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Peltier as a Thermoelectric Generator from Household Waste

Agus Supranartha[1*], I Wayan Dikse Pancane[1,2], Nengah Sunaya[2], I Gde Nyoman Sangka[1], I Nyoman Mudiana[1]

[1] Department of Technic Electrical Engineering, Politeknik Negeri Bali, Indonesia.
[2] Professional Program of Engineers, Faculty of Technology and Informatics, Universitas Pendidiknan Nasional, Denpasar, Indonesia

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Corresponding Author:
Agus Supranartha
agus_Supranartha@PNB.ac.id

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Abstract: The Utilization of heat energy as a generator of electrical energy with micro capacity can be done by using thermoelectric elements. Conversion system with Thermoelectric Generator (TEG) elements can be generated from heat from burning waste. Based on the nature and advantages of the fuel components, this study is to study and develop a system according to the capabilities of the TEG components that can be designed into a super mini generator system, namely by converting heat from fire into electricity. The method used in this study is a system for converting heat energy into electricity. The heat from the fire will be used to recharge batteries such as HT batteries, flashlights, GPS and others. The input or input to the system is the heat from combustion. The input component itself is a converter, namely a peltier. The function of the peltier is to directly convert heat energy into electricity. The results of the study are an output of 3.7 V. This design uses the IC LM317 as a regulator to process the output voltage of the conversion system. The purpose of regulation is so that the battery does not overcharge and is damaged.

Keywords: Thermoelectric, Thermoelectric Generator (TEG), Peltier, IC LM317.

Introduction

Energy is an object that can move due to a fundamental reaction. Now the availability of energy in the world and Indonesia in particular is decreasing. To overcome this problem, along with the development of technology, many alternative and renewable energies have been proposed to reduce the impact of global warming (Adriani, 2019). One of the efforts initiated is the creation of a Thermoelectric Generator (TEG) which is able to convert temperature differences into electrical quantities directly even though the efficiency level is low, namely 10% (Børset et al., 2017). TEG can be used in the results of electrical power for charging batteries as an alternative energy producer (Sasmita et al., 2019).

Basically, Thermoelectric is made of semiconductor materials composed of n-type and p-type compositions (Liao et al., 2018). The Thermoelectric phenomenon was discovered in 1821 by German scientist Thomas Johann Seebeck. Thomas Seebeck tried to connect copper and iron in a circuit. The movement of the compass needle indicates that an electric field arises in both metals due to heating on one side. Therefore, this phenomenon is called the Seebeck effect. Heating, either sunlight or hot fire from can be a source of electrical energy. There are two concepts underlying how peltier works. The concept of seebeck as the effect of two connected metal materials in an environment with two different temperatures, then in the material there will be an electric current or electromotive force.

The Thermoelectric effect is the opposite of the seebeck effect if two metals are glued together and then electricity is passed through them, then there is a temperature difference between the two sides of the metal (Al-Habahbeh et al., 2018). The reversible heat of the electrode reaction, called electrochemical Peltier heat (EPH), is also a very important quantity in thermoelectrochemistry, often used for research on reversible thermodynamics and kinetics. The change in the total energy of an electron is opposite in sign to the change in its electrostatic energy. If a charged particle moves freely in an electric field, energy is released. The

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opposite sign means that energy is absorbed at the hot junction of the thermocouple. The hot junction is cooled, and the cold one is heated (Muchlis & Permana, 2003; Nesarajah & Frey, 2016).

Thermoelectrics are divided into two types, namely Thermoelectrics as coolers and as generators, where the working process uses the Peltier effect to create heat flow (heat-flux) at the branching between two different types of materials (Rafika et al., 2016). conversion system with TEG elements that allow it to be used anytime and anywhere (Zoui et al., 2020). So this research was carried out to design an energy conversion tool from fire heat to electrical energy by regulating the voltage regulation of the conversion results so that it can be used as a battery charger using Peltier elements to convert fire heat into electric current (DC) with voltage (Lu et al., 2020; Ohnuma et al., 2017).

