Integrated Thermoelectric Generator

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1 Introduction

Nowadays, one of the most frequently talked issues varies around the global energy crisis. World energy consumption increased dramatically between 1950 and 2010, from approximately 100 EJ to over 500 EJ, and is still expected to be rising in the following decades, due to the rapid acceleration of technology and science growth. We cannot rely heavily on one energy source such as fossil fuel which currently fulfills our daily energy demand. Therefore, we are curious to find other potential energy sources. This research is dedicated to create an innovative way to utilize sunlight as a new alternative energy source, through a device named Integrated Thermoelectric Generator (InTEG).

2 Theory

Thermoelectric effect comes as a result of a combination of three effects, which are Seebeck, Peltier, and Thomson effect. TEG optimizes Seebeck impact. When a side of the TEG is heated, there will be thermal flow from the hot side to the cool one. Therefore electrons from the hot side will be difused to the cool side and generates flow of electricity.

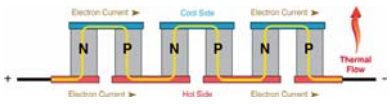

Fig.1 Seebeck Effect

3 Method of the experiment

We designed a generator, with a heat collector on top of it, taken from the solar cooker design. Afterwards, we measured the system's voltage and electric current so that we could calculate the amount of electricity that had been generated from the system. The generator efficiency:

$$\eta = \frac{V \times I}{c \times A} \times 100\% \qquad (1)$$

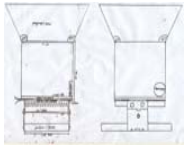

Fig.2 First design

Fig.3 InTEG 1.0

Fig.4 InTEG 2.0

4 Results of the experiment

Through the development progress, we have tested three major generators with unique designs. These are the highest outputs ever recorded by each generators in term of power.

Generator Types	Voltage / mV	Current / mA	Power / mW	Efficiency / x10^{-2} %
InTEG 1.0 (1 TEG)	267.0	46.40	12.39	4.18
InTEG 1.0 (5 TEGs in series circuit)	290.0	4.83	1.40	0.47
InTEG 2.0 (5 TEGs in series circuit)	400.0	25.00	10.00	3.38

Table 1 Results of Thermoelectric Generator Measurements

The 2nd data in Table 1 was recorded in a relatively cloudy day compared to others, while 1st data was recorded on the sunniest day. We concluded that the TEGs were able to generate small amount of electric current. The maximum power ever generated on our series of tests was 0.1 watt. Efficiency of the InTEG was around 0.016%, averaged from all the tests we had done using Eq.(1).

Latest design of the Integrated Thermoelectric Generator (InTEG 2.0) was able to power up a small cell phone vibrator motor, using hot water to heaten up the hot side.

5 Conclusion

The Integrated Thermoelectric Generator has fulfilled our main objective of generating electricity. Highest performance of the InTEG was recorded when it generated 0.012 watt of electricity. Efficiency of the generator was 0.016%.The amount of generated electricity is proportional to temperature difference between hot and cool side of TEG. Performance of the device is unstable due to the weather condition. Through observations in Jakarta, it can be concluded that the most optimal time of usage is around 11.00 AM – 02.00 PM. Although the amount of generated electricity is relatively small, high reliability and durability of TEG make up for its weaknesses.

References

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