International Journal for Innovative
Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

DOI: 10.48047/IJIEMR/V11/ISSUE 09/02

Title **SIMULATION OF ELECTRIC VEHICLE WITH FTP75 DRIVE CYCLE**

Volume 11, ISSUE 09, Pages: 16-22

Paper Authors

Satyavarapu Akash, Mandula Varun Kumar ,Dr. J.S.V.Siva Kumar

International Journal for Innovative Engineering and Management Research
A Peer Revieved Open Access International Journal
www.ijiemr.org

SIMULATION OF ELECTRIC VEHICLE WITH FTP75 DRIVE CYCLE

Satyavarapu Akash, Student GMRIT , **Mandula Varun Kumar**, Student GMRIT,

Dr. J.S.V.Siva Kumar, Assistant Professor, GMRIT

ABSTRACT:

Transportation through electric vehicles is a better approach to reduce the adverse impact on the environment. But it is a tough challenge to the researchers to design and develop a proper architecture of an electric vehicle as it includes many aspects like BMS, motor control, power control etc. Even though there are many electric vehicle designs in the market, each of them has few drawbacks in some aspects. Even though there are many negative impacts, there is huge need of electric vehicles in future as there is a rapid increase rate of fossil fuel depletion. This paper describes one of the better designs of an Electric Vehicle (EV) in detail. The model is built with an input of FTP75 drive cycle with 80Ah battery capacity. The model is built in MATLAB/SIMULINK and simulated for the results.

1. INTRODUCTION:

The history of electric vehicles (EVs) dates back to the turn of the century. Even up until 1918, when the market suddenly dried up, they were still fairly successful[1,2]. However, once the internal combustion engine (ICE) fuelled by gasoline became more reliable, people stopped using EVs for transportation. Due to being inferior in speed and cost to internal combustion engine (ICE) vehicles, the number of EVs had dropped to almost nothing by 1933. The EV's deficiencies, which led to it losing its early competitive edge, have not been fully resolved. In order to create electric vehicle (EV) powertrains with performance on par with that of internal combustion engine (ICE) powertrains, significant advancements in power electronics & microelectronics have been leveraged[3,4]. No comparable developments have occurred in battery energy storage; but, the development of materials and manufacturing technology has made it possible to realise the ambitious targets set for battery systems. Energy cost, energy independence, & environmental preservation are major drivers of the resurgence of EVs. People are beginning to see EVs as a viable mobility option as a result of the impending gasoline product crisis due to their high price and limited availability[5,6]. Electric vehicles (EVs) have unparalleled fuel versatility due to the wide variety of renewable energy sources from which electricity may be produced. In addition, they are typically recharged during times of surplus energy supply by power utilities. The realisation that electricity is preferable than gasoline from an ecological standpoint is largely responsible for the recent surge in interest in EVs. In dense urban locations, electric vehicles can significantly cut down on harmful emissions. The EV generates no emissions while operation, making it ideal for usage in urban stop-and-go traffic. Therefore, electric vehicles are in line with the national energy strategy's goal of achieving a safe, efficient, and ecologically responsible energy future. Some cities have implemented emission-free zones and stricter emissions laws to promote EVs in response to rising public concern about air quality and the potential implications of the greenhouse effect. The California Air Resources Board created the 2% Zero Emission Vehicle (ZEV) sales quota in 1998 and the 10% ZEV sales quota in 2003 in October 1990. That's why you see such a marked shift at the big automakers from R&D to production[7]. The 1990s saw a dramatic change in the outlook for electric vehicles, with major automakers launching aggressive programmes to develop electric vehicles for commercialization, power utilities launching infrastructure programmes for EVs, and intensive electric vehicle R&D conducted by government agencies, academic institutions, and related industries. Building EVs from the ground up is a distinguishing aspect of modern EVs like the GM Impact, Nissan FEV, BMW i3, and others. Despite using modern components, modified EVs still fall short of the performance of factory-built models. These distinctions originate mostly from inherent systemic disparities in optimization, as well as in body mass and physical appearance. In order to compete with their internal combustion engine (ICE) equivalents[3,5], electric vehicles (EVs) will need to offer comparable range, performance, personal comfort, safety, and trouble-free operation at an affordable price. Batteries, drives, controllers, DC motors, vehicle bodies, and transmissions are the six fundamental building parts of an electric vehicle. In this case, the input data is the driver's real drive cycle[6]. The introduction of the FTP75 driving cycle allows the designed vehicle to provide feedback on how it handles the drive cycle. The primary goals of electric vehicle (EV) design are data collection (driver speed, estimated SOC, travelled distance). The battery's remaining charge can be estimated with the help of the SOC block, and travel time and distance can be determined from those two variables.

