

Innovative Systems for Possible Energy Harvesting using Seebeck Effect

Ayush Agrawal¹, Akhil Varma²

Department of Computer Science and Engineering, PES Institute of Technology-Bangalore South Campus, Karnataka - 560100, India

Department of Mechanical Engineering, PES Institute of Technology-Bangalore South Campus, Karnataka - 560100, India

Abstract: *The present study attempts on designing and optimizing innovative structures for energy harvesting by modifying existing source structures by exploring thermoelectric effect. The supporting structures of some major non-conventional energy sources found in India are not utilized completely. These structures provide only support to the system and play no major role in the system itself. These may include wind power systems, solar street lighting systems, wind pump systems etc. to name a few. As there is ever increasing demand for energy, the present work describes effective use of such structures for power generation by optimizing Seebeck effect. A prototype configuration of extraction and storage of electrical energy has been designed. Also the opportunities and challenges of the same have been systematically studied to achieve an optimum design for the system.*

1. Introduction

Our energy system is based on extracting highly concentrated forms of energy we find in nature, such as fossil fuels. Unfortunately, our energy system is dysfunctional because highly concentrated forms of energy are in short supply and play critical roles in the ecosystem.

Energy is the basis of all activity. Without energy, nothing moves nor transforms and so a sustainable society can only exist based on a sustainable energy system. The depletion of non-renewable resources is mainly due to over exploitation by humans to meet the ever increasing demand for energy.

People have come to know of this fact and so many researches are being carried out time to time to minimize these resources and replace them with renewable resources.

Renewable resources are resources we obtain directly from nature. From [2] it is known that harnessing these resources or utilizing these resources to generate energy is the future of energy production. Today only 16.7% of the total energy produced is from renewable resources. As there is ever increasing growth of population, machinery and other forms of technology, in the near future more power would be needed to meet this demand.

There are already existing systems for harnessing renewable sources, but these systems are not efficient enough to give a good return for the investment.

Therefore, more and more researches are being worked upon to get the maximum output. The study is one such example, which incorporates two power sources in a single system. One source being the system and the other being the structure supporting the system.

Usually the structure is used only for support but the study enables us to use the structure as a power generating unit as well.

This is achieved by using one of the thermoelectric effects namely Seebeck effect. Seebeck Effect states that

“The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances.”

If the supporting structure of some non-renewable sources of energy is divided into two parts of two different conducting materials and one is maintained at a temperature higher than the other, then the induced voltage can be collected across the junction of the metals.

2. Proposed Prototype

The proposed prototype design is a small model of the system. For this prototype we have selected two metals namely, Copper and Aluminum having a conductivity of 1.68×10^7 Siemens per meter and 2.82×10^7 Siemens per meter respectively at a temperature of 20° Celsius. One end of the copper strip is attached to the first aluminum strip and the other end to the second strip of aluminum. The strips are coiled with copper wire so as to obtain the generated voltage.

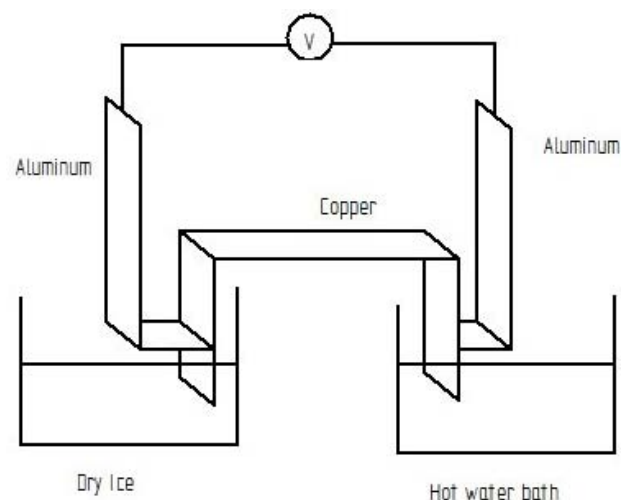


Figure 1: Proposed prototype design

The copper wire should have a lesser diameter so that the induced voltage is more. This is because the lesser the diameter of the wire, more is the voltage induced across it.

