e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

SOFT STARTING OF THREE PHASE INDUCTION MOTOR

Dr. S.P. Jolhe*1, Amol Gaikwad*2, Shubham Mane*3,
Sourabh Badashaha*4, Pavan Hattimare*5

*1Professor, Department Of Electrical Engineering, Government College Of Engineering, Nagpur, Maharashtra, India.

*2,3,4,5Students, Department Of Electrical Engineering, Government College Of Engineering, Nagpur, Maharashtra, India.

ABSTRACT

This project is designed to provide smooth and smooth starting of three-phase asynchronous motors. The three-phase induction motor generates much more current than its initial starting capacity, so the motor immediately reaches full speed. This causes muscle jerks and high electrical loads on the motor windings. Sometimes the coils can burn out. Asynchronous motors should start smoothly and gradually increase speed for safer operation. This project is intended to provide smooth starting of an induction motor powered by SCR ignition which is triggered by a strong ignition delay angle during starting, then gradually reduces the delay until it reaches zero voltage trip. This results in low voltage at start-up and then gradually to full voltage. As a result, the motor starts slowly and then resumes slowly at full speed. This project consists of six counter-parallel SCRs, two for each phase, the output of which is connected to a group of lamps representing the windings of a three-phase induction motor. The charging and discharging of the capacitor is interfaced with the comparator, resulting in a delayed ignition pulse during starting, then gradually reducing the delay until the engine runs at full speed. The output of the comparator is provided by photodetectors to trigger the SCRs.

Keywords: SCR Triggering; Firing Angle Delay; Opto Isolators; Opto Couplers; Zero Voltage Triggering ; Motor Current Control ; PWM Controller.

I. INTRODUCTION

The project aims to provide gentle and smooth starting of three-phase induction motors. The three-phase induction motor under initial starting conditions generates a much higher current than its capacity and thus the motor immediately reaches full speed. This leads to mechanical vibration and strong electrical stress on the motor windings. Sometimes the coils can burn out. The induction motor should start smoothly and gradually pick up speed for safer operation. This project is intended to provide smooth starting of an induction motor powered by SCR ignition which is triggered by a strong ignition delay angle during starting, then gradually reduces the delay until it reaches zero voltage trip. This leads to a low voltage at startup and then gradually to full voltage. As a result, the engine starts slowly and then slowly resumes at full throttle.

This project consists of six counter-parallel SCRs, two for each phase, whose output is connected to a group of lamps representing the windings of a three-phase induction motor. The charging and discharging of the capacitors are interfaced with the comparators resulting in a delayed ignition pulse during starting, then gradually reducing the delay until the engine runs at full speed. The output of the comparator is provided by photodetectors to trigger the SCRs. In addition, the design is often improved by using an on-site SCR IGBT with PWM control to reduce the harmonic distortions commonly encountered in the SCR triggering mechanism representing the soft start of an induction motor.

At the time of starting, the three-phase induction motor receives a very large current and has a low power factor. thanks to high currents, ripples and transients of motor torque content. due to transients and torque spikes cause the motor shaft to jerk, reducing the mechanical life of the rotor. To minimize this undesirable effect in the case of current and torque spikes in induction motors, a common method used is the soft start of an electronically controlled induction motor. Usually soft starter is used to avoid these problems and soft start is achieved by increasing the frequency of the stator. By using a soft starter, the efficiency of the induction motor is improved, as well as the load torque characteristics.

Power semiconductor ac motor starters are increasingly being used to replace traditional solenoid and reduced voltage starters due to their controlled soft starting capabilities. them with limited starting current.

Thyristor soft starters are cheap, simple, reliable and take up less mass, and therefore their use can be a possible solution to the problem of induction motor (IM) starting. Based on the initial switching versions of all three phases in the ready state, the IM can generate strong pulses on the electromechanical torque, whether driven by direct or soft starters. Electromagnetic torque pulses can shock the control unit and damage system components, such as shafts, couplings and gears, immediately if the material strength is exceeded or in the future due to fatigue. Smooth acceleration also relieves stress on the power supply with high starting currents that meet utility requirements to reduce starting voltages and eliminate low and slow running conditions. It also reduces shock to the load being driven with high starting torque that will cause conveyor jerks that damage product, or pump pools and pipeline collapse.

As a result, acceleration (uphill time) and starting torque can be fully adjusted for optimal starting performance, providing enough torque to accelerate loads while minimizing shock power to the system.

II. METHODOLOGY

The soft starter provides a reduced voltage to the stator windings of a three-phase induction motor by controlling the acceleration of the electric motor. The three-phase induction motor is a self-starting motor and the electromagnetic torque is generated by the interaction between the magnetic field around the rotor and the rotor current. Initially during starting, a rated voltage is applied, causing a large current to flow through the windings of the stator. However, this high current, higher than the rated current, can heat the stator windings and possibly damage the insulation applied to the stator windings. To avoid the problem of high starting current, a motor starter is required in the electric motor.

