

Dynamic Performance Improvement of Three Phase Asynchronous Motor using Ultra Capacitor fed DC motor Backup

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Abstract

This paper proposes a control strategy which can enhance the dynamic performance and stability of a three phase asynchronous motor under certain transitory conditions like overloading. A DC motor is mechanically coupled to the shaft of Asynchronous Motor to improve the dynamic performance. An Ultra- capacitor supplies energy to DC motor at very high rate through an electro-chemical battery, DC-DC converter and a PID controller to sustain the speed. The high specific power rating of ultra-capacitors is exploited in this proposed strategy to increase the transient stability. The entire system is simulated in Simulink environment and results are presented to study its dynamic performance.

Keywords: Battery, DC motor, Three phase asynchronous motor, Ultra capacitor.

I. INTRODUCTION

The three phase asynchronous motor is generally considered as main work horse in the present day industry due to the exclusive advantages like simple and rugged construction, easy controllability and low maintenance cost etc. Three phase asynchronous motors find tremendous applications in drilling machines, latches etc. Three phase asynchronous motor being a singly excited system from a balanced three phase supply run at sub synchronous speeds. As the load on the motor shaft exceeds a specified limit, the huge currents rushed into the machine may cause for its damage [1]. The Ultra-capacitor (or) Super capacitor is a new technology of a energy storage systems. These Super capacitors are excited by an electrochemical battery. Three phase Asynchronous motor is run on the shaft with load is kept on the shaft , if load increases on the shaft the motor performance of speed decreases gradually and motor draws more current it is not sufficient the motor run as efficient. To rectify the problem require high power rating, for high power rating toque should be high, require another motor run on the same shaft therefore two motors runs with same speed, torque increases due to ultra capacitor supply, ultra capacitor is excited by a battery during charging time and dissipates its energy during discharge mode controller will control the abnormal condition of three phase asynchronous by using ultra capacitor with DC motor back up protection. During starting, motor speed reaches to rated speed i.e 1500 rpm runs constant speed until motor gets overloaded, during transient period motor speed suddenly falls after some time motor again reaches rated speed. By using ultra capacitor it a short time to reach rated speed even transient period motor falls to some speed within few

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seconds motor again reaches to rated speed.

Therefore ultra capacitor will improve efficiency compared to other energy source devices. During the abnormal condition occurs the ultra capacitor dissipates its high power density into the load to make the system stable. Thus, the performance of induction motor will rely on energy storage system. DC-DC converters are also used to control the flow of energy among induction motor, energy storage system and the load.

Three Phase Asynchronous motor is coupled with Dc Motor with a common Shaft .Ultracapacitor is initially charge by means of battery during normal period and Ultra capacitor is discharge the energy by giving supply to the dc motor with the help of controller .controller is used to supply to the dc motor and back up energy for the three phase asynchronous motor. Three Phase Asynchronous motor Performance seen in Motor Speed, Motor Torque. During Normal Operating Conditions Motor Speed Runs at Rated Speed Motor draws rated current .as Load increases on the Shaft speed decreases gradually,

II. SYSTEM DESCRIPTION DIAGRAM

Electrolytic Capacitor etc. Flywheel energy storage system (FESS) stores more energy over the electrolytic capacitor. FESS System is a better power stabilising device for high fluctuating loads [2][4]. Ultra capacitor is a high power density device and good charging Capacitor i.e ultra capacitor store 25 times more energy over conventional energy storage devices.

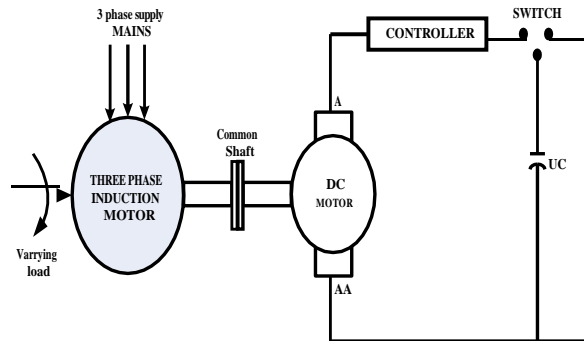


Fig.1 Three Phase Asynchronous Motor Modeling

BATTERY

Ultra capacitor is used to protect the battery during abnormal conditions. During Normal operating conditions ultra capacitor is energized by means of Battery .Ultra capacitor stores energy during normal conditions and delivers its energy in case of abnormal conditions it acts as supply for dc motor .dc motor run by means of ultra capacitor therefore torque develop in the motor increase power capacity with the same shaft run the induction motor run as efficient with dc motor .ultracapacitor is used to minimize the losses and improve the efficient[4]