Method

The method used is the observation method, starting from literature studies (looking for existing literature studies that can be used as a basis for carrying out observations), making tools (starting from design, purchasing materials, assembly), feasibility testing (initial testing of tools that can be used), field testing, testing aimed at obtaining real results.

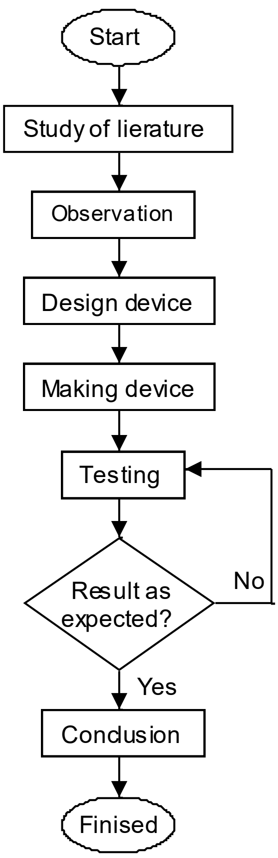

Figure 1. Research Flowchart

Peltier element to convert campfire heat into DC electricity with a maximum voltage of 12V with specifications Size: 40 x 40 x 3.9mm, lmax -7A, Umax —15.4V, Qmax —62.2W, Tmax —69C, 1.7 Ohm resistance, 127 thermo couples, Suhumax 180oC, Min operating temperature: —50oC.

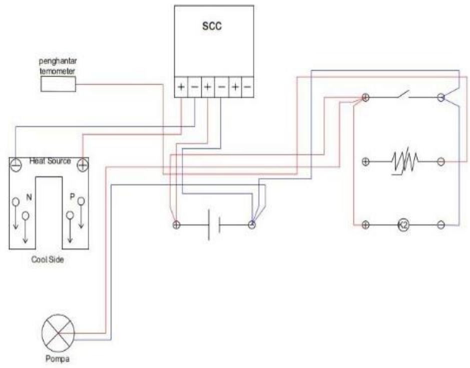

Figure 2. Block Diagram

The battery or battery in the power plant serves to store electrical energy in the form of chemical energy, which will be used to supply (provide) electricity to the load that will be used later, the following are the specifications of the battery used 12 V, 6 ah.

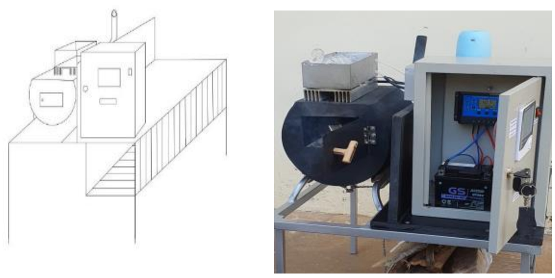

Figure 3. Desain product

This research is designed in such a way as to produce a simulation system of power generation using Thermoelectric Generator TEG. That the system input is the heat of fire given to the Peltier element. Peltier will convert heat into DC electricity (Chaturvedı & Mamtanı, 2020). some of the Peltier element inputs, electricity is collected and regulated as a stabilization process. At the process stage there is a change in heat energy that can produce electrical energy in the thermoelectric element (Dineva et al., 2014). The voltage output after regulation is stored in the battery then from the battery output enters the inverter input to convert the DC current to AC. The image above shows the design of the power circuit of the heat energy conversion system of fire into electrical energy (Chen et al., 2020).

Result and Discussion

The tests that will be carried out later include the output of the Peltier TEC1-12706, the furnace temperature, the scale of fuel usage, the battery charging time. The following are the measurement results data carried out on the device that was made. Testing of the TEG element is carried out by providing input through combustion and measuring the voltage value results after regulation is carried out. The measurement results are as in Table 1.

Table 1. Results use 1 peltier

Condition	Time (minute)	Generator Plate Temperature (°C)	Output TEG (V)	Charger condition
On	10	25	0	Off
On	15	30	0.30	On
On	20	35	0.40	On
On	25	40	0.53	On
On	30	45	0.65	On
On	35	50	0.67	On
On	40	55	0.80	On
On	45	60	0.86	On
On	50	65	0.92	On
On	55	70	1.1	On
On	60	75	1.4	On
On	65	80	1.6	On

From Table 1, it can be seen that in the condition of the fire in the furnace being on for 10 minutes and the temperature is 25°C, the Peltier output is 0.05, increasing the temperature to a temperature of 30°, the Peltier output increases to 0.30.

