Performance Analysis And Result of DC-DC Converter Fed Drive For Electric Vehicle System

Ms.Shubhangi G.Navalkar[1], Prof.Amit V.Mohod[2]
[1, 2] Dept of Electrical and power System
[1]PLIT,Buldana
[2]Prof.Ram Meghe COE & Management,Amravati

Abstract- *This paper describes bidirectional DC-DC converter fed separately excited dc motor for EV application. Battery fed electric vehicles (BFEVs) is required to function in three different modes namely: normal (steady-state) mode, acceleration mode and braking (regenerative) mode. During acceleration and normal modes the power flow is from battery to motor whereas during braking or regenerative mode the kinetic energy of the motor is converted into electrical energy and fed back to battery. This paper explain the Performance analysis and Result of DC-DC converter fed drive for electric vehicle system. Also shows the simulation of model.*

Keywords- DC-DC converter, dc motor, MATLAB

I. INTRODUCTION

Recently dc-dc converters are widely researched and developed for various applications. In case of the battery fed electric vehicles (BFEVs), electric energy flows between motor and battery side. For achieving zero emission, the vehicle can be powered only by batteries or other electrical energy sources. Batteries have widely been adopted in ground vehicles due to their characteristics in terms of high energy density, compact size, and reliability. The use of a Bi-directional dc-dc converter fed dc motor drive devoted to electric vehicles (EVs) application allows a suitable control of both motoring and regenerative braking operations, and it can contribute to a significant increase the drive system overall efficiency. Recently many Bi-directional dc-dc converter topologies have been reported with soft switching technique to increase the transfer efficiency. The DC-DC converter is required to perform mainly two functions: first to match the battery voltage to the motor rated voltage and second to control the power flow under steady-state and transient conditions, so that the drive performance is as per the requirement. In the present work closed loop operation of bi-directional dc-dc converter feeding a dc motor and its energy recovery due to regenerative braking has been demonstrated. The characteristics of battery operated electric vehicle under different drive condition are also presented. The effectiveness of the system is verified through the simulations using Simulink/ MATLAB.

II. CONTRIBUTION

1. Development of converter fed PMDC motor Power Stage Model.
2. Unified Controller during both the modes for the speed control of the PMDC motor.
3. Controlled regeneration during Braking to charge the battery.
4. Reduced electromagnetic interference(EMI) due to the elimination of parasitic ringing in the converter
5. Converter circuit parameter design procedure.

III. SIMULATION AND RESULTS

Closed loop Simulation of the Bidirectional Converter fed PMDC Motor with the designed values was done in the MATLAB Simulink. The inductor parasitic resistance and MOSFET turn-on resistance are not considered in this case. For the test condition of the proposed drive topology the following values of the different components of the converter are considered:

A separately excited DC motor model is used as load to the bidirectional dc-dc converter. The motor rated at 5 hp, 240 V, and 1750 rpm

Principal parameters of the bidirectional converter are:

Parameter	Value
L	1600 µH
CH	470 µF
CL	470 µF
fSW	20Khz
Battery voltage	48V
Battery capacity	16Ah
SOC	88%

Here we are going to consider total two cases of the drive system

1 Steady state operation: The reference motor speed is 120rad/sec with a constant torque demand of10Nm,
2 Transient state operation:

A. Case (I) when the speed changes from 60 rad/sec to 120 rad/sec with a constant torque demand of 10 Nm at time t=5sec

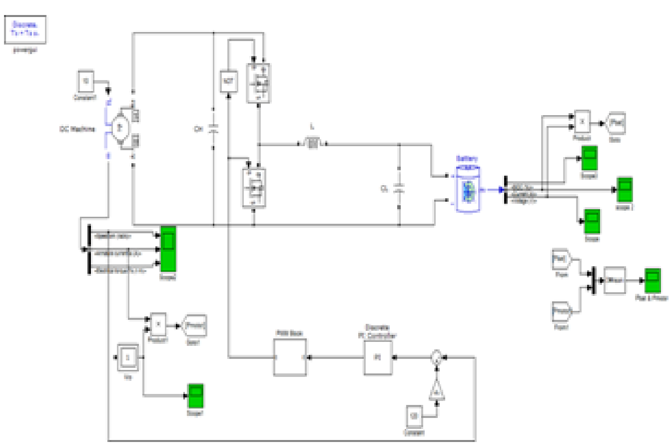
B. Case (II) regenerative braking mode: the speed changes from 120 rad/sec to 0 rad/sec. Torque changes from +10 Nm to -10 Nm at a step time of 5 sec.

The simulation is carried out for –

a. Motor speed,
b. torque,
c. motor current,
d. battery state of charge(SOC),
e. battery voltage,
f. battery current,
g. battery power and motorpower
h. battery energy and motor energy characteristic during regenerative braking mode.

