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PERFORMANCE ANALYSIS OF 48-V LI-ION BATTERY ELECTRICAL ENERGY CONSUMPTION ON E-BIKE 3 KW CAPACITY FROM ECONOMIC SIDE

Aleks Sander Siregar & Dahmir Dahlan*

*Department of Mechanical Engineering, Pancasila University, Jakarta
Email: alekssiregar.convergence.al@gmail.com

Abstract

This study aims to find out the data of conventional motorcycle consumption with the energy consumption of electric motorbikes using step-down transformers so that the energy consumption data obtained from these two types of vehicles can be used as a comparison of data results in both types of vehicles to get data optimization with electric vehicles that use step-down transformers. with a step-down transformer on an electric motorbike can increase the efficiency of energy consumption because the electric power wasted is smaller than existing electric bikes and far more efficient than conventional motorbikes. The first stage in the study is the identification of problems, which triggers to understand the problems in the analysist of energy consumption so that it is better by comparison of vehicles that use step-down transformers and without step-down transformers. The second stage of the study of literature, at this stage begins the search for data from several references that support this research such as books, journals, and social media such as the internet related to the research theme. Third is to make comparisons between the energy consumption that uses a step-down transformer and those that do not use a step-down transformer. The second data will be calculated later with the consumption of oil and gas-fueled vehicles. Fourth, by adding supporting data such as the price of oil fuels. Fifth, by calculating the value of consumption of non-electric fuels such as oil fueled vehicles and in terms of economics. The sixth comparative analysis, this stage is to do a comparison of calculations regarding the consumption of electric vehicles (E-Bike) with the consumption of non-electric vehicles. Seventh, namely drawing conclusions from all calculations with the type of vehicle being studied must be more efficient in terms of consumption and economy compared to vehicles that are already commercial. Electric motorbike with step-down transformer has proven to be better, the difference in two-wheeled vehicle when electric motorbike without a step-down transformer a value of 298.15 W per 100 m with 1.57 Wh per 100 m while on an electric motorcycle with a step-down transformer a value of 238.52 W per 100 m with 1.26 Wh every 100 m. In rupiah terms, an electric motorbike with a transformer has the most efficient value and a conventional motorcycle has an inefficient value efficiency compared to an electric motorbike using a step-down transformer and without a step-down transformer at an electric motorbike consumption rates with a step down transformer of Rp 1.7 per 100 m, the electric motorbike consumption rates rates without step-down transformers is Rp 2.12 per 100 m, the conventional motorcycle consumption rates is Rp 3.33 per 100 m.

Key words: electric motorcycle energy consumption, analysis of energy consumption, energy savings

1.0 PRELIMINARY

At present the need for electrical energy cannot be separated from human life. The availability of electrical energy in the future is an issue that is always a concern of all nations. The availability of energy must be able to meet the needs for electrical energy itself both in terms of quality and quantity [1]. The increase in the quantity of electrical energy itself is driven by increasing load growth. Energy sources derived from fossils (oil, gas and coal) that are commonly used by the supply are starting to feel reduced due to the increasing needs [2]. Automotive is an asset that is very necessary in human life, which is a primary need as part of transportation. Some systems and subsystems contained in the car are related to one another, one of which is the electrical system. Disturbances that most often occur include the charging system not working properly, the charging voltage is too high [3]. One solution to get a good charging system is that the charging voltage control system must work well, be measured and be accurate.