Table 2. Results use 8 peltier

Condition	Time (minute)	Generator Plate Temperature (°C)	Output TEG (V)	Charger condition
On	10	25	0	Off
On	15	30	2,4	On
On	20	35	3,2	On
On	25	40	4,24	On
On	30	45	5,2	On
On	35	50	5,36	On
On	40	55	6,4	On
On	45	60	6,88	On
On	50	65	7,36	On
On	55	70	8,8	On
On	60	75	11,2	On
On	65	80	12,5	On

Table 3. Result Output Tegangan Peltier

Variable	Output voltage peltier TEG (V)							
	1	2	3	4	5	6	7	8
I	0	0	0	0	0	0	0	0
II	0.30	0.6	0.9	1.2	1.5	1.8	2.1	2.4
III	0.40	0.8	1.2	1.6	2	2.4	2.8	3.2
IV	0.53	1.06	1.59	2.12	2.65	3.18	3.71	4.24
V	0.65	1.3	1.95	2.6	3.25	3.9	4.55	5.2
VI	0.67	1.34	2.01	2.68	3.35	4.02	4.69	5.36
VII	0.80	1.6	2.4	3.2	4	4.8	5.6	6.4
VIII	0.86	1.72	2.58	3.44	4.3	5.16	6.02	6.88
IX	0.92	1.84	2.76	3.68	4.6	5.52	6.44	7.36
X	1.1	2.2	3.3	4.4	5.5	6.6	7.7	8.8
XI	1.4	2.8	4.2	5.6	7	8.4	8.9	11.2
XII	1.6	3.2	4.8	6.4	8	9.6	11.2	12.5

Overall testing is done after all system components have been assembled Peltier elements are connected in series and put together (Dineva et al., 2014; Domínguez-Adame et al., 2019; Kim, 2018). In this test, a heat source is used from the combustion furnace This process continues as long as the combustion flame remains lit or remains hot After the flame goes out, a few moments later the generator voltage begins to drop In series, the device has functioned properly (Rohman et al., 2021). The test results of 8 Peltiers connected in series show a continuous increase in voltage due to the maximum temperature and series circuit applied to the Peltier circuit (Remeli et al., 2016; Spanner & Koc, 2016).

The use of Peltier elements as thermoelectric generators (TEGs) offers an innovative solution for converting household waste heat into environmentally friendly electrical energy. This technology leverages the Seebeck effect, where the temperature difference between the two sides of a Peltier module generates an electrical voltage that can be used for a variety of household applications (Tambunan et al., 2015; Wang et al., 2020).

Peltier modules, commonly known as thermoelectric coolers, can be operated in reverse as TEGs (Uchino, 2017). When one side of the module is heated (for example from burning household waste such as paper, wood, or food scraps) and the other side is cooled (using a heatsink or heat pipe), a temperature difference is created that generates electricity (Hakim et al., 2018; Haryanti et al., 2022). The greater the temperature difference, the greater the voltage and current generated (Tambunan et al., 2015; Varga & Rácz, 2022).

Conclusion

The utilization of heat in the combustion furnace with peltier as an electricity generator has been carried out and the results have been obtained according to what is desired. The acquisition of electrical energy from the 8 series peltier circuit of 12.5 v at a temperature of 80 0c this circuit can already blame the system to charge the 12V DC battery. The combustion heat of the furnace can be done by burning garbage, burning charcoal, or candle fire there are several parts that can be improved such as the use of more peltiers so that the energy produced is greater, providing a cooler in the furnace so that the peltier is not quickly damaged due to heat, can also replace heat sources such as solar heat and vehicle exhaust heat.

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This article was written by four authors, namely I. N. S., B. A., I. G. K. S. B., and I. K. P. All authors contributed together at every stage.

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Conflicts of Interest
The authors declare no conflict of interest.

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