MAT LAB ANALYSIS AND SIMULATION OF AN EV's REGENERATIVE BRAKING SYSTEM

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Abstract

There is huge amount of KE released from a vehicle while continuous braking and moving along a busy city, that increases rate of fuel consumption. In order to utilize that kinetic energy Regenerative braking system technology is highly recommended as it can be operated with reversing electric motors which can drive a vehicle. This can work as a generator which gives back energy to the EV and help to refill a bit of scope. This little enhancement in a battery capacity can increase overall efficiency in near future with frequent use. This project shows a MATLAB simulative analysis on the working of regenerative braking system in an electric vehicle having Lithium-ion batteries, where as a result we obtained a higher output torque which can be saved and utilized further to increase fuel efficiency by 9-18% in parallel regenerative braking.

Keywords: Regenerative braking; Electrical Vehicles; lithium-ion batteries; MATLAB simulation.

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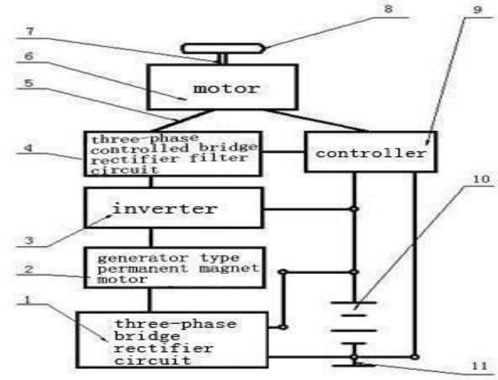
1. Introduction

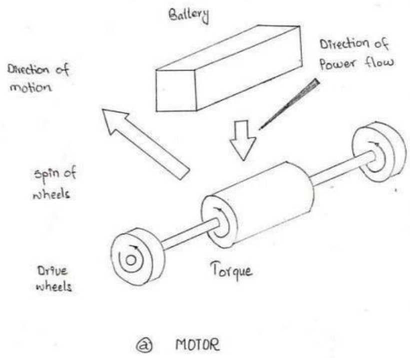
A method of breaking that uses mechanical energy of a motor by changing the KE into the electrical power and battery will receive the sent feedback. Basically, in order to charge the battery the conversion of KE is made by the regenerative braking system, by using the alternator principle.



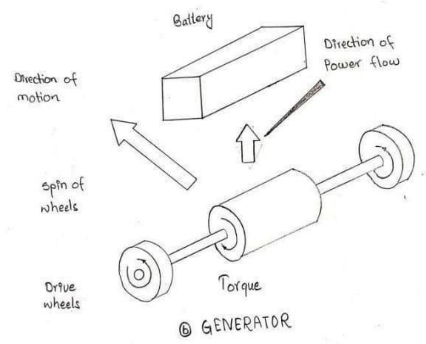
Dia.1- A simplified working diagram of energy recovery system with different components (1- Rectifier circuit bridge 3-phase; 2- PMM; 3- Inverter; 4-Controlled bridge rectifier filter circuit 3-phase; 5- 3-phase line; 6-PMM; 7-Shaft; 8- Wheel; 9-Controller; 10-Battery; 11- Negative end root)

Simulation of the Regenerative Braking System is done largely to draw a contrast in terms of the power output and energy expended to show the difference between conventional engine motors and electric vehicles.