As it can be seen in Table 1 from [1], which shows different values of voltages induced in different wires of different diameters. All values correspond to a temperature of 1648.89⁰ Celsius in a good conducting wire.

Table 1: Voltages induced

Wire diameter Inches (in.)	Voltage Induced milliVolts (mV)
0.035	8.830
0.030	8.842
0.020	8.909

One end of the junction is placed in dry ice having temperature -78.6⁰ Celsius and other junction placed in hot water bath at constant heating. The temperature difference between them is what induces the voltage and this voltage can be collected across the windings on the aluminum strips.

3. Future Applications

The present Study can be applied in the real world by either using it on the support structures of the energy producing systems or by setting up an extra system in places which are capable of providing ample heat energy.

A. Support Structures

- 1) *Solar street lamps:* One of many applications is the solar street lamps. These lamps convert the sun's energy to electricity using photovoltaic cells and provide light. But the supporting structure is not involved in the generation process. So by implementing the prototypic design to a larger scale this through these lamps we can increase overall output efficiency of the system.
- 2) *Windmill:* In windmills and wind pumps the power generation process takes place only at the hub but again supporting structure is not of much use. Therefore by implementing this study on the stem of the windmill we can increase output efficiency of the windmill.
- 3) *Solar towers:* The towers that support the photovoltaic array can also be modified to generate additional power for the system.
- 4) *Wind pump:* A wind pump uses the wind to collect water across streams, canals and rivers. Mostly used in rural areas, it can act as a potential source for power.
- 5) *Solar farms:* A collection of solar towers around a single tower which is covered in mirrors to reflect light upon the solar towers. The main tower absorbs a lot of heat energy from the sun which in turn can be used to create temperature differences.

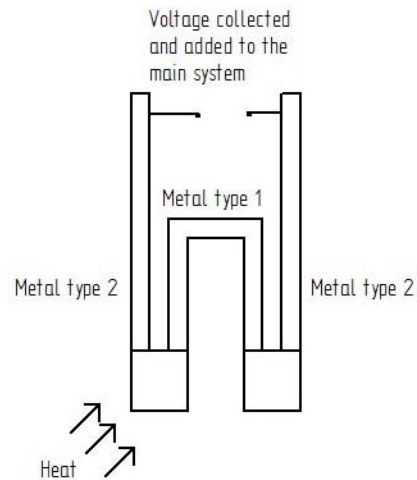


Figure 2: Support Structure used for power generation

As can be seen from Fig. 2, the support structure collects the voltage induced across the terminals and it is added to the main system responsible for power generation. Hence, improving overall efficiency of system by utilizing all its components.

B. As an extra added accessory

- 1) *In geothermic areas:* In geothermic area the earth's heat can be used to create the required temperature difference in one part of the extra added structure so as to initiate Seebeck effect. This would add to the total output power generated by a geothermal plant.
- 2) *Solar ponds:* A solar pond traps the sun's heat within itself and uses it to power turbines. The heat extracted from a solar pond can be used to create the temperature difference needed to induce voltage which can be collected and added to the overall output power, hence improving its overall efficiency.

4. Acknowledgment

This research has been made possible due to the support and help of many people. We are very thankful to Dr. Muhammad Faisal (Associate professor in Physics, Department of Science and Humanities, PES Institute of Technology-Bangalore South Campus) for his guidance, encouragement and co-operation throughout this research. We sincerely thank our parents, who provided us with their advice and financial support. We avail this opportunity to convey sincere thanks to all the individuals who have assisted us during the course of the research. We have tried our best to gather all the relevant details subjected to the research. Lastly, we would like to thank dept of mechanical engineering of people's education society institute of technology for conducting RISE, which gives us an opportunity to present our work.

References

- [1] J. F. Swindles "Precision Measurement and Calibration" U.S. Department of commerce, NBS, vol. 2, 1968
- [2] <http://www.decent-democracy.org/Energy-Problems.html>