to adapt. Power generated from Energy harvesting can be used on large scale such as in building lighting, medical devices and equipment, and even satellites. Energy harvesting techniques are depended on resources such as relative motion, light, temperature gradient, Electromagnetic radiation, chemical reactions and many more. The relative motion used to convert electric energy will depend on piezoelectric, electromagnetic & electrostatic effect. The light energy converted to electrical energy will depend on photoelectric effect and temperature gradient will depend on thermoelectric effect.

Energy harvesting with relative motion

The generation of electrical energy from mechanical energy will depend on the relative motion of any object. This technique utilizes piezoelectric material which produced the voltage in response to mechanical strain and vice versa. The devices which are used to convert mechanical energy such as motion, force, pressure into voltage is called as piezoelectric transducers. The most commonly used piezoelectric materials are Quartz, barium titanate and lead zirconium etc. [5]Based on the same concept the vibrational energy of passing vehicles on highways, runways can also be used to generating electricity and can be categorized as Parasitic Energy Harvesting technique. This concept has been using on small scale where 4-lane highway could produce about 2 megawatts of power for every km. In Tokyo, 1400 kilowatt of electricity per second will be generated with travelers walking through the station each day. This has been possible with the invention of

piezoelectric generators which can generate electricity based on the change in its weight, motion, vibration and temperature. Piezoelectric generators basically consist of a thin box around the piezoelectric material, which is then placed under the floor on any highway, runway etc. Whenever force exerts pressure on box the piezoelectric material will convert the(force) vibrational energy into electrical energy which can be store in batteries for further use. The figure 1 shows the diagram of piezoelectric generator with 3 different cross-sectional views. [1]

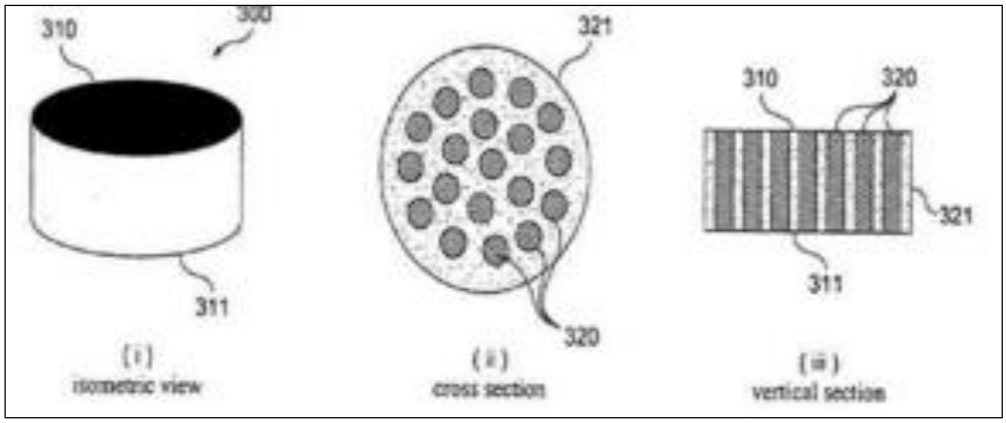

Fig 1. Piezoelectric Generator

When a force is applied on piezoelectric generator, the electric charge will be generated across the faces of the piezoelectric crystal. The piezoelectric crystals are very small in size, weight which make them suitable in many applications The energy generated from piezoelectric materials are of low cost and does not require much maintenance and replacement as compare to traditional wall plug and batteries. In spite of all these advantages still energy generated from piezoelectric generators are not be fully used over a large scale.

Energy harvesting with light

As we all know that the most common renewable source of power generation is solar energy but this power generation will depend on weather conditions, geographical locations, day/night alteration and many more. In present area there will be automation of every system like home, offices, buildings, malls and many more.[4] The concept used in energy harvesting using light energy will based on the photovoltaic effect where, light energy captured and absorbed from environment which is further converted in to electrical energy. In this, the photovoltaic cells which are used to capture light will be installed inside the homes, offices and energy generated can be used to power smart devices such as speakers, gadgets, wearable health sensors and many more. The light energy released inside buildings which will be otherwise wasted can be utilized properly in many applications. The energy generated with this is eco friendly and does not harm the environment as compare to batteries which releases harmful toxic chemicals or gases. There will be no replacement and maintenance cost. Solar cells used to capture low illumination level are of amorphous silicon rather than crystalline silicon. As the light hits the silicon structure, the ions react and positive – negative charge generated across it. Solar cell such as Panasonic Amorton of size 53*35 millimeter can generate power of about 4.26 microamperes at 2.6 volts with very low illumination level of approximately 50lux.

