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# The effect of temperature on energy transfer capacity by laser

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# The effect of temperature on energy transfer capacity by laser

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**Abstract**. This study aims to obtain an overview of the effect of temperature on energy transfer capacity by laser which can later be used as one of the basic considerations for transferring electrical energy through air that is converted into the form of light until it is received by the receiver by comparing the transmitted power and power received. The research method uses an experimental method with the design of a laser and a photovoltaic cell as a receiver. The schematic experiment starts with setting up equipment. It is then treated with temperature changes as an effect on the laser. The results of the treatment were analysed so that conclusions were obtained. Based on the results of the study, it was found that the significance level of probability value's calculation or the significance coefficient was 8.26E-30 which means it is smaller than the specified error rate / alpha (α) of 0.05. And if the coefficient F is uses, the value of the calculated coefficient F is 459.3736 which means it is greater than the F table 4.001191. In accordance with the provisions that apply in testing the hypothesis, it can be concluded that the null hypothesis (H_o) which states "No effect of temperature on output power" is rejected. This means that the evidence of results accepts the alternative hypothesis (H_1) which states "There is an influence of temperature on the output power". The correlation of the effect of changes in temperature to output power gives the equation y=3E-10x^3-3E-08x^2+6E-07x+5E-05. So it can be concluded that temperature changes have an effect on output power.

## 1. Introduction

A laser is a device that emits light by stimulating the actual reinforcement and transferring electrical energy [1,2]. It is known that view is an electromagnetic wave, especially a laser which with its unique characteristics has a very strong, concentrated, and well-coordinated light properties [3]. As a result, the light coming from the laser's light intensity will increase, due to the increase in light energy, the same beam diameter will increase with increasing power [4]. Unlike the sun, the laser power can be adjusted according to the wishes because of the laser design and its supply [5]. Meanwhile the power that comes from solar energy cannot be constant (constant) as desired because solar energy is a natural property that comes from the fusion process [6].

Energy light coming from a laser cannot automatically be converted into electrical energy. There needs to be a device that changes light energy into electrical energy, which is called a photodetector [7]. This type of photodetector is commonly used to capture a wide range of light, commonly known as photovoltaic or solar cells [8]. The capture of beams of light by photovoltaic or solar cells is determined by the intensity of the incoming light radiation [9]. The light radiation is affected by temperature [10]. With the background above, researchers are interested in researching the effect of temperature on energy transfer capacity using laser applications.

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## 2. Method

This research was carried out by using an experimental approach with the design of a laser as a transmitter and a photovoltaic cell as a receiver. Then, the temperature change treatment is given.

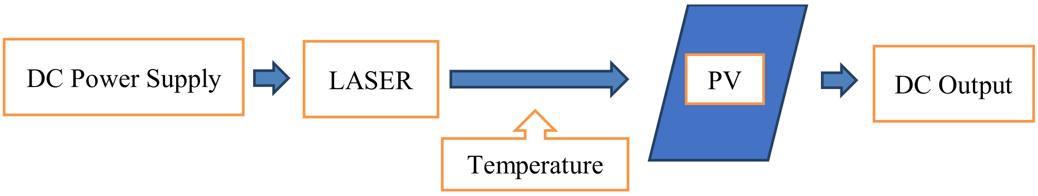


**Figure 1.** Research setting design.

In the experimental setting, the DC power supply provides electricity to the laser. The laser supply voltage is 4 volts, so the DC power supply needs to set the output voltage to 4 volts following the supply voltage to the laser. The change in treatment is given to the temperature between laser and photovoltaic. Furthermore, from the amount of electricity that enters the laser, it is then converted into a laser beam. Then, the laser beam is captured by photovoltaic, and the output is measured directly using a digital multimeter. The photovoltaic values measured by digital multimeters include voltage, current, and power. After the experiment settings are made, then enter the measurement data into the table as follows:

