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EFFECT OF HEATSINK FIN AND THERMAL INSULATORS ON OUTPUT OF THERMOELECTRIC POWER OF HEAT OF MOTORCYCLE EXHAUST GAS

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KEYWORDS

Thermoelectric
heatsink
thermal insulator
heat exhaust power plant

ABSTRACT

Thermoelectric can be utilized to convert exhaust heat into electricity. This study aims to determine the effect of heatsink height and thermal insulation on electric power generated from thermal powered thermoelectric plants. This research is using an experimental method. The technically of data analysis is descriptive comparative. In this research were used 10 mm, 20 mm, and 30 mm heatsink fin. Thermal insulator materials are glass wool and aluminum foil. Electrical power obtained from multiplication of electrical voltage and electric current. The data analysis was indicated the increasing electrical power with increasing heatsink fin height. The higher power is accomplished by using heatsink fin 30mm at 0.56-watt power output, and the smaller power is obtained by using heatsink fin 10mm at 0.32-watt power output. The results of thermal insulation testing indicate that there is an increase in electrical power when the use of thermal insulator. Data analysis were reported the most significant strength is obtained on the use of 30 mm heatsink with an isolator of 0.76 watts, and the smallest power is obtained on the use of high heatsink 10 mm without thermal insulator is 0.32 watts. The results of this study indicate that the heatsink fins height and thermal insulators affect the power generated by thermoelectric power plants.

INTRODUCTION

As we know, human needs for transportation are increasing. Based on data from the Central Statistics Agency (2016), it can be seen that the number of motorized vehicles increases every year. From these data, motorcycle ranks the first largest, namely 105,150,082 units. If one bike consumes 2 liters of fuel every day, it means that the fuel needs reach 200 million liters per day. However, the spark ignition vehicle cannot convert 100% of the combustion energy into mechanical energy. The heat from the combustion is thrown away to the exhaust and into the environment without being used again. This becomes a loss and can reduce the efficiency of using combustion energy. According to Sugiyanto (2013), the spark ignition engine is fueled by gasoline, about 30% of the primary energy will be wasted as waste heat through the exhaust gas. Sugiyanto's opinion is in line with Nugroho, W.A., Muh. Soni H., & Rudhiyanto (2015), of about 1 liter of fuel included, only 40% of them are used to drive engines.

Thermoelectric is a technology that works by converting heat energy into electricity directly (thermoelectric generator), or vice versa, from voltage to produce cold (thermoelectric coolant) (Ilham, 2013). Nugroho, W.A., Muh. Soni H., & Rudhiyanto (2015) conducted a study on converting flue gas heat to electricity using thermoelectric

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generator components. From the results of the Exhaust Test System, the generator can work and can convert the exhaust gas heat into electrical energy. In testing, when a motorcycle runs at a speed of 10 km / h for 3 minutes, it produces the most significant electrical output of 0.5 volts with a current of 0.07 amperes. Sugiyanto, Muh Tarum N. Umam, and Endra Suciawan (2015) also conducted the same research. From the test results, it was found that the voltage could be stable at 664-665 mV after 15 minutes the motorbike was turned on. From the test it was also concluded that the energy generated was still low; this was due to the cooling of the aluminum fins not yet optimal. Besides, extraordinary efforts are needed to maximize the temperature difference between the temperature of the exhaust surface and the temperature of the exhaust so that more electrical energy can be produced.

The heatsink is designed to be able to move heat from a heat source to the environment. By optimizing the aluminum fins, it is hoped that it can maximize the difference in temperature produced so that it will affect the power output generated by the exhaust gas heat power plant. To improve heatsink performance can be done by expanding the heatsink area. To speed up the heat dissipation process, it is done by extending the heatsink cooling area (Putra and Wachid, 2018). Based on research conducted by Prasetyo (2015), the increase in heatsink area affects decreasing heat heatsink temperature, increase in COP, an increase in cooling efficiency. With the addition of fin height, the heatsink surface area can be expanded. The higher the heatsink fin, the wider the heat transfer surface will be. The results of the Asrofi (2014) study show that the increase in the length of the longitudinal fin affects the increase in the heat transfer rate. With an increase in heatsink fin height, cooling will be more optimal. Better cooling will reduce the temperature of the heat sink. Due to the decrease in heatsink temperature, the temperature difference between the two sides of the thermoelectric can be increased. By increasing the temperature difference, the power produced by the thermoelectric is greater.