From these considerations, a research proposal was proposed on optimizing the battery recharging system by utilizing the 48V BLDC motor rotation on the E-Bike [4]. Battery technology made from lithium ion can be a solution to improve the efficiency of electricity consumption. Older types of batteries, for example those that use nickel, do have a memory effect that causes it to be treated as such. If it is not filled from empty to full, for example only up to 75%, then the battery will assume that the capacity is only 75% [5]. As a result, the battery will no longer be able to be filled to 100%. However, Li-ion batteries no longer have a memory effect, so there is no need to empty the battery capacity to recharge. In fact, emptying Li-ion batteries too often can cause damage. In addition, this type of battery can last up to hundreds of charge-discharge cycles. One charge-discharge cycle is a condition of full capacity, then used until it feels the need to charge again [6]. However, it turns out this type of battery is very sensitive to heat. If the temperature is too high, the battery can explode and this is very dangerous. Fortunately, the Li-ion battery is now equipped with a circuit that can prevent the battery from overheating. When the battery temperature is too hot, this circuit will cut off the flow of the current until the temperature is back to normal. However, we must remain careful with the temperature of our batteries [7]. In addition, the general age of this battery only lasts 2-3 years, even in conditions not used though. So, don't be surprised if in 2 or 3 years your battery already asks to be replaced. The transformer can be used to increase and decrease AC voltage levels, which is useful to help the electric power transmission system. When the electric power transmission process, with a higher voltage will get a lower current so that it can reduce the power losses that occur during the transmission process [8]. Therefore, transformers are widely used to get higher efficiency in the process of transmitting electric power from one place to another through the process of raising and lowering the voltage level. After electric power is transmitted, the voltage level can be reduced again according to the needs of consumers using a step-down transformer [9]. Based on the problems that have been explained in the background of the problem, the problems that need to be further investigated are explained as follows :

1. How to analyze the energy consumption of the battery?
2. How to improve the efficiency of energy consumption on the battery?
3. How to analyze the performance of an electric motorcycle is better than an oil-based motorcycle based on economical terms?

In the preparation of this research there are several research objectives, namely as follows:

1. Analyze the energy consumption of the battery
2. Increase the efficiency of energy consumption in the battery
3. Analyzing the performance of electric motorbikes is better than oil-based motorbikes based on economic terms

The benefits that can be expected in optimizing the improvement of power efficiency on the E-Bike from this side are as follows:

1. Analyze battery usage limits when driving with E-Bike.
2. Increase the efficient use of electrical energy as a rechargeable battery
3. Making E-Bike as an efficient vehicle in the land transportation route

2.0 RESEARCH METHODS

In this research study consists of two factors that cause this research, namely research materials and research tools.

Research Materials

The electric motorcycle used as research material has a dimension of 1.8 m in length, 0.72 m in width and 1.05 m in height. This electric bicycle has a mass of 70 kg, for more details about the electric motorcycle used in the study can be seen in Figure 1.

Figure 1. Electric Motorbike

Lithium ion batteries as electrical energy sources consist of anodes, separators, electrolytes, and cathodes. At the cathode and anode generally consist of 2 parts, namely the active material (the entry and exit of lithium ions) and the electron collector (collector current). The battery used in this study has a type of Li-Ion with a power capacity of 1440 W with a voltage of 48 V and has a current of 30 Ah. This battery has a mass of 8 kg and is a self-assembling, for batteries used can be seen in Figure 2.

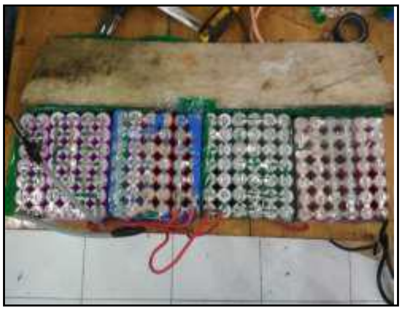


Figure 2. Battery

The electric motor used is the type of Brushless Direct Current Mid Drive (BLDC) with a power of 3000 Watt has a voltage value of 48 V with a maximum torque of 20.8 Nm, a maximum speed of 4489 rpm with a mass of 8 kg with the Merck Golden Motor. For more details about the electric motor used in this study can be seen in Figure 3.

Figure 3. Electric DC Motor

Gas handle (throttle) is a component that serves to regulate the speed of the vehicle so that the vehicle can go at the desired speed. The gas handle in this research can be seen in Figure 4.