2. WORKING OF THE SYSTEM:

At first, the DC-DC power converter transfers energy from the battery to the dc motor. The necessary voltage will be adjusted automatically by the controller. In order to get the power from the motor to the wheels of a vehicle, the controller will use the drive cycle reference to determine how many revolutions per minute (rpm) the motor should be running at. The controller will also include in the vehicle's top speed and compeer into their calculations.

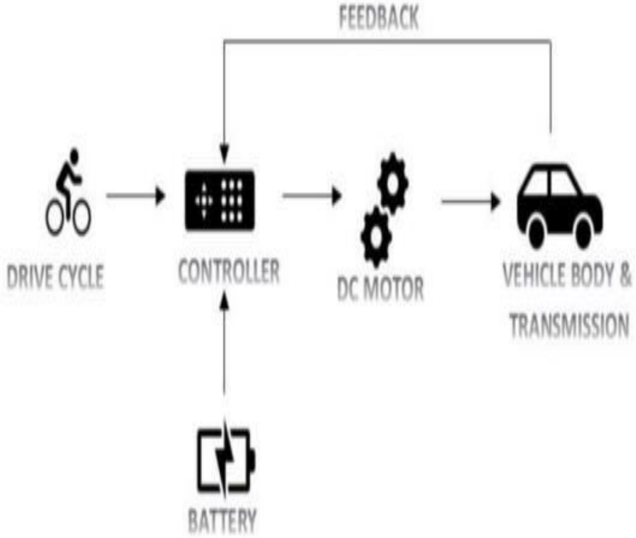

Fig-1: Schematic block diagram of Electric Vehicle

3. SIMULATION MODEL OF ELECTRIC VEHICLE:

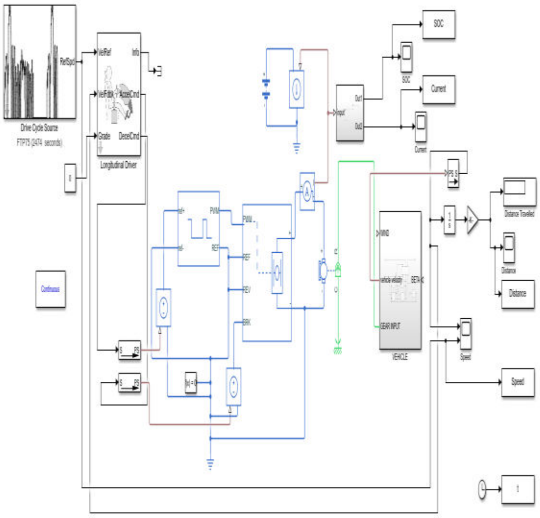

Fig-2: Simulation diagram of Proposed Electric vehicle

3.1. Controlled PWM Voltage Source:

This building block generates a Pulse-Width-Modulation (PWM) voltage between its PWM and REF terminals. Whenever the pulse is weak, the output voltage is zero, and whenever it is strong, it is equal to the amplitude parameter of the output voltage. The input value controls the duty cycle. To toggle between the electrical +ref/-ref ports & PS input u for setting the input value, right-click the block and select simscape block options.

A high-intensity pulse is generated at zero unless the duty cycle is also zero or even the pulse time delay is greater than zero.

There are two options for the simulation mode: PWM and Averaged. When the mode is set to PWM, a PWM signal is generated as the final output. With the Averaged setting, the output is always set to the mean value of the pulse width modulation (PWM) signal.

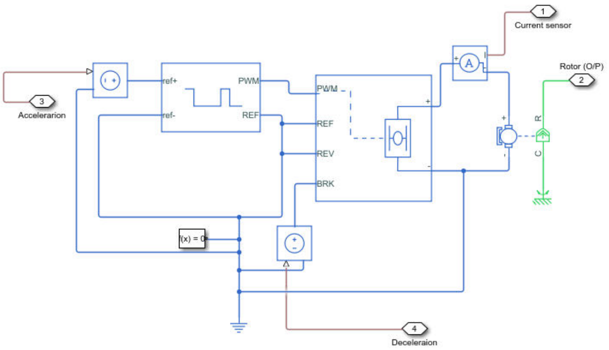

Fig-3: Simulation diagram of DC motor and control system

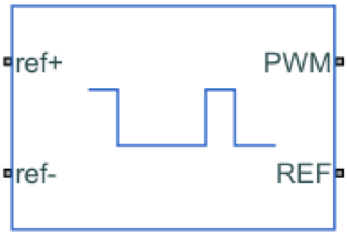

Fig-4: Controlled PWM Voltage

3.2. Power Converter:

Figure-5 represents the H-Bridge motor drive. The PWM voltage control block can operate in either PWM or Averages mode, allowing for flexible block operation. If the voltage at the PWM port is greater than the enable threshold voltage, then the motor is powered. The on-time relative to the PWM period is specified by dividing the PWM port voltage by the PWM signal amplitude parameter in averaged mode. The block provides an average voltage to the load based on this ratio and other assumptions about the load, ensuring that the average load current is correct. The Controlled PWM voltage block and the H-

Bridge block require the same parameter value for the simulation mode.