The engine can be started in three ways. First, by applying full load voltage i.e. direct line starting. Second, by gradually applying voltage using star delta and soft starters. Third, by applying partial winding starting, i.e. automatic transformer starting. A soft starter provides voltage drop and therefore torque reduction to the electric motor. A soft starter consists of semiconductor devices such as thyristors. The voltage supplied to the motor is controlled by power semiconductor devices such as thyristors. In a three-phase induction motor, the torque is proportional to the square of the starting current, which is proportional to the applied voltage. The starter works on the principle described above.

Therefore, torque and current can be controlled by applying voltage drop when starting the electric motor. Both types of controls can use soft starters. The first is open-loop control and the second is closed-loop control. In open-loop control, a starting voltage is applied over time.

This starting voltage is applied regardless of traction current or motor speed. For each phase, the two SCRs are connected in the reverse direction in parallel, and the initial SCR is initiated at a delay angle of 1800 for the respective half-wave cycles. Each SCR completes every half cycle. This delay decreases with time as the applied voltage reaches full supply voltage. The drop voltage increases to full voltage and at the same time the firing angle decreases from 1800 to 00. This type of system is known as a time voltage ramp system.

This method has the disadvantage of not being able to control the acceleration of the engine. In closed-loop control, any motor characteristic is monitored for the desired response. The starting voltage is varied depending on the required motor current or motor speed. The current in each phase is precisely monitored and the timing voltage gradient is stopped when the current in each phase exceeds a certain set point. The supply voltage applied to the stator winding of a three-phase induction motor is controlled by controlling the conduction angle of the SCR. The soft starter essentially consists of two anti-parallel SCRs in each phase of a three-phase induction motor. A total of six SCRs are required for the three stages for the electric motor to accelerate smoothly.

These SCRs are power semiconductor devices that are normally in the OFF state, but these SCRs start conducting when triggering signals are transmitted to them and thus allowing voltage and current to flow through them. Initially, to perform a soft start, an ignition pulse is applied to the SCRs so that only the remainder of each half-cycle of the sinusoidal voltage curve passes through them. The duration of the trigger pulses is then reduced, allowing more voltage to pass through the SCRs.

Finally, the firing pulses are applied exactly at the zero cutoff of the voltage that passes 100% of the voltage. This is also considered to increase the voltage from the voltage drop at startup by allowing more voltage to pass through the SCRs.

In this way, a full voltage is applied from the voltage drop at startup. The reverse procedure is performed for soft shutdown. Full voltage is allowed to pass through the thyristors, and when the off time is approaching, the trigger pulses are delayed, allowing less voltage to pass through. Instances of firing pulses are increased until the end of tension. Then no more voltage is applied to the motor and this way the motor will stop.

III. MODELING AND ANALYSIS

The given soft starter is tested and hardware model is created to understand the operation of starter for three phase Induction motor. The hardware model for soft-starting is shown in Fig. 1.

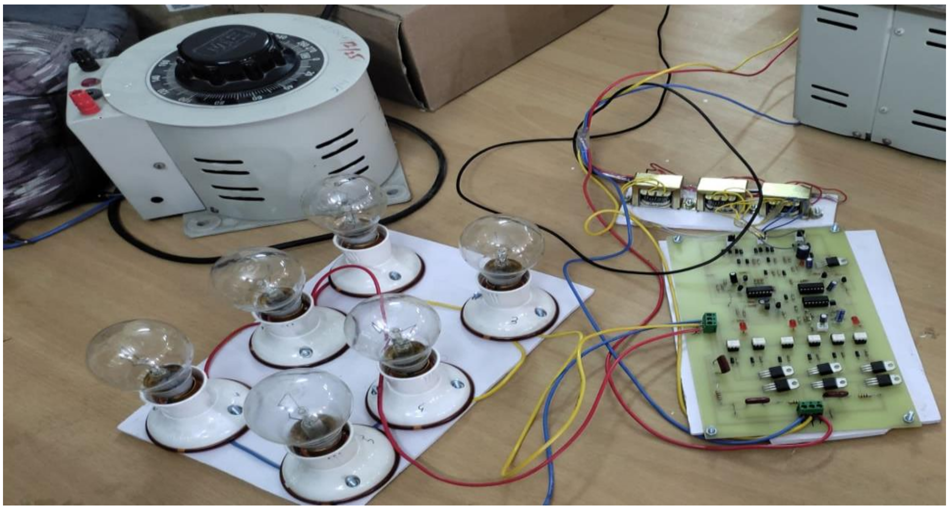

Figure 1: Hardware Prototype of Soft Starting of Three Phase Induction Motor

The components used in soft-starters are shown in tabular form.

