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# The Effect of Motor Temperature on The Performance and Consumption of Electric Vehicle Prototypes

**Musri Kona[1], I Wayan Yogi Arta[2*], Aris Budi Sulistyo[3], Arif Devi Dwipayana[4]**

[1,2]Airport Electrical Engineering Department, Jayapura Aviation Polytechnic, Papua, 99117 Indonesia

[3,4]Department of Automotive Technology, Bali Transportation Polytechnic, Bali, 80582 Indonesia

**ABSTRACT:** This study aims to determine the effect of motor temperature on the performance and consumption of electric current in BLDC motors. The method used in this study is the experimental method. The sample used is an electric vehicle prototype with a 3 kW BLDC motor drive. There are 6 (six) different types of tests with motor temperatures which include 34.8℃, 43.7℃, 52.6℃, 63.5℃, 74.4℃ and 87.3℃. This study uses descriptive analysis as a data analysis technique. The results showed that the power of the electric motor increased from low temperatures and decreased at high temperatures. Motor torque reaches its highest peak at low temperatures, and decreases with increasing motor temperature. While the use of electric current has increased along with increasing temperature.

**KEYWORDS:** BLDC Motor, Temperature, Performance, Electric Current.

## I. INTRODUCTION

Motorized vehicles generally use fossil fuels as an energy source to start the engine. Fossil fuels are non-renewable energy which are increasingly depleting and can cause an energy crisis. In addition, motorized vehicles produce exhaust gases which are very harmful to the human body and cause global warming. An inventory of emissions from 2021 to 2022 shows that 70% of emissions in urban areas are generated by motorized vehicles [1]. Therefore, it is necessary to find alternative energy that is more environmentally friendly, not rare and easy to find [2]. Electric vehicles are an alternative that is being developed as a substitute for vehicles that use fossil fuels to reduce environmental impact and also to reduce the use of fossil fuels. Electric vehicles are vehicles that do not use fossil fuels. The main propulsion of electric vehicles is an electric motor with a voltage supply from the battery. Improving energy efficiency, energy security, and energy conservation in the transportation sector, it is necessary to accelerate the battery-based electric motorized vehicle program that needs to be developed [3]. From this explanation, development and innovation to support electric vehicle infrastructure in Indonesia need to be encouraged by involving all interested parties.

Electric vehicle drives have several types that are often found, namely the Brushless Direct Current (BLDC) motor inlet and motor outlet types. BLDC is an electric motor with a synchronous type. Basically, BLDC works with the attractive force between two magnetic fields. The pulling force causes the motor to work or rotate. The higher the engine speed, the engine temperature also increases [4]. The BLDC motor construction has fixed poles because the BLDC rotor has permanent magnets while the BLDC stator is in the form of a wire so that the magnetic poles can change depending on the current polarity of the stator winding given by the controller. Magnetic and magnetic field strength decreased with increasing temperature. So, from this research, magnets that experience a decrease in performance can also affect the performance of electric motors [5]. The performance of the electric motor in question is the amount of power and torque produced by the motor. Motor performance decreases when the temperature increases. Motors with temperatures of 125℃ and 25℃ require different amperage consumption and produce different torques. Electric motors with a temperature of 125 ℃ require a greater current than electric motors with a temperature of 25 ℃. [6]. The consumption of electrical energy for a three-phase induction motor without load with a star connection at a speed of 3000 rpm is 0.079 kWh (48%) or Rp. 51.376 for one hour compared to a speed of 2570 rpm [7]. Rotational speed from 605 – 850 rpm will cause the voltage to vary from 101 – 214 volts and the frequency will vary from 51.8 – 85 Hz [8]. Energy consumption when the fan rotation speed is 30% minimum, which is 314.26 kWh and energy saving is 17.7% of the maximum fan rotation speed [9].

The results of the study also show that the greater the load weight and speed on a motorcycle, the greater the power and capacity of the battery released so that the use of batteries on motorcycles becomes more wasteful and the battery life becomes shorter [10]. Measurements were also carried out using a thermo gun with the result that the temperature when loaded was greater, namely 64.3°C compared to when it was not loaded, which was 62.1°C. The longer the working time of the motor, the greater the temperature generated [11]. For a winding rotor motor with a power of 2.2 kW, Cos ø 0.82 and insulation class B when supplied with a nominal voltage of 220 volts, the maximum time for the rotor block to occur so as not to damage the motor insulation is 30 seconds [12]. This shows that changes in the increase in motor rotation can affect the temperature of the motor and can reduce the performance of the electric motor. To maintain the performance of BLDC motors in electric motor prototypes, it is necessary to conduct research on the effect of electric motor temperature on the performance and consumption of electric current in electric vehicle prototypes.

The electric motor used in this study is a BLDC motor type.

Experimental research was carried out by varying the temperature of the electric motor and then testing it to find out the performance produced by the electric motor and the consumption of electric current needed by the electric motor.

