Modelling and Simulation of Battery Bank System of Electric Vehicle

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***Abstract*—Electric Vehicle is one of the emerging technology in today's world. Batteries that are mainly used are made up of lithium. A model of it can be framed by performing Simulink in MATLAB. After that taking different parameters such as the weight of the passenger for either a two-wheeler or a four-wheeler model, we can find what is the capacity of distance travelled or the amount of torque is applied to the vehicle. Nowadays, impedance vehicles are taken for this purpose. Paper works are the scientific proof of the actual performance of the model in the real world which brings clarification to the real world. After the simulation is performed, there is not much difference between the actual value and the simulated value. Thus the world is turning into a new phase of system which makes transportation of people much faster and smoother due to the introduction of Evs.**

Keywords – ***lithium battery, simulation, modelling, battery system***

I. INTRODUCTION

An electric vehicle (EV) is a physical system with mechanical, electronic and hydraulic components whose design needs coordinated modelling and simulation in multiple disciplines. At present, there are two commonly used multi-domain modelling methods. One is the Interface based method and Unified Multi-Domain Modelling Language.

Transportation has become much more convenient with the invention of Electric vehicles and Hybrid Electric vehicles. According to the report of international energy outlook report, the transportation sector is going to increase its share in the world's total oil consumption by up to 55% by 2030. That is why the introduction of Electric vehicles in this world means rapid growth in this sector. With this, pollution-free can also be introduced and there is a reduction of Carbon oxide in this world. Besides all the advantages, there are some disadvantages of an electric vehicle such as it takes high power density and high consumption of electricity which increases the cost of the system. For this, an electrostatic battery system is used. In general, Lithium battery is used for this purpose There are mainly three types of batteries, mainly the electrostatics battery, reduced equivalent circuit battery and Neural Network Model. Electrochemical models use physical laws, such as concentrated solution theory and porous electrode theory that govern the internal electrochemical processes of the battery, to describe the battery microscopic and macroscopic behaviour in detail. Now a day's another great challenge to the power grids is that they cannot supply the proper amount of charging capacity which is to be used for the charging of the electric vehicle. These requirements should be a characteristic of both parts of the system: the energy supplied by the power grid, as well as the energy consumed by the equipment connected to the grid. Besides the harmonics, other power quality problems, as inter-harmonics, noise (electromagnetic interference), momentary interruptions, sags, swells, flicker, notches, and transients can also occur. But in regards to the integration of electric mobility in a Smart Grid, the degradation of the power quality is mainly caused by the non-linear current consumption of the batteries charging systems. Here is my project, I will discuss how to simulate an Electric vehicle making a model in MATLAB and then compare the values of torque, speed and other parameters to make a good result with different weights of a passenger. The model looks like the following figure :

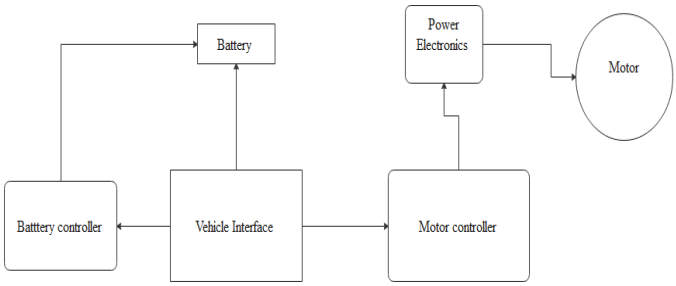

Figure-1: Electric vehicle design

II. ELECTRIC VEHICLE MODELLING

For making a model of an electric vehicle, we need some special items such as the battery, Vehicle body, Battery controller, and finally the motor which drives the vehicle body and the model. Here, we will simulate the results of torque and speed of the motor according to the weight of a different passenger in that vehicle. In making the entire model in MATLAB by using the simulation process, I first used four wheels and which are directly connected to the vehicle body. Then in addition to it, switchgear is added with the wheels. Thus the total structure is designated as Substation. After the making of the Substation, then we add the total system to the Dc motor with an additional rotational reference frame with it. After that the total system is connected to H – bridge, then it is connected to the Controlled PWM voltage.

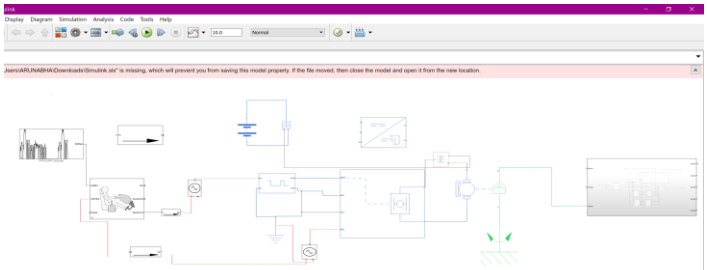

Figure-2: MATLAB model of an Electric Vehicle

The system is then connected with a battery and that battery gives the power to drive the electric vehicle. But the vehicle does not run without a driver. For that longitudinal driver is attached with this model. Finally, the model is ready for simulation.