Sr. No.	Name of component	Rating of Component	Number of Components
1.	Transformer	220-240/12V	3
2.	Diode	1N4007	12
3.	Opto-isolator	moc3021	2
4.	Voltage Regulator IC	lm7812	1
5.	Capacitor	470 micro-farad	1
6.	TRIAC	BT136	3
7.	Bulb	100W	6
8.	Resistance	120 Ω 330 Ω 1000 Ω 3.3 kΩ 10 kΩ	3 4 3 2 2
9.	Op-amp	lm324 lm339	1 1
10.	Transistor	bc558 bc547	1 1
11.	Filter	-	-

The circuit diagram of a three-phase induction motor soft starter is shown in figure 1. The circuit diagram consists of a voltage regulator, a zero detector, a PWM controller and a TRIAC circuit. The TRIAC circuit acts as a soft starter in each phase of a three-phase induction motor. The TRIAC circuit basically consists of two anti-parallel SCRs connected back-to-back. This soft starter is used for soft starting of induction motors.

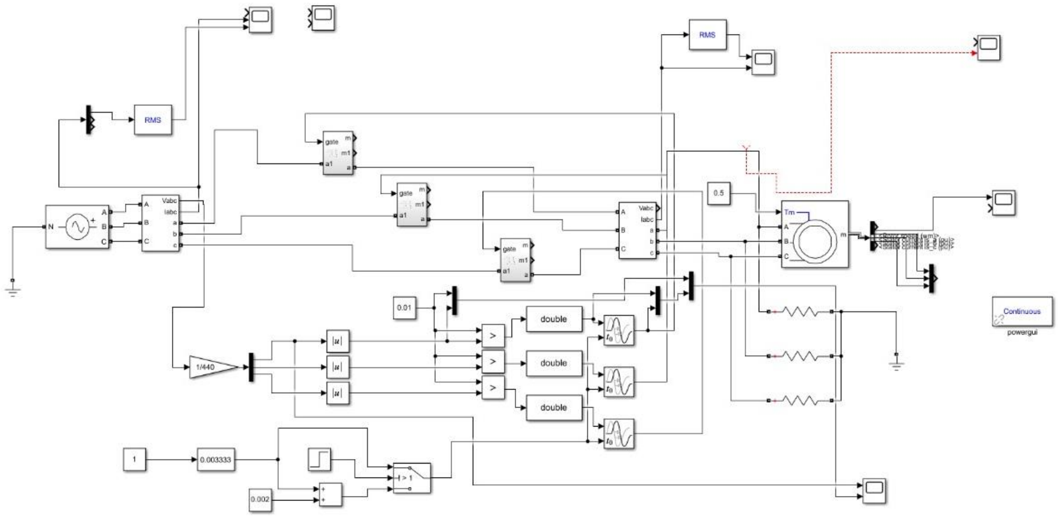

Figure 2: Circuit Diagram of soft starting of three phase induction motor.

Initially, the program provides maximum delay to reduce the power supplied to the motor and gradually reduce the delay to zero and thus deliver the full power to the motor. The negative terminal of the SCR in the TRIAC circuit is connected to the load terminals of the induction motor.

IV. RESULTS AND DISCUSSION

This method of soft starting initially after turning on the trigger is performed and it is related to the condition of the parallel connected SCRs in each phase. The activation is done by the amplifier trigger method. The current limiting process in the soft start method is very efficient compared to that of the D.O.L. starter and star-delta starter. The amount of current limiting can be changed or adjusted by varying the trigger angle of the SCR.

V. CONCLUSION

An effective and efficient technique has been presented in this paper which provides reduced voltage and reduced current at starting and at the same time, a control in an electromagnetic torque is also obtained. The motor torque is varied according to load torque and acceleration is maintained constant over the entire starting period with the help of this technique. The proposed approach eliminates shaft torque pulsations at the time of starting. The starting current is reduced significantly with the use of soft-starter circuit. The soft starter also eliminates the starting losses in the motor and hence it results in increased life and increased efficiency of an electric motor. It is found that the heating losses are reduced by 50% when soft-starters are employed during starting of three phase induction motor.

VI. REFERENCES

[1] Eltamaly, A.I. Alolah and R. M. Hamouda “Performance Evaluation of Three Phase Induction Motor under Different AC Voltage Control Strategies”. 2007 IEEE.

[2] G. Zenginobuz, I. Çadırcı, M. Ermiş, and C. Barlak, “Performance Optimization of Induction Motors During Voltage-Controlled Soft Starting,” IEEE Trans. Energy Conversion, vol. 19, no. 2,pp. 278- 288, June 2004.

[3] “Soft start for three phase induction motor”, IJAMTES, ISSN NO. 2249-7455.

[4] Ahmed Riyaz, Atif Iqbal, Shaikh Moinoddin, SK.Moin Ahmed and Haitham Abu- Rub ” Comparative Performance Analysis of Thyristor and IGBT based induction motor soft starters”. International journal of engineering, Science and Technology Vol.1, No.1,2009, pp. 90-105.A. M.

[5] https://youtu.be/5_0eRnkm3pk.