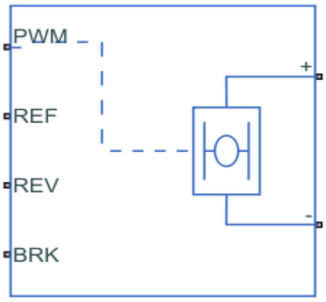

Fig-5: H-Bridge

When the voltage at the REV port is higher than the reverse threshold voltage, the output voltage flips polarity. One bridge arm in series with the parallel combination of a second bridge arm as well as a freewheeling diode short circuited the output terminals if the voltage at the BRK port is greater than the braking threshold voltage. The PWM, Rev, and BRK ports all have their voltages defined in relation to the REF port.

3.3. Drive Controller:

Parametric longitudinal speed tracking controller that uses reference and feedback velocities to provide controller-normalized accelerating and braking commands. To prevent the determined closed-loop orders from being executed automatically, temporarily suspended, or overridden, use the external actions to input signals. The order of these priorities is what the block utilizes for its input commands: turn off, pause, and bypass. The longitudinal driver, which is linked to the driving cycle, features six inputs for varying speeds: reference velocity, feedback velocity, grade, information, acceleration, and deceleration. The driving cycle data provides VelRef, while the motor output provides VelFdbk. In comparison, the motor controller will receive an acceleration or deceleration signal. The regenerative braking is generated by connecting the acceleration command to the PWM generating block and the deceleration command to the regenerative port of the H-Bridge. Any further information can be obtained by inputting info into a longitudinal driver block. To provide the driver block with information about gradeability, use the grade. The driver cycle block uses this information to generate the current state of the vehicle's driver.

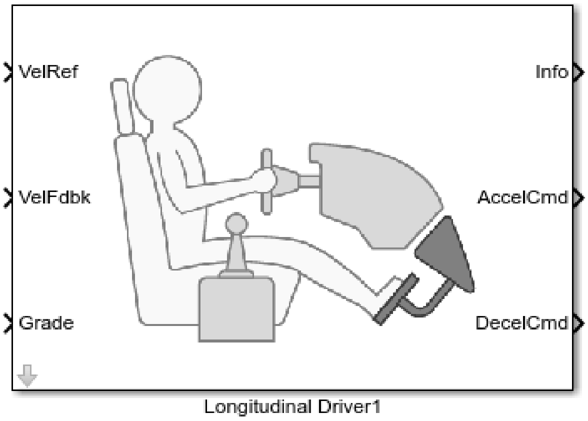

Fig-6: Simulation block of Longitudinal Driver

3.4. Battery

The controller & motor cannot function without the battery's electricity. The maximum speed is achieved through the controller drawing power from the battery in accordance with the input from the motor. All of the automobile's electrical components get their juice from the battery. There are two stages of battery life: charging and draining. In this configuration, an 80AH battery is employed.

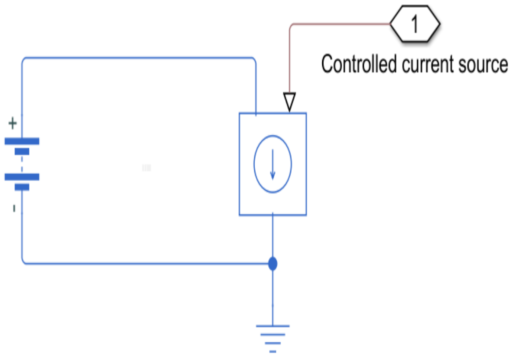

Fig-7: Simulation diagram of Battery system

3.5. Vehicle body and transmission:

The motor's rotational output is fed into the vehicle's frame and transmission. The gear system here absorbs the rotational output to keep the transmission speed stable from the motor to the tires.

