

# The Development of Renewable Energy : Thermoelectric Charger – A Review

<sup>1</sup>Dody Novriansyah, <sup>1</sup> Kharis Salahuddin, <sup>1</sup>Hathfina Ghesani Aljrine & <sup>1</sup>Andry Meylani,

*Electrical Engineering Department, State Polytechnic of Sriwijaya, Palembang, South Sumatera, Indonesia*

<sup>1</sup>dodynofriyansa@yahoo.co.id, <sup>1</sup> kharis\_salahuddin@yahoo.co.id,  
<sup>1</sup>ghathfina\_orin@yahoo.co.id, a.meylani22@yahoo.com

**Abstract.** Electrical energy is a primary need for human, but overusing will cause scarcity of electrical energy. It causes the decreasing availability of fossil energy so it is necessary to find alternative renewable energy. One of them is by utilizing the wasted heat using the peltier element that will be converted into electrical energy and applied to generator thermoelectric. The results of burning fuel is absorbed by the exhaust system on a motorcycle mostly wasted into the environment through the engine and exhaust without any further utilization. Thermoelectric Charger is a conversion device exhaust thermal energy into electrical energy source that can be used to recharge power bank or gadgets while driving a motorcycle so that people don't need to be having a hard time when traveling. The motor part that will be utilized exhaust thermal energy is part of the exhaust flue (duct silencers). In it section was installed thermoelectric peltier. The principle works by utilizing the difference in temperature between surface and natural temperature converted into electrical energy. Then magnitude of electrical energy generated thermoelectric measured by multimeter with variables such as voltage and amperage, The farther the comparison between the two temperatures the greater the voltage and current generated.

**Keywords:** *Thermoelectric Charger, exhaust, peltier, electrical energy, thermal energy*

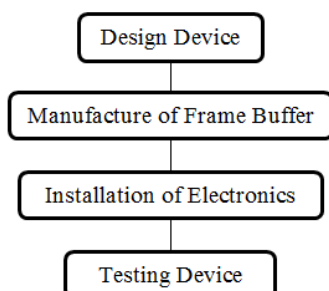
## A. INTRODUCTION

Over time usage of motor vehicles in Indonesia is increasing. This was due to the prices are relatively cheap compared to other means of transportation. Of several litres of fuel are included, only 40% of them are actually used to move the machine.[1] Subsequently thrown away into the exhaust heat and radiator. Therefore, we required a way to be able to utilize heat energy out of the motorcycle into something more useful. One of the ways that can be done is convert the wasted heat energy into electrical energy that has the more potential for greater usability.

To do that, it is requires a device that could convert the heat energy into electrical energy i.e. thermoelectric. By installing close to the exhaust, then automatically the heat coming out of the exhaust is converted into electrical energy.[2]

Then the electrical energy can be utilized, such as to recharge the phone battery on the time of the trip.

## B. METHODOLOGY



**Figure 1.** Steps to created the device

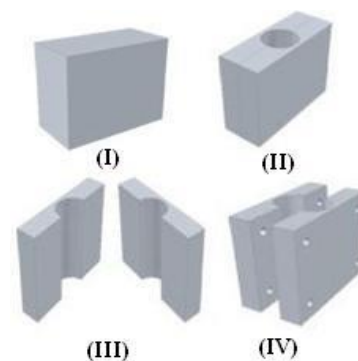
### Design Device

Before the device is created, design the dimensions THERGER (Thermoelectric Charger) using autocad software first.

Design created twice, during the time of the initial ideas and the time to do the analysis and improvement of materials designed to be a tool that can be minimalist and efficiently adjust the position on the motorcycle.

### Manufacture of Frame Buffer

In this step, made the frame buffer as in the design. The materials needed are 1 electrical conductive metal, such as aluminium block (I)



**Figure 2.** Steps of manufacture of frame buffer using aluminium

The next step, perforate the center of the aluminium metal by using a drilling machine (I). Aluminium metal is cut in the central hole by using a hacksaw (III). Four corners of the aluminium frame is perforated by using a drilling machine as a mounting bolt.

**Installation of Electrical Energy Storage**

The exhaust heat that has been converted into electrical energy is further utilized as a portable battery charger (charger). The output voltage generated by thermoelectric Peltier is clearly still uneven and the ripple factor is still large. DC voltage like this is not good when used for charging the battery. Therefore, the need for a device that can keep the battery is not easily damaged, namely by charging controller (charger controller).

