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Simulation of Single Phase Controlled Three Phase Electronic Soft Starter

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Abstract— *Soft starter is generally used to control the high inrush current drawn by motor during starting. The power section of soft starter is equipped with three sets of silicon controlled rectifiers connected back to back in parallel. This paper presents, silicon controlled rectifiers which are connected in series in one phase of the power supply circuit of a three phase induction motor. This paper aims to construct an inexpensive soft starting device with reduced complexity, size and losses.*

Key words— Soft starter, induction motor, single phase control, torque pulsation.

1. Introduction

Induction motor is widely used in industrial as well as domestic applications. Due to the extensive use of induction motors in industrial and residential applications, precise and smooth control of induction motor is essential requirement. High inrush current may cause adverse effects on induction motors. The problem is more severe in areas where the loads represent a high portion of the power demand. Medium or large induction motors draw such large current during direct-on-line starting process that it can pull down the voltage of the power supply net, which will severely influence the other electrical devices in the same power net. On the other hand, it also makes the temperature of motor become higher, which may lead to motor damage. Therefore, the motor's starting process needs to be controlled to reduce the start-up current to safe value. The idea behind a soft start is to gradually allow the motor current to rise until the motor reaches its steady state. This reduces start-up current and also reduces start-up motor torque. With the development of power semiconductor technology, it is proposed to achieve the soft starting of induction motor.

Soft starter provides a reliable and economical of these problems by delivering a controlled release of power to the motor, thereby providing smooth, steeples acceleration and deceleration. The damage to windings and bearings are reduced, resulting in an extended motor life.

A soft starter for a three-phase induction motor, comprising semiconductor devices for controlling voltages applied to the motor in three of the phases by adjusting firing angles of semiconductor devices, wherein two semiconductor devices are connected in anti-parallel with each other in each phase, are been used as shown in fig 1. The firing angle of the semi conductor devices is used for controlling the amount of energy supplied to the motor.

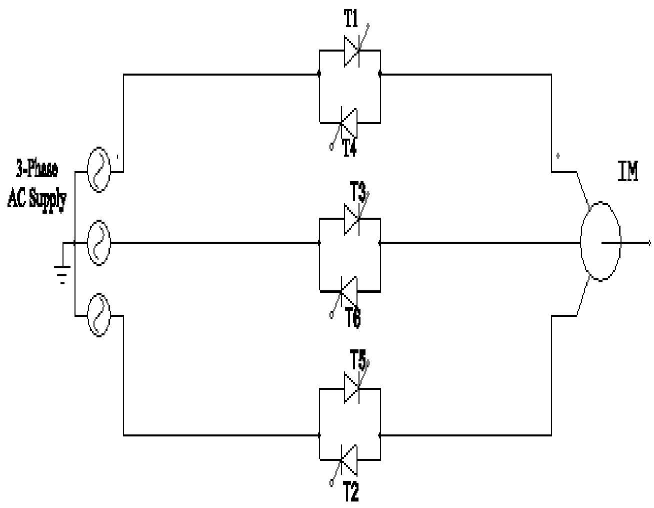

Fig. 1. Schematic of conventional soft starter.

In principle, reducing the impressed voltage upon the motor during starting reduces the starting current and torque pulsations. This is due to the fact that the starting torque is approximately proportional to the square of the starting current and consequently it is proportional to the square of the starting voltage. Therefore, by properly adjusting the applied effective voltage during start up, the starting torque and current can be reduced.

However, the semiconductor devices have become a cost-determining factor of such a soft starter, so a soft starter having only one pair of such semiconductor devices for three of the phases is used for controlling the voltage applied to three-phase motors. This means that the remaining two phases is in the form of a conductor, which cannot be switched. Firing angle α is a nonlinear function of motor speed and torque and it is very tricky to find the exact value of for any motor speed and torque. This paper proposes a new starting topology for selection of firing angles for thyristors in voltage controlled induction motor. In this paper simulation and results have been presented for the proposed method.

2. Proposed topology

Because of the advanced technology and revolution in power electronics, devices are going more & more compact.

However, the disadvantages of the above described prior art devices lie in the facts that their constructions are complicated and their cost is high, In this competitive world, everyone is worried about cost, power consumption and size of the device. The present topology provides improvements in regard to the previous drawbacks described above. The present topology relates to a device wherein silicon controlled rectifiers are connected in series in one phase of the power supply circuit of a three-phase induction motor and the other two phases are directly connected to motor. The present invention aims to construct an inexpensive soft starting device.

