Characteristics of LED and CFL Lamps Products: Efficiency of Using Indoor Lighting Lamps

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Abstract: Efforts to save the use of electrical energy by consumers are carried out by using lighting lamps that are considered energy efficient. The considerations that are often used by consumers in choosing the use of lighting lamps are generally limited to choosing based on the type of lamp that is cheaper, which does not consider the quality of the light produced or the amount of electrical energy absorbed by a lamp. The use of different lighting products with known efficiency parameters can be considered in the use of lighting in the home by consumers. The research was conducted to determine the characteristics of various types of lighting products according to the intensity of the light produced, the amount of electrical energy used, and the level of sensitivity to available low-voltage sources. The research method uses an experimental approach. This research was conducted by testing and analyzing the electrical parameters of several types of light-emitting diodes (LEDs) and compact fluorescent lamps (CFLs). This research is expected to be a reference for users to choose the type of lamp that is considered efficient in its use according to the parameters studied. The research data was obtained from the results of testing and measuring the lamps used as samples. The data obtained were analyzed using a quantitative approach, followed by a qualitative analysis based on needs. The test results show that: (1) LED type lamps produce better light intensity compared to CFLs at the same electric power consumption; and (2) the use of electric power from LED type lamps is lower and produces stronger lighting when compared to LED type lamps. CLF and (3) LED lamps have components that allow them to operate at lower voltages.

Keyword: efficiency, lighting products, LED, and CFL

1 Introduction

The use of lighting is one component that uses electrical energy and is a major requirement in human life. The use of lighting lamps greatly supports all human activities during the day and night, so that the use of electrical energy absorbed for the use of lighting for electricity consumers is quite large[1]. The burden of electrical energy in Indonesia reaches 49.83% used in household groups which are generally for lighting [2]. The use of very large lighting lamps is accompanied by advances in lighting product technology with various types, so that there are quite a lot of various types of lighting products on the market. This condition occurs because energy-saving lighting products produced by manufacturers are considered very important as an effort to meet user needs. User information and understanding of lighting products on the market is very weak, resulting in difficulties for consumers in choosing various kinds of lighting brands on the market, because consumers do not have a reference in choosing according to their needs. The lack of information to consumers or users about the characteristics of lamps causes consumers to be unable to determine whether all the

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lamps in circulation really have high efficiency, or whether one type of lamp is better than a similar lamp with a different brand, and which type of lamp is suitable. used as needed.

One of the criteria to be considered in selecting household lighting needs is to take into account the use of electric power used to produce the required light. One of the lamp specifications that users must recognize is the ability of a lamp product to produce light optimally, which is known as the power of light. The light efficacy of a lamp describes the ratio of light brightness per watt. The power generated by the lamp can be in the form of light flux from the output source, or it can be in the form of the total electrical power used from the source [3]. The many types of lamps on the market today are very helpful for users in meeting their needs. At this time there are several types of lamps circulating in the market which are products of new technology, so that several types of old lamp products have been abandoned by users, such as (1) incandescent lamps because they are considered to be inefficient in their use, (2) types of tube lamps (TL)) or full fluorescent lamps because apart from not being environmentally friendly these types of lamps also absorb more electrical energy. Based on the characteristics of the new lighting products, it appears that the types of lamps that are more widely used by the public today are the types of lamps that use diode technology known as Light Emitting Diode (LED) and Compact Fluorescent Lamp (CFL) types.

The CLF lamp type is a type of fluorescent lamp whose working principle is based on the fluorescent mineral fluorescence process, where when the mineral material in the lamp is exposed to ultraviolet light, a reaction will occur with the gas in the lamp to produce ultraviolet light. The ultraviolet light produced by the lamp will then react with the phosphor, which is a mixture of minerals that coats the inside of the light bulb. Lamp technology that uses diodes or LED lamps is produced using a special type of diode made of semiconductor diode material. LED lamps are equipped with chips of semiconductor material that are filled, or treated, with impurities to form structures known as p-n junctions. The light emitted by a lamp has a certain color wavelength, which is affected by the material configuration of the energy bands used in the p and n pole relationships. The positive and negative (p-n) connections on the LED lamp chip will emit light when the current flowing through the chip connection flows forward from the positive pole to the negative pole. This condition is designed so that the LED lamp technology, which is made of semiconductor material, can only flow electric current in one direction and not the other way around. LED lights that are on will emit light in the form of electromagnetic energy that radiates perfectly in the visible part of the spectrum [4] and [5]. In general, LED lamps have characteristics such as: a longer service life when compared to other types of lamps; the hours on which the lamp is on can reach an average of up to 30,000 hours; the use of electrical energy is more efficient by up to 80–90 percent when compared to other types of lamps; they can last longer and be lit at a lower voltage; and the light produced is brighter and does not produce heat. This type of lamp also has a very long life of around 50,000–100,000 hours and uses low electric power [6]. Although there is a decrease in the quality of light after 6000 hours [7], it can reach a lifespan 25 times longer than CFL lamps [8].