III. STEADY STATE SIMULATION MODEL & RESULTS

a. **Simulation Model (Steady state)**



b. Steady state results

Figure 5.2 shows the simulation result of the drive system at a reference speed of 120rad/sec for a total simulation time of 10 sec. Motor speed reaches at its steady state speed of 120 rad/sec at time less than 0.5 sec. Figure 5.3 and5.4 shows the motor torqueand current of the drive respectively. The battery SOC was initially set at 88%, Figure 5.4 shows the SOC of the battery, when the drive was running for 10 sec at a speed of 120rad/sec. Figure 5.6 and 5.7 show the battery voltage and current under this condition. Figure 5.8 shows the comparison between the battery power and motor power.

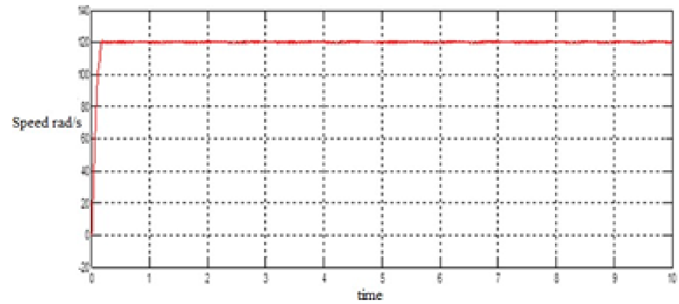


Figure 5.2: Motor speed

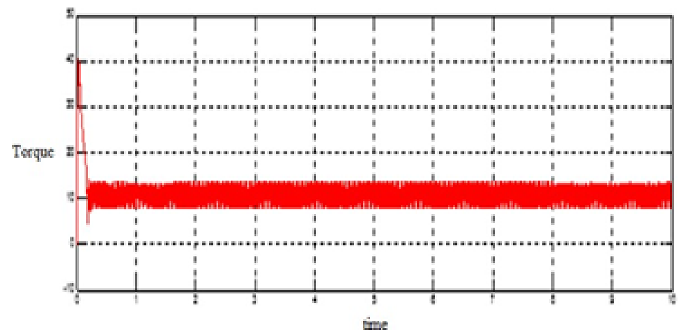


Figure.5.3: Motor Torque

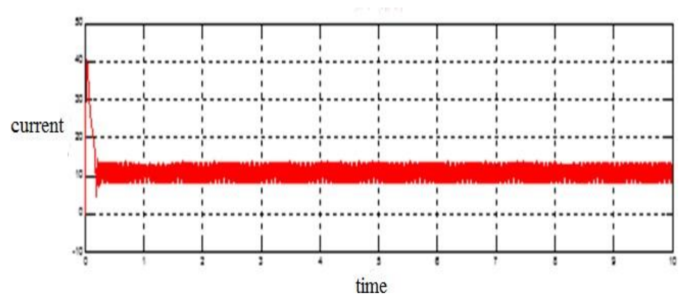


Fig.5.4: Motor current

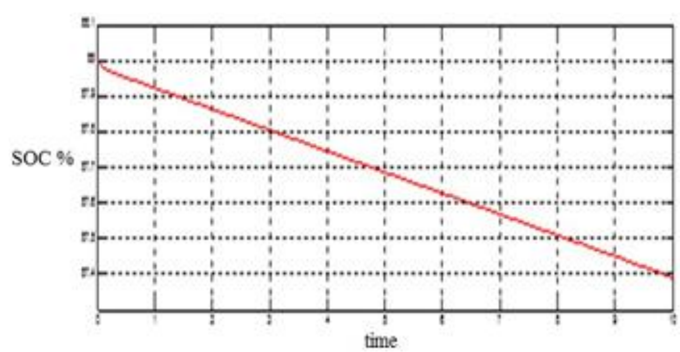


Fig.5.5: Battery State of charge

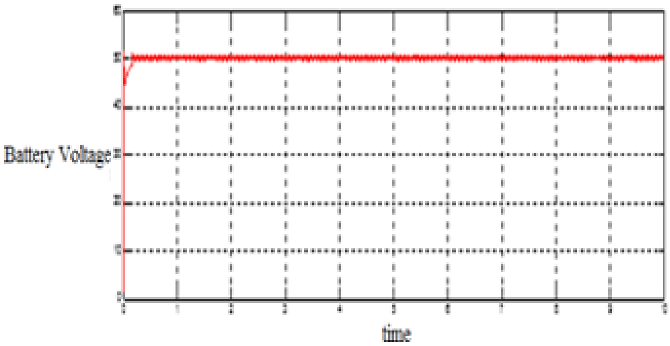


Fig.5.6: Battery voltage.