A thermal insulator is a tool that can be used to inhibit the heat transfer rate. According to Burlian and M. Indah (2014), it shows that the use of thermal insulators can impede heat transfer, the thicker the heat insulator, the higher the value of thermal resistance. By installing thermal insulators on the hot side heat exchangers, the heat transfer rate from the hot side heat exchanger to the environment can be inhibited, so that the hot side heat exchanger temperature increases. With this increase, the temperature difference between the two sides of the thermoelectric is more significant. The more significant the temperature difference between the two sides of the thermoelectric, the higher the electrical power that can be produced.

RESEARCH METHODS

This research is using the experimental method. Data analysis used in this research is descriptive analysis technique. This study aims to determine the effect of the heatsink and thermal insulator height on the exhaust output power of the exhaust heat gas thermoelectric generator. The height variations of the fins used are 10 mm, 20 mm and 30 mm. The variation in the use of thermal insulators used is without thermal insulators and with glass wall thermal insulators and aluminum foil.

The thermoelectric used is TEG SP1848 27145 SA. Heatsink used is made from aluminum with a length x width of 70 mm x 60 mm with eight fins. Aluminum frame or hot side heat exchanger made of semi-cylindrical aluminum. On one side of the aluminum frame, there is a semi-cylindrical basin according to the outer diameter of the exhaust pipe, and the opposite side is flat as the thermoelectric generator attaches. Aluminum frames are explained in the following figure:

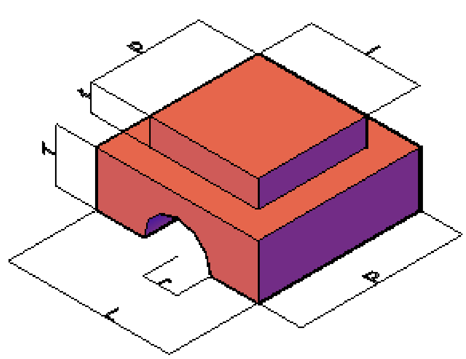

Figure 1. Aluminum frame

Table 1. Image Information

Section	Size (mm)
P	60
L	60
T	20
R	12,5
P	10
L	40
T	40

The motorcycle used is the 110cc Honda Beat. Installation location 20cm from the tip of the exhaust neck. The installation location is based on the thermoelectric specification, which can only last up to a temperature of 150 C. Installation according to the following picture.

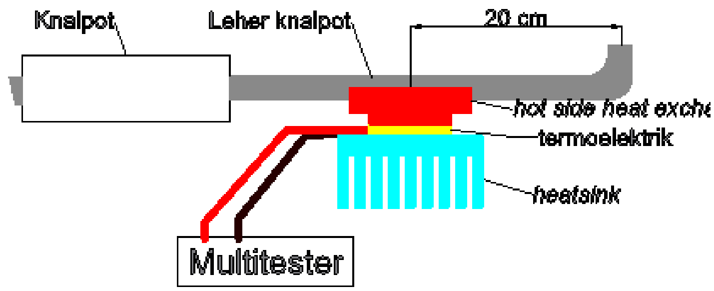

Figure 2. Installation of Exhaust Gas Exhaust Power Plant

Tests are carried out at idle rotation (around 1800rpm). Measurements were made after the exhaust reached a temperature of 140 C (approximately 15 minutes after the motorcycle turned on) at a 5-minute interval for 20 minutes. Digital multitester obtains measurement data — the measurement results in the form of electric voltage and the electric current generated by thermoelectric. Electrical power is received from the results of multiplying the electric energy and electric current. The results are then analyzed and compared between variations and conclusions are drawn.