Consumers who use lamps really need information about the types of lamps that have good quality, according to their needs. The information needed must be able to provide confidence in its use, so testing and research are needed to find the profile of the type of lamp that suits the user's needs. The effectiveness of using LED lamps is proven by the results of studies [9] and [10], which found that LED lamps have a higher level of effectiveness compared to TL lamps and incandescent lamps. LED lamps have the lowest level of energy use, with an average efficiency of 32%. LED lamps can also produce high-intensity lighting when compared to other types of lamps, with an average of 30 lux. According to [11], the light

intensity produced by LEDs confirms that the lumen/watt value of an LED lamp is known as the "binning value" of the LED, and this binning value is the key to the strength of the resulting light intensity, so the smaller the binning value, the better the quality of the lamp. [12] also conducted a study to determine the effect of source frequency on the lifetime of CLF, LED, and incandescent lamps and found that all three types of lamps experienced a decrease in illumination due to changes in the source frequency.

Many studies related to the use of this type of lamp have been carried out, but in general, they have not been able to provide complete information to users about the profile of the use of CLF and LED lamps, which are much needed by the community. Based on these conditions and facts, the study in this study was conducted to determine the profile of the various types of lamps on the market, especially those related to the types of CLF lamps and the types of LED lamps. The main objective of this research is to enrich information for the user community so they can choose the type of lamp to be used according to their needs. The research results are expected to (1) find types of lamps that are more effective at producing light, (2) find types of lamps that use less electric power, and (3) determine the level of sensitivity of each type of lamp to fluctuations in the voltage source. The results of this study also serve as a reference and a source of information for students who study electrical and lighting installations.

2 Methods

The research was conducted using an experimental approach. The research was conducted at the Installation Engineering Laboratory, Department of Electrical Engineering Education, Faculty of Engineering, Medan State University. The types of lamps that comprised the research sample consisted of CFLs and LEDs. The lamp products sampled in this study consisted of the types of lamps most commonly used by users, such as Hannochs, Sun Free, Philips, Omai, NVC, and Sun Sonic. Research equipment, tools, and materials consist of measuring instruments in the laboratory, such as luxmeters, wattmeters, voltmeters, ammeters, and cos-j meters. Additional equipment is used, such as voltage regulator equipment, installation equipment, and dark room control equipment. The test is carried out by measuring the intensity of light produced from each type of lamp in a dark room by setting the distance between the point of light and the measuring instrument as far as 2.5 meters. Under the same conditions, measurements of the use of electrical energy are also carried out simultaneously. Testing the intensity of the light produced by the lamp is also carried out through changes in the source voltage flowing in the lamp. The voltage flowing through the lamp is gradually increased until it reaches a normal voltage. Each type of lamp that became the research sample was treated under the same conditions and using the same measuring instrument.

Data from lamp testing results obtained from measurement results is tabulated, grouped, and then described based on certain observed properties, such as the use of electrical energy, the intensity of the light produced, and the ability to work to produce light at varying voltage supplies on the lamp. The collected data was analyzed quantitatively and descriptively. The grouping of the data obtained is carried out based on the required lamp profile information targets, such as the effectiveness of using electric power, the ability to produce light intensity, and the ability to work at lower voltages. The data grouping is done to make it easier to describe the characteristics of a type of lamp being tested. The data that has been grouped is then presented in the form of tables and graphs that describe the characteristics of each type of lamp to make it easier to understand. To find out the difference in the results of the lamp test, a different test was carried out. The difference test used is a different type of non-parametric test.

