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STUDY OF MATERIAL STRENGTH IN THE CHASSIS OF AN ELECTRIC MOTORCYCLE PROTOTYPE DESIGNED WITH 3000 WATT POWER

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ABSTRACT

Motorized vehicle can't be apart from our daily activity, because it's very significantly save our time and energy. According to Erwin (in Sasongko, 2014: 1) mentioned air pollution that comes out from motorized vehicle is very high, so it can pollute the environment and harm human health. Besides, the fossil fuel is an unrenewable which is running low and will cause an energy crisis. So we need alternative energy that is more eco friendly, common, and easy to obtain. Therefore, electric vehicle are one solution to this problem. Electric vehicle is a fuelless vehicle that ran by electric motor with battery for the energy supplier. In accordance with the Kepmen ESDM No. 13 Tahun 2020 about "that to increase the energy efficiency, energy resilience, and energy conservation in transportation sector, it needs to accelerate the battery-based electric motor vehicle program" so that it is necessary to develop innovations to support electric vehicle infrastructure in Indonesia. BLDC Motor is one of the motor type that used in electric vehicle. BLDC Motor used by one of the electric vehicle brands in Indonesia named GESITS, experienced an overheat on the BLDC motor after travelling 30 kilometers around Bekasi (GESITS, 2016). Finally to add cooling to the BLDC Motor, an external fan is installed. This experience shows the importance of cooling to maintain BLDC Motor durability. In addition to cooling the electric motor, it is necessary to pay attention to the efficiency produced by the electric motor. So that it can make consideration of battery consumption on the motorcycle design. Based on the problems above, this research will analyze the efficiency and thermal of a 3000 Watt BLDC Motor in the design of an electric motorcycle. The data collection will be carried out by using the Dynotest tool or Chassis Dynamometer to obtain amount of power, torque, electric current and thermal on the electric motor being tested. From these data calculations will be carried out for the efficiency of a 3000 Watt BLDC Motor. So that this research can be used as a reference for the further development of electric vehicles.

Keywords: bldc; electric vehicle; efficiency; thermal

INTRODUCTION

Motorized vehicles cannot be separated from daily life activities, because their function is very significant in saving time and human energy. However, many motorized vehicles use fossil fuel engines as their energy source, so a combustion process occurs to be able to move the vehicle. This causes negative impacts such as toxic air pollution which can cause various diseases and also result in global warming. According to Erwin (in Sasongko, 2014: 1) states that air pollution from motor vehicles, power plants, industry and households contributes 70% with a quantity composition of carbon monoxide (CO) of 99%, hydrocarbons (HC) of 89% and nitrogen oxides (NOx) as much as 73% as well as other particulates which include lead, sulfur oxide and dust particles. Apart from that, fossil fuels are non-renewable energy which is increasingly depleting and will cause an energy crisis. So energy alternatives are needed that are more environmentally friendly, not scarce, and easy to obtain. Therefore, electric vehicles are one solution to this problem. Electric vehicles are vehicles without fuel that are driven by electric motors with an energy source from batteries.

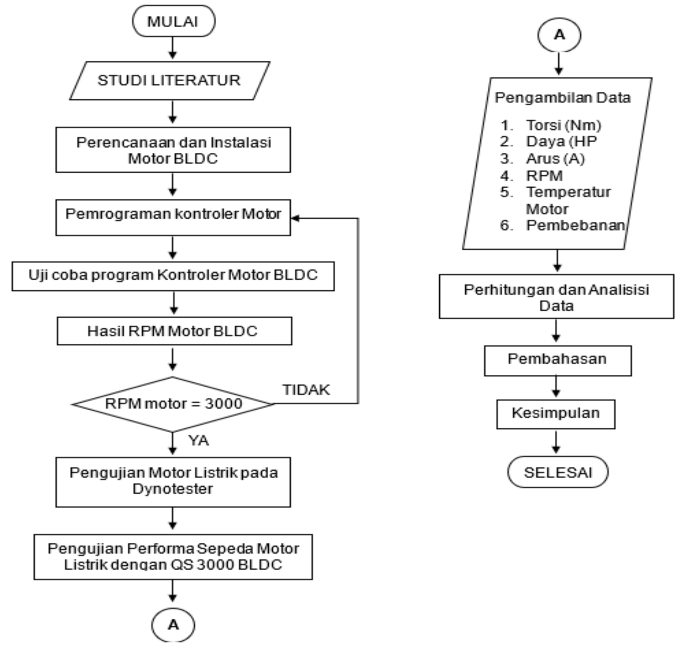
In accordance with the Minister of Energy and Mineral Resources Decree No. 13 of 2020 concerning "that in order to increase energy efficiency, energy security and energy conservation in the transportation sector, it is necessary to accelerate the battery-based electric motor vehicle program" so it is necessary to develop innovations to support electric vehicle infrastructure in

Indonesia [5] . Therefore, it can be said that this vehicle is emission free compared to fossil fuel vehicles. BLDC Motor is a type of motor used in electric vehicles. The BLDC motor used by one of the electric vehicle brands in Indonesia, namely GESITS, experienced overheating on the BLDC motor after traveling a distance of 30 km in the Bekasi area (GESITS, 2016).

