Analysis of Characteristics Electrical Conversion Motor (BBM to Electricity) using an automatic cooling system

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Abstract. electric conversion motors have great potential to be developed, this is in line with Indonesian government policy, however, regarding the coolant for electric conversion motors, it still needs to be developed in order to obtain maximum motor performance at various speeds, the application of pending peltier to obtain the ideal torque value to be applied on a conversion motorbike with a 2KW electric motor using a 72 Volt lithium battery,

From the results of research carried out to obtain optimal torque performance that is included in ISO 13064-1:2012, namely by using a cooler and not using a cooler, the best torque obtained is by using a cooling system with speed variations with an average torque value of 1.29 Nm.

Keywords : electric motor, torque, speed, coolant

1. Introduction

The Indonesian government has carried out the conversion of electric motorbikes in a well-planned manner. Indonesia has a target to develop 2,200 units of 4-wheeled electric/hybrid vehicles and 2.1 million units of electric/hybrid vehicles by 2025. Presidential Regulation Number 55 of 2019 [1]. From the considerations above, our research position is to continue the conversion of existing electric vehicles, followed by analysis of manual transmissions so that they are more effective with driver behavior and the vehicle's ability to overcome urban terrain conditions.[2].

In the cooling system for electric vehicles, one way to maintain the temperature of the controller is to maintain it properly, one of which is using the thermoelectric method, by utilizing the Peltier effect. Cooling in vehicles, especially electric vehicles, has an important role. Apart from keeping the temperature stable, it also maintains the performance of electric vehicles to remain optimal [4] One of the main components in electric vehicles that requires cooling is the controller which functions to regulate the electric current flowing to the electric motor [3] There is research that states the working temperature of the motor The Neo Blits electric car drive, which is the object

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of cooling, can be maintained at a temperature of 50° C according to its set point value [4]

In this case, electric motors have greater powertrain efficiency, minimal maintenance requirements, and zero tailpipe emissions [5]. The Presidential Decree specifically states that electric motorbikes are a priority for shifting. This directive is in line with trends in India [15], Philippines [6], UAE [7], China [8], [9], and Germany [10]

The research carried out a dynotest test on a converted electric vehicle by measuring the rpm, torque and power of the main drive motor by considering the use of coolant to see the resulting performance. Tests were carried out under various different load conditions, so that the power and torque values obtained in each condition were the optimal power capable of working at maximum load [11].

2. Methodology

Testing of the conversion motor using Peltier cooling was carried out using a dyno test to test torque and horse power. Next, ensure that the device is functioning properly before integrating it with other devices. The integration, improvement and testing phases are the longest phases. Vehicle speed during testing is set to a maximum of 90 km/hour. Converted vehicles are tested with varying speeds

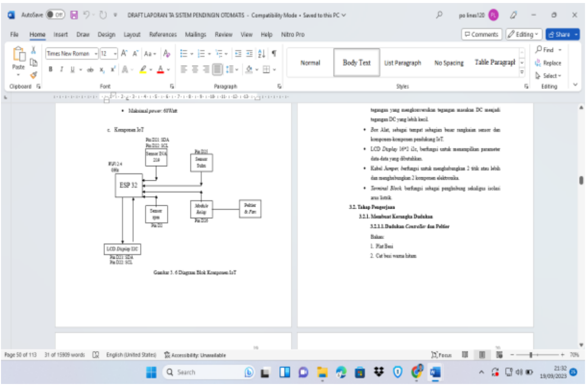

Fig 1. Flow Chat

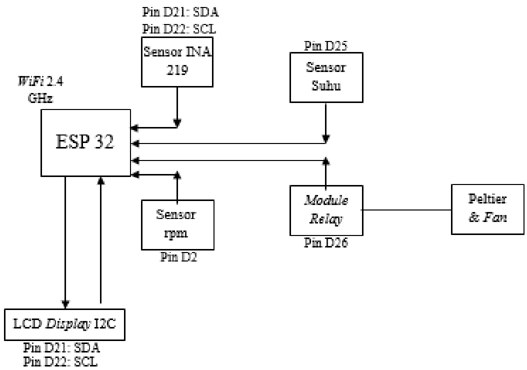

Fig 2. Wiring diagram Electric IoT System

Fig 3. Motor Design

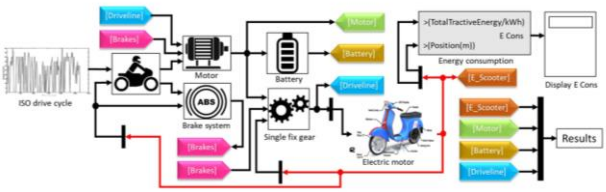

Fig 4. Simulation model of convertible motorbike with Peltier

From Figure 4, the longitudinal modeling was chosen by considering several supporting components for the conversion motor drive. The energy flow equation according to reference [12]