1.1 Different driving conditions:



Dia 1.1.1- General driving condition

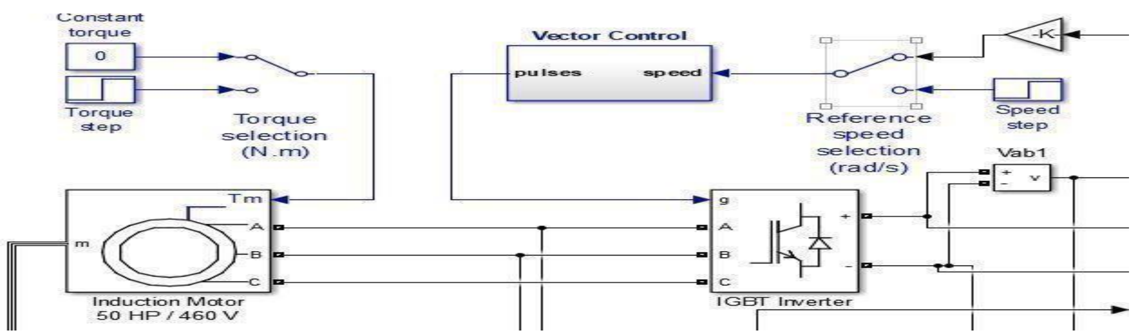


Dia 1.1.2- Condition during Regenerative braking

Regenerative braking is using a motor to decrease the speed of a vehicle during the application of brake, electric motor works in the opposite avenue thus reducing the speed of a vehicle. Battery gets recharged, when the motor acts as a generator, while moving backward as shown in dia. (1.1.1). At the same time in dia. (1.1.2) showing the vehicle in general driving condition where motor is rotating in the forward direction and getting energy from the battery. After implementation of regenerative braking, the rate of fuel consumption hugely reduced, increasing fuel economy and decreasing emission.

2. Simulation

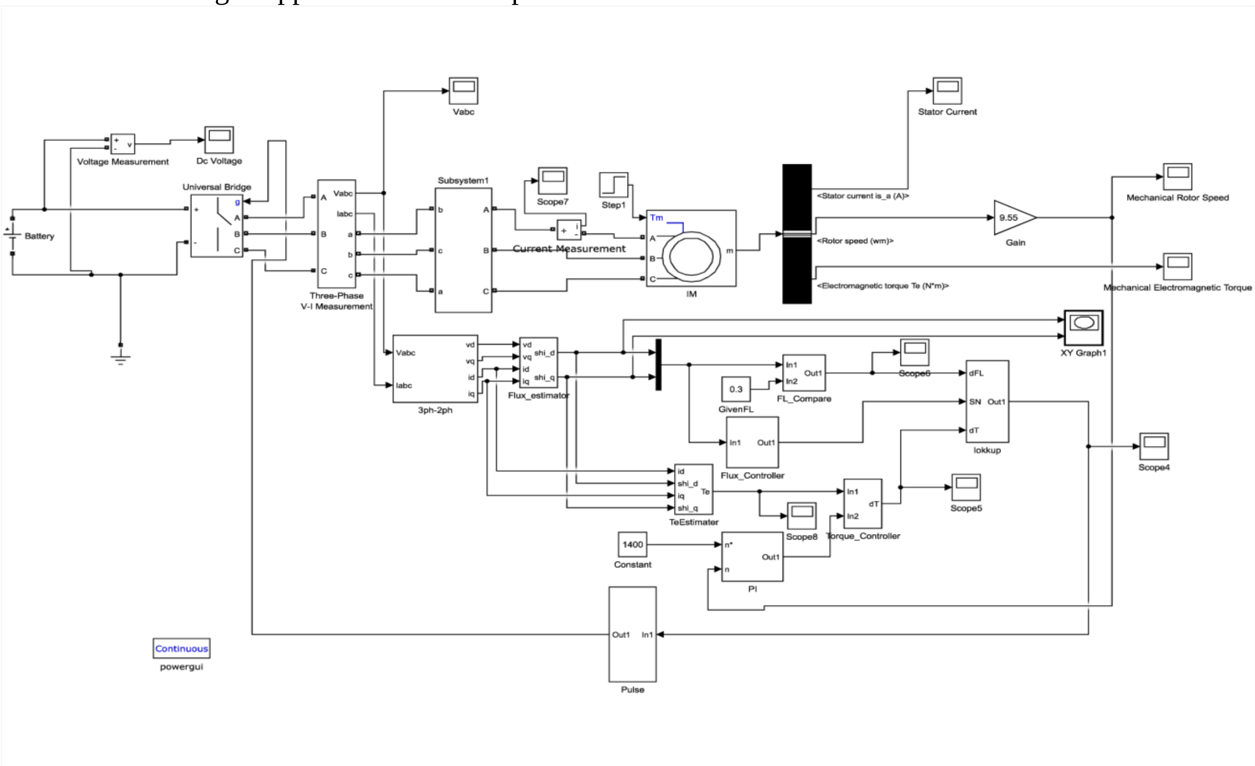
MATLAB is used to generate the simulation architecture based on comparison of vehicle speed in both models. The overall model structure in MATLAB/Simulink is easier to comprehend and the algorithm is easier to access and record as it provides to test algorithms immediately without recompilation along with quick image processing. The assumptions taken in order to culminate the findings that the HEV provides a greater economical fuel advantage over the conventional IC engine vehicles and also reduces emissions substantially. Below is a layout of one of the primordial stages of the simulation involving aroundthe Induction Motor Block



Dia 2.1- Diagram shows the vector control of an Induction Motor in which the simulation is carried out by

using 50 HP, 460 Vinduction motor, an inverter and a close control process to generate Pulse-Width Modulation (PWM).