Finally, to add cooling to the BLDC Motor, an external fan is installed. This experience shows the importance of cooling to maintain the durability of BLDC motors. Taskwati, A. T. (2004, 01 27) revealed that to produce the same torque, namely 1.65 Nm, a motor with a temperature of 125o C requires a greater electric current compared to a motor with a temperature of 25o C. Peak Power for a motor with a temperature of 125o C occurs at a torque of 1.65 Nm while Peak Power Motor with a temperature of 25o C has a torque of 2.88 Nm. This shows that an increase in motor temperature can reduce the performance of the electric motor. In order for the BLDC Motor to have optimal performance, appropriate cooling is required. The method used to cool electric motors in general is to use fins located on the outer surface of the motor housing. Based on the problems above, this research will carry out an analysis of the efficiency and thermal of a 3000 Watt BLDC motor in the design of an electric motorbike.

METHOD

This research uses an experimental type of research. According to Sugiyono (2009) experimental research can be interpreted as a research method used to find the effect of certain treatments under controlled conditions. Experimental research uses a specially designed experiment to generate the data needed to answer research questions (Margono, 2005). In this research, several problems were found with the 3000 Watt electric motor, so research needs to be carried out. This problem is to determine the efficiency and thermal management of a 3000 Watt BLDC motor in the design of an electric motorbike. This research was conducted at the Bali Transportation Polytechnic laboratory. Efficiency and thermal testing of the 3000 Watt BLDC motor was carried out using Dynotest or chassis dynamometer test. Dynotest testing was carried out at SMK PGRI 2 Badung. The research period starts from April 2022 to December 2022. The sample used in this research is a 3000 Watt electric motor assisted by displays such as chassis components. The independent variables in this research are loads of 90kg, 120kg, 150kg and 180kg. The dependent variables in this research are electric current consumption, 3000 Watt BLDC Motor engine performance and 3000 Watt BLDC Motor thermal distribution. The control variables in this study are room temperature and air humidity. After testing the efficiency of the BLDC motor, the things that need to be considered are analysis of test results, preparation of test data reports. The data collection technique in this research is by measuring the efficiency of the object under study and recording the necessary data. The data required is power, torque, current consumption, thermal value and electric motor rotation. After testing, the data analysis technique used is the descriptive analysis method. This was carried out to provide an overview of the phenomena that occurred after thermal testing on the BLDC motor regarding the motor's efficiency.

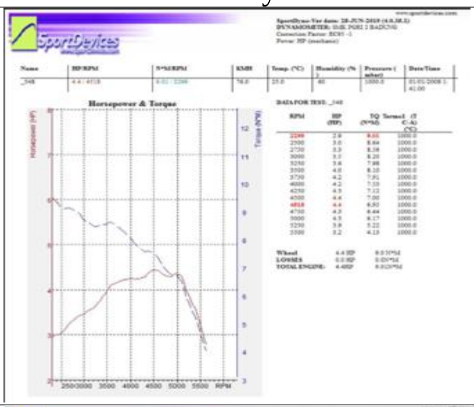
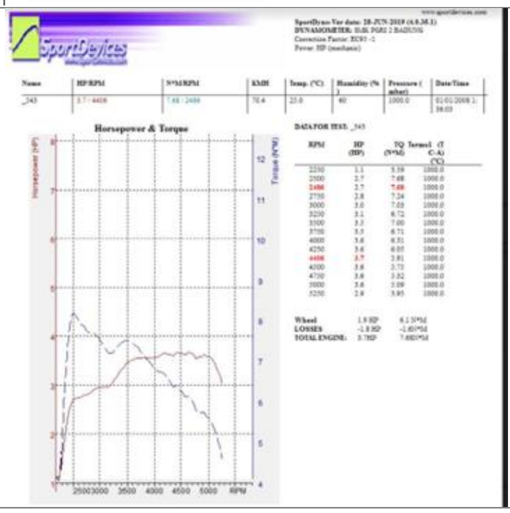


RESULTS AND DISCUSSION

Test results using Dynotest, Thermal and Electric Current

This process is the most important determination to produce and answer the problem formulation. The following are the results obtained in carrying out dynotest testing by varying the loading.

