DESIGN AND DEVELOPMENT OF HYBRID ELECTRIC TWO-WHEELER SUITABLE FOR INDIAN ROAD CONDITIONS

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Abstract: The concern over the environment with respect to pollution, conservation of fuel resources in the world, the automotive industry has entered into a new dimension in production of more fuel efficient, low emission vehicles and new technologies. One of the greatest innovations is Hybrid Electric Vehicle (HEV). The hybrid electric vehicle consists of two or more energy sources for total propulsion of the vehicle. In this paper, two independent propulsions, ICE and electric motor are independently operated for combined effort derivation in total propulsion of the vehicle. The Combined effort of ICE and Electric motor in propelling the vehicle more suitable for country like India is being analyzed in this paper. The ICE will be active in initial pickup and electric motor acts as supportive propulsion deriver. The test area chosen is Mysore City, India in deriving the driving cycle.

Keywords: Hybrid Electric Vehicle, Two Wheeler Hybrid Vehicle, Hybrid Electric Scooter.

I. INTRODUCTION

The invention of internal combustion engine is one of the greatest inventions of mankind. The conventional vehicles with ICE provide a good performance and long operating range. However they have caused and continue to cause serious problems for poor fuel economy, environment pollution and human life. Reducing fuel consumption and emissions is one of the most important goals of modern design. The hybridization of a convectional combustion engine vehicle with an advanced electric motor drive may greatly enhance the overall efficiency and achieve higher fuel with reduced emissions. Considering the urban status in India, a well organized and fuel efficient scooter has to be designed and developed.

II. HYBRID ELECTRIC VEHICLE AT A GLANCE

HEV are the vehicles with more than two energy sources are present. The major challenges for HEV design are managing multiple energy source, highly dependent on driving cycles, battery sizing and battery management. HEV□s take the advantages of electric drive to compensate the inherent weakness of ICE, namely avoiding the idling for increasing the fuel efficiency and reduce emission during starting and speeding operations, to use regenerative braking instead of mechanical braking during deceleration and down slope driving.

HEV can meet customer□s need and has added value but cost is the major issue. These vehicles are of high cost and certain program should be supported by the specific government for marketing HEVs.

The HEVs are classified into two basic kinds- series and parallel. Recently with introduction of some HEVs offering the features of both series and parallel hybrids, the classification has been extended to three kinds- series, parallel and series-parallel. It is interesting to note that some newly introduced HEVs cannot be classified into these three kinds. Hereby final classification involves series, parallel, series-parallel, complex hybrid.

III. DEVELOPMENT OF DRIVING CYCLE

The first step in developing a driving cycle is to measure and record real driving behaviors. The obtained data has to be analyzed in forming a representative cycle from real conditions. The obtained data is classified in different sections based on traffic conditions.

IV. SPEED CONDITION AND RECORDING METHODS

The initial need for this work is to measure and record the vehicle speed. The measurement of speed is divided into two groups

1. Using the equipment provided in the vehicle like speedometer.
2. Usage of some additional equipment like GPS system.

V. CLASSIFICATION OF TRAFFIC CONDITIONS

The traffic condition varies with respect to different parts of the city. In classifying the traffic conditions the parameters used to be the average speed and percentage of idle time for each of the trip. The four traffic conditions based on the above criteria are as follows

1. Congested urban conditions: An average speed of 8kmph to 10kmph with low to high idle time.
2. Urban conditions: An average speed of 10kmph to 25kmph with moderate to low idle time.

3. Extra urban conditions: An average speed of 40kmph with low idle time.
4. Highways: An average speed more than 40kmph with very low idle time.

VI. ANYALYSIS OF THE RECORDED DATA

As the primary need for this work is to record the data, the method of recording the speed is done through dynamometer provided in the vehicle. The test vehicle is driven in stock condition through the given test route of Mysore city, India. The propulsion is only through ICE running on petrol fuel. The route chosen in the test area is as shown in the Figure.1.

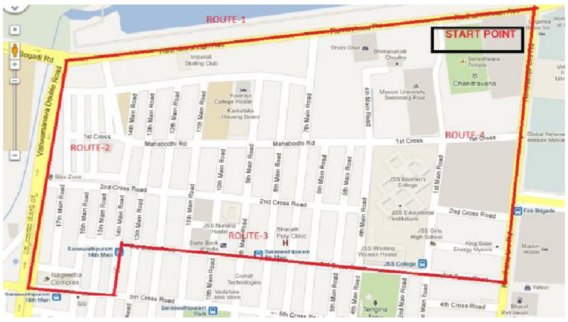


Figure1- Driving Route chosen in the test area (Ref.: GOOGLE MAPS)

The following data are recorded by making the vehicle to travel in the selected route in anticlockwise direction from start point marked on the map. The recorded data is as given in table-1.