Figure 4. Gas Throttle

The controller is a component used to control the flow of electrical energy to the motor. The controller used is the VEC48VDC type with the Golden Motor brand and has dimensions of 190 x 180 x 50 mm and a mass of 2.5 kg. The controller image in this study can be seen in Figure 5.

Figure 5. Controller

Step-down transformer serves as a voltage reducer, if the primary voltage is greater than the secondary voltage, the number of primary winding is greater than the number of secondary winding. The step-down transformer in this study is only a simulation by optimizing the consumption of electrical energy when using a step-down transformer. More clearly about the step-up transformer can be seen in Figure 6 [10].

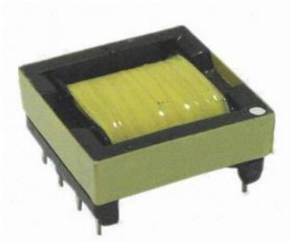


Figure 6. Step-down transformer

Research Tools or Instruments

The tools used in this research are MCB and power meter. The following will explain about MCB and power meter. MCB functions as a switch that functions to disconnect or connect electric current so that electricity can occur and electric bicycles can operate properly. The picture of MCB can be seen in Figure 7 [11].

Figure 7. MCB

Power meter serves as a tool to measure current, voltage and power when an electric motorcycle is running. The power meter used in this study has a PAEM-051 type with a voltage value between 6-100 VDC, dimensions 89.6 x 49.6 x 24.4 mm, and LCD screen with a screen dimension of 51 x 30 mm and a power level of PAEM-051. For more details about the power meter can be seen in Figure 8 [12].

Figure 8. Power meter

3.0 Data Collection and Collection Procedures

The first stage in the study is the identification of problems, which triggers to understand the problems in the analysis of energy consumption so that it is better by comparison of vehicles that use step-down transformers and without step-down transformers. The second stage of the study of literature, at this stage begins the search for data from several references that support this research such as books, journals, and social media such as the internet related to the research theme. Third is to make comparisons between the energy consumption that uses a step-down transformer and those that do not use a step-down transformer.

The second data will be calculated later with the consumption of oil and gas-fueled vehicles. Fourth, by adding supporting data such as the price of oil and gas fuels. Fifth, by calculating the value of consumption of non-electric fuels such as oil and gas-fueled vehicles and in terms of economics. The sixth comparative analysis, this stage is to do a comparison of calculations regarding the consumption of electric vehicles (E-Bike) with the consumption of non-electric vehicles. Seventh, namely drawing conclusions from all calculations with the type of vehicle being studied must be more efficient in terms of consumption and economy compared to vehicles that are already commercial. The research flow diagram will be explained in Figure 9.

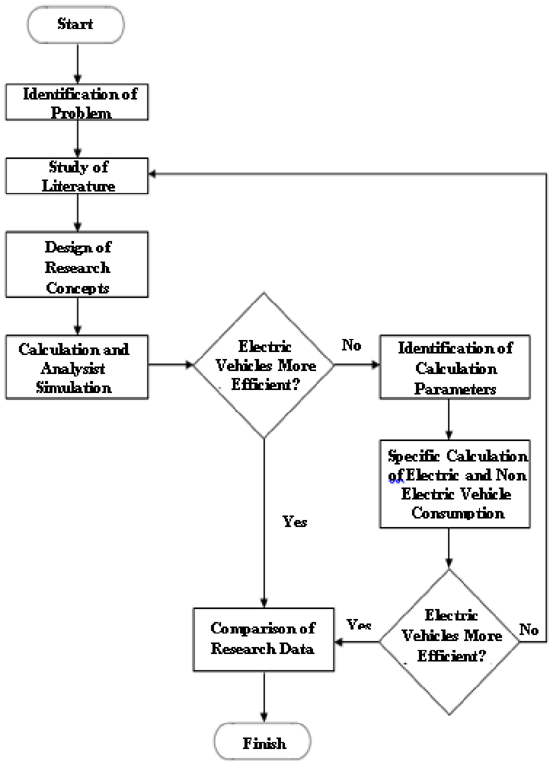


Figure 9. Research flow diagram

4.0 RESULTS AND DISCUSSION

This analysis refers to previous research related data, and at the analysis stage the results of the temporary measurement refer to the values of voltage, current and electrical power that have occurred before. Next is the data presentation that refers to the value of electricity consumption at different distances and is explained in table 1 [13].