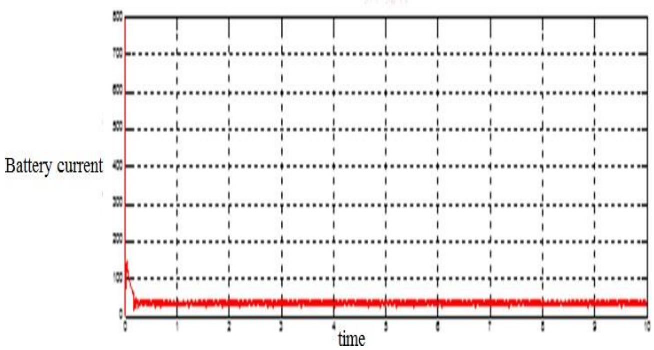


Fig.5.7: Battery current

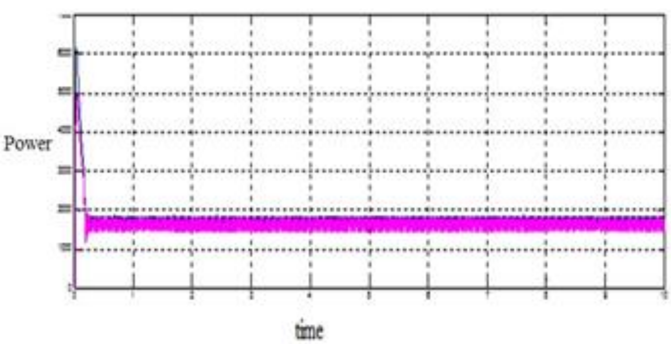


Fig.5.8: Motor and battery power

c. Step Down Transient Results

Simulations are also performed for the braking operation when the speed is changed from 120 rad/sec to 100 rad/sec while the motor torque and current has reverse characteristic as shown in Figure 5.16, 5.17 and Figure 5.18 respectively. Figure 5.19 shows the battery SOC during regenerative braking mode. Figure 5.20 and 5.21 shows the battery current and voltage respectively. Figure 8(g) shows the characteristics of motor power and battery power under the same drive condition.

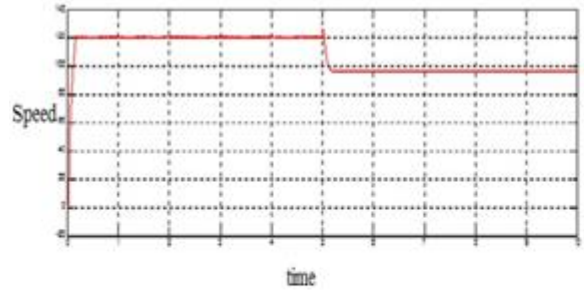


Fig.5.16: Motor Speed

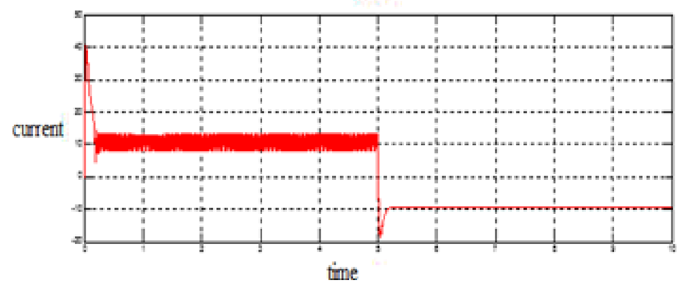


Fig. 5.17: Motor current

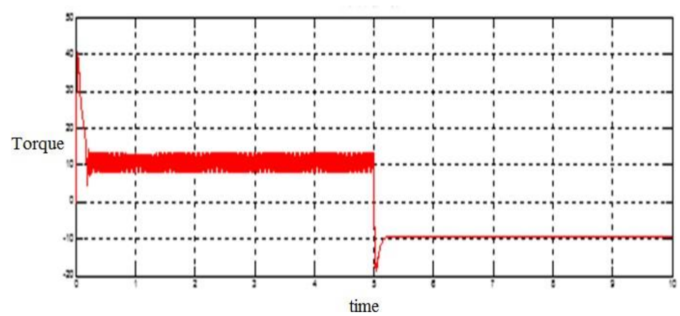
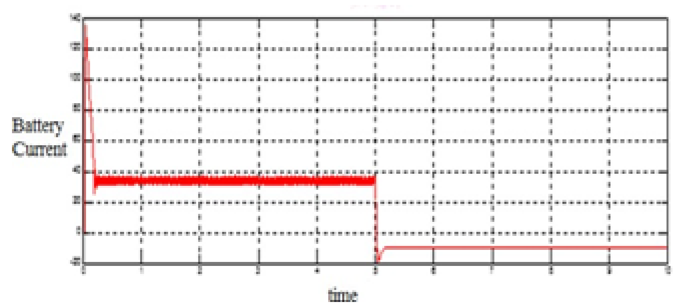