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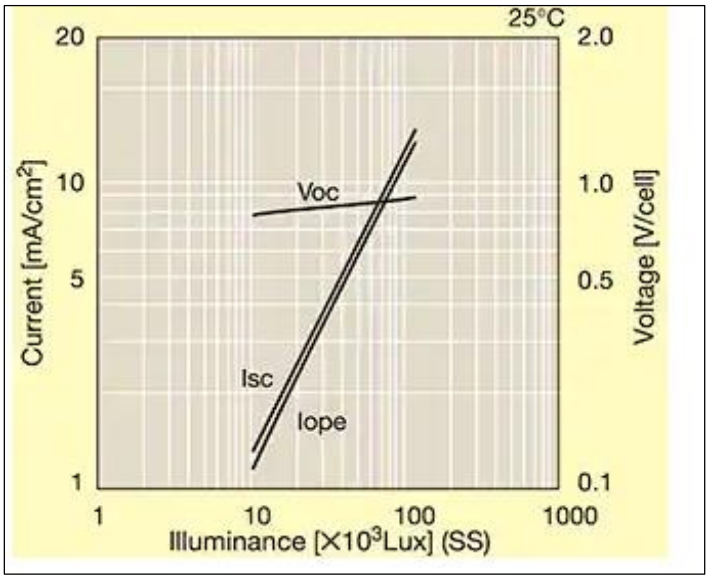

Fig 2. Solar cell Illumination Vs voltage

Energy harvesting using temperature

Another method to generate electrical energy is to convert the dissipated heat of environment from many devices into usable form. The energy generated can be called as Green power and can be used in microscale applications such as medical applications, sensors, consumer electronics etc. [4] The concept used in this technology is Thermoelectric effect where the temperature gradient is converted into electrical energy. The various thermoelectric materials and thermoelectric generators (TEG) are used to harvest electrical energy. [3] The range of electrical energy generated can be of µW to mW for different applications. The given figure 3 shows the schematic diagram that how the lost heat in environment can be used to generate energy using TEG.

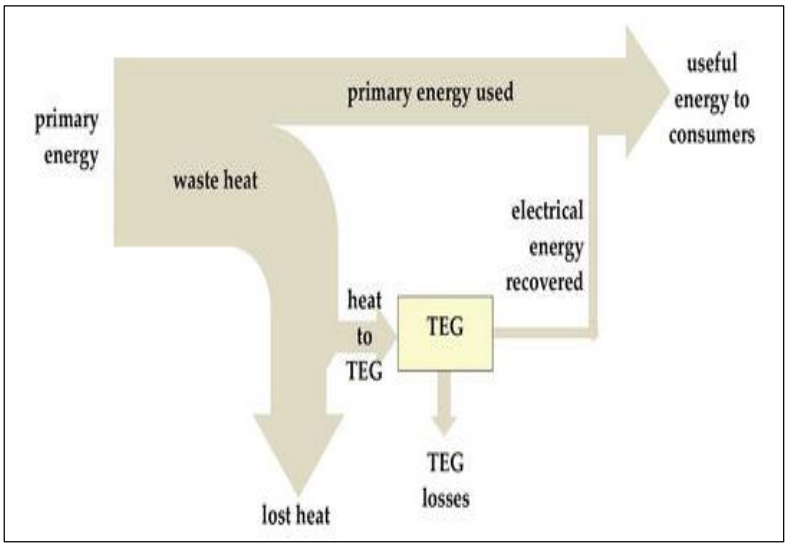

Fig3. Energy generated from lost heat in environment

The conversion of thermal energy to electrical energy uses the Peltier effect, Thomson effect & Seebeck effect in which there will be emission of charge carriers across the conductor if there is thermal gradient across two ends of conductor. Nowadays, The implantable medical devices in our body need not to depend on batteries as they use the thermal energy (temperature difference between human body and environment) of our body using TEG.

Conclusion

In conclusion we can say that most low power electronic devices such as smart gadgets, wireless sensors, wearable devices, speakers, implantable devices and many more can be easily have power from different energy harvesting techniques. In present era energy crisis is most important issue that every part of world is facing. As compare to conventional & natural resources dependence for energy generation now we can rely different other resources which generate eco friendly electrical energy . These energy harvesting techniques very easily replace batteries which are costly, toxic and difficult to maintain. The resource for these energy generation are relative motion, light (indoor also), temperature gradient, chemical reaction etc. The range of energy generation is of few milliwatts but it can be easily increased on large scale in future.

References

[1] P.S.Goyal (2013). *Energy Harvesting using Piezoelectric Materials*, ETRX, journal

[2] Digi Key North American (2020). "*A simple approach for Energy Harvesting for Indoor Lighting*".

[3] Diana Enescu "Thermoelectric Energy Harvesting" Intech Open,2019.

[4] M.J Moran et al (2015). "*Principle of Engineering Thermodynamics*". Wiley global education.

[5] *Karki, James September,2000 "Signal Conditioning Piezoelectric Sensors" . Texas Instruments.*