SCAVENGING ENERGY: THERMOELECTRIC BASED MOTORCYCLE EXHAUST WASTE HEAT RECOVERY SYSTEM

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1. Introduction

Majority of people in Indonesia use motorcycle as their main mode of transportation. 67% of the population relies heavily on motorcycles to commute. At least 40% of the energy in gasoline used in these motorcycle is wasted as heat. Therefore, in conjunction with the Seebeck effect, thermoelectric module is utilized to convert this waste heat into electricity.

The aim of this research is to determine the efficiency and the feasibility of thermoelectric module TEC 12706 and TEG SP 1848 27145 SA to be used as electricity generator utilizing motorcycle exhaust waste heat.

2. Research Method

The first stage is to determine maximum power point (MPP) and efficiency of thermoelectric module. For simulation purposes, an iron is used as the heat source. Experimental set up is planned to measure firstly the input power and secondly the output power. Blow up view of the setup is shown in figure 1.

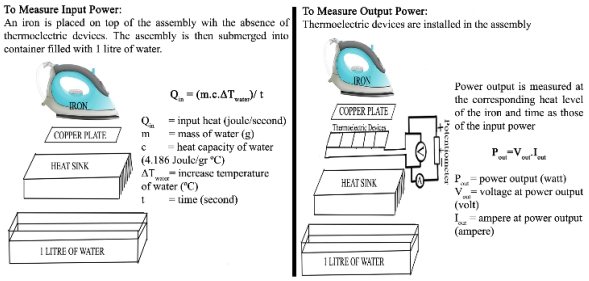


Fig 1. Experimental setup to determine the input power (left) and the output power (right)

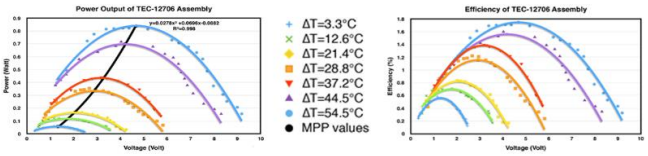
Visible in figure 1 (right) is 5 units of TEC 12706 (later replaced by TEG SP1848 27145 SA) serially connected then enclosed by copper sheet and heat sink to create temperature difference to generate electricity. The assembly is then connected serially to potentiometer to best match the load resistance to determine the maximum power point (MPP). Efficiency of the thermoelectric assembly can be calculated as follows,

$$\eta = P_{out} / Q_{in} \times 100\%$$

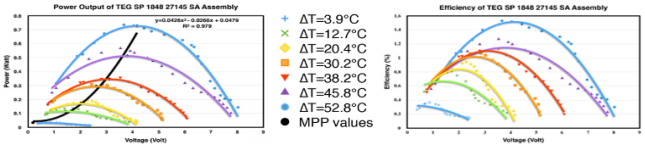
(where η= thermal efficiency, P_{out}=power output (watt), Q_{in} = input heat (watt)

The second stage is to test the assembly on motorcycle with the potentiometer is set to the optimal resistance value at MPP determined by the result of previous stage of the experiment to measure maximum deliverable electrical power.

3. Results



Graph 1. Power output (left) and efficiency (right) of TEC 12706 assembly



Graph 2. Power output (left) and efficiency (right) of TEG SP 1848 27145 SA assembly

At the highest temperature gradient, power output at MPP for TEC 12706 is 0.8377 watt, and the efficiency is 1.75% while power output at MPP for TEG SP 27145 SA is 0.73 watt, and the efficiency is 1.513%. The graphs show the correlation between power and voltage output at MPP across temperature gradients in quadratic relation which follows Ohm's law where Power=Voltage^2/Resistance.

The test shows that at low temperature sector (below 150˚C), efficiency of TEC and TEG is not significantly different. Therefore, due to its lower price and efficiency, in this experiment, TEC 12706 is chosen to generate electricity utilizing motorcycle exhaust waste heat. TEC assembly is then mounted on the exhaust of the motorcycle. Six trials that lasted 15 minutes each, generated maximal power of 0.74 watts and energy of 333.63 Joule.

4. Conclusion

At low temperature sector (below 150°C) TEC 12706 offers better economic value and performance than TEG SP1848 27145 SA. The research shows that thermoelectric module could generate fair amount of electricity utilizing exhaust waste heat of the motorcycle. Currently, generated electricity could not replace alternator but could be stored in power bank. In the future, better exhaust pipe design and better material for thermoelectric semiconductors could increase the amount electrical energy generated.

5. References

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[2] Putra, Nandy. Potensi Pembangkit Daya Termoelektrik untuk Kendaraan Hibrid: Makara, Teknologi, Vol 13, No. 2, November 2009.