The total distance covered in this trip is 3Km. The time taken for covering this distance is 272 seconds under moderate traffic condition. The speed-time curve is plotted for the above readings. The obtained speed-time curve is analyzed as quadrilateral type as

ROUTE	SPEED (KMPH)	DISTANCE (KM)
ROUTE-1	50	1
ROUTE-2	50	0.5
ROUTE-3	30	0.95
ROUTE-4	40	0.55

shown in Figure.2

Table-1

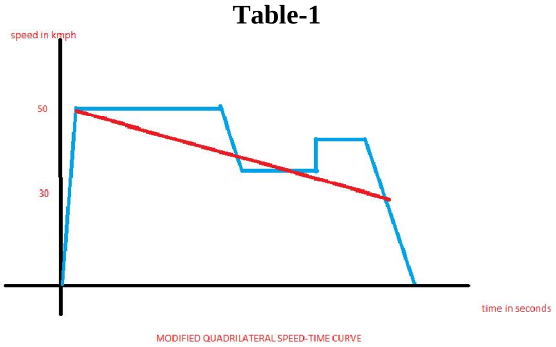


Figure.2-Quadrilateral Speed-Time Curve

The parameters obtained from the curve is as follows in table-2

Table-2

Maximum speed attained at the end of acceleration period	50kmph
Speed at the starting of braking retardation	30kmph
Starting acceleration	6.25kmphps
Braking retardation	7.5kmphps
Coasting retardation	0.07kmphps
Total time of run	280 seconds
Total distance	3km
Average speed	38.5km
Per liter test vehicle mileage	35km (considering the road gradients)

From the obtained average speed, it can be concluded that, the selected test area comes under the category of Extra Urban traffic conditions.

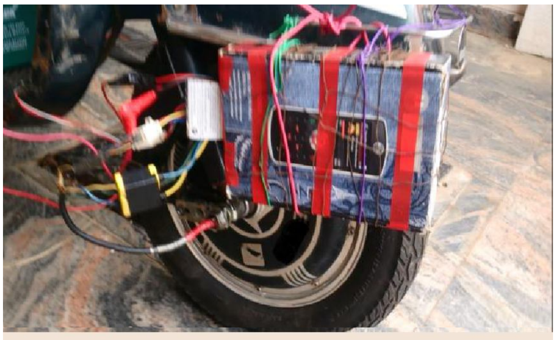
Table-3 shows the comparison between different cycles based on statistical parameters. It can be concluded that the obtained values of the current cycle are much superior compared to other in terms of acceleration, average speed and maximum speed.

Table-3

Cycle	Avg. Speed (km/h)	Max. Speed (km/h)	Run. Speed[1] (km/h)	Stop freq. (%)	Avg. Accel. (m/s^2)	Max. Accel. (m/s^2)
DTD4SK	15.42	55	20.56	24.983	1,22	2.83
ECE-15 (UDC)	18.7	50	27.7	26.1	0.75	1.04
FTP-75	25.78	91.2	39	37.95	0.51	1.50
MODE 10-15	22.72	70	33.107	31.375	0.57	0.79
Urb. ARTEMIS	17.68	57.7	23.02	26.7	0.77	2.36

VII. DESIGN AND DEVELOPMENT OF ELECTRIC SCOOTER

The design concept is developed for driving a scooter with individual wheels of the vehicle separately propelled with different sources. The rear wheel will be coupled to the vehicle as in before driven by ICE, whereas the front wheel is replaced with an electric motor in-wheel drive driven by five DC batteries. The chosen test vehicle for the analysis purpose is Kinetic Honda Y2K, made, two-stroke, continuously variable transmission, more suitable for testing purpose. For analysis, the mechanical arrangements with respect to suspension in the front wheel are being altered as per the required design for holding the motor wheel.



The controller for the motor is being interfaced with the motor speed regulation. The speed controlling throttle is being interfaced through the motor controller circuit. The motor used here is 48V, 250W, Ampere made hub motor. The controller for the motor is also Ampere made suitable for controlling the specified motor. The throttle is an ampere made throttle for speed regulation of the specified motor.

The input to the motor is supplied by five Exide made Electra lead-acid batteries each of 12V, 20Ah through controller for testing purpose. Two independent propelling sources are being employed for obtaining total propulsion of the vehicle.

VIII. ANALYSIS OF THE DESIGN

The hardware model is developed for the testing purpose as displayed below.

The designed test vehicle is analyzed in the test area route. The area considered for stock vehicle analysis in deriving the above driving cycle is the same route chosen for analyzing the design. The vehicle is driven in the test area with both ICE and motor in running condition for propelling the vehicle. The observed parameters are given below in table 4. The driving cycle analysis remains the same as describe earlier in this paper.

Table-4

Maximum speed attained at the end of acceleration period	40kmph
Total time of run	350
Total distance	3km
Average speed	30kmph
Per liter test vehicle mileage	52-55kmph (considering the road gradients)

DISCUSSION AND CONCLUSION

It is observed that, the ICE in this built hybrid electric vehicle is utilized for obtaining the propulsion of the vehicle from the rest, as the speed is increased; the electric motor propulsion is combined with the ICE propulsion for total movement of the vehicle. The total torque obtained by both ICE and electric motor are synchronized for respective road gradient by varying suitably the respective controllers utilized. By doing torque distribution accordingly, battery life per total charge can be enhanced in driving the electric motor also minimizing the fuel required for ICE propulsion. For the test route chosen, the vehicle in stock condition, eligible for giving a mileage of 35km (as observed in stock driving), With this type of arrangement, can enhance the mileage performance efficiently by 25%. The throttle with respect to ICE was moderately involved in obtaining the propulsion during the test run. The throttle involved in driving the electric motor was mutually made involved with respect to ICE throttle. Both motor torque and ICE torque were responsible in propelling the vehicle during the test run. The torque distribution between ICE and electric motor has to be enhanced by designing a suitable torque synchronizer. The short battery life issue related to present electric bikes can be solved implementing this technology. Also low-emission, electric / ICE mode of operations can be further enhanced in this project. The motor

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