Table 2 :Specifications of ultra capacitor

Ultra capacitor specifications	Ratings/number
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Series capacitor	6no
Parallel capacitor	13no
DC Series resistance	2.1e-3 ohms
Rated voltage	220V
Operating temperature	25°

Three phase supply is provided to the three phase asynchronous motor .During Normal conditions three phase asynchronous motor working normally i.e.,rated current, rated speed, etc.as load increases on the shaft speed decreases ,motor draws more current it is not reliable to the motor to rectify the overload conditions ultracapacitor is used to rectify the problem use another motor run on same shaft run with same speed.Ultracapacitor is giving supply to the dc motor improves the torque therefore improves the power .

a. DC Motor:

DC motor is a constant speed motor. DC motor is running with 3 phase asynchronous motor running on the same shaft. DC motor runs at Rated Speed same as 3 phase asynchronous motor until motor gets overloaded speed falls

c. Battery:

Battery Can store energy within itself .When motor gets suddenly after few seconds ultra capacitor action enters in the systems giving supply to the DC motor. Motor attains rated speed .In the existing model the motor initially the motor attains rated speed i.e 1500 rpm after 2sec load is kept on the shaft the motor falls speed to 1000 rpm.

Table 1:DC Motor Speed variation with Time.

S.No	Speed(rpm)	Time(sec)
1	1500	0.5
2	1000	2
3	1500	2.5

b. Ultra Capacitor:

Ultra capacitor is new version of energy storage system device it stores more energy compare to FESS and overloaded speed decreases and dc motor is back up energy for three phase asynchronous motor by using ultra capacitor. Initially ultra capacitor is excited by a battery during charging period. Battery performance generally seen in ampere hours.

III. CONTROL ALGORITHM

a. Controller:

Controller is a device which controls the conditions of normal and abnormal conditions[8]. During Normal operating conditions there is no signal for control the condition because ultra capacitor is connected with battery by means of switch Ultra

capacitor stores energy until gets motor get overload and abnormal conditions occurs. During Abnormal Conditions ultra capacitor is acts as source for dc motor by means of switch ultra capacitor gets connected the controller ,therefore the controller action takes place controller is control the abnormal conditions PID Controller is used in the system to improve the steady state

performance of the system. By using PID Controller the performance of speed, Current is better than DC motor without PID controller.

b. Simulation Diagram

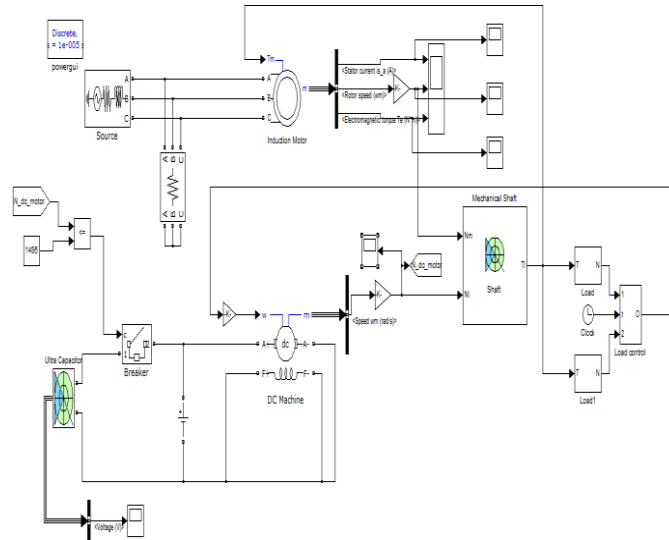


Fig.2: Simulation Diagram of Three Phase Asynchronous Motor

Simulation diagram of three phase asynchronous motor without PID controller as shown in above fig2. Three phase asynchronous motor is excited by a three phase supply is run on same shaft with dc motor. DC Motor is excited by a ultra-capacitor by means of a breaker. Breaker condition changes from 0 to 1 i.e during normal condition breaker switch value on 0. During abnormal conditions switch changes from 0 to 1 ultra capacitor is connect with dc motor to overcome the condition of overload, motor runs at a rated speed, current reaches constant value.

