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A Review on Energy Conservation by Using Automatic Star Delta Star Starter

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ABSTRACT: India is developing country. Electric power is the basic necessity for the economic development of country. So, the power should be handled efficiently to meet the requirement. In Conventional Star Delta Starter design normally consists of three contactors, an overload relay or circuit breaker, and a timer for setting the time in the Star position (starting position). In Conventional Star Delta starter has some limitations of power saving. So, the proposed project presents the delta star convertor which is interfaced with the conventional star-delta starter. When the load on motor is less than 40-60% of the full load, it switches the motor connection in star mode to save electrical energy. When load on motor exceeds approximately 50% of the full load, it changes over the motor connection automatically in delta mode without any disturbing working of the motor. By implementing this module in industries for saving of electrical energy is possible.

KEYWORDS: Contactors, Timer, Induction Motor etc

I. INTRODUCTION

The main use of motor starter is to reduce the starting current. The starter used for three phase Squirrel cage induction motors (>5HP) are Star delta Starter. But when the starting action taking place, the motors take maximum current which is approximately 7-8 times than rated current of motor. If this will happen in the starting period then copper losses occurring in the motor and rotor windings due to high starting current are very large which would produce a lot of heat in the motor and it may damage the insulation of winding and motor becomes short-circuited and it does not work.

For providing the protection against overcurrent Star Delta starter is used for those purposes. When motor starts in starting period in Star mode and then it switches to Delta mode after speed reaching to 70-80% of maximum speed of the motor. In industries most of times three phase induction motors are used. Since industries are consuming more power, so we have to focus on that area.

The proposed systems save the energy by switching the stator winding connection either in star or delta mode according to load variations. When the load on motor is lesser than 50% of full load then motor terminal switches to star mode to save the energy. When load on motor is increased beyond the 50% of full load then motor terminal is switches to delta mode.

Since the power utilisation in delta mode is 3 times greater than star mode. So, this will lead to power saving.

II. LITERATURE SURVEY

Conventional Star delta starter-

This type of starter used very common in three phase induction motor. This starter uses concept of reduced voltage technology. A star delta starter will start a motor with a star connected stator winding. When motor reaches about 80% of its full load speed, it will begin to run in a delta connected stator winding. The below figure shows the wiring diagram of star delta starter.

Since, the motor is in star mode during starting the starting current is reduced by $\sqrt{3}$ times of the delta mode starting current and also the windings will get the line voltage across it. Since the torque developed by the induction motor is proportional to the square of the applied voltage.

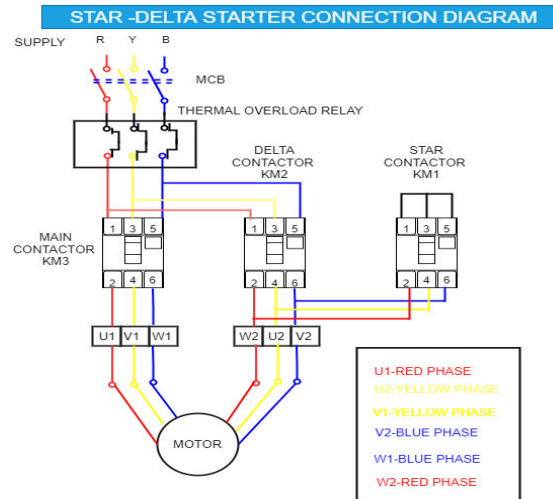


Fig. 1. Power circuit diagram of automatic star delta starter for 3 phase induction motor

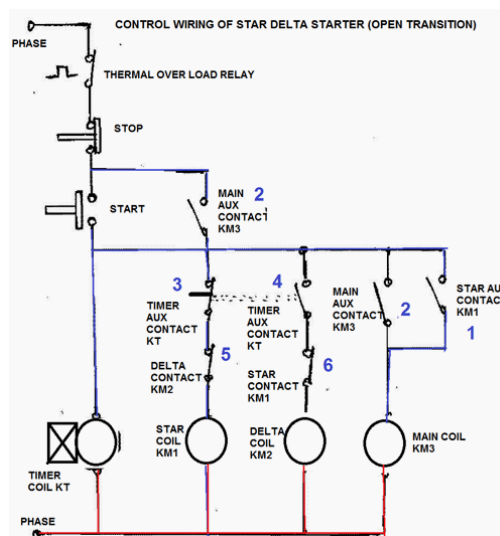


Fig. 2. Control circuit diagram for automatic star delta starters for 3 phase induction motor