The electrical voltage storage unit used is the battery. The voltage stored on the battery can then be used for chargers (recharge) power bank, HP batteries, gadgets. Etc

**Installation of Electronics**

Installation of Electronics consists of mounting peltier on the hottest position on a motorcycle. Thermoelectric affixed between the aluminium frame and the heatsink. Then attach the frame buffer to the exhaust will be used. Voltage enhancer is added to stabilize the voltage generated by the thermoelectric peltier.

**Testing Device**

At this stage, all the components required in this research are installed and the appliance is ready to be tested.

**C. RESULT AND CONCLUSION**

**What is thermoelectric?**

Thermoelectric is a technology that works by converting heat energy directly into electricity (thermoelectric generators) or vice versa<sup>[3]</sup>. To generate electricity, the thermoelectric material is placed in such a way in the circuit that connects a source of heat and cold. From its circuit will be produced according to the type of materials used.

**How to Concept Seebeck theory?**

The Seebeck concept illustrates that if two metal materials (usually semi-conductor) connected are in an environment with two different temperatures, then the material will flow electric current or electric motion force. This concept When applied to motor vehicles with exhaust gases on a motor fuel engine ranging between 200-300°C and an ambient temperature ranging between 30-35°C will generate an electric motion force which can then be used to move an electric motor or stored in the battery. Seebeck concept and Peltier concept is the embryo of the emergence of thermoelectric module. Thermoelectric modules are integrated circuits in solid form that use three known thermodynamic principles As a Seebeck effect, Peltier and Thompson. The construction consists of p-type and n-type semiconductor pairs that form thermocouples that have a sandwich-like shape of two thin ceramic wafers.

**How does the work of thermoelectric?**

The working principle of thermoelectric is based on the Seebeck Effect, "If two different metal pieces connected one

end, then given a different temperature on the connection, then the voltage difference occurs at the end of the one with the other end"<sup>[4]</sup>

For example, the heatsink temperature heated in 80°C, whereas the heatsink temperature of heat exhaust 55°C so peltier has 30°C temperature difference. The farther the difference, then the electric produced will increase, but otherwise, if it is too hot, it could cause overheat.

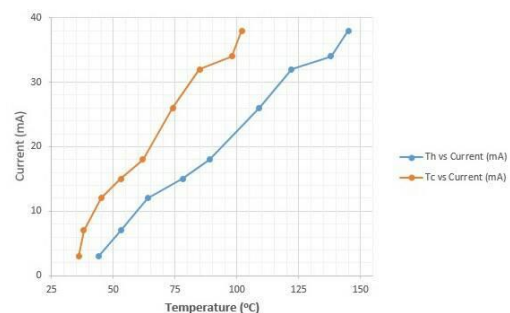
If this concept applied on the vehicle with 200°C-300°C exhaust on the motorcycle machine and environment temperature is between 30°C-35°C, it would produce electricity energy that can be used to move the motor or saved in the battery.

**How the effect of environment to the input of thermoelectric peltier?**

**Table 1.** Data sample of test result specification identifying of Thermoelectric Peltier initial conditions

Test	Testing Form			Results
	Peltier Amount	Heater	Cooler	
1	1 Piece	100°C Iron	Heatsink and fan	2.88 – 3.3 Volt
2	1 Piece	100°C Iron	Heatsink and water	2.86 – 3 Volt
3	1 Piece	186 °C Iron	Heatsink and water	3.9–4.45 Volt
4	3 Pieces Series Assembled	100 °C Hot Plate	Heatsink and water	3.6 – 4.0 Volt
5	3 Pieces Series Assembled	100 °C Hot Plate	Heatsink and water	4.9 – 8.0 Volt

The second Thermoelectric Peltier test directly carried on the motorcycle exhaust cylinder. The tested motorcycle are in idle condition and the machine is turned on. In this test, Thermoelectric Peltier applied on the Thermoelectric Peltier buffer frame which was made because exhaust part been used is the closest part with output valve on the piston cylinder. It is caused of the highest temperature on the exhaust part reaching 200°C



**Figure 3.** Graphic of connection between amperage and heat and cold

The result from the graphic known that the temperature difference resulting from heat of the exhaust with the environment temperature are very influencing.<sup>[5]</sup> In the graphic above, the environment temperature is not optimal yet, because of the distinction between the hot side and the cold side are not maximal. Therefore, it is necessary to add consistency of the peltier cold sidewith giving holes on on the pores and inserting water tube that could give cold temperature on the peltier hot side, so the exhaust has different paths with the peltier cold side. So the power that produced is decent and as expected and the voltage remain stable. If the temperature difference could be maximized, so the obtained amperage will be greater and could reach the maximum. The power that been produced by the element will also maks effect, if the amperage is small, so the power that produced is small, because power proportional to amperage and voltage. Therefore, voltage, amperage and power depends on the size of the temperature difference that produced. It is caused by bad isolation from both sides, so the heat flows from the hot side to the cold side. This result comply to the seedback theory.