The transmission in this model is front-wheel drive. The front wheels' axels receive the gear's output; the circuit depicts the gear's connection to the wheels' axels and the wheels' connection to the vehicle's propulsion system. Tire-generated normal force (represented by N) is sent through the normal force port located on the vehicle's body. H-Hub, S-Tire Slip, N-Normal Force, Axle Connection, V-Velocity, Inclination Angle, and Inclination are all parts of the vehicle's chassis. The hub of each tire is linked to the vehicle's chassis through a central axis. We may customize the wind speed and direction by connecting the vehicle's body to a constant block and the beta-inclination angle to a second constant block, respectively. How fast the car is going can be read off the vehicle's velocity output port. By subtracting the velocity from the position and charge, we can determine the distance travelled.

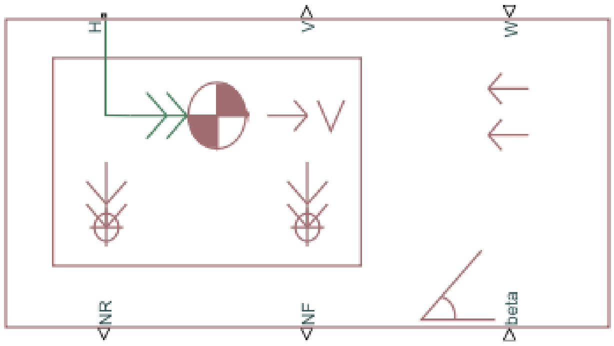

Fig-7: Simulation block of Vehicle body

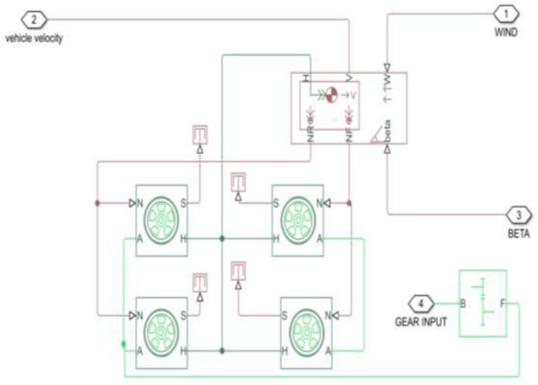

Fig-8: Simulation of Vehicle body and Transmission

3.6. State of Charge (SoC):

An electric vehicle's battery's "state of charge" (SoC) is the percentage / level to which it has depleted over the course of a given amount of time or distance driven. The designed system for determining the state of charge of a vehicle's battery involves passing the value through a rate transition, a gain where 1/(nominal battery capacity), and finally a discrete-time integrator, where the value is subtracted from 1 because 100% is assumed to be battery and then multiplied by 100 to determine the percentage of battery that is actually present.

Simscape bricks make up the bulk of the system, and a physical - Simulink converter is utilised to get the physical signal from the blocks into Simulink.

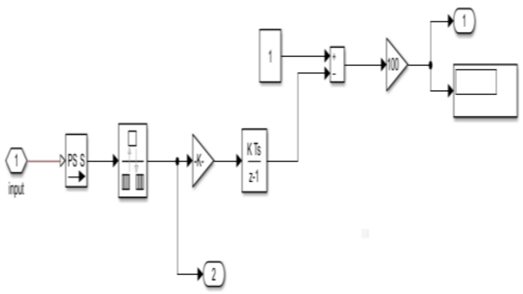

Fig-9: Simulation diagram of SoC

4. RESULTS AND DISCUSSION

The proposed Electric vehicle is designed in MATLAB and simulated by setting the time of 2474 seconds. The results for the design is shown below.

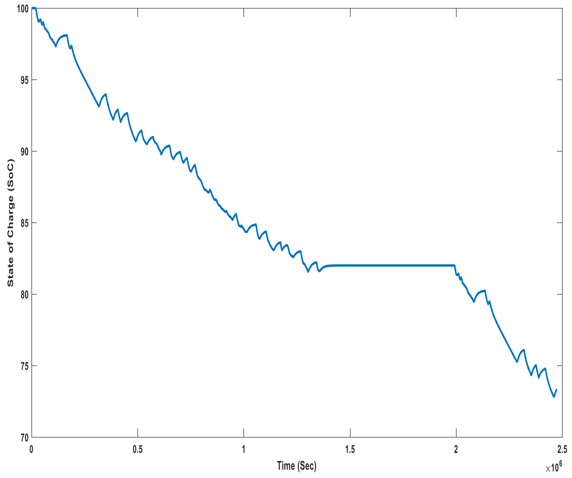

Fig-10: SoC of Battery

The above graph displays the vehicle's State of Charge, which indicates how much battery life is left. The SoC of the battery is 73.35%.