Table 1. Temporary Measurement Results for Total Power Value

No	Calculation Parameters	Horizontal Conditions		
		100 m Distance	200 m Distance	300 m Distance
1	t (s)	19	28	38
2	v (m/s)	5,5	7,14	7,89
3	a (m/s^2)	0,29	0,255	0,21
4	F_{Ia} (N)	29,09	25,59	21,07
5	F_m (N)	24,61	24,61	24,61
6	F_{ad}(N)	0,513	0,86	1,06
7	F_t (N)	54,21	51,06	46,74
8	τ (Nm)	11,71	11,029	10,09

9	P_{total} (W)	298,15	364,57	368,78

In planning the analysis of the energy consumption of electric motorbikes, several things must be considered, namely the calculation of electric power that occurs, the calculation of energy consumption on the battery, the calculation of the charger time and the calculation of E-Bike consumption from an economic standpoint. At this stage economic value will be compared using a step-down transformer and without a step-down transformer. When there is a decrease in power efficiency due to the step down transformer from 100% to 80% so that with changes in the value of the transformer efficiency, the power that comes out of the transformer becomes smaller in value with a ratio of 5: 4, in the calculation of the electric motorbike energy consumption no parameter values are needed force, weight, acceleration etc. Following is the calculation of secondary power after going through a step-down transformer. Secondary power calculations can be seen in equation 1 [14].

$$Ps = P_{total} \times 80\% \quad (1)$$

For the breakdown of secondary power data (output power) on the transformer with the calculation of the total power value from the temporary measurement multiplied by 80%. The value of battery energy consumption is very necessary because to get the value in units of rupiah, then the initial step is to know the calculation for battery energy consumption then after it is obtained, it can be continued to the next stage. The time value that occurs refers to table 4.1, namely 19 s for 100 m distance, 28 s for 200 m distance and 38 s for 300 m distance. For battery energy consumption can be seen in the calculation below. Energy consumption can be seen in equation 2 [15].

$$W = P_{total} \times t \quad (2)$$

E-Bike energy consumption from the economic side or commonly called the electric power tariff by taking into account the value of energy consumption and the price per 1 kWh. The value of energy consumption can be seen in equation 3 [16].

$$BEP = Battery / W_{PLN} \times Rp\ 1{,}352.00 \quad (3)$$

Analysis of the calculation of electrical energy consumption in the form of data calculation of electric power that occurs, the calculation of battery energy consumption, calculation of charger time, calculation of E-Bike consumption from the economic side will be explained in table 3

Table 3. E-Bike consumption from the economic side

No	Calculation Parameters	Horizontal Condition					
		without trafo *step-down*			with trafo *step-down*		
		100 m	200 m	300 m	100 m	200 m	300 m
1	P_{total} (W)	298,15	364,57	368,78	238,52	291,66	295,02
2	W (Wh)	1,57	2,83	3,89	1,26	2,27	3,11
3	TDL (Rp)	2,12	3,83	5,26	1,7	3,07	4,2

The most well-known by the public of this automatic motorbike is its achievement which succeeded in breaking into the Indonesian Record Museum as the most economical automatic motorbike with the achievement of 109.8 kilometers per 1 liter of fuel. In addition, recently the virtual universe has been stirred again by the news that the Suzuki F1 super F1 was once banned from participating in the race because it always won. Eco racing has the ability to increase the efficiency of vehicle consumption up to 50% if 1 tablet for 5 L of fuel. Eco Racing is a fuel additive that is safe for engines because it is made from 100% organic ingredients. Fuel consumption of vehicles using eco racing and without eco racing will be explained in table 4 [17].

