The effect of increasing current to temperature of alternator

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ABSTRACT – Alternator is a major component in the charging system. Alternator act as main power source, providing current to power the electrical component in a vehicle. As more power demand, the more current is produced, and the more heat is generated. This heat has contributed an increase of under hood ambient temperature. An experiment has been done to investigate how the current and heat relate to each other. The car used is Proton Preve 1.6L Manual. The alternator has a rating of 12V/90A. The result shows that temperature increase exponentially with increase of current.

1. INTRODUCTION

Every automobile has a charging system. For a car, it consists of the alternator, regulator, and the interconnecting wiring. Charging system act as main source of electrical energy, and provide power to electrical components in the car while the engine is running. If there is no charging system, battery will be the source of power. But until the battery is weak, and there is no power source to charge the battery, then this will cause the engine to has less current to fire the spark plugs [1]. In this case, the engine will be forced to stop running.

The alternator, like most mechanical and electrical machinery, cannot withstand at maximum output for extended periods of time. Maximum output for a short period of time might be tolerable. But for most of the time, alternator operates at about three quarter of full output potential. Also, like any other machinery, alternators produce heat as a by-product of generating electrical power [2]. As the more power is produced, the more heat they make. During the 80's, the alternator can produced power up to 1500W. Then, as technology advancing and more research development, and due to increasing power demand, the alternator has been modified and designed so that it can produce power to 2000W. This has increased the under hood ambient temperature from 110 degrees C in 1980 to 130 degrees C nowadays [3]. But the alternator has been designed so that it can work well at temperature up to 300 degrees C.

One of the wastage or inefficiency that happen in the automotive engine is the unused current generated by the alternator. The electricity supply by the alternator is continuous when the engine is in operation, there will be surplus of energy generated by the alternator that will be wasted in term of thermal energy. The higher the power demand, the more current is generated by the alternator. And the more heat is being produced. Whenever an electric current flows through a material that has some resistance, it creates heat. This resistive heating is the result of friction [4].

In this research, an energy audit is performed to find out how temperature is increasing in the cable at the alternator output, and at the alternator itself. The study will focus on the energy audit on the electricity produced by the alternator. The car used in this research is Proton Preve 1.6L manual. And the experiment is done at engine is at idle.

2. METHODOLOGY

Figure 1 shows how the experiment is done. An AC/DC Clamp is used to get the reading of alternator current output. It is being clamped at the current output cable. A K-Type thermocouple is being put inside the cable at the alternator output to get the reading of the wire temperature. A thermal imaging camera is used to take the temperature at the alternator coil. K-Type thermocouple is not used to take temperature at the coil to avoid it from melting, which will affect the reading. Thermal imaging camera cannot be used to take reading of temperature inside the cable as it only can take reading of temperature at the surface.

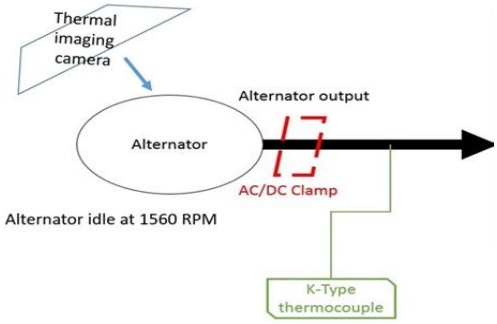

Figure 1 Schematic diagram of experiment.

The engine is idle at 1560 RPM, measured by a tachometer. All the available electrical components were turned on one after another by sequence. Table 1 shows how the electrical components were arranged and turned on by sequence. The reason for the arrangement and sequence was to get a constant result when doing repeating testing.

Table 1 Electrical components turned on in sequence.

No.	Electrical Component(s)
1	Radio
2	Front lamp
3	Rear lamp (brake)
4	Hi-beam
5	Spotlight (R)(L)
6	Interior lamp
7	Air-cond
8	Wiper, signal, hazard, power window, radiator fan

3. RESULTS AND DISCUSSION

Table 2 below shows the average data for the experiment. The experiment was repeated six times. Figure 2 and Figure 3 shows that both graph have same pattern, which tells that the heat at the wire and alternator have same behavior. As the current increase, the temperature rise. The line of the graph is increase exponentially. This prove that heat will increase as the current increase.

