Speed Comparation Between Two-wheeled Fuel and Electrically Converted Vehicle Using Simulation

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***Abstract*— Revo motorcycle conversion using 2 kW electric motor create slow two-wheeled electric vehicle which only reach 23,3 kph compared to it's ICE propelled version which could reach 100 kph for equal space on chassis. Faster conversion based on Mio motorcycle using 3 kW BLDC motor resulting 75 kph maximum speed. A novel conversion kit based on Beat motorcycle using equal wattage BLDC motor claimed to be 90 kph which have some mechanism modification. To acquire similar comparison without many mechanism modification, simulation conducted using a pair of equally powered electric motorcycle model compared to it's ICE motorcycle model. With the same 5.9 kW power rate and 250 kg mass resulting higher motorcycle top speed using ICE propulsion which is 61.959 kph, then the electrically converted motorcycle was 52.840 kph.**

Keywords*—Vehicle Conversion; Simulation; Electric Motor; Electrically Converted Motorcycle

I. Introduction

Fuel vehicle conversion to be electric vehicle using 2 kW electric motor based on Revo motorcycle successfully reduce carbon emission followed by propulsion power and top speed of those vehicle. Electric Revo (Evo) average speed reach 23.3 kilometer per hour (kph) [1]. Other similar motorcycle reach 40 kph using 1 kW BLDC motor [2]. Too low compared to Internal Combustion Engine (ICE) propelled version which could reach 100 kph [3].

Some experiment of electrically converted Mio motorcycle speed reach 40 kph using 1.5 kW [4][5] or 1.8 kW [6], and 75 kph using 3 kW [7] BLDC motor. Novel conversion kit based on Beat motorcycle claimed could reach 90 kph [8].

Because bigger electric motor could not assembled yet, simulation use to model an electrically converted motorcycle equal to an ICE propelled motorcycle. All-Terrain Vehicle (ATV) simulation [9] were easy expected model to adopt. The model modified to be motorcycle model by changing value of parameters.

II. Research Methodology

To create possible motorcycle model from [9], general specification of two-wheeled vehicle using similar mechanism were done. Simulation modification shown on Figure 1 applied to engine, wheel number, and vehicle dimension to be specified as Mio motorcycle [10]. Created two-wheeled vehicle model duplicated with different propulsion but using single input, hence the output could be compared. The central one were ICE version model of ICE propelled motorcycle, then the bottom one is electric version model of electrically converted motorcycle.

To measure the performances, sensors were added in vehicle body block. Main measurement was Power using Watt unit, then the power split to Speed which should converted from radian to kph unit and Torque using Newton meter unit. Another measurement was Distance using meter unit, but the Distance would not included as discussion.

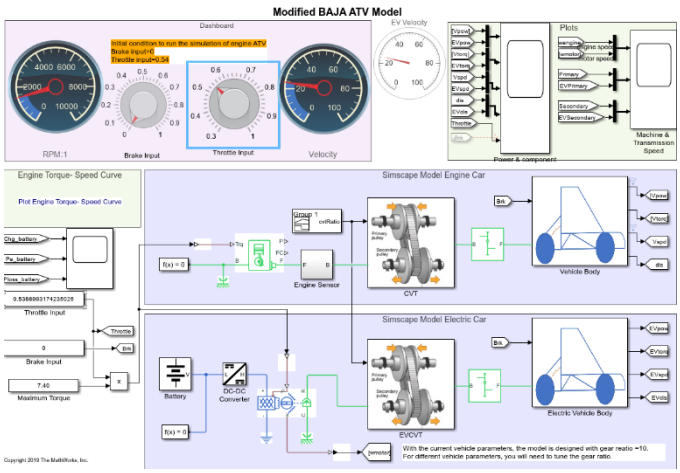

Figure 1. Simulation modelling

Input command for General Engine block of ICE version model using throttle value from 0 to 1. Then Motor & Drive block of electric version model input command using torque value. To ease input command by sourcing to single throttle, torque value comparator to throttle were created before electric motor block. Vehicle physical dimension were equaled. Model difference was the kind of propulsion, so the value weren't included in physical parameter on Table 1.

Table 1. Physical parameter of both motorcycle

Property	Value
Mass (kg)	250
Area (cm^2)	7087.5
Drag coefficient	1.92
Air density (kg/m^3)	1.18

Motor & Drive block power and torque of electric version model refer to General Engine block is 5.9 kW and 7.4 Nm shown on Figure 2 [10]. Power being main output from inside of each Vehicle Dynamics block which split to speed, torque, and distance. Both fuel and battery model were assumed unlimited, therefore power consumption didn't calculated.