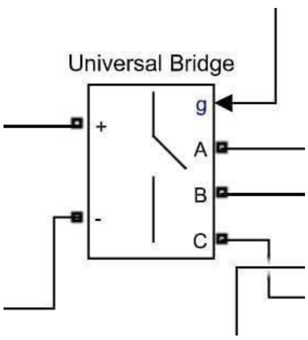
A 3-phase induction motor is represented by Induction Motor block which utilizes the 3-phase input voltage to manage the individual phase current, regulating the motor torque or speed control was built in with the other components. The motor in the previous figure has a 50 HP,460Vdimension and is paired with a IGBT inverter in a close control process. For the high current and voltage applications the 3-phase semiconductor insulated gate bipolar transistor (IGBT) used as an electronic switch. The PWM inverter acts as a PWM rectifier generating AC current elevation in regenerative operation of the alternator for the inductive generator, if required and power will be supplied to the battery at a DC voltage which is VDC.



Dia 2.2- System simulation layout

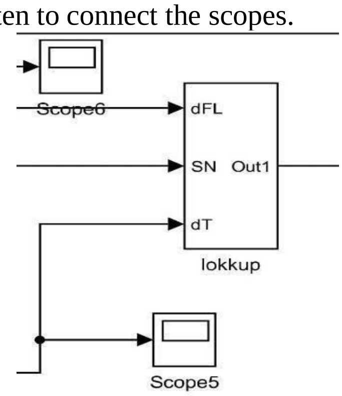
Below are the descriptions of some of the major components taken for the diagram above:

1) Simulation of converters being allowed by the universal Bridge block using both inherently reduced power electronic devices (diodes or thyristors) and forced-commutated devices (GTO, IGBT, MOSFET). The Universal Bridge block is the basic block for building two-level voltage-sourced converters (VSC).



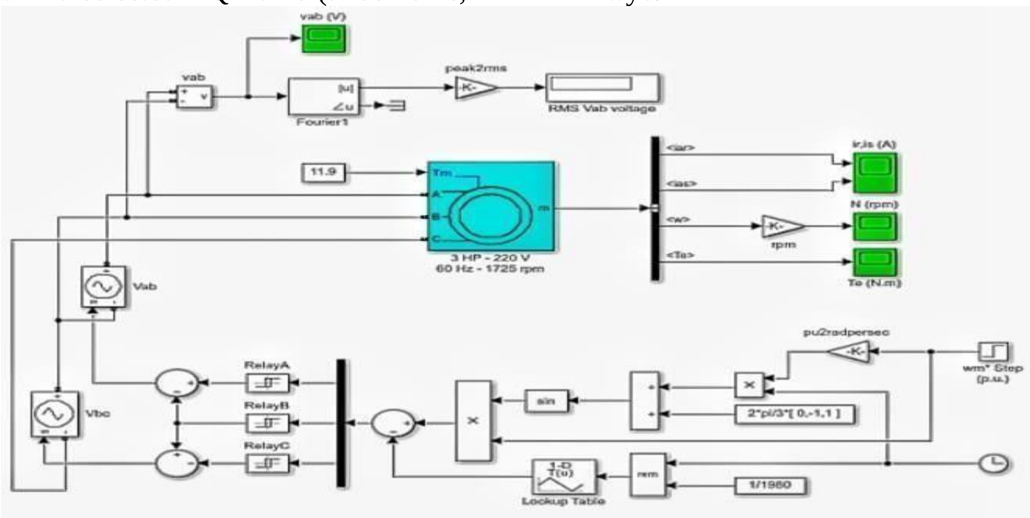
Dia 2.3- Universal Bridge Block

2) The time and range of input values shown will be adjusted by scope. The Scope window can be moved and resized. Also values of scope parameters can be modified at the time of simulation and at the beginning Simulink will not be started immediately, even though a data is written to connect the scopes.