III. SIMULATION

A. Requirements :

The main physical quantities required for this experiment are :

Cross-sectional area, Required speed, wheel size, the efficiency of the motor, rolling resistance, coefficient of drag, area of the vehicle (m^2), the density of air and dimensions of the vehicle. Here for the calculation purpose, we will take a two-wheeled vehicle for the calculation purpose.

B. What to find out :

Here we will find out the different parameters by using the above physical quantities :

1. Linear Distance Covered
2. Speed of the vehicle
3. Revolution per minute
4. Power used by the Vehicle
5. Torque of the vehicle

The above parameters are totally depending on the weight of the passenger riding on the vehicle and other quantities also.

C. Formula used:

The formulas which are used are as follows:

1. Linear Distance travelled: 2πr (r: radius of the wheel)
2. Speed = Distance covered / time taken
3. RPM (Revolution per minute) = Total distance covered per hour /Linear distance travelled.
4. Power = {(mass in kg) *(acceleration in gram)
5. *(Rolling resistance)*(velocity)} +{ (air density)*(co efficient of drag) *area *velocity^3}
6. Torque = (Efficiency *input power)/frequency

IV. CALCULATION

Let , weight = 110kg, efficiency = 85 % , wheel size = 10 inch , Radius = 6 inch = 0.152 m

Length = 1834mm , Width = 650 mm , speed = 45 kmph ;

1. **Linear Distance Travelled** :

   2πr = 2*3.14*0.152 = 0.954m

2. **Speed :**

   Speed = 45 kmph = 45000/3600 = 12.5m/s

3. **Revolution per minute** :

   RPM = total distance covered per hour / linear distance

   = 45000/(0.954*60) = 786 RPM

4. **power :**

   power =

   [(mass in kg) * (acceleration in g)*(velocity)*(rolling resistance)]+[air density *co-efficient of drag *area*velocity^3]

   = [110*9.8*12.5*0.01]+[0.6465*0.88*1.19*1953.12]

   = 134.75+1322.2 = 1457.4 watt (peak power at 12.5 m/s)

5. **Torque** :

   Efficiency = 85%

   = Pout/pin

   Pout = eff. * pin

   Torque * work = eff. * pin

   Work = (2π * RPM)/60 = (2*3.14*786)/60 = 82.26

   Now, Torque = (0.85*1457)/82.26 = 15.05 N.m

V. DATA TABLE

According to above to calculation system , we have taken some other values and make a table according to that:

Weight(Kg)	RPM	Power (Watt)	Torque(N.m)
110	786	1457.04	15.05
70	600	1471.74	19.90
60	478	1605.7	27.13
40	707	1335.9	15.30

VI. GRAPHS

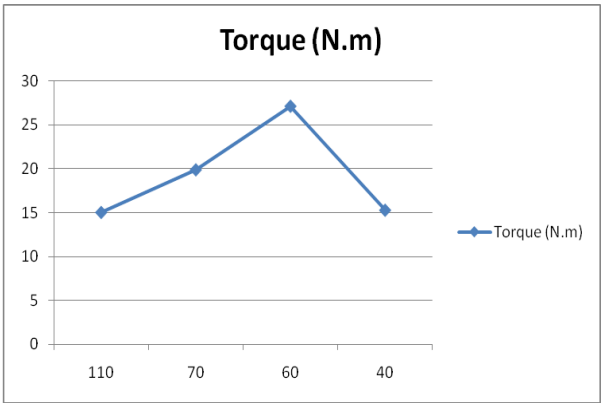

Fig : Torque(N.m) v/s Weight(kg) graph

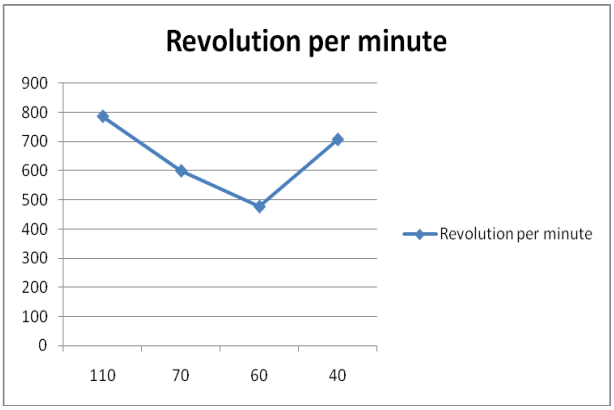

Fig : RPM v/s Weight (kg)

VII. CONCLUSION

It can be said that this domain is an emerging domain where much research is still pending. Many scientists and researchers are day by day working in this domain to make it much more innovative and better. In my paper, I used to describe the overview of simulation and modelling by using a simple EV model.

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