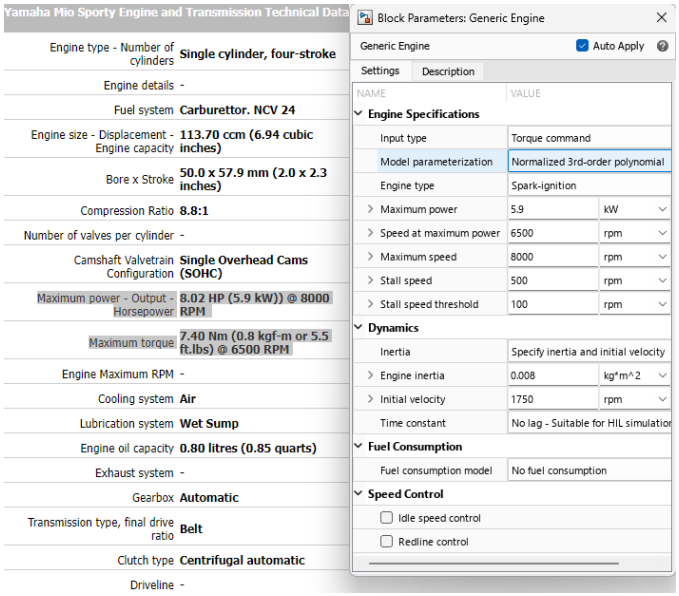

Figure 2. Power and torque referring.

III. Result and Discussion

Simulation started by throttling from 0.3 because ICE version model wouldn't start below those value. Throttle increased slowly until highest value then decreased to minimum. Braking were done after minimum throttling. ICE version model will totally stopped on full braking but electric version will run again after the brake released.

Measurement result graphics displayed on Figure 3, then the highest output value written in Table 2. Graphics were arranged as this: top left is power, bottom left is torque, top right is speed, bottom right is reached distance. Blue curve for ICE model version and red curve for electric model version.

Initial speed show similarity at approximately 22 kph. When throttle value up to 1, ICE version model approximately 10 kph faster than electric version model.

Table 2. Acquired highest data value

Value	ICE Propelled	Electrically converted
Power (kW)	4,757	2,839
Torque (Nm)	73,54	51,25
Speed (kph)	61,959	52,84

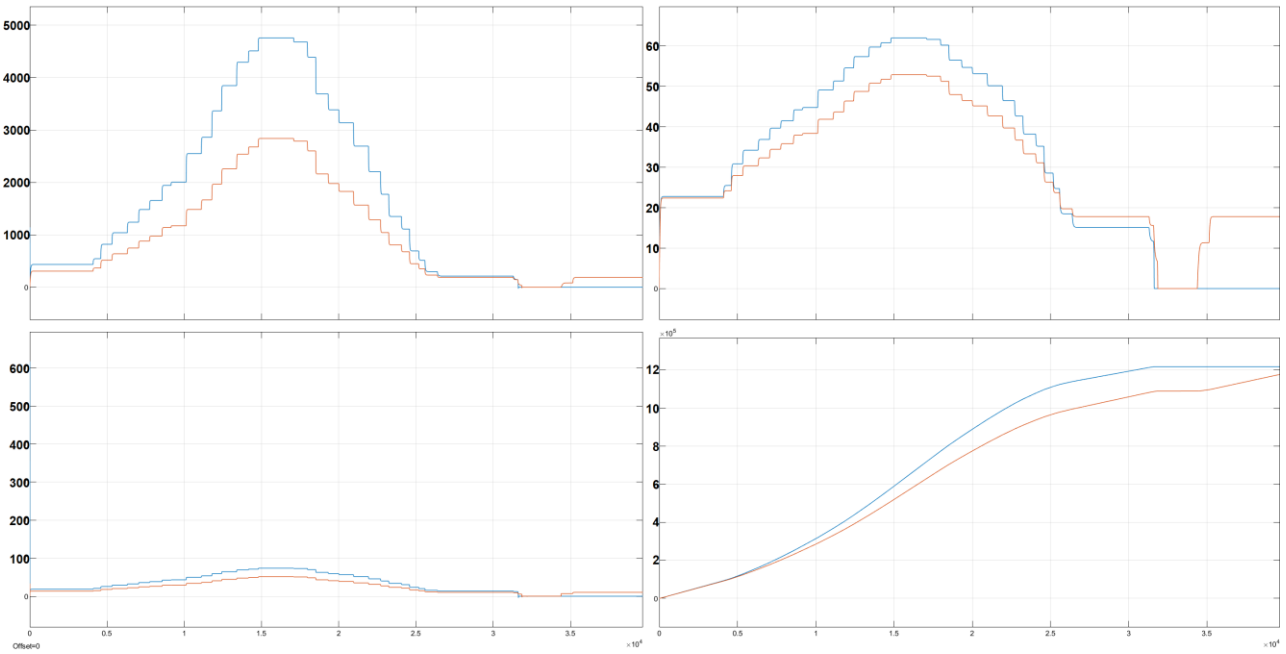

Figure 3. Simulation result

IV. Conclusion

Based on simulation, ICE propelled motorcycle have higher speed about 9 kph than electrically converted motorcycle in equally powered and mass specification. Simulation were not include each power consumption which could be added at next experiment.

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