3 Results and Discussion

3.1 The Use Of Electric Power and The Intensity Of The Light Produced

One of the considerations that becomes a benchmark in choosing a lamp is the consumption of electrical power and the strength of the light it produces. Based on the measurement results, it appears that there is a difference between the written lamp power and the measured lamp power under normal voltage conditions. The difference between the written and measured power of the lamp varies greatly depending on the product being measured. The difference between written power and measured power on Hannochs products shows an average of 10.41%, Philips products 10.41%, NVC products 0.65%, and sun-free products 60.73%.

The test results on the use of electric power and light intensity from each lamp tested at normal voltage indicate that there are differences in the characteristics of the light intensity produced by each LED lamp from a different brand. Based on the results of the test, it appears that the type of Hannochs brand LED lamp and the type of NVC brand lamp show the use of electric power with a more comparable and consistent intensity of light produced. Meanwhile, Philips and Sun Free lamps c po electric power, but the light intensity produced by these lamps is less comparable and not linear. These conditions can be seen in Figure 1.

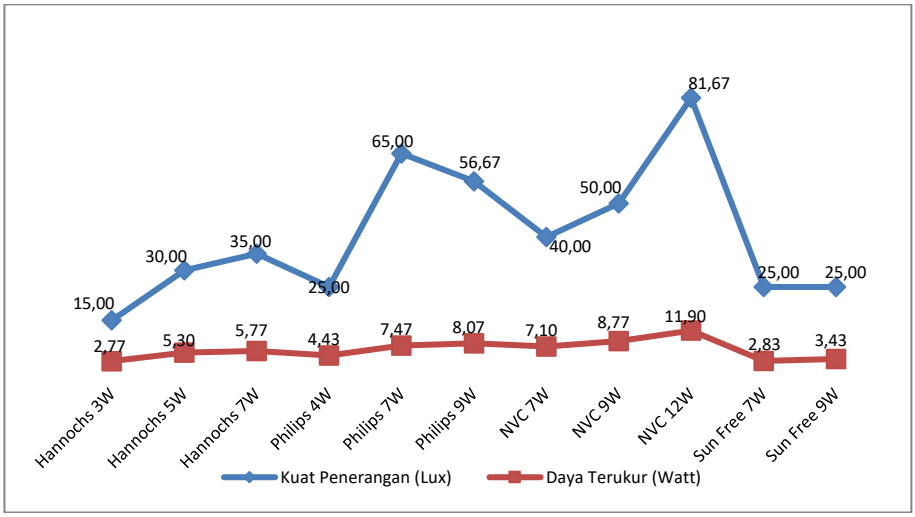

Figure 1. Characteristics of Electric Power Usage and Light Intensity of LED lights

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Under the same conditions as the LED lamp, the test results on the type of CFL lamp showed that the intensity of the light produced by the lamp was also different (Figure 2). The power of the CFL-type lamp that is written on the label is different from the lamp power that is measured when the lamp is turned on. The stated power difference tends to be higher than the rated power at normal supply voltage conditions. The results of measuring the use of electric power and light intensity of each lamp tested under normal voltage conditions indicate that the type of CFL lamp for each product produces different light intensity characteristics. The measurement results show that the type of each lamp cannot show consistency between the amount of electric power used and the intensity of the light produced. This shows that there are some products that are more effective in their use than others. Based on the test

results, it is shown that for Hannochs products, the effective types of lamps are those with types 8W and 18W, while the types of lamps that are effective for Phips products occur in 12W and 18W types. These conditions can be seen in Figure 2.