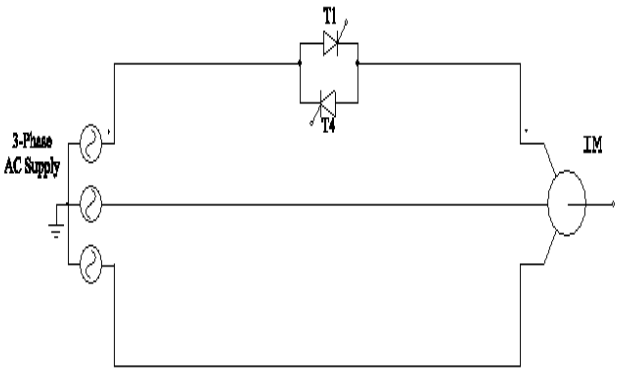

Fig. 3. Schematic of single phase controlled three phase soft starter

In this type of soft starter any one phase can be controlled. It can be R phase, Y phase or B phase. R phase controlled soft starter is shown in Fig. 3. In R phase controlled soft starter, Y phase and B contains higher current because of unbalanced voltage supplied to the motor.

In soft starter voltage supplied to the motor is controlled by varying firing angle of the SCRs. In conventional soft starter all three phases are controlled and hence balanced voltage is applied to the motor while in proposed topology two phases are directly connected to the soft starter and hence unbalance voltage supply is given to the motor. Because of unbalanced voltage, unbalanced current flow through the soft starter. Because of unbalanced current, unbalanced thermal stress is applied to the SCRs of controlled phase. Further it increases the harmonic content and optionally even turned into an additional direct current component of the current. This in turn causes an asymmetrical power distribution within the load. In an electric motor overload occurs thereby increased torque fluctuation. It can damage device as well as motor.

3. control strategy

Due to unbalanced voltage which produces unbalanced current in proposed topology we need to find a new starting sequence for selection of firing angle α for thyristor. In this topology we found the new range of firing angle α for thyristor by trial and error method. The firing angle α range decreases from 110˚ to 40˚. The graph of firing angle α is shown in the fig 4

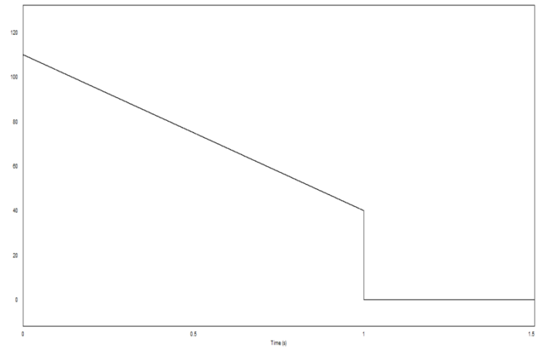

Fig. 4. Range of firing angle α

Simulation result on motor starting performance of conventional & proposed topology were obtained for a 1hp, 415V, six-pole, three phase induction motor, the characteristics of which are given in Appendix. Two simulation cases were conducted for comparisons, namely: 1) conventional soft starter; 2) proposed topology with proposed control. The simulation work was carried out in a PSIM.

The three phase conventional soft starter was first simulated. The results of the three phase motor currents are shown in Fig 6. As one can observe therein, the motor currents have smooth starting profiles as the firing angle is decreasing, with low starting currents. Here current in all three phases are equal while current in proposed topology with conventional control strategy has unequal current. To equalize this current, new corrective firing angle is applied which leads to equal voltage supply which results in a balanced current. The simulation. The result of three phase motor current for single phase controlled soft starter is shown in the fig 7. When the output is uncontrolled the current obtained was about nearly 380 ampere and by using the proposed scheme we controlled our output to nearly about 250 ampere.

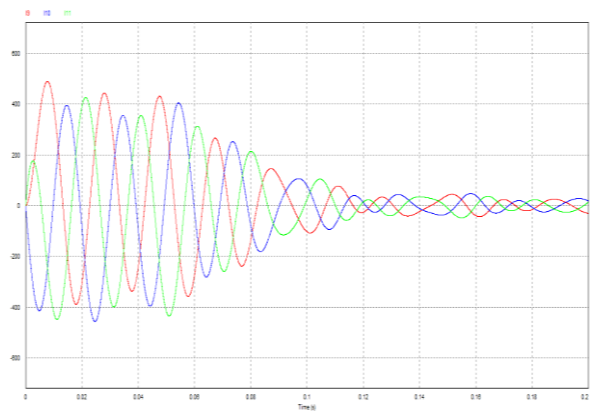

Fig. 6. Motor current in conventional topology.

