Performance Measurement and Comparison of Hybrid Two Wheeler

Ravi Soni, Nityam Oza

Abstract— **At recent, tremendous research work is carried out in the field of automobile engineering to counteract the problem of conventional fuel depletion and harmful pollutant emissions. Electric vehicles has been proved for low running cost and reduced pollutant emission compared vehicle powered by conventional fuel like gasoline and diesel. However, electric vehicles are not popular because of low range of vehicle and require long charging time. Whereas, IC engine powered vehicle provides longer range, smaller refilling time and higher efficiency at cruising speed. However, during part load operation of Gasoline based IC Engine, higher harmful pollutant emission and poor fuel economy is observed. A hybrid two wheeler is developed to tap the advantage of long range and higher efficiency at cruising speed of IC Engine and lower emissions & efficient operation at low speed of electric power. The hybrid TVS Scooty ES two wheeler is tested in Vadodara city with driving conditions involve congested city driving and driving at cruising speed. The result shows 11.41 % improvement in fuel consumption compared to conventional gasoline based two wheeler.**

Index Terms— **Electric vehicle, Fuel, Hybrid power, IC Engine**

I. Introduction

Automobile world is currently facing severe problems of depletion of fossil fuels and regularly strengthen emission norms. Research has been carried in the field of alternative fuels and alternate power train technology, renewable energy and hybrid technology. Bio fuel has shown improvement in this concern however availability and infrastructure requirement is quite large. Renewable energy sources like solar energy have good potential but technology development is still under progress. Electric powered vehicle has shown remarkably acceptance and has considerable penetration in an automobile market. IC Engine fueled by conventional fuel has proved their importance in automobile market and still today majority of the vehicles are powered by IC Engine. However, IC engines are facing problems of depletion of fuel and strengthen emissions norms. Further, during the city driving conditions of low speed, frequent start and stop, longer idling operation of IC engine worsen the problem [1]. In contrast, electric vehicle shows remarkable advantages like low running cost, less pollutant emissions (considering emissions production due to production of electricity) and silent operation. However, low range, longer charging time and higher cost has made acceptance of electric vehicle limited. To tap the advantages of IC Engine like efficient operation at cruising speed, long range & negligible refueling time and Electric like low running cost & efficient operation at city driving conditions, a hybrid vehicle is developed. Hybrid vehicle has two or more power sources, delivering energy for propulsion either solely or in combinations, to run the vehicle[3]. During low speed and city driving conditions power for the propulsion will be provided by electric energy[4]. During cruising speed condition the IC Engine provides power for propulsion.

Ravindra Soni, PG Student-Mechanical Engineering Department, Parul Institute of engineering and Technology, Vadodara, India
Nityam Oza, Assistant Professor-Mechanical Engineering Department, Parul Institute of engineering and Technology, Vadodara, India

II. Development of Hybrid Two Wheeler

A. Present Vehicle

The vehicle selected for this purpose is TVS Scooty ES model. Major specifications are as given in Table I.

Table I: Specification of Two Wheeler

Make	TVS
Model	Scooty ES
Engine	4-stroke, Single cylinder
Displacement	60 cc
Max. Power	5 BHP@6500 RPM
Max. Torque	5.8 Nm@4000 RPM
Weight	75 kg

B. Modification and major components

Original vehicle is rear wheel drive vehicle. The IC Engine is powering the rear wheel only. To make the vehicle hybrid, a 250 W Brush Less DC motor, shown in fig.I, is fitted in the hub of front wheel. Front brake is removed to place the BLDC motor. The BLDC motor is a closed loop synchronous motor. It can save 30-50% of power consumed by a normal motor and efficiency range of 80-90%. It can provide high torque at low speed. To provide constant voltage to the motor

Fig. I: BLDC motor fitted in front wheel hub

controller is needed to vary the current to produce necessary torque. The power electronics are designed to the specific characteristic of the electric motor. It is loacated at the front of

the vehicle as shown in Fig I. Four lead acid batteries, 12 V and 20 Ah capacities each, are connected in parallel to provide necessary current at 48 V to BLDC motor are shown in Fig II. Weight of the battery pack measured is 12.83 kg.

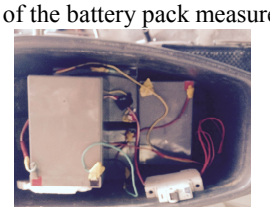

Fig II Battery pack connected in Parallel

A Battery charger, shown in Fig III, is used to charge the battery by converting domestic supply AC current in to DC current. Charger also records the consumption of electric unit and displays same. A Battery charging point is placed under the seat near choke. Speed of the electric motor is controlled by accelerator lever (fig. V) placed on left side of steering by adjusting current through controller. A changeover switch (fig VI) is provided to change the power supply from electric to IC Engine or vice versa. The QStarz BT-Q1000eX GPS data logger shown in fig IV is used to record the data for lap. This device records Time duration, Distance travelled, moving time, stopped time, Maximum speed and average speed during the lap. The data recording was done at 10Hz i.e. 10 times location in 1 second.