**How the effect of the heatsink density to the environment temperature?**

**Table 2.** Test result of second condition with *heatsink* density 0.5 cm

Test	Test Form			Result
	Heater Temp.	Environment Temp.	Temp. Differences (ΔT)	
1	78°C	58°C	20	1.1 V
2	135°C	114°C	21	1.5 V
3	117°C	98°C	19	1 V
4	140°C	115°C	25	2.06 V
5	136°C	119°C	17	0.9 V

**Table 3.** Static test of two Peltier thermoelectric coupled parallel.

Volt	T1(°C)	T1(°C)	T1(°C)	Arus(mA)	Time(m)
0.379	44	36	8	-	2
0.659	53	43	10	-	4
0.737	63	46	17	-	6
0.843	71	52	19	-	8
0.903	78	58	20	-	10
0.963	85	64	21	-	12
0.992	94	71	23	-	14

0.982	97	77	20	-	16
1	102	79	23	-	18
1.101	105	83	22	420	20
1.205	107	84	23	500	22

**Table 4.** Condition test result with heatsink density 1 cm

Test	Test Form			Result
	Heater Temp.	Environment Temp.	Temp. Differences (ΔT)	
1	78°C	52 °C	26°C	0.95-1 V
2	92°C	53°C	39°C	0.9 V

The third test applied on the heatsink density condition are very tight from the motorcycle exhaust. So it could be concluded that the heatsink density affecting on the voltage production. Therefore, buffer frame of the heatsink should be tight to motorcycle exhaust.<sup>[2]</sup>

**How is the voltage and the amperage produced by the renewable energy from the thermoelectric charger?**

The following is the amperage that has been statically produced/minute fluctuates reaching the defines maximum.

**Table 5.** The amperage power of static thermoelectric charger testing

No	Time to- (minutes)	Amperage (mA)
1	0	0
2	2	5.17
3	4	5.31
4	6	5.45
5	8	5.48
6	10	5.59

The table shows amperages value on the USB output that used to recharge gadgets or cellphone. Recharging process will run when the voltage reaching 1.115 volt. The voltage could be reach with turning on the motor machine for 10 minutes n static mode. The produced voltages is not reach the minimum value of recharging process, that 5 volt so the thermoelectric charger circuit needs a transistor system. The voltage in the output from transistor is 5.5 volt.

The time problem in recharging process can be overcome by adding transistor circuit, so when the heat produced from the exhaust overheat can be dimmed by the transistor circuit. Besides its used to increasing the amperages and the voltages, it could be used as a constant stabilizer. Therefore, when it used, it would not cause damage to the cellphone or the battery, so the recharging process is times free and unlimited.

### D. CONCLUSION

Conversion of thermal energy into electrical energy is one of the efforts of renewable energy. Excessive use of electric energy can lead to increased use of fossil energy resources as the main component of electrical energy generator.

It also results in reduced availability of fossil energy. Thermoelectric charger has shown that the thermoelectric generator has a bright prospect in the future as an alternative electric energy. So, wherever there is wasted heat, thermoelectric generator can change wasted heat into electrical power.



### REFERENCES

- [1] Putra, Nandy, cs. 2009. Potensi Pembangkit Daya TermoelektriK Untuk Kendaraan Hibrid.
- [2] Mukminin,Amiril,cs. 2014. “THREGER” Thermoelectric Charger sebagai Alat Konversi Energi Panas Buang Motor Bakar menjadi Sumber Energi Listrik.
- [3] S, Denniswara,cs.2011. Efek Termoelektrik.
- [4] Muhaimin.1993. Bahan-Bahan Listrik untuk Politeknik. Jakarta. Pradnya Paramita
- [5] Tambunan, Walfred,cs.2013. Pengembangan dan Optimalisasi Elemen Peltier Sebagai Generator Termal Memanfaatkan Energi Panas Terbuang.
- [6] Nugroho, Wisnu Adi,cs.2015. Exhaust System Generator:Knalpot Penghasil Listrik Dengan Prinsip Termoelektrik

### APPENDIX