Working-

From L1 The phase current flows to thermal overload contact through fuse, then OFF push button, On push button Interlocking contact 2, and then C3. This way, the circuit is completed, as a result;

1. Contactor coil C3 and timer coil (I1) is energized at once and the motor winding then connected in Star. When C3 is energized, its auxiliary open links will be closed and vice versa (i.e., close links would be open). Thus, C1 Contactor is also energized and Three Phase Supply will reach to the motor. Since winding is connected in Star, hence each phase will get $\sqrt{3}$ times less than the line voltage i.e., 230V. Hence Motor starts safely.
2. The close contact of C3 in the Delta line opens because of which there would be no chance of activation of contactor 2 (C2).
3. After leaving the push button, Timer coil and coil 3 will receive a supply through Timer contact (Ia), Holding contact 3 and the close contact 2 of C2.

4. When Contactor 1 (C1) is energized, then the two open contact in the line of C1 and C2 will be closed.
5. For the specific time (generally 5-10 seconds) in which the motor will be connected in star, after that the Timer contact (Ia) will be open (We may change by rotating the timer knob to adjust the time again) and as a result;
6. Contactor 3 (C3) will be off, because of which the open link of C3 will be close (which is in the line of C2) thus C2 will also energize. Similarly, When C3 off, then star connection of winding will also open. And C2 will be closed. Therefore, the motor winding will be connected in Delta. In addition, contact 2 (which is in the line C3) will open, by which, there would not be any chance of activation of coil 3 (C3)
7. Since the motor is connected in Delta now, therefore, each phase of the motor will receive full line voltage (400V) and the motor will start to run in full motion.

Power relationship in star and delta connection-

Consider V_s is supply voltage per phase. So, the line voltage of supply will be $\sqrt{3}$ times V_s

For delta connected load:

Power per phase, $P_d = I^2 R = (\sqrt{3} V_s) / R$ {line voltage of the supply is directly applied to the phase of the delta load}

$P_d = ((\sqrt{3} V_s) / R)^2 R = (3 V_s^2) / R$ watts per phase.

For 3 phases: $P_{3d} = 3 P_d = (3 * 3 V_s^2) / R = (9 V_s^2) / R$ in watts.

For star connected load:

$P_s = I^2 R = (V_s / \sqrt{3})^2 R = (V_s^2) / 3 R$ in watts.

For 3 phases: $P_{3s} = 3 P_s = (3 V_s^2) / 3 R$ in watts

So, we can see that the power in the delta connection is 3 times greater than that of the star connection.

Proposed star delta star starter

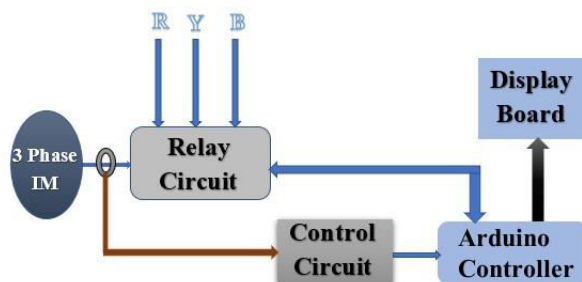


Fig. 3. Block Diagram of Proposed Starter

It is an electrical device which saves electrical energy during variable load conditions in three phase induction motor by means of running motor in star mode. The 3-phase winding inside the motor can be connected in star or delta connection. If the windings of a 3-phase motor are in star the voltage applied across per phase winding is reduced to only $(1/\sqrt{3})$ of the voltage applied to the winding when it is connected in delta. The current per winding is reduced to only $(1/3)$ of the normal running current taken when it is connected in delta so, because of the Power Law,

$$P = V * I \text{ (Watt)}$$

As per law,

If we can reduce the applied voltage on the winding then the power consumption by the motor is also reduced to $1/3$ as per mentioned in above.