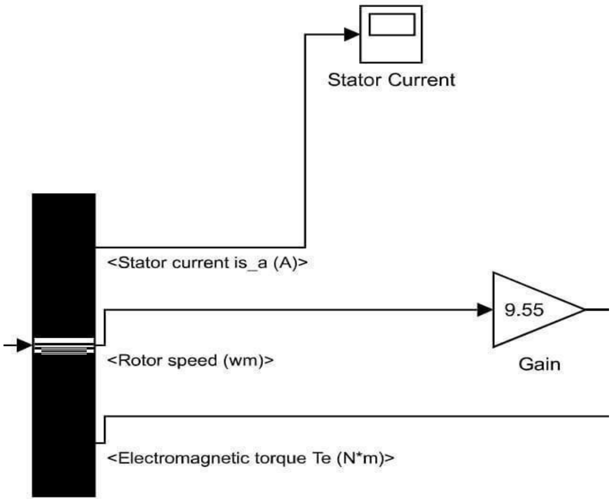


Dia 2.4 - Scope Block

3) Asynchronous executes a 3-phase allochronic machine (W-rotor, S-cage or double S-cage) designed in a selected DQ frame (allochronic, rotor, stator). With internal neutral points, stator and rotor windings are connected with in wye.

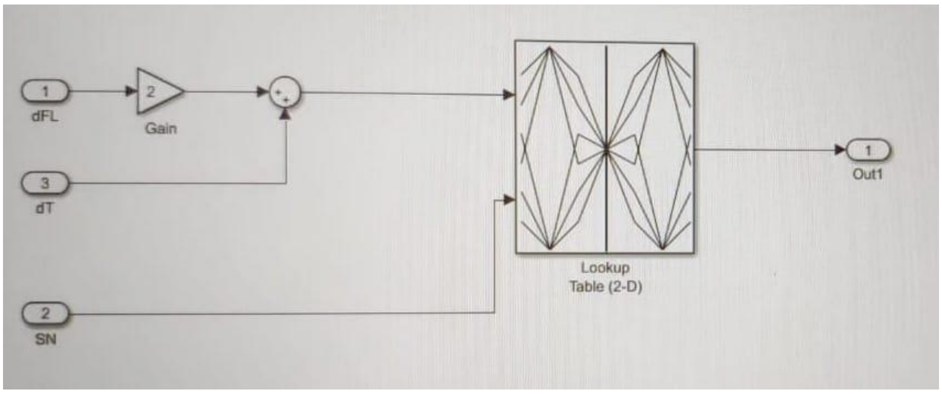


4) The entire circuit stator current can be found by dividing the phase voltage with the analogous complex reactance.



Dia 2.6 - Stator current block accompanied by Rotor Speed and Electromagnetic torque

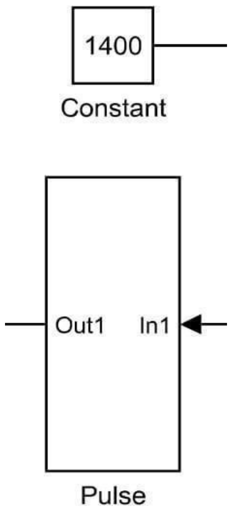
5) n-dimensional interpolated table performed by lookup table including index searches. N variables functions are represented in the table in a sampled manner. The top (or left) input port analogous to the first dimension.



Dia 2.7 – 2-D Look up Table

6) Constant value parameter describing about the constant output. The unchanged value will be treated as 1-D array. The unchanged value is a vector and elucidate vector parameters as 1-D is on. If not, output matrix

is having the equal dimension as like the constant value.