Table 1.
Electric motor performance test results using Dynotest.

Results Dynotest	Information
	testing using a load of 90 kg
	testing using a load of 120 kg

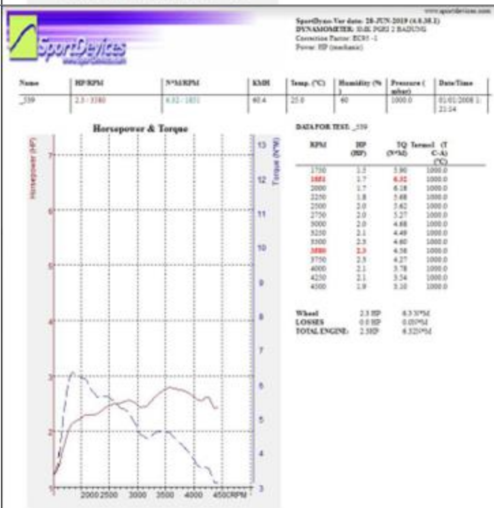
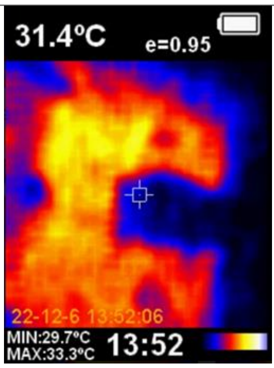
	testing using a load of 150 kg
	testing using a load of 180 kg

Table 2.
Electric motor thermal distribution test results using a Thermal Camera.

Thermal camera	Information
	testing using a load of 90 kg

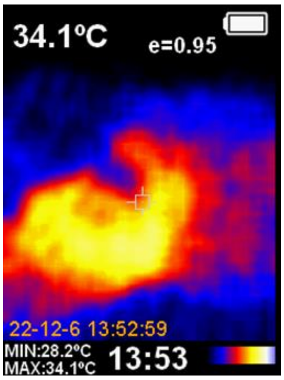
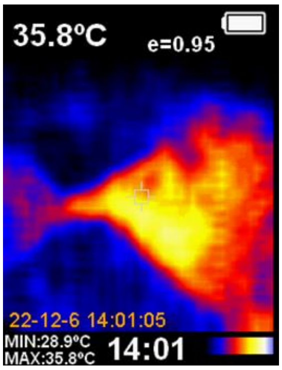
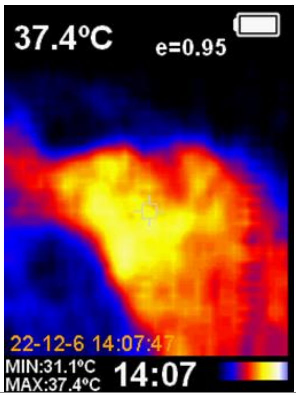
	testing using a load of 120 kg
	testing using a load of 150 kg
	testing using a load of 180 kg

Table 3.
Test results for the electric current consumption required by an electric motor using an Ampere Meter.

Electric Current Consumption	Information
	testing using a load of 90kg

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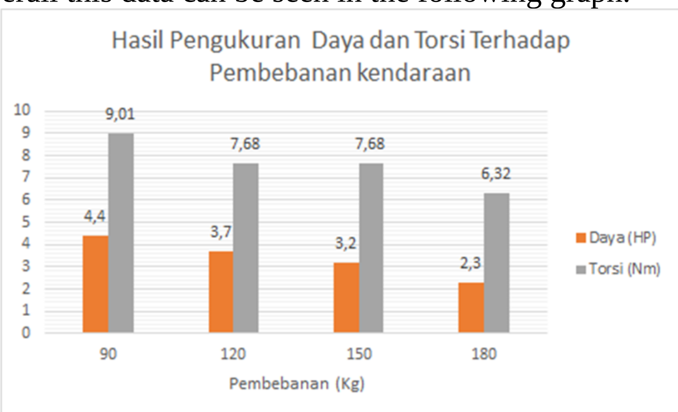
	testing using a load of 120kg
	testing using a load of 150kg
	testing using a load of 180kg

