ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

A Novel Idea of Replacing IC Engine of a Conventional Vehicle with PWM Controlled BLDC Motor

Basil Varghese[1] , Sreeveena K S[2] , Stefi Jomi[3] , Rakhi Rajesh[4] , Rini Varghese P[5] , Arun Eldho Alias[6]

UG Students, Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India[1,2,3,4]

Assistant Professor, Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India[5,6],

ABSTRACT: India is facing a major problem in the dependency on foreign fuels. The fuel price is escalating day by day making it hard for the common men to afford. With the growth of population and urbanization, the demand for transportation and alternative energies are rising. This indicates that the advancement in transportation and effective use of energy will be the intermediate challenges we have to overcome. This system focuses on the replacement of IC engine of a conventional vehicle to a BLDC motor drive controlled vehicle with high torque and efficiency.

KEYWORDS: BLDC Motor

I.INTRODUCTION

Air pollution is one of the greatest threats in the world right now, and in a country like India with a population of almost a 130 million (17% of world's population), it is already getting difficult to breathe in most of the metropolitan cities. The main cause of this exponential increase in the pollution levels is the fuel-thirsty vehicles. In India, transportation sector emits an estimated 261 tones of CO2, of which 94.5% is contributed by road transport. Here comes the need of electric vehicles. More than four million internal combustion engine vehicles were sold in India in 2017. Therefore the entire vehicles cannot be replaced by electric Era in a go, which may lead to other problem of automobile waste. This came to the idea of replacing the internal combustion engine of the conventional vehicle by an electric motor, in other words retrofitting**.** This system mainly focus on the BLDC motor for driving the vehicle, since it provides high torque, high efficiency, less noise and easy speed control.

BLDC motors are simple in their design and durable. The motor is then controlled by a motor controller. The motor detects the position using a hall sensor. The BLDC motors are electronically commutated.

II.ECONOMIC ASPECTS OF RETROFITTING

In automobile engineering, electric vehicle conversion is the replacement of a vehicles' combustion engine and connected components with an electric motor and batteries, to create an all-electric vehicle. Another option is to replace a large combustion engine with an electric motor (for power) and a small combustion engine (for speed), creating a hybrid electric vehicle or a plug-in hybrid electric vehicle.

The new electric vehicle normal model cost around 20,00,000/-. The retrofitting vehicle in same aspects of normal vehicle, the cost is around 5,00,000/-. Conventional vehicle have high running and maintenance cost around 6/- per kilometer. For retrofitted EVs the running cost is around 1/- per kilometer. The retrofitted vehicle is charging through Solar is majority. Commercially-manufactured electric vehicles are inhibited by the limited range per charge of batteries (up to 560 km, 350 miles), battery charge times that are slower than gasoline filling times, apparent greater initial cost over combustion engines, and potentially high service costs for used or worn-out batteries.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

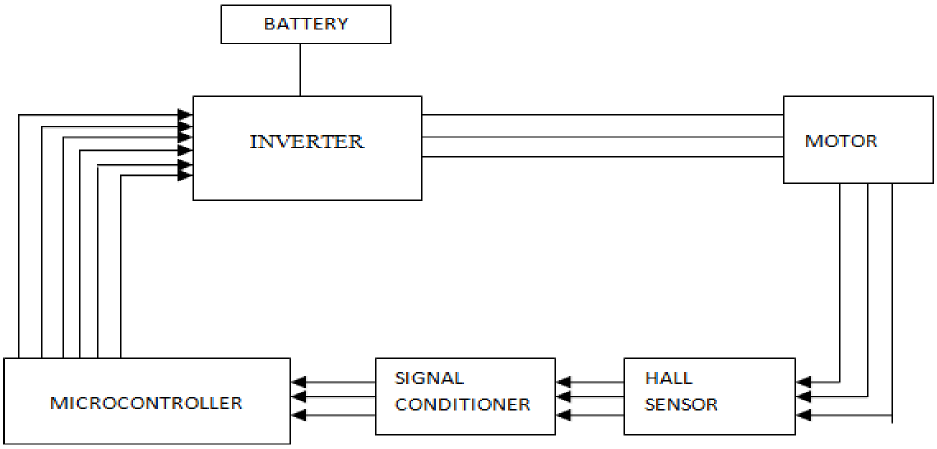
International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