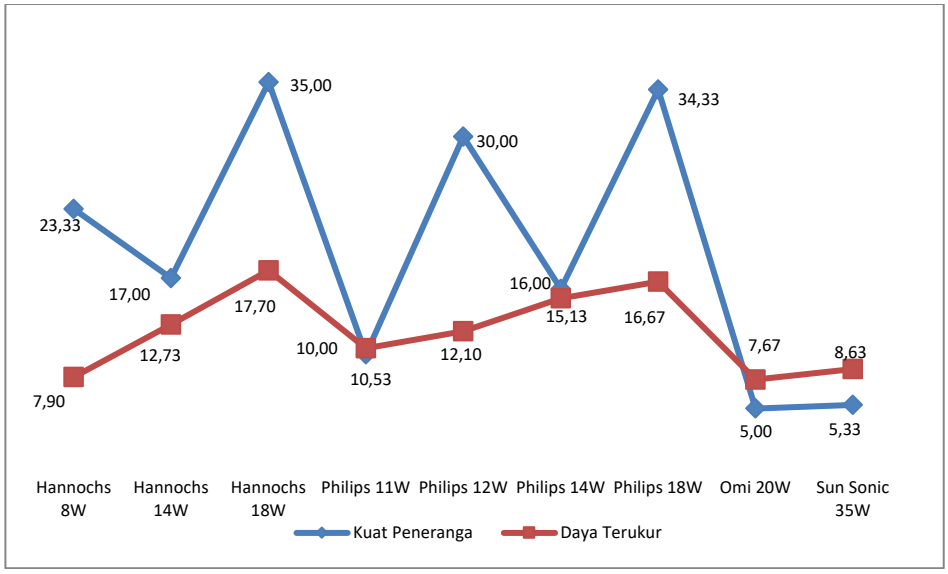

Figure 2. Characteristics of Electric Power Usage and Strong Illumination of CFL Lamps

3.2 Characteristics of Lamp Sensitivity to Changes in Electric Voltage

The results of the tests carried out on the types of 3W, 4W, and 5W LED lamps, which were carried out by adjusting the variation of the supply voltage source, are shown in Figure 3. Based on the test results, it appears that this type of Philips lamp can produce light after obtaining a voltage of 200 volts, while the Hannoc lamp type can produce light at a voltage source of 50 volts. The results of this test indicate that for this type of LED lamp with low power, the Hannochs type lamp shows better sensitivity because it can light up and produce light well at a voltage of 150 volts.

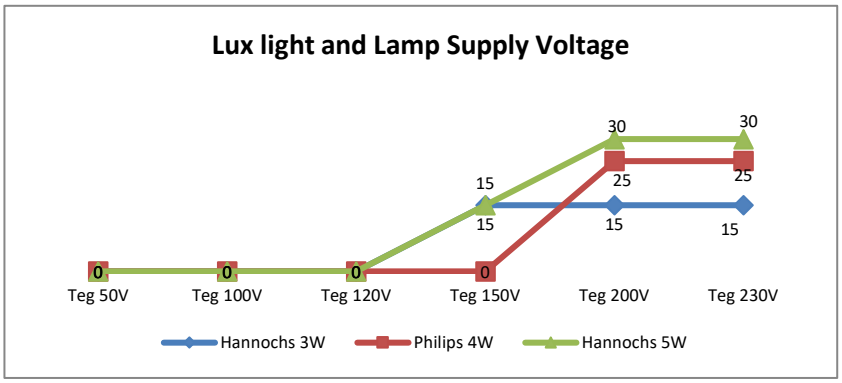

Figure 3. Sensitivity Characteristics of Low-power LED Lamps to Changes in Electrical Voltage

Tests carried out by changing the supply voltage on a 7W lamp obtained data as shown in Figure 4. Figure 4 shows that this type of Philips 7W lamp produces a light intensity of 45 lux at a supply voltage of 100 volts. The results of this test prove that this type of lamp has the most effective lighting characteristics because it can produce maximum light from a relatively low voltage source. This type of NVC lamp can also work at low electric voltages, but the intensity of the light produced is still relatively low. NVC-type lamps can produce a light intensity of 10 lux when they get a 50 volt power source, but this type of lamp is only able to produce a light intensity of 40 lux at normal voltage. This type of lamp will work safely at 120 volts.