## II. RESEARCH METHODS

This research uses the type of experimental research. Experimental research can be interpreted as research methods used to determine the effect of certain treatments under controlled conditions [13]. Experimental data collection was carried out at SMK PGRI 2 Badung, Bali. Test to determine the effect of BLDC motor temperature on the performance produced by the motor and the consumption of electric current used by the motor. testing was carried out using a dynotest to determine the performance of an electric motor consisting of power and torque. Measuring electric current using an ammeter. The duration of this research starts from March 30, 2021, to February 20, 2023. The data needed is power, torque, and electric current using temperature variations on different BLDC motors.

The sample used in this study is an electric vehicle prototype that uses a BLDC motor drive with a capacity of 3kW. The main components of an electric motor include the stator as a magnet which is activated and regulated by the controller, and the rotor as a permanent magnet. Overall, the BLDC motor can be seen in the following figure.

Part description:

1. Close the top casing
2. Upper bearing
3. Top stoper magnet
4. Disc rotors
5. As a mover
6. Magnets
7. Magnet stoper bottom
8. Bottom bearing
9. Winding
10. Heatsink
11. Cover the bottom casing

There are 6 (six) types of tests that differ with the temperature of the motor, namely 34.8 ℃, 43.7 ℃, 52.6 ℃, 63.5 ℃, 74.4 ℃ and 87.3 ℃. This temperature is the result of previous research obtained from testing motor rotation which includes rotation of 750rpm, 1000rpm, 1250rpm, 1500rpm, 1750rpm and 2000 rpm (Arta, I W Y, 2023). The motor rotation test is carried out on a dynotest to produce a temperature according to the predetermined independent variables. The dependent variable in this study is the results obtained from measurements using a dynotest to determine motor performance and an ampere meter to determine the consumption of the motor used. The following is a picture of the vehicle settings on the dynotest tool.

The data collection technique in this study was to measure the performance of the object under study and record the necessary data. Testing is carried out according to the procedure using a dyno test by starting the motor and testing according to the variables that have been set repeatedly in order to obtain maximum results. The data needed is motor power (HP), motor torque (Nm) and electric current (A).

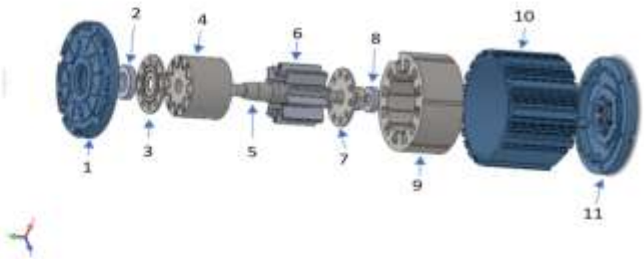


**Fig. 1. BLDC Motor Specification**


**Figure 2. Data collection techniques using ampere meters**

## RESULTS

In testing the performance of the motor using the dynotest, the results are as shown in Figure 3 and the consumption of electric current using an ammeter is obtained as shown in Figure 4.

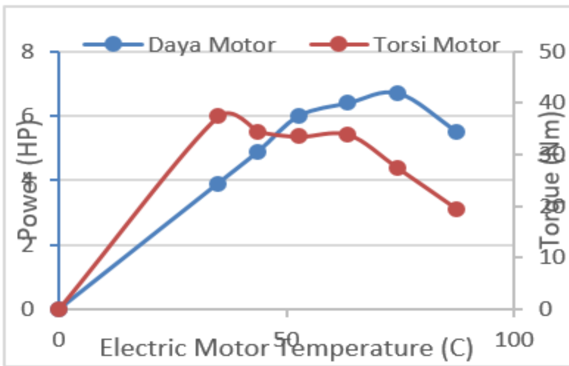


**Figure 3. Graph of Electric Motor Temperature on Electric Motor Performance**

Fiure 3 shows that at an electric motor temperature of 34.8℃, the power generated is 3.9 HP and the torque generated is 37.37 Nm. At an electric motor temperature of 43.7°C, the power generated is 4.9 HP and the torque generated is 34.51 Nm. At an electric motor temperature of 52.6°C, the power generated is 6 HP and the torque generated is 33.51 Nm. At an electric motor temperature of 63.5°C, the power generated is 6.4 HP and the torque generated is 33.87 Nm. At an electric motor temperature of 74.4°C, the power generated is 6.7 HP and the torque generated is 27.31 Nm. At an electric motor temperature of 87.3°C, the power generated is 5.5 HP and the torque generated is 19.38 Nm.