III.BLOCK DIAGRAM



It consists of a three phase inverter, position sensors, signal conditioner and a digital controller. The inverter along with the position sensor arrangement is functionally analogous to the commutator of a dc motor. The commutation of a BLDC motor is controlled electronically. The stator windings should be energized in a sequence in order to rotate the motor. Rotor position should be known in order to switch the winding in sequence. The BDLC motor detects the position of the rotor using Hall sensors. The torque and speed of motors is managed by microcontroller. A sufficient amount of processing power is required to solve the algorithms needed to generate Pulse Width Modulated (PWM) outputs for motor.

IV. SELECTION OF POWER RATING OF MOTOR

The vehicle selected for the retrofitting is Maruti Esteem. The vehicle has got a kerb weight of 850 kg and engine is of 1298cc and produces a torque of 110Nm @ 4500 rpm. The system makes use of BLDC motor for driving the vehicle at required torque. The power rating of the motor to drive the vehicle at required speed and at a gradation on 30° is as given. When selecting drive motor for the electric vehicle, a number of factors must be taken into account to determine the maximum torque required. These factors are:

1. Rolling resistance

2. Grade resistance

3. Acceleration force.

Step 1: Calculation of the rolling resistance

Rolling resistance is the opposing force that the vehicle has to overcome due to the rolling motion between the vehicle wheel and the surface of the motion of the vehicle. It is mainly caused by non elastic effects that is, not all the energy needed for deformation of the wheel, roadbed, etc, is recovered when the pressure is removed.

Rolling resistance = Gross vehicle weight* coefficient of rolling friction ……... [1]

Frictional force = Cos (30°)*(Coefficient of friction of wheel bearings + rolling friction coefficient)* Vehicle weight * 9.81 N ……… [2]

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

Step 2: Calculation of grading resistance:

Grading resistance is the force that pulls the vehicle back when climbing a inclined surface. Grading resistance is added when a vehicle climb an inclined surface.

Grading resistance = Gross weight of vehicle *sin θ * 9.81 N ……… [3]

Step 3: Calculation of accelerating force:

It is the force that helps the vehicle to reach predefined speed from rest in specific period of time. The time should be between 10- 15secs to attain the speed of 0100kmph for an efficient vehicle.

Accelerating force =Mass of vehicle * acceleration Mass of vehicle

= Gross vehicle weight / gravitational constant ……… [4]

Step 4: Calculation of total tractive effort [TTE] :

The total tractive force is the sum of all the forces affecting the performance of vehicle

Total tractive effort = Acceleration resistance + Grading resistance + Rolling resistance ………. [5]

Step 5: Calculation of power required

Speed = 10km/h = 10000 meter /hour

=10000/(60*60) meter/sec

= 2.7 meter/ sec. ……… [6]

Total power required = TTE * speed

From equation [5] and [6] we get,

Total power required = TTE * 2.7 m/s

Step 6 : Torque to drive the vehicle:

Maximum torque τ = friction factor * TTE * radius of wheel ……. [7]

The gross weight of the vehicle is about 950kg, it is assumed to have a gradation of 30°. Therefore we get a rolling resistance about 161.418N from equation [1]. Assuming the coefficient of rolling friction to be 0.01, from equation [2] we get grading resistance about 4659.75N. Hence from equation [6] we get the power required to overcome the resistances as 13.1 KW. A ‘10 kW motor’ is recommended, considering practical scenario. And also the gear box will help to achieve the balance required torque at peak loads.