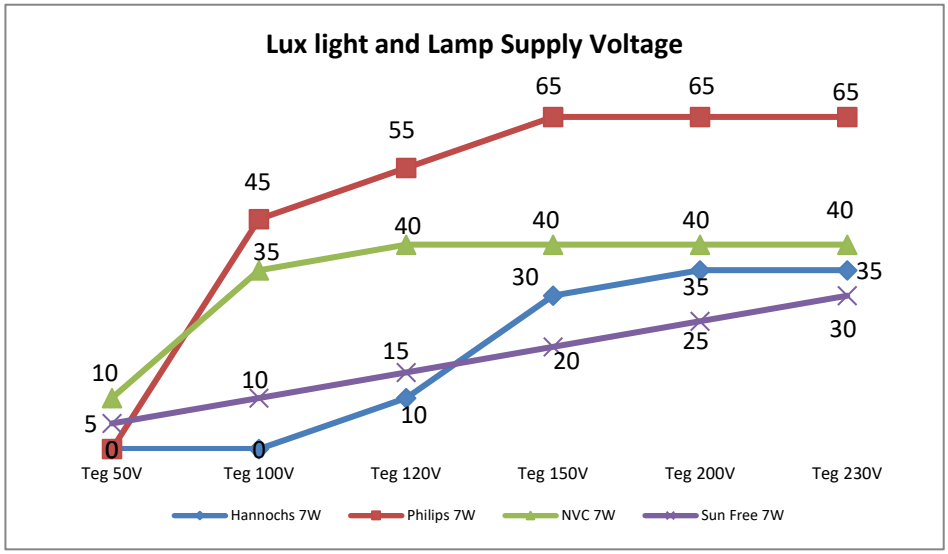

Figure 4. Characteristics of 7W LED Light Sensitivity to Changes in Electric Voltage

Figure 5 shows the results of testing the types of 12W and 9W lamps by treating variations in the supply voltage source to see the sensitivity of these lamps to changes in the received supply voltage. The test results show that this type of Philips 9W lamp can produce a light intensity of 45 lux with a supply voltage of 100 volts, and this type of lamp has the best lighting characteristics in its group. The results of testing the level of sensitivity to the source of electric voltage indicate that the type of lamp, the Sun Free 9W, shows the ability to produce light at a lower supply voltage. Sun-free lamps can produce 5 lux of light at a voltage of 50 volts, but the light intensity produced by this type of lamp is a maximum of 30 lux at a normal supply voltage.

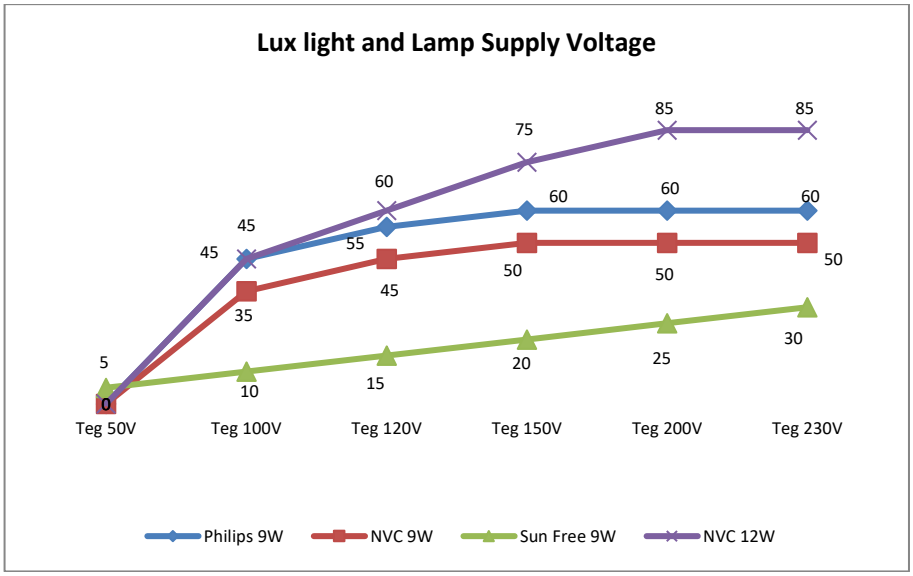

Figure 5. Sensitivity Characteristics of 9W and 12W LED Lamps to Changes in Electrical Voltage

Figure 6 shows the results of testing a group of CLF-type lamps, which were carried out by changing the supply voltage source to see the level of light intensity produced. This group of CFL-type lamps consists of 8W, 11W, 12W, and 14W lamps. The test results show that with a 100-volt power source, all types of lamps can produce light. This shows that all types of lamps have the same level of sensitivity to the supply voltage source. The test results also show that the 8W type Hannochs lamp can produce better lighting characteristics when compared to the 11W and 14W type CFL lamps.