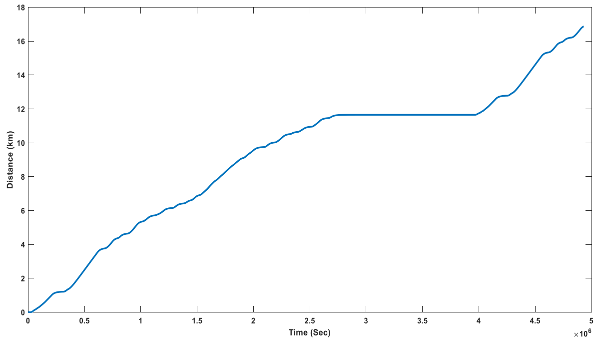

Fig-11: Total distance travelled

The proposed design of Electric Vehicle for a given input of FTP75 drive cycle with the battery of capacity 80Ah is able to cover 17.77km distance.

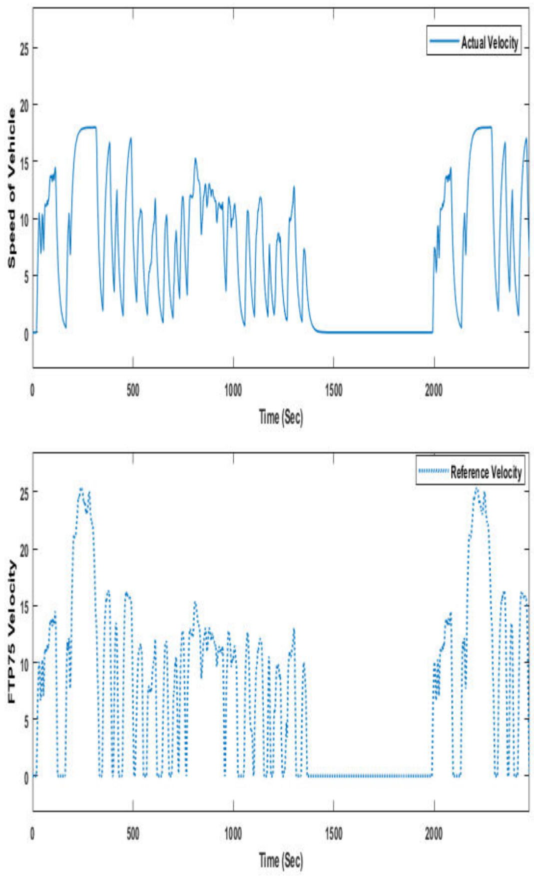

Fig-12: Speed travelled

5. CONCLUSION:

The basic need of EV in now-a-days and the design of proposed EV is described briefly. The design of main sections of the

Electric Vehicle is described. There are many input drive cycles which can be given as input to the vehicle. But this EV is given input of FTP75 drive cycle and a battery of capacity 80Ah. After simulating for 2474 seconds the results are as follows.

- Initially the SoC of the battery is taken at 100%. But the SoC of the battery left with 73.35% after simulation or the vehicle runs for 2474 seconds. This was represented in Fig-10.
- From the Fig-11, it can be observed that the vehicle could able to travel for a distance of 17.77km in 2474 seconds for given inputs.
- Fig-12 represents the vehicle speed performance with respect to reference speed (FTP75 velocity). It can be concluded that the vehicle has attained its maximum speed and there is a delay in the acceleration and deceleration.

6. REFERENCES

1. Albatayneh, A.; Assaf, M.N.; Alterman, D.; Jaradat, M. Comparison of the Overall Energy Efficiency for Internal Combustion Engine Vehicles and Electric Vehicles. Environ. Clim. Technol. 2020, 24, 669–680.
2. Berjoza, D.; Jurgena, I. Effects of change in the weight of electric vehicles on their performance characteristics. Agron. Res. 2017,15, 952–963.
3. Liu, L.; Kong, F.; Liu, X.; Peng, Y.; Wang, Q. A review on electric vehicles interacting with renewable energy in smart grid. Renew.Sustain. Energy Rev. 2015, 51, 648–661
4. Hawkins, T.R.; Gausen, O.M.; Strømman, A.H. Environmental impacts of hybrid and electric vehicles—A review. Int. J. Life Cycle Assess. 2012, 17, 997–1014.
5. Shuai, W.; Maillé, P.; Pelov, A. Charging electric vehicles in the smart city: A survey of economy-driven approaches. IEEE Trans.Intell. Transp. Syst. 2016, 17, 2089–2106
6. Das, H.; Rahman, M.; Li, S.; Tan, C. Electric vehicles standards, charging infrastructure, and impact on grid integration: A technological review. Renew. Sustain. Energy Rev. 2020, 120, 109618.
7. Electric Car Use by Country. The Electric Vehicles world Sales Database. Available online: http://www.ev-volumes.com/(accessed on 21 February 2021).