Fig. 5.18 Motor torque



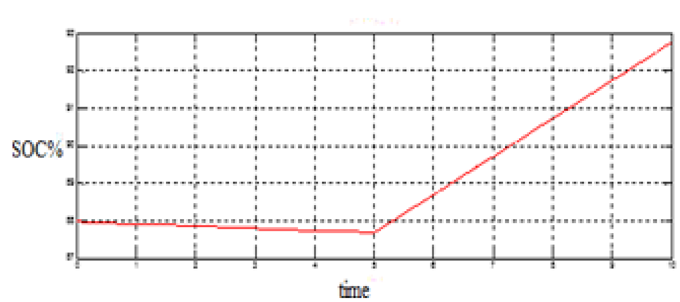


Fig.5.19: Battery State of Charge

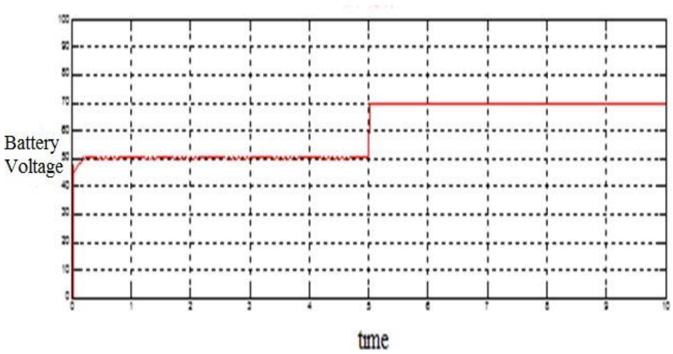
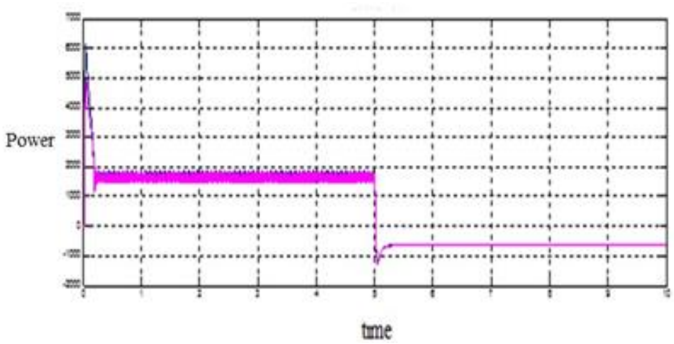


Fig.5.20: Battery Voltage



5.22 Motor and Battery Power

IV. CONCLUSION

This work demonstrates the performance of a battery operated hybrid electric vehicle system and it shows satisfactory performance at different driving condition. This control technique with PI controller find suitable for this electric drive. The performance of the BFEV is verified under forward motoring mode, regenerative mode and when there is step change is speed command. It is found that hybrid electrical vehicle by using PMDC motor drive has better results in case of voltage, current and torque. The overall cost and volume of the battery operated electric vehicle is less with the least number of components used in the system.

REFERENCES

[1] Premananda Pany, R. K. Singh and R.K. Tripathi "Bidirectional DC-DC converter fed drive for electrical vehicle system" International Journal of Engineering, science and technology, vol.3, no.3, 2011, pp 101-110.

[2] Khaligh, Alireza, and Zhihao Li. "Battery, Ultracapacitor, fuel cell, and hybrid energy storage systems for electric, hybrid electric, fuel cell, and plug-in hybrid electric vehicles: State of the art." Vehicular Technology, IEEE Transactions on 59, no. 6 (2010): 2806-2814.

[3] Du, Yu, Xiaohu Zhou, SanzhongBai, SrdjanLukic, and Alex Huang. "Review of non-isolated bi-directional DC-DC converters for plug-in hybrid electric vehicle charge station application at municipal parking decks." In *Applied Power Electronics Conference and Exposition(APEC), 2010 Twenty-Fifth Annual IEEE*, pp. 1145-1151. IEEE,2010.

[4] Bertoluzzo, Manuele, and Giuseppe Buja. "Development of electric propulsion systems for light electric vehicles." Industrial Informatics, IEEE Transactions on 7, no. 3 (2011):428-435.

[5] Junhong Zhang, Jih-Sheng Lai and Wensong Yu. "Bidirectional DC-DC Converter Modelling and Unified Controller with Digital Implementation" IEEE 2008