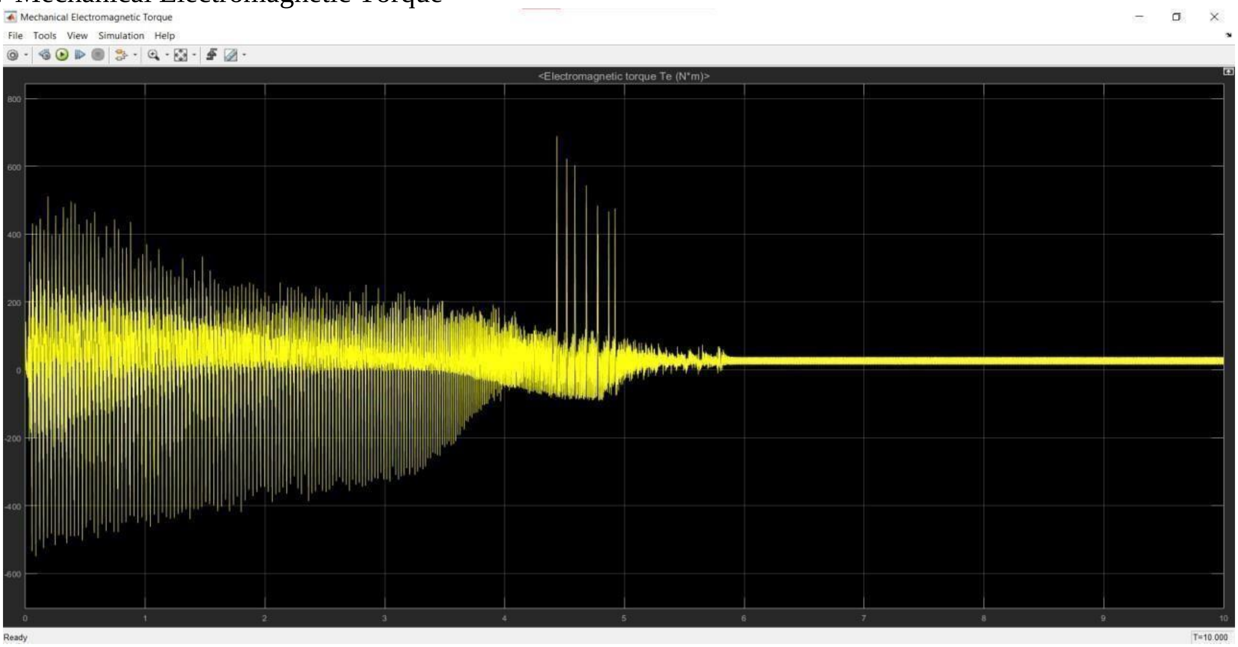


Dia 2.8 - Constant output accompanied by a pulse block

3. Results

The Y versus X graph is representing the 2D- line plot. Following plots are showing the mechanical rotor speed, mechanical electromagnetic torque, X-Y plot, stator current and DC voltage.