When the motor is connected in star mode the total output torque is only $1/3$ of the rated torque produce when running in delta mode. During partial load or no-load period motor is supplied with 415v or 440 volts per phase, but that much power is not required in that load condition. So, by reducing the voltage applied during partial load condition power can be saved. Normally motors run in delta mode (not depending upon load). So, by making motor to run in star mode during these no-load periods only $1/\sqrt{3}$ time's line voltage is applied which reduces power input to the motor.

Current sensor used which continuously monitors the current variations and provides the necessary feedback signal as per the designed. Based on the feedback from current sensor the delta-star module is introduced which performs as an energy saver, to avoid the frequent unwanted switching's the output from the sensor will be monitored by using an additional timer and this period can be varied manually as per the requirement. During starting the motor will start in star and change over to delta (if load is greater than 30%) and then motor must be run in star (when load on motor less than 30%), for that starter should changeover connection to star to save the electrical energy.

This proposed starter changeover connection from star to delta or delta to star is based on current instead of time that the motor is started with different loads at different times and the timing set in the timer may not be always suitable for these differing loads. It may be too high or too small. About 20-25 % of energy gets saved by incorporating delta star conversion module. This is carried out by using comparator circuit.

Proposed Result-

Sr. No.	Conventional Star- Delta Starter		Proposed Star- Delta-Star Starter	
	Voltage	Current	Voltage	Current
1.	432	4.1	227	2.52
2.	431	4.3	226	2.53
3.	430	4.2	229	2.54
4.	428	4.4	236	2.55
5.	429	4.5	234	2.56
6.	427	4.6	231	2.56

Table No.1

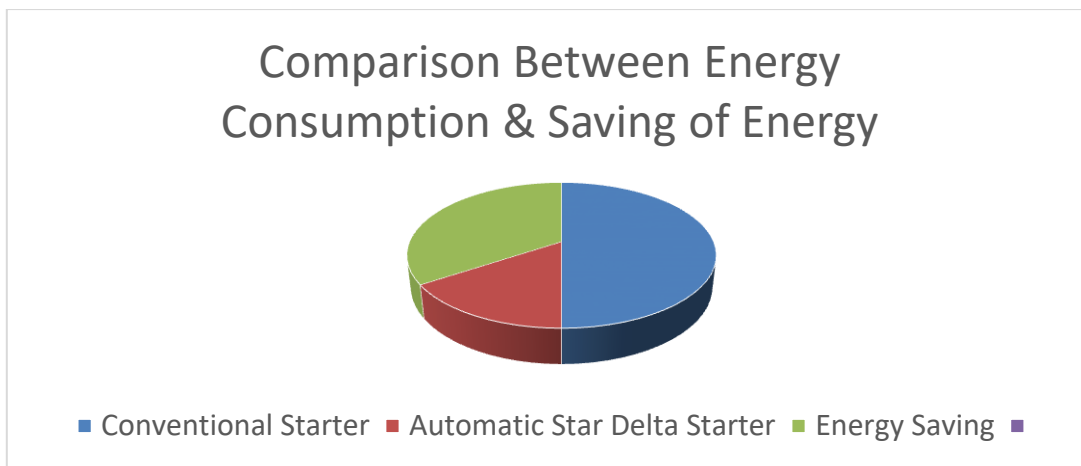


Fig. 4. Comparison Between Energy Consumption and Saving of energy

ADVANTAGES:

- Energy Conservation
- Increase Efficiency
- Reduce Starting Current
- Reduce No Load Losses
- Improve Power Factor
- Life is more
- Good torque and current performance

APPLICATIONS:

- Press machine
- Conveyors and Textile Mills
- Centrifugal Compressor.



- Industrial Agitator's. (Chemical & Food)
- Hoist, Escalators
- Machine Tool

III. CONCLUSION

If the motor can be takes the torque requirement in star mode, then we can always run the motor in star mode. This can save 30% of power when compared to delta mode. The operating life of the machines also is increased by the implementation of this module.

- i. Power factor is better in star mode.
- ii. Usage of capacitor banks to improve power factor is reduced.
- iii. The size of the conductor can be reduced.

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