RESULTS AND DISCUSSION

Based on the results of testing the use of high variations of fins and thermal insulators on exhaust heat power plants, the results are as follows:

Table 2. Output measurement results (watts)

Trial	Power
10 mm fin height without thermal insulator	0,31
Height of 20 mm fin without thermal insulator	0,47
Height of 30 mm fin without thermal insulator	0,55
10 mm fin height with thermal insulator	0,44
Height of 20 mm fin without thermal insulator	0,61
Height of 30 mm fin without thermal insulator	0,75

The results of the tests are illustrated in the graph as follows:

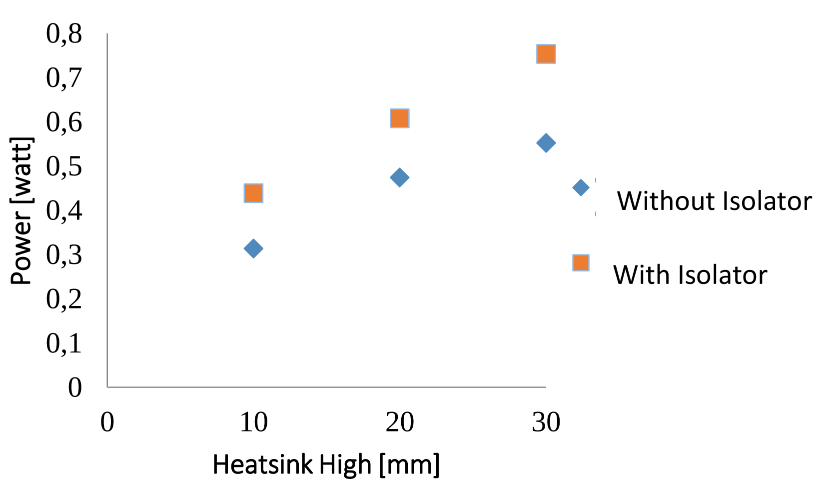

Figure 3. Output Power Graph

Tabel 3. Temperature *hot side* and *heatsink*

Trial	*Hot side °C*	*Heatsink °C*
10 mm fin height without thermal insulator	60,00	96,67
Height of 20 mm fin without thermal insulator	51,25	96,67
Height of 30 mm fin without thermal insulator	45,33	96,67
10 mm fin height with thermal insulator	60,33	103,33
Height of 20 mm fin without thermal insulator	53,33	103,33
Height of 30 mm fin without thermal insulator	47,67	105,00

The results of the tests are illustrated in the graph as figre 4 follows:

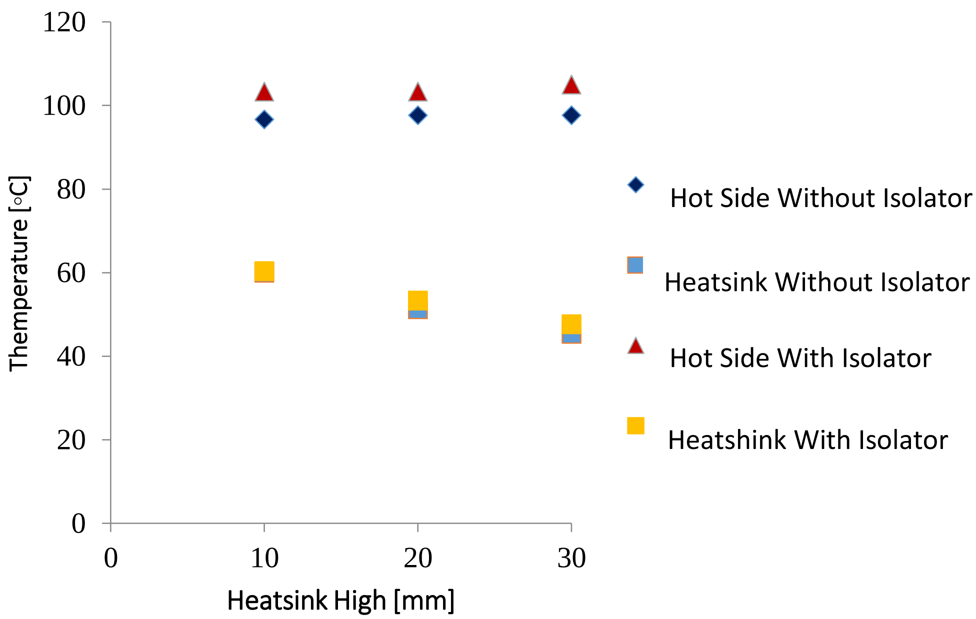

Figure 4. Hot Side Templates and Heatsink without and with Thermal Insulator

High Effect of Heatsink Fins on the Power Generated by Thermoelectrics

From Figure 4 it can be seen that the use of different heatsink fin height causes differences in the power generated from the exhaust gas heat power plant. The high increase in the heatsink fin causes an increase in the energy produced by the thermoelectric. In testing without thermal insulators, the resulting power of 30 mm heatsink fin produced scattered power of 0.56 watts, and the smallest power was obtained using 10 mm heatsink fin which was 0.31 watts. These results also occur in testing with thermal insulators, where the most significant energy produced by the power produced 30 mm heatsink fin produces scattered power of 0.76 watts, and the smallest power obtained in the use of 10 mm heatsink fin is 0.44 watts.

From the results of the tests carried out, the height of the fins will affect the power produced by the exhaust gas heat power plant. The expansion of the heat transfer surface can be done by raising the heatsink fin. By expanding the heatsink area, the heat dissipation process can be accelerated (Putra and Wackhid, 2018). A faster heat sinking process will make the cooler side temperature of the exhaust gas power plant lower. From Figure 5, it can be seen that the heatsink temperature decreases as the fins rise high. Of the three variations of fin height, a 30 mm tall heatsink has the lowest temperature. Because the cooling side temperature is lower, the temperature difference from both sides will be more bearable so that the power generated by the exhaust gas heat power plant will be even higher.

The Effect of Using Thermal Insulators on the Power Generated by Thermoelectrics

From figure 4, it can be seen that there is an increase in the electrical power produced in each test with the use of thermal insulators. Spread energy is created by the use of 30 mm heatsink fins with the use of thermal insulators at 0.75 watts while the smallest power is obtained from the use of high 10 mm heatsink fins without thermal insulators.

From the tests carried out, it can be seen that the use of thermal insulators affects the electrical power produced by exhaust gas heat power plants. Power increases with the use of thermal insulators. The purpose of thermal insulators can inhibit heat transfer, the thicker the heat insulator, the higher the value of thermal resistance (Burlian and M. Indah, 2014). This is because the use of thermal insulators can reduce the heat transfer that occurs in the hot side heat exchangers towards the environment so that the heat transferred from the exhaust to the thermoelectric by hot side heat exchangers is not wasted into the background. Because heat transfer from the hot side exchanger to the environment can be reduced, the temperature of the hot side heat exchanger will increase. This is evidenced by data from the test results in Figure 5, where the average temperature of hot side heat exchangers with the use of thermal insulators is higher than the average temperature of hot side exchangers without the use of thermal insulators. With the increase of the hot side heat exchanger temperature, the difference in temperature difference from both sides of the thermoelectric can increase. With increasing temperature differences, the power generated by the exhaust gas heat power plant will also increase.

CONCLUSIONS AND SUGGESTIONS

From the results of the tests carried out, the effect of using high heatsink fins and thermal insulators on the power produced by exhaust heat power plants is as follows:

The use of top heatsink fins affects the amount of electrical energy generated by exhaust heat power plants. The highest power is obtained using the 30 mm heatsink fin, which is 0.55 watts. While the lowest power was obtained using the 10 mm heatsink fin, which was 0.31 watts.

The use of thermal insulators affects the electrical power produced by exhaust heat power plants. The highest authority is obtained from the use of thermal insulators with a 30 mm heatsink fin which is 0.75 watts while the lowest electrical power is achieved by using a 10 mm heatsink fin without a thermal insulator, which is 0.31 watts.

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