**Table 1.** Measurement parameters.

| Temperature ($^oC$) | Measurement Data | | |
|---|---|---|---|
| | Voltage (V) | Current (A) | Power (W) |
| 20 | 2,914 | 0,000019 | 0,0000554 |
| 21 | 2,902 | 0,000019 | 0,0000551 |
| 22 | 2,882 | 0,000019 | 0,0000548 |
| 23 | 2,870 | 0,000019 | 0,0000545 |
| 24 | 2,863 | 0,000019 | 0,0000544 |
| 25 | 2,860 | 0,000019 | 0,0000543 |
| 26 | 2,850 | 0,000019 | 0,0000542 |
| 27 | 2,845 | 0,000019 | 0,0000541 |
| 28 | 2,825 | 0,000019 | 0,0000537 |
| 29 | 2,805 | 0,000019 | 0,0000533 |
| 30 | 2,790 | 0,000019 | 0,0000530 |
| 31 | 2,770 | 0,000019 | 0,0000526 |
| 32 | 2,755 | 0,000019 | 0,0000523 |
| 33 | 2,732 | 0,000019 | 0,0000519 |
| 34 | 2,718 | 0,000019 | 0,0000516 |
| 35 | 2,703 | 0,000019 | 0,0000514 |
| 36 | 2,693 | 0,000019 | 0,0000512 |
| 37 | 2,679 | 0,000019 | 0,0000509 |
| 38 | 2,669 | 0,000019 | 0,0000507 |
| 39 | 2,662 | 0,000019 | 0,0000506 |
| 40 | 2,645 | 0,000019 | 0,0000503 |
| 41 | 2,635 | 0,000019 | 0,0000501 |
| 42 | 2,625 | 0,000019 | 0,0000499 |
| 43 | 2,614 | 0,000019 | 0,0000497 |
| 44 | 2,612 | 0,000019 | 0,0000496 |
| 45 | 2,605 | 0,000019 | 0,0000495 |
| 46 | 2,601 | 0,000019 | 0,0000494 |
| 47 | 2,593 | 0,000019 | 0,0000493 |
| 48 | 2,587 | 0,000019 | 0,0000492 |
| 49 | 2,578 | 0,000019 | 0,0000490 |
| 50 | 2,575 | 0,000019 | 0,0000489 |

## 3. Results

In this experiment, temperature regulation is made by raising and lowering the temperature from room temperature. Changes in temperature by raising it are carried out by blowing high-temperature air from an air hot gun. Meanwhile to reduce the heat it is done by blowing air from the a RAC (Room Air Conditioner) window type. Then, read and note the voltage and current values of each change in temperature. At first, the temperature of the air is blown so that the temperature rises to a temperature of 50°c. Then, the temperature blowing of the wind is stopped so that the temperature decreases. From each temperature drop from 50°c, 49°c, 48°c, etc., each of them records the voltage and current values. Because the room temperature is only 28°c, treatment is needed to reduce the heat by blowing cold air to 20°c. The results of recording the trial measurements are as follows:

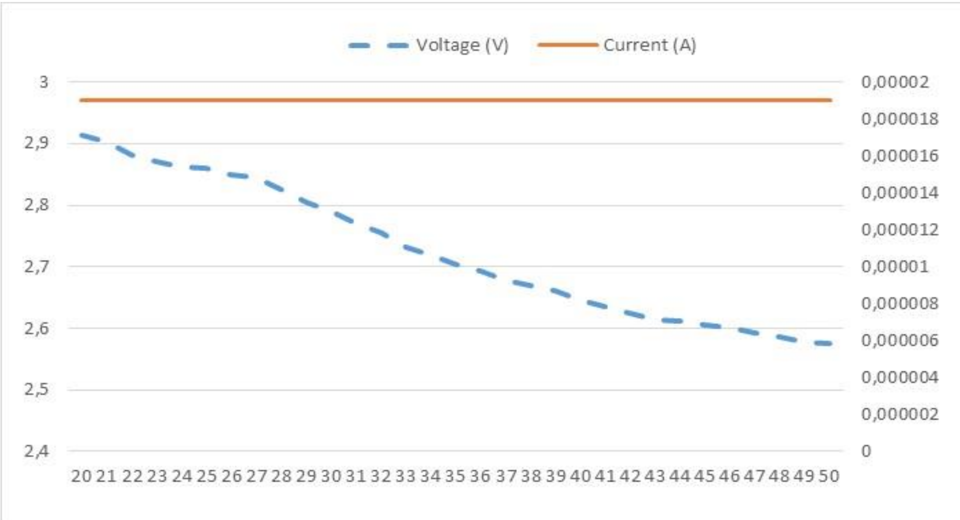


**Figure 2.** Temperature changes against output voltage and current.

The results of the analysis to determine the significance of the relationship between changes in temperature and changes in power received by photovoltaic is displayed in the ANOVA table 2.

**Table 2.** ANOVA of effect temperature on output power.

Anova: Single Factor

SUMMARY

| *Groups* | *Count* | *Sum* | *Average* | *Variance* |
|---|---|---|---|---|
| Temperature (°C) | 31 | 1085 | 35 | 82.66666667 |
| Power (W) | 31 | 0.001604683 | 5.1764E-05 | 4.50441E-12 |

ANOVA

| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
|---|---|---|---|---|---|---|
| Between Groups | 18987.44384 | 1 | 18987.44384 | 459.3736412 | 8.25927E-30 | 4.001191 |
| Within Groups | 2480 | 60 | 41.33333333 | | | |
| | | | | | | |
| Total | 21467.44384 | 61 | | | | |

Based on the results of the analysis presented in the ANOVA table show that the significance level of the probability value's calculation or the significance coefficient is 8.26E-30 which means it is smaller than the specified error rate/alpha (a) of 0.05. By the provisions that apply in testing the hypothesis, it can be concluded that the null hypothesis (H0) which states "There is no effect of temperature on the output power" is rejected. This means that the proof of results accepts the alternative hypothesis (H1) which states "There is an influence of temperature on the output power."