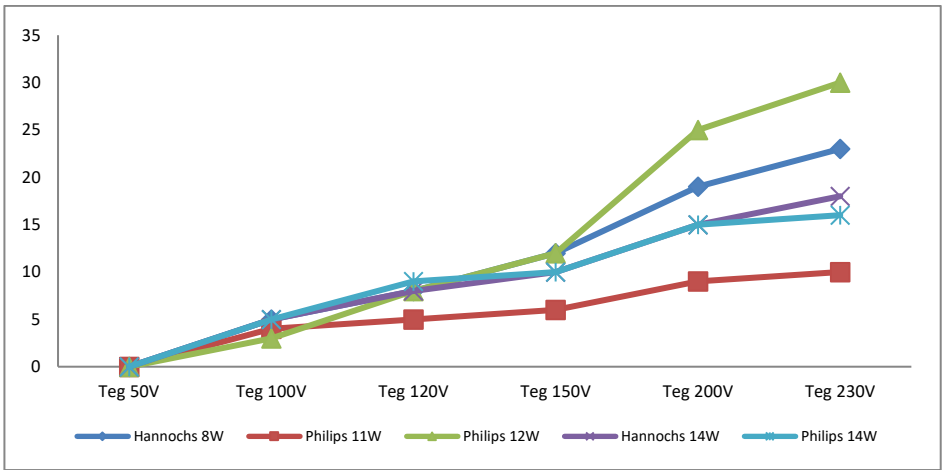

Figure 6. Characteristics of 8-14W Type CFL Lamp Sensitivity to Changes in Electrical Voltage

The test results were also carried out on changes in the supply voltage in groups of 18W, 20W, and 35W CFL-type lamps. The test results (Figure 7) obtained show that this type of Philips 18W lamp has relatively better sensitivity to the supply voltage. This type of lamp is capable of producing a light intensity of 5 lux at a supply voltage of 100 volts. The test results also show that the 18 W Hannochs type lamp can produce better light intensity characteristics when compared to other types of CFL lamps when receiving a normal supply voltage.

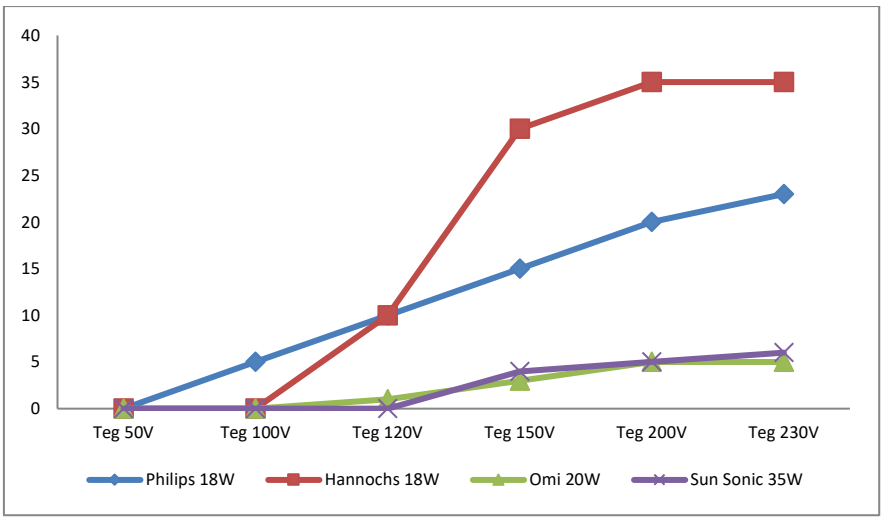

Figure 7. Characteristics of Sensitivity of 18W, 20W, and 35W CFL Lamps to Changes in Electrical Voltage

3.3 Discussion

Based on the data from testing the use of electrical energy and the intensity of light produced by a type of LED lamp, it shows sever9 W.al phenomena that occur, including: There here are several power levels 7W on the lamp that do not match the measurement results for each type in that is the research including: (1) There are several power levels listed on the lamp that do not match the measurement results for each type of lamp in the research sample. ample . The type of lamp whose power is not in accordance with the measured power occurs in the type of lamp whose power is greater than 9W. There here are types of lamps that produce more prominent light intensity when compared to other types of lamps, such as Philips lamps with a power 7W 12 W 12W NVC lamp types. There here are several types of lamps that show the use of electrical energy that is not linear with the intensity of the light produced, especially types of lamps that include a power label greater than 7W. The results of the study prove that the type of lamp that includes a power label of less than 7W is relatively more consistent between the use of electrical energy and the resulting light intensity, as shown in Figure 1.