V.SPECIFICATION OF CONTROLLER

Kelly’s programmable motor controllers provide efficient, smooth and quiet controls for small and midsize electric vehicles, such as golf carts, go-carts, stacking cars, forklifts, hybrid vehicles and electric boats, as well as industrial motor speed control. It uses high power MOSFET’s and SVPWM and FOC technology to achieve efficiencies of up to

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

99%. A powerful microprocessor brings in comprehensive and precise control to the control. The operating frequency of about 10 KHz and has a standard battery current greater than 0.5mA. The maximum output frequency can reach up to 250 Hz with a maximum operating range varying between 18V to 1.25 times the nominal voltage.

VI. RESULT AND DISCUSSION

By considering the weight and required driving torque the system used a 10 KW, 3000rpm,72 V BLDC motor. The battery used was 72V, 130Ah lead acid battery that is by using six cells of 12V 130Ah with plug in charging method. A battery management system was also involved in order to protect the battery from over voltage and thermal protection. The motor provided a rated torque of 31.9 Nm @ 1800 rpm . The motor is coupled with a gear box of gear ratio 1:3.

VII. CONCLUSION AND FUTURE SCOPE

With steady escalation in oil prices, the future scope for electric vehicles is bright. Plummeting battery prices, long-range models, and more number of charging stations are driving forward the electric vehicle sales. And with the industry investing billions to meet strong pollution standards globally, the oil industry has good reason to be nervous. Ban of conventional Vehicles from 2040 will lead to increases in demand of electric vehicles. At that situation the only way is to retrofit the existing Vehicles to electric vehicles with a small amount of capital cost protecting the economy and environment.

The final output was a zero-emissive car below 1300cc.The electric car is more efficient than the conventional ICE cars. Cost per kilometre is only 0.5/- rupees whereas for IC engine esteem is 5.47/- rupees .The engine and other accessories are replaced with the retrofitting kits designed for the vehicle. The weight saved by removal of engine can be used to add more batteries, improving range. EVs reduces carbon emissions and reduces air pollution. The future of EVs is bright as there are sufficient Lithium reserves to power 4 billion electric cars.

REFERENCES

[1] Alireza Tashakori Abkenar, "*BLDC Motor Drive Controller for Electric Vehicles*", pp.7-31, 2015

[2] Saurabh Chauhan "*Motor Torque Calculations For Electric Vehicle*", International Journal of Scientific & Technology Research ,Vol. 4, issue 08, August 2015

[3] B. Balasubramanian, "*Development and Analysis of an Electric Vehicle Controller for LCV*", SAE Int. J. Commer. Veh, vol. 8, no. 1, pp. 244-251, 2015.

[4] Derrick Zechmair, Kurt Steidl "*Why the Induction Motor could be the better choice for your electric vehicle program*", World Electric Vehicle Journal,2012 Vol. 5, pp.0546

[5] B.W. Zhou, T. Littler, H.F. Wang, "*The impact of vehicle-to-grid on electric power systems: a review*" , 2nd IET Renewable Power Generation Conference (RPG 2013),pp.1-4(2013).

[6] V. Rattankumar, N.P.Gopinath, " *Solar Powered Car using Brushless DC Hub Motor With Advanced PIC Micro controller*", 2012 International Conference on Emerging Trends in Electrical Engineering and Energy Management (ICETEEEM), pp. 422 - 423, IEEE(2012).

[7] T.Porselvi1 , Sriharihar an .M. K "*Selection of Power Rating of an Electric Motor for Electric Vehicles*"

[8] Y Mastanamma 1 , Dr M Aruna Bharathi " *Electric Vehicle Mathematical Modelling and Simulation Using MATLAB-Simulink*" IOSR Journal of Electrical and Electronics Engineering Volume 12, Issue 4, PP 47-53

[9] M.Ehsani ,K m rahman ,H A Toliyat "*Propulsion system design of Electric and Hybrid vehicles*", IEEE Trans. Industry Electronics, Vol. 44, pp.19-27, Feb 1997.

[10] Hx.Wu. et al "*A control of Brushless DC Motor for Electric vehicle*",IEEE transaction on Magnetics, Vol. 41, pp.507-513, 2005