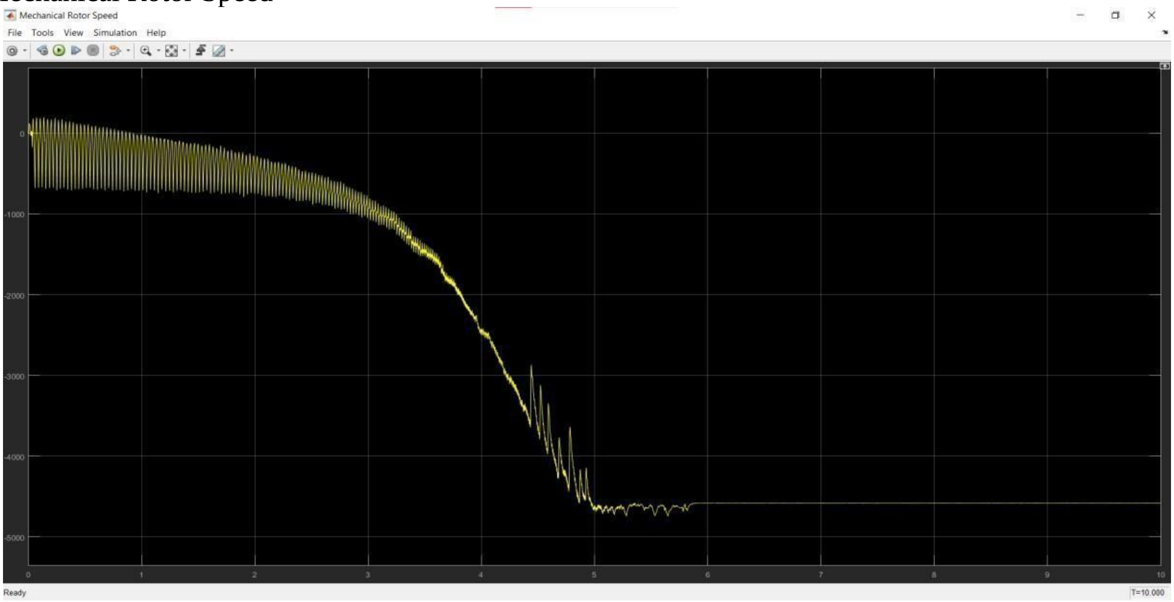
A. Mechanical Electromagnetic Torque



Dia 3.1- Mechanical Electromagnetic Torque in a Torque (Nm) vs Time (s) graph

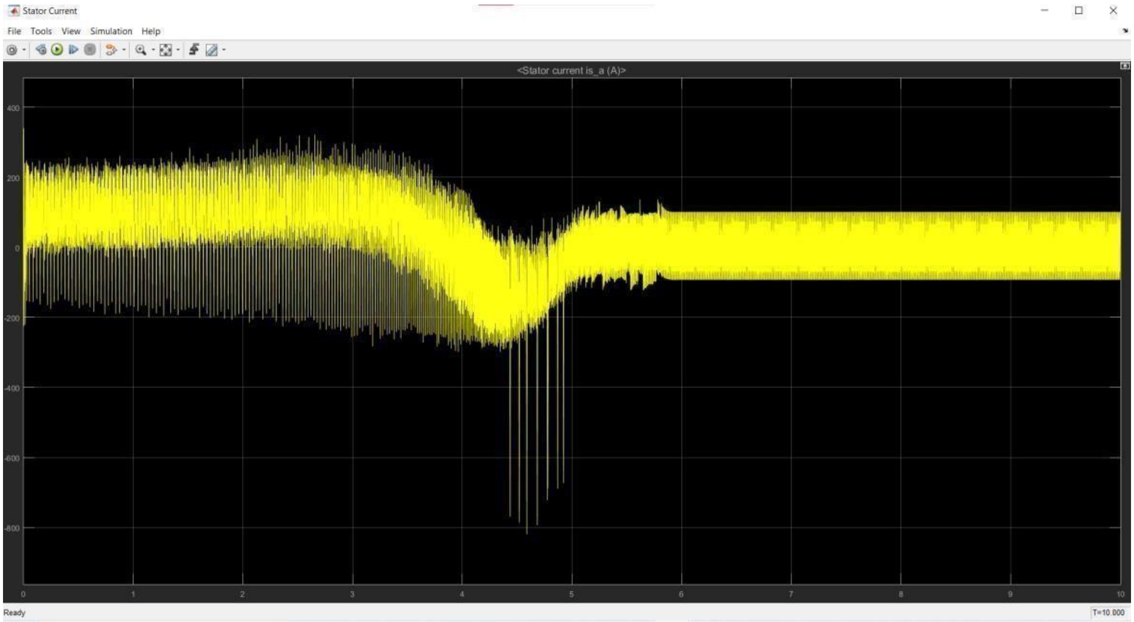
The mechanical electromagnetic torque obtains a constant value at 50-60 rpm after 5.8 secs. The initial stage variation in torque is due to the rotation of the motor in both directions. The comparison of required brake torque and motor speed can be used to calculate the availability regenerative braking force in the brake control unit. The constant value obtained gives a stable, higher output torque which can be saved and utilized further to increase fuel efficiency by 9-18% in parallel regenerative braking.