When using the coefficient F, the value of the calculated F coefficient is 459.3736 which means it is higher than the F table 4.001191. By the provisions that apply to the testing of the hypothesis, it can be concluded that the null hypothesis (H0) which states "There is no effect of temperature on the output power " is rejected. This means that evidence of results accepts the alternative theory (H1) which states "There is an influence of temperature on the output power."

After obtaining the analysis results it shows that there is an influence of temperature on the output power, the equation between temperature changes with changes in control received by photovoltaic can be seen through the trend line format.

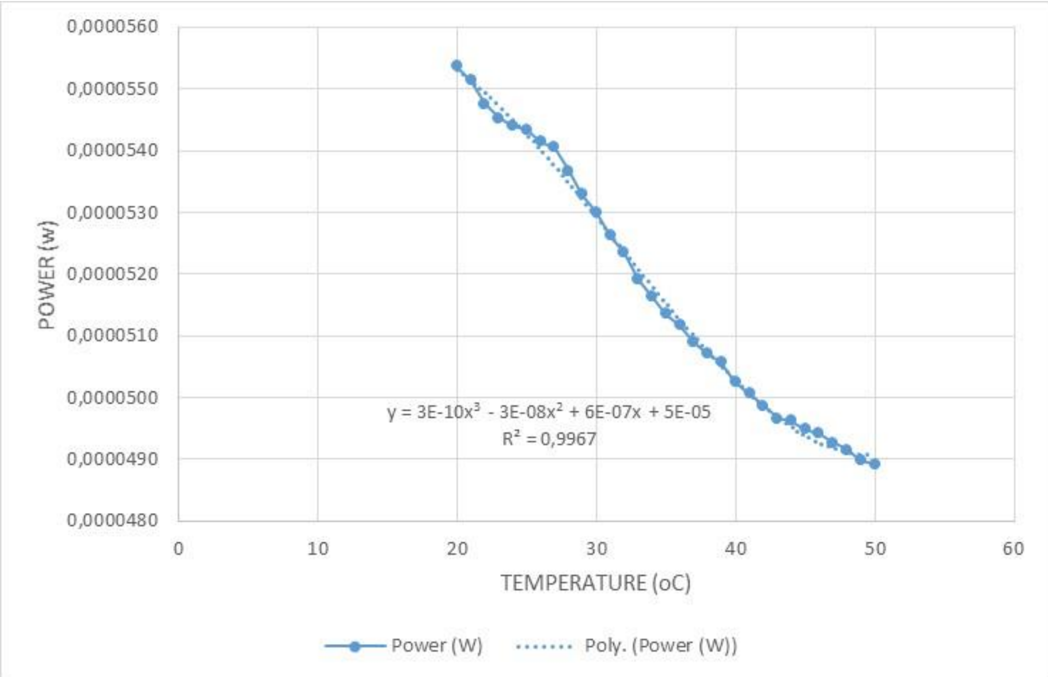


**Figure 3.** Temperature change curve against output power.

In the curve above, the lower temperature is the smaller the power loss that occurs is. The correlation between power and temperature gives the value of $R^2$ obtained close to 1 or equal to 0.996. This means that independent factors that affect the temperature on the output power are minimal for the above function or not significant. Based on the correlation relationship above gives the equation=$3E\text{-}10x^3\text{-}3E\text{-}08x^2\text{+}6E\text{-}07x\text{+}5E\text{-}05$.

## 4. Conclusion

Based on the results of the study, it was found that the significance level of the probability value's calculation or the significance coefficient is 8.26E-30 which means it is smaller than the set error rate/alpha (a) which is 0.05. And if using the coefficient price F obtained, the value of the coefficient F count is 459.3736 which means it is more significant than the F table 4.001191. By the provisions that apply in testing the hypothesis, it can be concluded that the null hypothesis (Ho) which states "There is no effect of temperature on the output power" is rejected. This means that the proof of results accepts the alternative hypothesis (H1) which states "There is an effect of temperature on the output power." The correlation between the effect of temperature changes on output power gives the equation $y\text{=}3E\text{-}10x^3\text{-}3E\text{-}08x^2\text{+}6E\text{-}07x\text{+}5E\text{-}05$.

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