$$E_{Cons}=\frac{E_{Batt}}{d} \qquad (1)$$

E_{Cons} is energy consumption divided by distance (kWh/km),
d is the total distance traveled by the electric scooter (km) E_{batt} is the total energy of the battery (kWh).

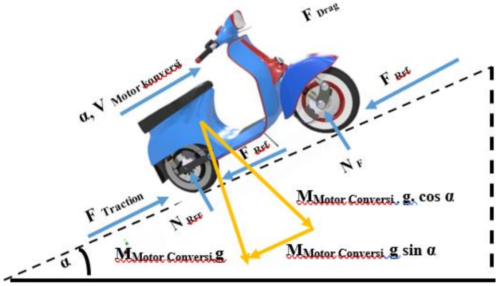

Fig 5. Dynamics longitudinal

On picture. 5, the longitudinal model method can be described as follows.

RTotal = FTraction (2)

Pwhell = FTraction. VMotor Conversi (3)

F Traction = FDrag + FRolling Resistance + FGrade + FInertia (4)

$F_{Drag} = \frac{1}{2} \rho . c_d . A_f V_{Motor\ Conversi}{}^2$ (5)

$F_{Rolling\ Resistance}$= FrontTire (F_{Rrf}) + RearTire (F_{Rrr}) (6)

= $C_{RR}.M_{Motor\ Conversi}$. g. cos α (7)

F_{Drag} = $M_{Motor\ Conversi.}$ g. sin α (8)

$F_{Inertia}$ = $M_{Inertia}$. α (9)

$M_{Inertia}$ = 1,15 x $M_{Motor\ Conversi}$ 10)

From equations (1) to (10), for calculations using MATLAB modeling. This method is based on the work reported in reference [13].

Table.1 conversion motor parameters

Parameter	Note	Values
$M_{motor\ conversi}$	Total motor conversi mass	220 kg
C_d	Coefficient of Drag	0,6
A_f	Coefficient of tire rolling resistance	0,8
C_{rr}	The Velocity of electrik motor conversi	0,013
$V_{motor\ conversi}$	Velocity of the motor conversi	110 kph (max)
H_p	Powertraint efficiency	90%
Accesries load	Power to supply accessories load	90 Watt (consisten)
Transmission ratio	Singgle fixel ratio	1:5, 1:6, 1:7

Whell radius	Rear tire radius	0,260 M
Motor Power	Power Motor	2000 Watt
Motor Tourqe	Max/min	20 Nm/25 Nm
Motor Speed	max	5000 rpm

According to ISO 13064-1:2012 the data is required and has been applied in previous research [11] a model was developed to determine energy needs and will be combined with the influence of cooling use. Furthermore, it was validated using experimental tests on a dynamometer and on-road conditions which were proven to be valid.

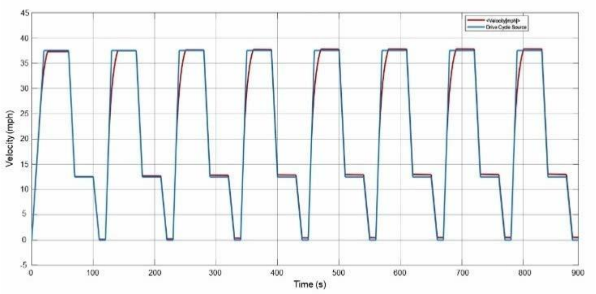

Fig 6 .ISO 13064-1:2012

According to Fig. 6, the speed is described on the blue line coinciding with the drive cycle speed line in the form of the red line

The drive cycle is related to the power and torque (ISO 13064-1:2012) that will be required. And the power required to work is 3.0 kW (Fig. 7 and 8).