B. Mechanical Rotor Speed



Dia 3.2 – Mechanical Rotor Speed in a Speed (rpm) vs Time(s) graph

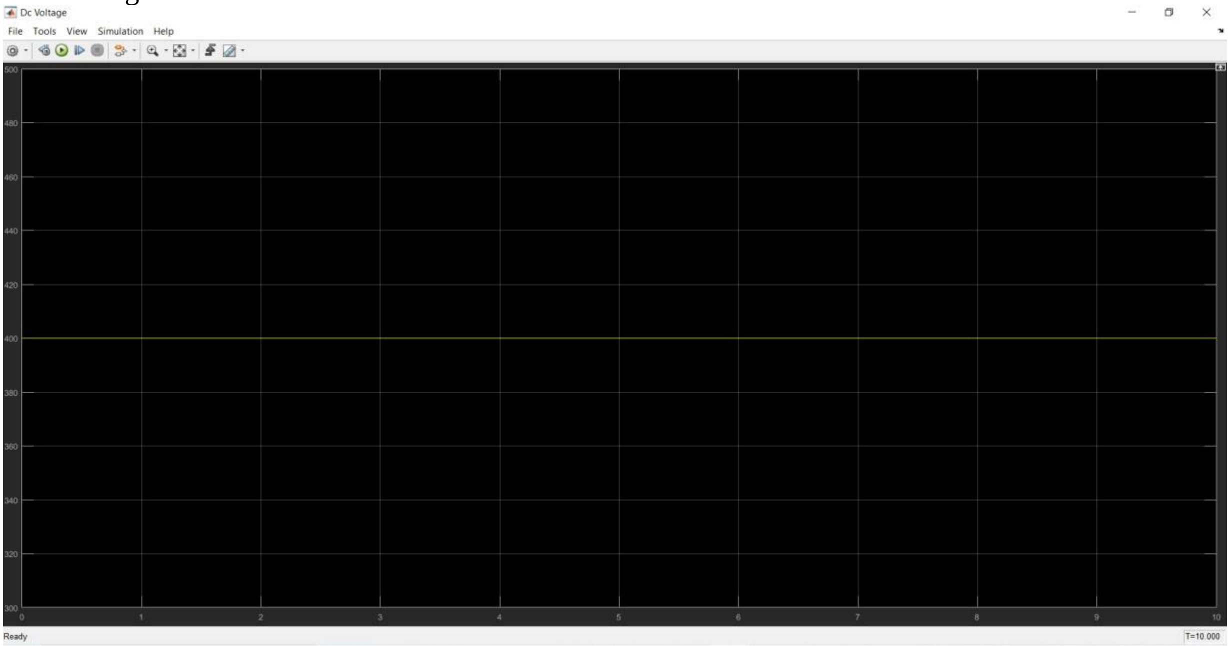
C. Stator Current



Dia 3.3- Stator Current in a Current (amp) vs Time (s) graph

The stator current value starts becoming constant at 5.9 secs and shows a constant value between 100 to -100. Rs, Xs and Xm are the stator parts, where Wr and Rr are rotor components. The stator current (Is) obtains a constant value (after minimizing error occurred due to more variation in the initial stages) between -100 to 100 after 5.9 seconds signifying that we can store the current properly due to which the system stability will increase without affecting the performance of the proposed drive.

D. DC Voltage



Dia. 3.4 –The DC Voltage plotted in a Frequency (hz) vs Time(s) graph

The DC Voltage remains constant at a value of 400 at a time. The AC power source or a general storage can be fed by the regenerative braking taking energy from the motor, where it can be reused. Efficiency will be enhanced because of this feeding energy as here AC to DC is taking place only once. Here the motor stator windings, generating a static magnetic field which implementing a static torque to the rotor is being supplied with the DC source. For which the rotor slows down and ultimately stops. The rotor will be kept in position and redistricting any attempt to rotate it, provided that the DC voltage is supplied to the windings. The graph plots a constant DC voltage as the form of the stable power output which can be stored for further use in the vehicle motor.

4. Conclusion

According to the data obtained plotted in our above graphs, we can conclude that in the place of the candor of moving parts of AC induction motor, the EV will never experience any engine constrict braking as like a traditional IC Engine. When batteries are completely charged regenerative braking is essentially limited but because of the extra charging the voltage of a completely charged battery can jump up above the safety level, EV's motor controller will control the regenerative torque. In such case, giving a better vehicle and brake control to the drivers, at the same time that turns braking energy into electricity, enhancing the EV's battery range. A number of factors are affecting its effectiveness, but there are reports of enhancing a EV's range up to 30%. The battery can be saved up to 18% and combined with the Li-ion rechargeable batteries, it makes the users more reliant on single charges for a longer time, giving a more economical solution to fuel emissions, vehicle heating and damage.

5. References

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