Fig: III – Battery Charger

Fig: IV – GPS data logger

Fig: V – Accelerator for Electric mode

Fig: VI –Electric Changeover Switch

Table II shows the major specification of modified vehicle as below.

Table II Specification of Modified Vehicle

Make	TVS
Model	Scooty ES
Displacement	60 cc
Max. Power (Gasoline Mode)	5 BHP@6500 RPM
Max. Power (Electric Mode)	250 W
Max. Torque (Gasoline Mode)	5.8 Nm@4000 RPM
Max. Torque (Electric Mode)	3.6 Nm
Battery	48 V/20Ah
Charging Period	6-8 Hours
Max. Speed (Electric Mode)	24 to 28 kmph
Weight	87.46 kg

III. Performance Measurement and Comparison

To measure the performance of vehicle fuel consumption is considered in both the case. The route selected for the test is stared from Malhar point followed by Shrenik cross roads, Dandia bazar, Mandvi, Panigate, Vrundavan cross road, Sardar estate, Panigate, Mandvi, Dandia bazar, shrenik cross road and Malhar point in Vadodara, Gujarat. The total route is 17.8 km long. The stretch from Dandia bazar to Panigate 3.7 km comprises of heavy traffic city area where vehicle is required frequent start and stop and heavy idling due to dense traffic and signaling. For the rest stretch of 5.2 km comprises of light traffic and wide roads which allows vehicle to run at cruising speed at most of the time and less stop and go & idling time. At first lap the vehicle run in only gasoline mode throughout the lap. Fuel consumption and other data are recorded and shown in Table III. In second lap the vehicle is run in Gasoline mode through 5.2 km stretch of light traffic and in electric mode through the 3.7 km stretch of city area with dense traffic. Fuel consumption, Units required to charge the battery and other data are recorded and shown in Table III. In both the lap, The QStarz BT-Q1000eX GPS data logger is recording the data and connected to the internet to show the lap on Google map. The captured data with QStarz BT-Q1000eX GPS data logger is

Table III: Data Collection for major comparison

	Vehicle (Gasoline)	Vehicle (Hybrid)
Max Speed (kmph)	53.13	36.2
Avg. Speed (kmph)	20.72	20.49
Idle Time (min)	11	12
Moving Time (min)	52	53
Total Time (min)	63	65
Lap Distance (km)	17.8	17.8
Gasoline Consumption (gm)	587	248
Electric Unit Consumption	----------	0.83
Electric to gasoline(gm)		272
		520