IV. RESULTS AND DISCUSSIONS

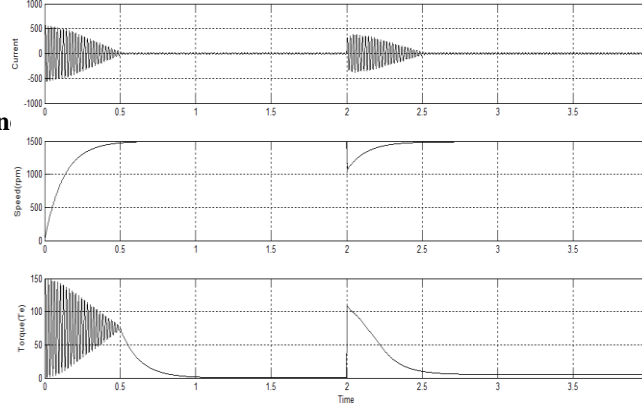
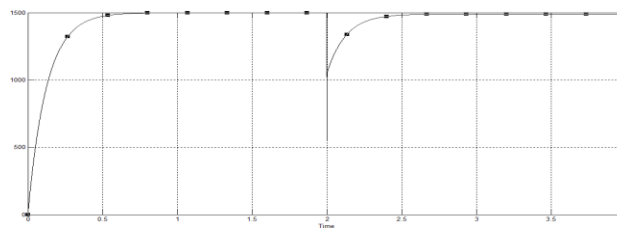


Fig.3: Simulation Results of a Three Phase Asynchronous Motor (i)Current versus time.(ii)Speed versus time.(iii)Torque Versus time.

Three phase asynchronous motor is excited by three phase supply current flows in the motor at rated current, if load increases on the shaft ,current increases more than rated current it is cause to damage internal winding of motor.as shown in figure 3(i). Initially current reaches to maximum value more than rated current(50A) and comes to zero in 0.5 Secs. Again after 2sec load increases on the motor Current reaches 40A less than initially by using ultra capacitor. Motor speed reaches to rated speed 1500 rpm initially, load increases on the shaft suddenly speed falls to 1000 rpm at 2secs and again speed reaches to rated speed in 0.5secs. Intillay motor comes to rated speed more than 0.5 secs by using ultra capacitor comes to rated



speed in few seconds. Torque is initially 150 newton’s and comes to zero in 1 sec and after 2secs 100 newton’s.

Fig.4: Simulation results of DC Motor versus Time

DC motor is run on same shaft with three phase induction motor runs with same speed with induction motor initially motor reaches to rated speed at 0.5 secs. After seconds load increases on the shaft speed falls to 1000rpm within few seconds dc motor reaches to rated speed.

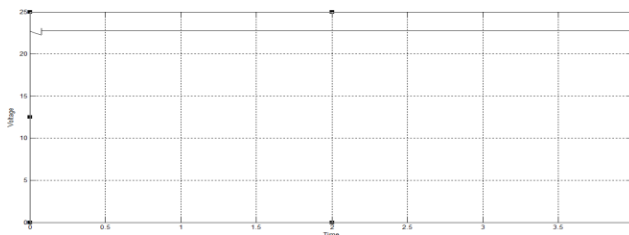


Fig.5: Ultracapacitor Voltage versus Time

Ultracapacitor voltages initially at a rate of 22.88 V is constant for entire time period ultra capacitor is initially charge by means of battery for certain time period controller gives signal to the switch.

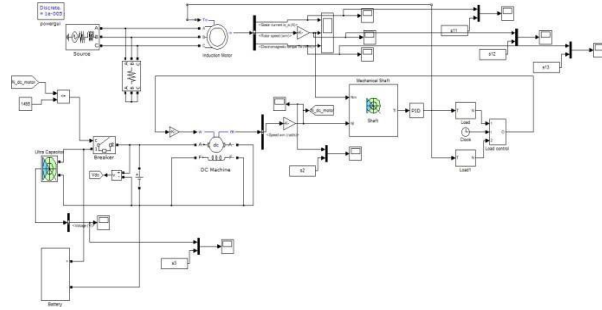


Fig. 6: Simulation Diagram of Three Phase Asynchronous motor with PID controller

Simulation Diagram of Three Phase Asynchronous Motor with Excited by three phase supply and three phase asynchronous motor is run on same shaft with dc motor and PID controller is connect to dc motor by providing excitation from ultra capacitor.