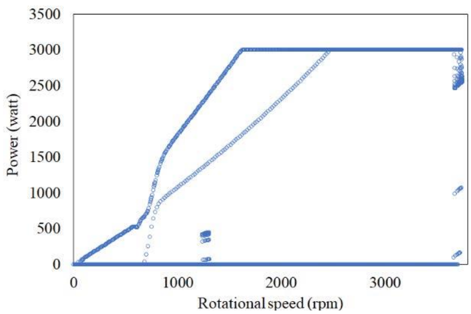

Fig 7 . motor power (watt) versus speed (rpm)

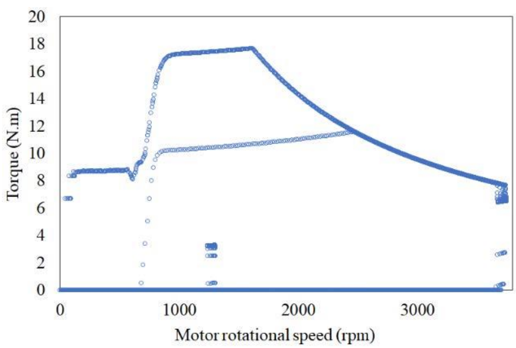

Fig 8 . **Torque (Nm) versus speed (rpm)**

It can be concluded that the longitudinal method has been tested to determine the limits of the capabilities of electric motors so that we can use them with conversion motors using speed variation cooling

3. Result

The results of this study are illustrated in graphical form

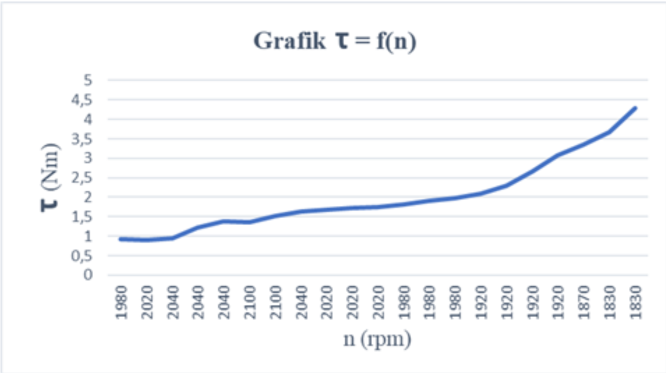

Fig 9. Relationship of Torque (Nm) to Speed (rpm) Without a Cooling System

Figure 9 shows the relationship between torque (Nm) and speed (rpm) without using an automatic cooling system. It can be seen that the relationship between torque and speed is inversely proportional. The higher the torque, the lower the resulting speed. It can be seen in Figure 10 that the speed increases to 2100 rpm with a smaller torque, namely 1.52 Nm, compared to when the speed decreases to 1830 rpm, the torque value will be greater, namely 4.28 Nm. This is in accordance with the theory $\tau = (5252 \times P)/n$ (Winther, 1975). Where the torque value is inversely proportional to speed

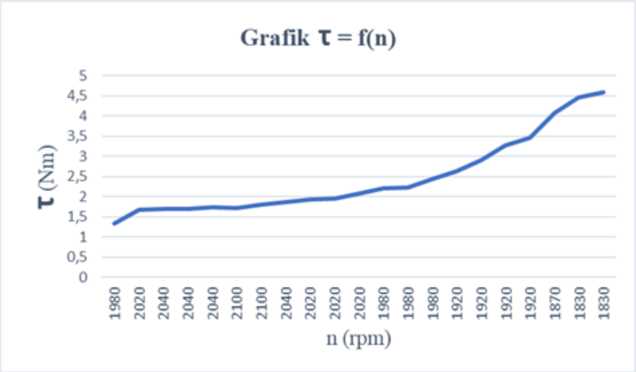

Fig 10. Relationship between torque (Nm) and speed (rpm) with the cooling system

Figure 10 shows the relationship between torque (Nm) and power (HP) without an automatic cooling system. It can be seen in Figure 8 that the relationship between power and torque is directly proportional. The greater the power released, the higher the torque produced. It can be seen in Figure 11 that if P out is the lowest, namely 0.35 HP, then the resulting torque value will also be small, namely 0.93 Nm. But if the P out is high, namely 1.49 HP, then the torque it produces will also be greater, namely 4.28 Nm. And in testing without a cooling system, the average torque produced was 1.98 Nm

4. Conclusion and discussion

From the results of speed variations for conversion motors using Peltier cooling on the controller, an average torque value of 1.98 Nm

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