The results of testing the use of electrical energy and the intensity of light produced by the CFL lamp type group show that: (1) there are several types of lamps that are not linear between the use of electrical energy used and the intensity of the light produced, such as the 14W type Hannochs lamp and the 14W type Philips lamp. (2) There are several types of lamps

that consistently use electrical energy that is proportional to the intensity of the light they produce, such as the type of 18 W CFL lamp from the Hannochs and Philips brands. (3) There are types of lamps that indicate the power label listed does not match the measured power usage, and even the intensity of the light produced is very low, such as the 20-watt Omni lamp and the 35-watt Sun Free lamp. The results of this study also found that there are several types of CFL lamps that consistently display good performance by producing maximum light intensity while using lower electrical energy, such as the Hannochs 8W, Philips 12W, and 18W lamps.

A different test was performed to determine the good performance of the different types of LED lamps and CFL lamps. The data used for comparison includes the ability of lamps to produce light intensity with a lower use of electrical energy. The results of the various test analyses related to the ability to produce light intensity show that the average type of LED lamp can produce more lighting intensity than the type of CFL lamp. This condition is evident from the measurement data for LED and CFL lamp types, which illustrates that LED lamp types provide better light intensity figures when compared to CFL lamps. This indication can be seen in Figures 1 and 2, which use the same lamp power, but the illumination produced by LED lamps is much higher than that of CFL lamps. The same condition has been found by [13]: the efficacy of LED lamps is better than that of tube lamps (TL) and incandescent lamps. The results of the study also prove that the use of electrical energy for LED lamp types is much lower when compared to the use of electrical energy for CLF lamp types to produce the same light intensity. The performance of this type of LED lamp, which uses less energy while producing maximum light intensity, demonstrates that it is more effective than the type of CFL lamp. The study's findings [14] also show that LED lamps with low power but a sufficiently high lumen (light intensity) have an effect on the minimum lighting costs. The results of the comparison of several lamps that have almost the same lumen value show that LED lamps are the most efficient compared to other types of lamps in the use of electrical energy and have an impact on the efficiency of lighting energy costs for consumers [15]. Calculation results [16] found that the use of LED lamps was 25.54% more efficient than electronic TL lamps. This condition is also in accordance with the findings [17], which show the occurrence of efficient monthly operating costs on LED lamps after being converted from TL lamps.

The power label on each type of lamp is different from the power measured when the lamp is on under normal voltage conditions. The difference between the listed lamp power and the measured lamp power occurs for both LED and CFL lamp types. The magnitude of the label power deviation listed with the measured lamp power on CFL lamps averaged 18.88%. The magnitude of the label power deviation listed with the lamp power measured on the average LED lamp reaches 9.88%. The results of this test illustrate that the level of accuracy in labeling power on LED lamp types is better than that on CFL lamp types. The measurement results also show that the accuracy of the use of electric power from various types of LED lamps on the market is better than that of the type of CFL lamp, and this type of LED lamp uses less electric power to produce the same intensity of light compared to the type of CFL lamp.

The ability of a lamp to produce light at a lower voltage source also differs between types of LED lamps and types of CFL lamps. This type of LED lamp has the ability to produce light at a lower temperature than a CFL lamp. The test results prove that this type of LED lamp is capable of producing a light intensity of 40 lux when it is supplied with a voltage of 100V. Under the same conditions, CFL lamps are only capable of producing a light intensity of 5 lux. These results prove that the sensitivity level of LED lamps is better than that

of CFL lamps. This finding is relevant to research findings that make LED-type lamps adjustable even though they will produce very high harmonic levels during dimming operation, which can affect the quality of AC power [18].

4. Conclusion

The results showed that:

1) LED type lamps produce better light intensity compared to CFL type lamps at the same electric power consumption.
2) LED type lamps use less electrical power to produce strong lighting when com;pared to CFL types.
3) There are differences in the measured power usage and the power label listed on several types on lighting lamps on the marker.
4) The difference between the measured power usage and the power label listed on the type of LED lamps is 9.88%.
5) The difference in measured power usage with power label listed on the type of CFL Lamps is 18.88%.
6) This type of LED lamp has components that support its performance to produce good light intensity at a lower voltage source.

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