Discussion of measuring motor power and torque under load

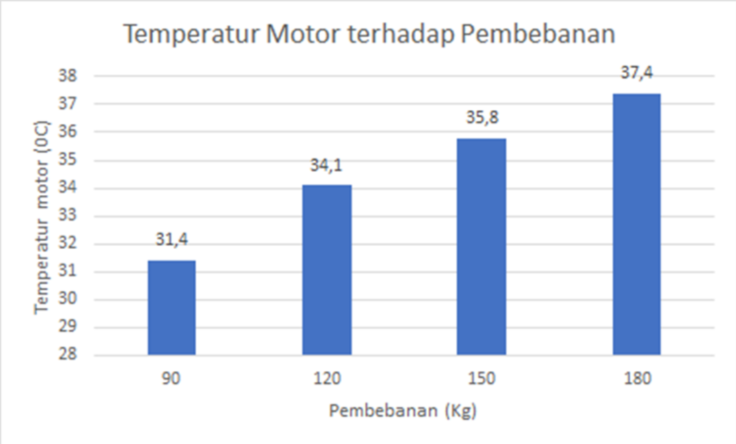
In the first test, it can be seen that the power produced by the motor is 4.4 HP at 4500 rpm and the torque produced is 9.01 Nm at 2300 rpm using a load of 90kg. The second test was carried out by giving a different load, namely 120 Kg. In this second experiment, the results obtained were that the motor power produced was 3.7 HP at 4400 rpm and the torque obtained was 7.68 at 2500 rpm. The third experiment carried out changes in the load. by increasing the load to 150 Kg. The third test obtained data results, namely the amount of power produced by the motor was 3.2 HP at 4000 rpm and the torque produced was 7.68 Nm at 2000 rpm. The final load change was carried out by providing a load of 180 Kg. in the 180 Kg loading experiment, the motor power test results obtained were 2.3 HP at 3500 rpm and the torque obtained was 6.32 Nm at 1800 rpm. Overall this data can be seen in the following graph.



Graphic image 1. Results of measuring motor power and torque against motor loading.

Discussion Motor thermal distribution test using a Thermal Camera

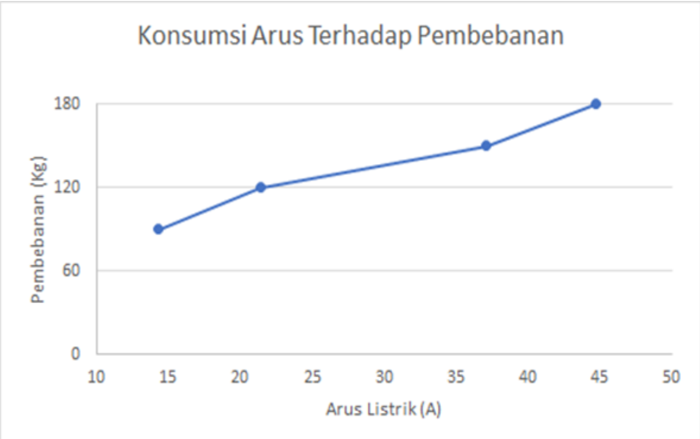
In the first test, it can be seen that the thermal value obtained was 31.4 C using a load of 90kg. The second test was carried out by applying a load of 120 Kg, at the second load the thermal results obtained from the electric motor were 34.1 C. Continued with the third test with a load of 150 Kg. In this test, the results obtained from the thermal camera showed the highest temperature of 35.8 C. and the final test was carried out by providing a load of 180 kg. In this fourth test, the maximum thermal results obtained on the motorbike were 37.4 C. In more detail, the test results can be seen in the following graph.



Graphic image 2. Motor temperature against electric motor loading

Discussion of Motor Current Consumption Test Results against Loading

In the first test it can be seen that the electric current required is 14.3 A using a load of 90 Kg. The second test was carried out by giving a weight or load on the vehicle of 120 Kg, with this loading the results obtained were that the current consumed by the motor was 21.4 A. Continued with the third test, namely by giving a load on the vehicle of 150 Kg and the consumption measurement results were obtained. The motor current is 37.1 A. The test with the final load was 180 Kg, and the measurement results obtained were 44.7 A of the current required by the electric motor. This test is carried out at maximum RPM at midel acceleration (speed 2) on the vehicle. From the test results, a value can be obtained between the load and the amount of current, which is directly proportional, according to the load given to the vehicle. For more detail, the results can be seen in the following graph.



Graphic image 3. Motor current consumption against loading

CONCLUSION

The efficiency of a 3000 Watt BLDC motor in electric motorbike design is that the load is inversely proportional to HP and torque at the same rpm. The thermal distribution of a 3000 Watt BLDC motor in the design of an electric motorbike is that the loading of the electric motor is directly proportional to the resulting temperature. The greater the load given, the higher the resulting temperature. With thermal management on the 3000-watt BLDC motor, it can increase the efficiency of electric motorbike design.

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