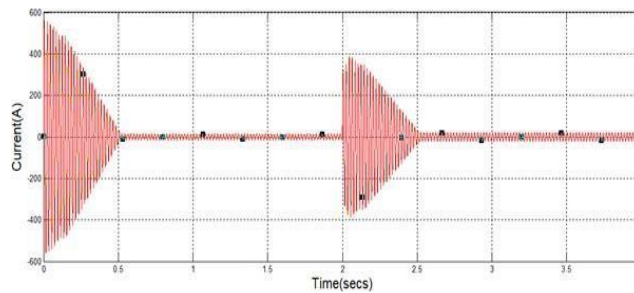


Fig. 7 Current Waveform of Three phase Asynchronous motor with PID Controller

Three phase Asynchronous Motor with PID controller current fluctuations is occurs in small duration and peak value is also less compare to Three phase induction motor without PID controller. Current floats between less than 500 value.

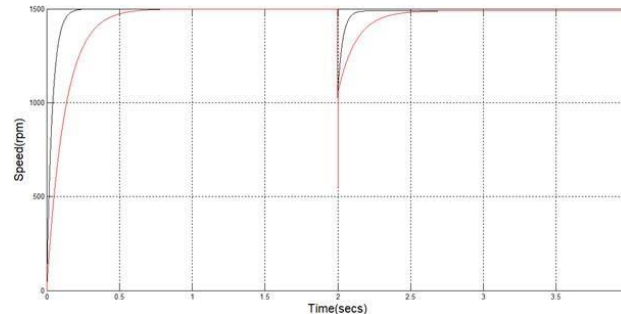
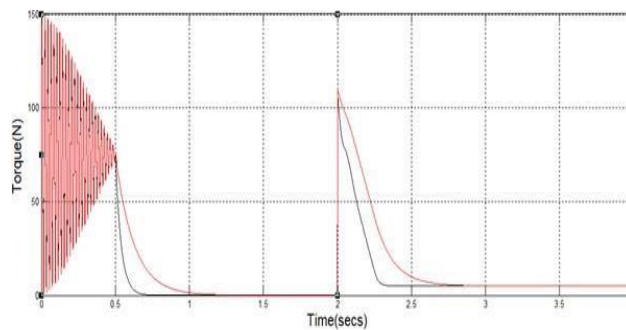


Fig.8 Three Phase Asynchronous Waveform Speed waveform with and without PID controller

Three phase asynchronous motor speed waveforms with and without PID controller. Without PID controller the speed reaches zero to rated speed 1500rpm after 2 sec load increases speed falls to 1000 rpm with in secs speed reaches rated speed, similarly with PID controller initially speed reaches rated speed in less compare with without PID controller. After 2secs load increases speed falls to 1200 rpm with in secs speed attains its original speed in less time over



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without PID controller.

Fig. 9 Three phase Torque Waveform with and Without PID Controller

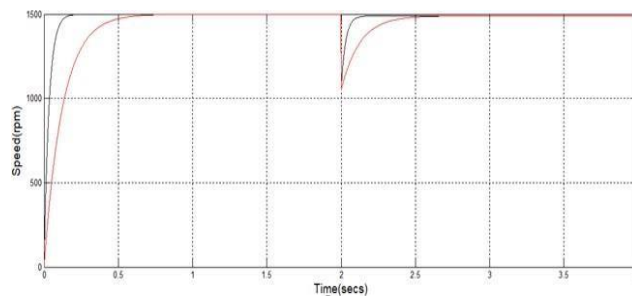


Fig. 10 DC Motor Speed Waveform with and without PID Controller

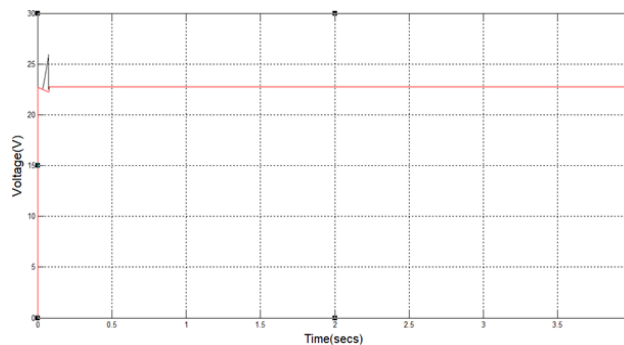


Fig. 12 Ultra capacitor output voltage of with and without PID controller

V CONCLUSION

The speed of the three phase asynchronous motor has been sustained using PID controller. A DC motor has been coupled to the shaft of induction motor and fed with a Ultra Capacitor through a DC-DC converter and PID controller. The results have been presented with and without controller. As the ultra-capacitor is able supply energy at very high rate and it helped the motor to maintain the stability during abnormal conditions. The DC motor remains disconnected and ultra-capacitor has been energized by battery under normal conditions.

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