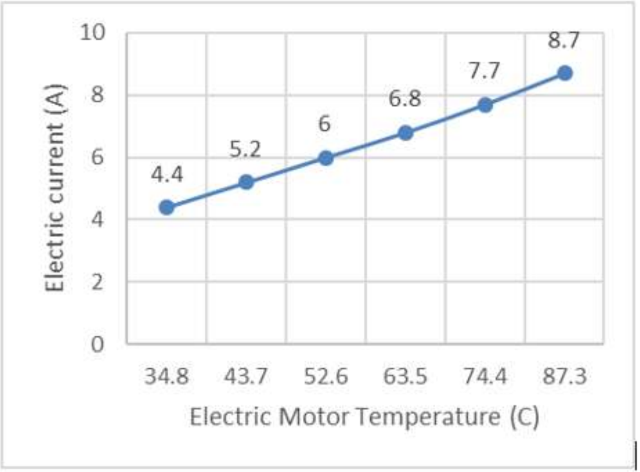


**Figure 4. Graph of Electric Motor Temperature to Electric Current Consumption**

Figure 4 shows that at an electric motor temperature of 34.8, the electric current consumption as measured using an ampere meter yields 4.4 A. At an electric motor temperature of 43.7°C, the electric current consumption as measured using an ammeter obtains 5.2 A. At a motor temperature electricity consumption is 52.6°C, the electric current consumption measured using an ammeter is 6.0 A. At an electric motor temperature of 63.5°C, the electric current consumption measured using an ammeter is 6.8 A. At an electric motor temperature is 74.4°C, the current consumption electricity measured using an ampere meter yielded 7.7 A. At an electric motor temperature of 87.3°C, the electric current consumption measured using an ampere meter obtained 8.7 A.

The performance of electric motors and consumption of electric current shows the characteristics of the motors that have been tested. Electric motor power has increased from low temperatures and decreased at high temperatures. If seen from the torque graph, the motor torque reaches its highest peak at low temperatures, and decreases with increasing temperature. If seen from the consumption of electric current. The use of electric current has increased with increasing temperature. Each increase in the temperature of the electric motor has a different consumption current value. The amount of electric current used can affect the strength of the magnetic field generated on the motor stator. The use of electric current can also affect the temperature of the electric motor, thereby affecting the performance of the motor.

## III. CONCLUSION

The results obtained in experimental research show the characteristics of electric motors. The results obtained are related or interconnected, because when the temperature increases it will require a current that is used to form a magnetic field so that it will produce losses in the form of heat and reduce the performance of the electric motor. Thus, the experimental results illustrate that the higher the temperature of the electric motor, the greater the consumption of electric current, and the performance of the electric motor also decreases

## REFERENCES

1. Kementerian LHK., 'KLHK Gelar Uji Emisi, Tekan Polusi Udara Di Wilayah Kota', 2022, 082/HUMAS/PPIP/HMS.3/03/, URL: http://ppid.menlhk.go.id/berita/siaran-pers/6458/klhk-gelar-uji-emisi-tekan-polusi-udara-di-wilayah-kota.
2. Almaghrabi, M., 'Forced Convection Cooling of Electric Motors Using Enhanced Surfaces', 2016, pp. 1–108.
3. Kepmen ESDM, 'Peraturan Menteri Energi Dan Sumber Daya Mineral Republik Indonesia'., 2020, Nomor 13.
4. Wakhid, M.U., 'Analisis Dampak Emisi Gas Buang Kendaraan Bermotor Co Di Uin Raden Intan Lampung', Unversitas Islam Negeri Raden Intan Lampung, 2018, pp. 1–124.
5. Purwanto P. 'Effect of Magnetic Properties in the Addition of Multiwalled Carbon Nanotube to Material Composite Fe0,8- C0,2', 2018, Metalurgi 27(3):175.
6. Montone, Dan. 'Temperature Effects on Motor Performance'. 2013, USA: Pittman/Metek Pecision Motion Control
7. Atmam, E. Zondra, and H. Yuvendius, "Konsumsi Energi Listrik Terhadap Perubahan Kecepatan Motor Induksi Tiga Phasa", SainETIn, Dec. 2019, vol. 4, no. 1, pp. 9 - 18.
8. Supardi, A, dkk, "Pengaruh Kecepatan Putar Dan Beban Terhadap Keluaran Generator Induksi 1 Fase Kecepatan Rendah" Jurnal Teknik Elektro, 2016, vol 14 no 01.
9. Erham, E., "Analisis Konsumsi Energi Listrik Pada Sistem Refrigerasi Cascade Akibat Perubahan Kecepatan Putaran Fan Kondenser", ReTII, Nov. 2018, pp. 254-258.
10. Ikhsan, M., dkk, "Pengaruh Pembebanan Dan Pengaturan Kecepatan Motor Bldc 1 kW Pada Sepeda Motor Listrik", JEE, Nov. 2022, vol. 6, no 2.
11. Aisyah, S. "Analisa Temperatur Lebih Saat Berbeban Pada Motor Induksi Satu Phasa", skripsi, 2020.
12. Amien, S. "Kenaikan Temperatur Pada Motor Induksi Tiga Phasa Akibat Rotor Terkunci", Jurnal of Electrical Techology, Jun 2016, vol. 1, no. 2.
13. Sugiyono, Metode Penelitian Kuantitatif Kualitatif dan R&D, 2010, (Bandung: Alfabeta)