As shown in Figure 2 and Figure 3, there is a drastic increase of temperature at current 48.6A to 50.4A. At that point, by referring to Table 1, it shows that at that time, the right and left spotlight are being turned on. The spotlight may contribute in this sudden increase of temperature.

The more current is produced, the more heat generated. Electrical current is the flow of electrons through a substance that will permit that flow. The substance is called a conductor, which resist electron flow to some extent. The current transmitted is fast, causing more friction per unit time and therefore a higher resistance. When electron flow is resisted, some of the energy in the electrons does not travel through all the way. Because energy is conserved, the energy that was moving the electrons forward is converted to heat energy [5].

Table 2 Alternator output current and temperature.

Alternator Current output (Amp) (Approximately)	Wire Temperature (°C)	Alternator coil temperature (°C)
13.30	33.50	101.14
22.60	34.00	104.5
27.10	34.20	109.23
35.90	35.10	127.45
48.60	38.30	144.83
50.40	43.30	182.79
58.90	45.00	203.13
62.20	47.30	218.72

4. CONCLUSION

The car used in this experiment has an alternator rating of 12V/90A. The alternator can produce up to 90A of current. Without any external electrical component, the maximum power demand is 62.2A. And the maximum temperature for alternator output cable is 47.3°C, while maximum temperature at coil is 218.72°C. The more current is produced, the more heat generated. If there is any external electrical component is being installed, the current and temperature may rise. This is not good for lifespan of the wire and the alternator itself.

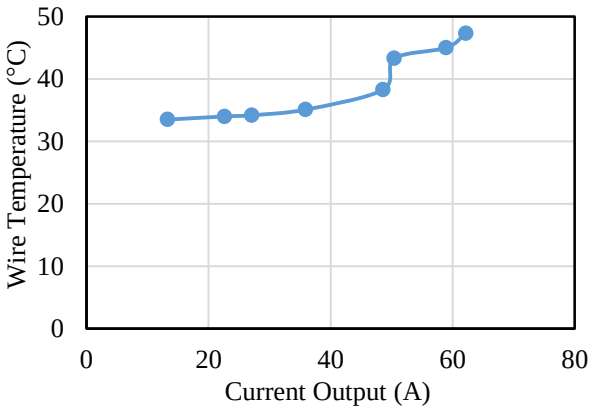

Figure 2 Current output against wire temperature.

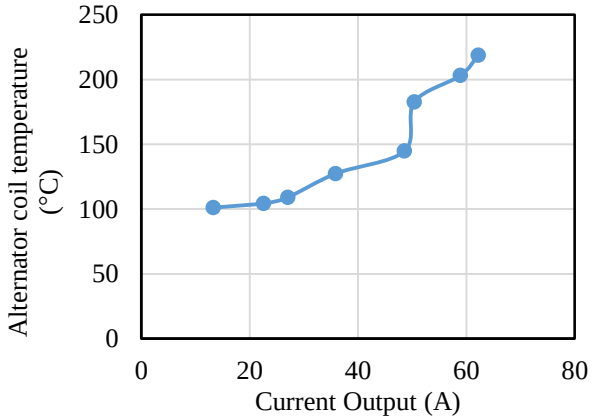

Figure 3 Current output against alternator coil temperature.

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REFERENCES

[1] C. Ofria, "*A Short Course on Charging System*". [Online] Retrieved from http://www.carparts.com, 20 Dec 2015.

[2] M. Hamilton, "*Voltage Regulator, Alternator, and Battery Operation*" [Online] Retrieved from http://www.madelectrical.com, 20 Dec 2015.

[3] M. Bradfield, "*Thermal Design Challenges in Automotive Alternator Power Electronics*" [Online] Retrieved from http://www.electronics-cooling.com, accessed on 20 Dec 2015.

[4] E. Csanyi, "Resistive heating explained in details" [Online] Retrieved from http://electrical-engineering-portal.com, accessed on 20 Dec 2015.

[5] "Why does electrical current make heat?" [Online] Retrieved from http://www.qrg.northwestern.edu, accessed on 20 Dec 2015.