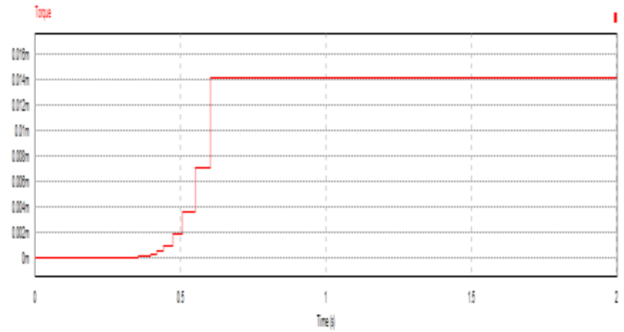

Fig. 7. Motor torque developed by conventional soft starter.

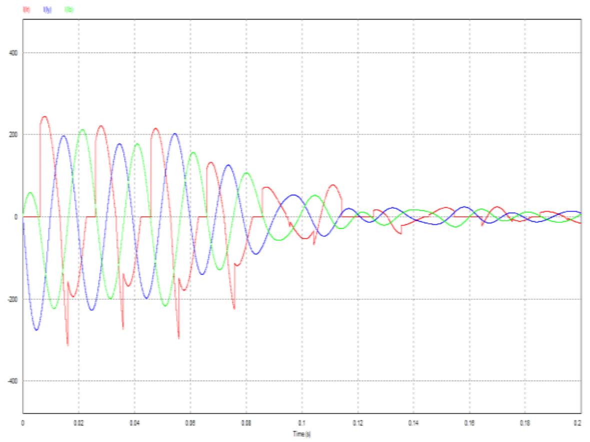

Fig. 8. Motor current developed by proposed soft starter.

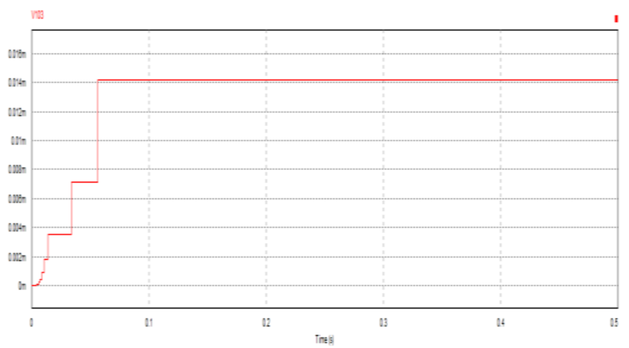

Fig. 9. Motor torque developed by proposed soft starter.

CONCLUSION

Single phase controlled soft starter uses only two SCRs instead of six SCRs and provides nearly same result as that of conventional topology. Average current flow through the motor in both the topology i.e. conventional and proposed is nearly equal. By eliminating four SCRs it can reduce cost of the soft starter. It also helps to minimize the size and losses of the soft starter thereby reducing the thyristors

APPENDIX

Rated Power:-	1 hp
Rated Voltage (Line-Line):-	415 Volts
Rated Current:-	26 Amps
Rated Frequency:-	50 Hz
Rated Speed:-	970 RPM
Phase:-	3
Number of Poles:-	6
Stator Resistance:-	0.294 Ω
Stator Inductance:-	0.001 H
Rotor Resistance:-	0.156 Ω
Rotor Inductance:-	0.0007 H
Magnetising Inductance:-	0.0041 H
Moment of Inertia:-	0.42 Kg.m^2

References

1. W. Shephered and J. Stanway, "The poly phase induction motor control by firing angle adjustment of silicon controlled rectifiers," IEEE International Convention Record, pp, 135-154, 1964.

2. W. Shephered, " On the analysis of the three phase induction motor with voltage control by thyristor switching," IEEE Transaction on Industry and general Application, Vol, IGA-4, pp, 304-311, May/Jun 1968.

3. C. B. Jacobina, R. L. de A. Ribeiro, A. M. N. Lima, and E. R. C. da Silva, "Fault- tolerant reversible AC motor drive system," IEEE Transactions on Industry Applications, Vol. 39, No. 4, pp. 1077-1084, Jul/Aug 2003.

4. G. Zenginobuz, I. Cadirci, M. Ermis, and C. Barlak, "Soft starting of large induction motors at constant current with minimized starting torque pulsations," IEEE Transactions on Industry Applications, Vol. 37, Issue 5, pp. 1334-1347, Sep/Oct 2001

5. M. S. Mendes and A. J. M. Cardoso, "Fault-tolerant operating strategies applied to three-phase induction-motor drives," IEEE Transactions on Industrial Electronics, Vol. 53, No. 6, pp. 1807-1817, Dec. 2006.

6. M. B.de R Corrêa, C. B. Jacobina, E. R. C. da Silva, and A. M. N. Lima, "An Induction motor drive system with improved fault tolerance," IEEE Transactions on Industry Applications, Vol. 37, No. 3, pp. 873-879, May/Jun2001