Table 4. Comparison of conventional vehicle consumption price data and using eco racing

No	Calculation Parameters	Horizontal Conditions	
		Without Eco Racing	With Eco Racing
1	Premium	Rp 6,38/100 m	Rp 3,64/100 m
2	Pertalite	Rp	Rp 3,33/100

		5,89/100 m	m
3	Pertamax	Rp 7,05/100 m	Rp 3,82/100 m
4	Pertamax Turbo	Rp 6,6/100 m	Rp 3,59/100 m

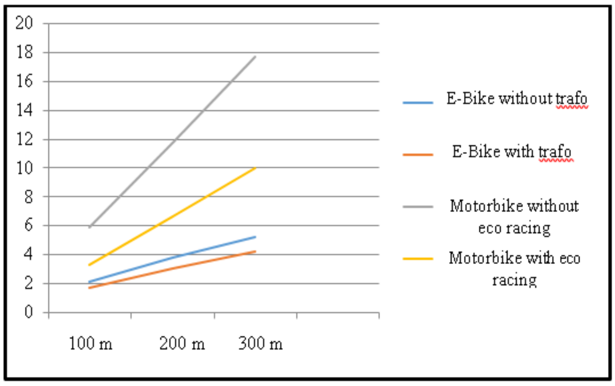
After obtaining the data of the two types of vehicles, namely electric vehicles and conventional vehicles regarding energy consumption in rupiah units and calculated per 100 m, then converted into 200 m and 300 m as a reference. Comparison of energy consumption of conventional vehicles and electric motorcycles will be explained in table 5.

Table 5. Comparison of energy consumption of conventional vehicles and electric motorcycles

No	Calculation Parameters	Horizontal Conditions		
		100 m	200 m	300 m
1	E-Bike :			
	Without Step-down trafo	Rp 2,12	Rp 3,83	Rp 5,26
	With Step-down trafo	Rp 1,7	Rp 3,07	Rp 4,2
2	Motorbike without eco racing			
	Premium	Rp 6,38	Rp 12,76	Rp 19,14
	Pertalite	Rp 5,89	Rp 11,78	Rp 17,67
	Pertamax	Rp 7,05	Rp 14,1	Rp 21,15
	Pertamax Turbo	Rp 6,6	Rp 13,2	Rp 19,8
3	Motorbike with eco racing :			
	Premium	Rp 3,64	Rp 7,28	Rp 10,92
	Pertalite	Rp 3,33	Rp 6,66	Rp 9,99
	Pertamax	Rp 3,82	Rp 7,64	Rp 11,46
	Pertamax Turbo	Rp 3,59	Rp 7,18	Rp 10,77

For specific comparisons as optimization research will be taken 4 calculation parameters namely E-Bike without step-down transformer, E-Bike with step-down transformer, motorcycle without eco racing, and motorcycle with eco racing. Specific comparisons for conventional motorbikes pertalite fuel data is taken because it is proven to be the most efficient and will be explained in figure 10.

Figure 10. Specific comparison of electric motorbikes with conventional motorbikes



5.0 CONCLUSIONS

In the optimization of electric bicycle research, we must pay attention to options that can be used as research novelty, with the existence of a step-down transformer, it is proven that E-Bikes that use step-down transformers are more efficient than E-Bikes that do not use step-down transformers. Optimization of research by adding a step-down transformer has become an innovation in energy consumption by comparing the most efficient gasoline motorcycles coupled with the use of eco racing as a tablet to increase the efficiency of fuel motorcycle consumption. Proven in research at a distance of 100 m, E-Bike that uses a transformer only costs Rp 1.7 / 100 m, E-Bike that does not use a transformer costs Rp 2.12 / 100 m, Suzuki nex f1 motorcycle costs Rp. 3.33 / 100 m using pertalite fueled eco racing, and Suzuki nex f1 without eco racing cost Rp 5.89 / 100 m. So the step-down transformer can outperform ordinary E-Bikes and even the most fuel-efficient gasoline motorcycles.

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