Fig VII: Data recorded by QStarz BT-Q1000eX GPS data logger in Gasoline Mode

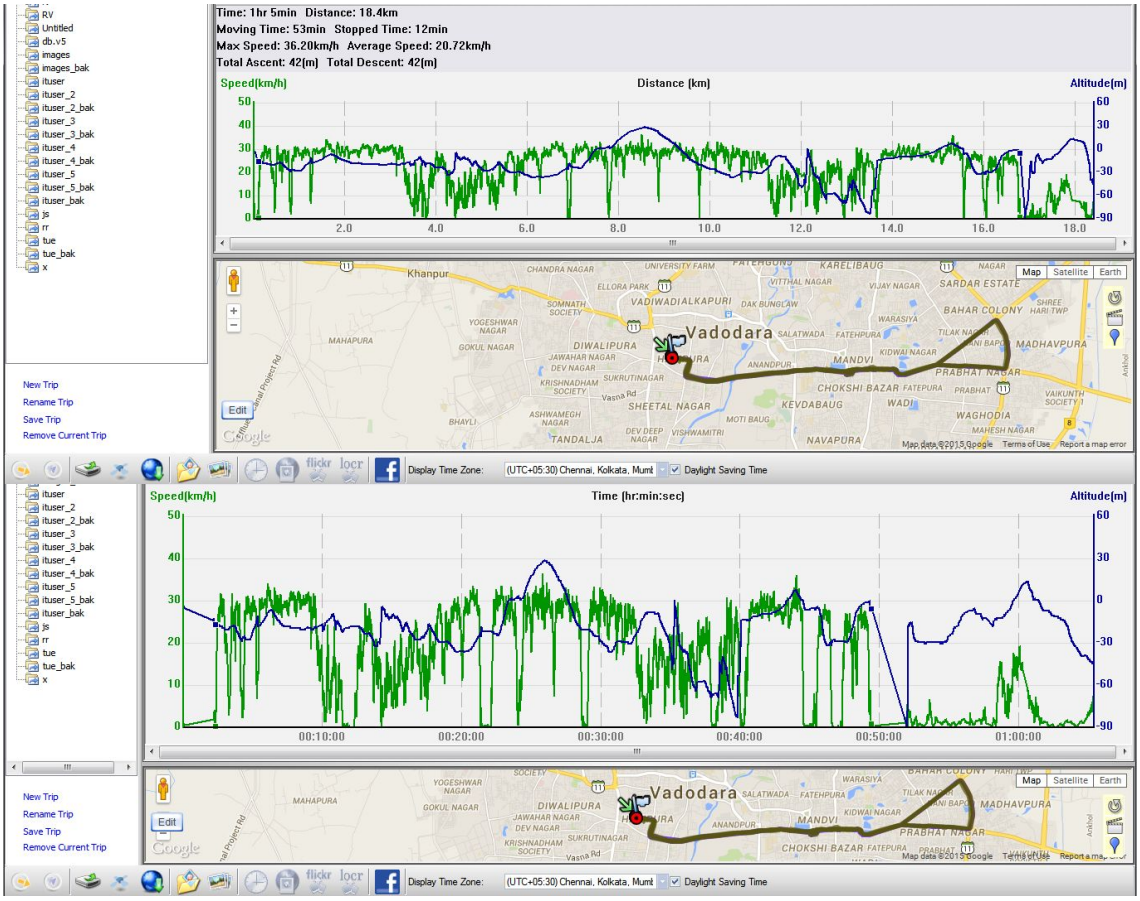

Fig VII: Data recorded by QStarz BT-Q1000eX GPS data logger in Gasoline Mode

CONCLUSION

From the Table III , it is seen that maximum speed attained is less in hybrid vehicle. The cause for the same is increase in traffic in second round, higher weight of hybrid vehicle due to battery and other components. The average speed of gasoline and hybrid vehicles is comparative. In similar manner idle time, moving time and total time are very similar in gasoline and hybrid mode. At first, tremendous savings in fuel is observed 49.23% in hybrid mode compared to gasoline mode. However, considering electric energy supply the (0.830 (Unit-J/S)*3600(Time-S)/1000=2966kJ: Considering Coal to Home energy efficiency 0.25: hence Energy Supply = 11864 kJ. Considering CV of gasoline as 44000kJ/kg the electric energy equivalent amount of fuel comes to be 272 gm and total fuel consumption in hybrid mode comes to 520 gm. Thus, Hybrid vehicle shows 11.41 % less fuel consumption compared to gasoline vehicle. As 67 gm of fuel is saved for the lap the same amount of pollution emission is also reduced. Further, power plant emits CO_2 which is less harmful than CO and HC[2].

REFERENCES

[1] Amy Y. HU, William T. LIN, Grace P. CHEN, Chiung-Wen CHANG, and Cheng-Wei SU, "Characteristics of Emissions and Vehicular Operations of Buses in Taipei's Exclusive Bus Lanes" Proceedings of the Eastern Asia Society for Transportation Studies, 2013 ,Vol.9

[2] C. A. R. De Carvalho, And W. Q. Lamas "The Use of Hybrid Vehicles As A Proposal For Reducing CO_2 Emissions and Its Contribution to Reducing Greenhouse Gas Emissions" University of Taubate, Vol. 8, No 01, June 2009. p. 07-11

[3] Hans-Jürgen Schacht, Roland Kirchberger Franz Winkler and Stephan P. Schmidt "Range Extender for Two-Wheeler Applications" 2015

[4] K.S. Nesamani and K.P. Subramanian "Impact of Real-World Driving Characteristics On Vehicular Emissions" December 2005, UCI-ITS-WP-05-5

[5] Sanghpriya H. Kamble, Tom V. Mathew and G.K. Sharma "Development of real-world driving cycle: Case study of Pune", Central Institute of Road Transport, Pune, Department of Civil Engineering, Indian Institute of Technology Bombay, Powai, Mumbai, Maharashtra 400 076, India.

[6] Sanjeev Sinha And Ravindra Kumar "Driving Cycle Pattern For Cars In Medium Sized City Of India", Proceedings Of The Eastern Asia Society For Transportation Studies, Vol.9, 2013

[7] Sudhir Gupte "Experimental Analysis and Feasibility Study Of 1400 CC Diesel Engine Car Converted Into Hybrid Electric Vehicle By Using BLDC Hub Motors, 4th International Conference on Advances in Energy Research 2013, Energy Procedia 54 (2014) 177 – 184

[8] Tony Markel and Andrew Simpson "Cost-Benefit Analysis of Plug-In Hybrid Electric Vehicle Technology "NREL/JA-540-40969, WEVA-2006-053

Ravi Soni pis PG student of IC Engine and automobile engineering. He is pursuing research in the field of Hybrid vehicle. He is a student member of SAE India.

Nityam Oza is an Assistant professor. Currently he is pursuing PhD in the field of Automobile Engineering. He has pursued his ME in Mechanical-Automobile Engineering from Government Engineering college, Bhuj. He has pursued BE-mechanical from Nirma Institute of Technology. He has published and presented more than 17 papers in International Journals, in National journals and National Conferences. He has supervised 10 ME dissertation thesis. He has carried out research work in the area of Alternate fuels and and regenerative braking. At present he is a life member of ISTE and member of SAE.