Energy Conservation Using Automatic Star-Delta-Star Starter

D.M. Bokde[1], S.S. Jalkote[2], M.V. Birajdar[3], Asst. Prof. R.S.Biradar[4]

[1](Electrical Engineering, JSPM's BSIOTR, Wagholi, Pune
[2](Electrical Engineering, JSPM's BSIOTR, Wagholi, Pune
[3](Electrical Engineering, JSPM's BSIOTR, Wagholi, Pune
[4](Asst. Prof. of Electrical Engineering, JSPM's BSIOTR, Wagholi, Pune

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Abstract - *India is a developing country. Power is the basic necessity for the economic development of country. So the power should be handled efficiently to meet the requirement. The proposed paper present the efficient use of the star-delta starter in since of power saving. The delta star convertor is interfaced with the conventional star delta starter. When the load on motor is less than 30% of the full load, it switches the motor connection to operate in star mode to save electrical energy. When load on motor exceeds 30% of the full load, it change over the motor connection automatically in delta mode without any disturbing working of the motor. By implementing this module saving of electrical energy is possible. So that contribution to reduce maximum demand, reduction in KVA, increase in power factor to the power system.*

Key Words: **- delta-Star starter, Energy Saving, Timer.**

1. INTRODUCTION

India has 16% of world's population, but less than 1% of the world's energy resources. Deficiency in the demand and availability of energy the total installed capacity is 207006MW and the present peak demand s 2170000MW. The real challenges for the power sector is to narrow this gap.

This can be done by increasing the installed capacity; which has it's own limitation. Hence going by the dictum energy saved is energy generated. It is big challenges for the power sector save the energy to narrow the gap between demand and supply.

In industries, more than 80% of the motors are the induction motor. Since industries are consuming major part of the power, we have to concentrate on energy saving from this area. There is huge potential to save energy in this sector up to 25%.

Now a day's usage of electrical energy gradually increasing, to meet that requirement, either to increase generation or to focus on electricity conservation. But the expansion of power generation, power grid and transmission has been restricted due to limited resources and environmental, economical constraints. Here in this project proposal for energy saving in induction motor is introducing apart from reducing fossil fuel consumption. Proposed system saves energy by changing the stator windings connections either in star or delta mode according to load variations. When load on the motor reduces below 30% of full load, it switches the motor to operate in star connection from delta to save the energy. When the load increases beyond 30% of the full load, it switches the motor connection to operate in delta mode. Since the power consumption in star is $\frac{1}{3}$ rd of delta, this will lead to power saving.

2. WORKING

2.1 Conventional star delta starter

This method is used in case of motors which are built to run normally with a delta-connected stator winding. the six terminals from the three phases of the stator must be available on motor terminal box.

The starting of induction motor with the help of conventional automatic star delta starter is done. The time delay in this starter, before changing over from the star to delta connection should be sufficient to allow the motor peak up to its normal running speed. This period may be taken as 10 second, but could be less for a lightly loaded motor and greater for a slow starting heavily loaded motor

In an automatic star-delta starter, this delay is obtained by using a timer. During starting period motor should start in star mode, applied voltage is reduced by rd operated voltage. Since the starting current of motor will reduced 1/3rd of the current with compared to the delta connection. Since the torque developed by induction motor is proportional to the square of applied voltage. Therefore star delta starting reduce the starting torque by 1/3rd that of the direct online starting.

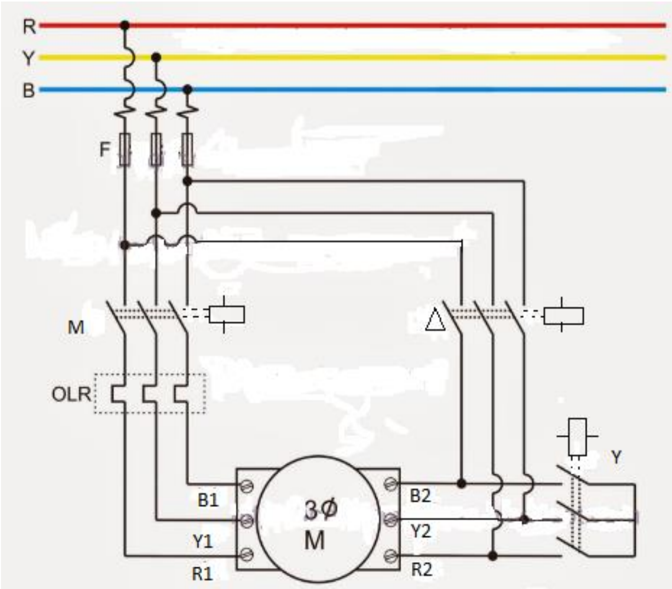


Fig. 1 Power circuit diagram of automatic star-delta starter

Fig.1: Power circuit diagram of automatic star-delta starter.

The above fig.1 shows power circuit diagram of conventional automatic star-delta starter.

The schematic diagram for the control circuit has been shown in fig.2

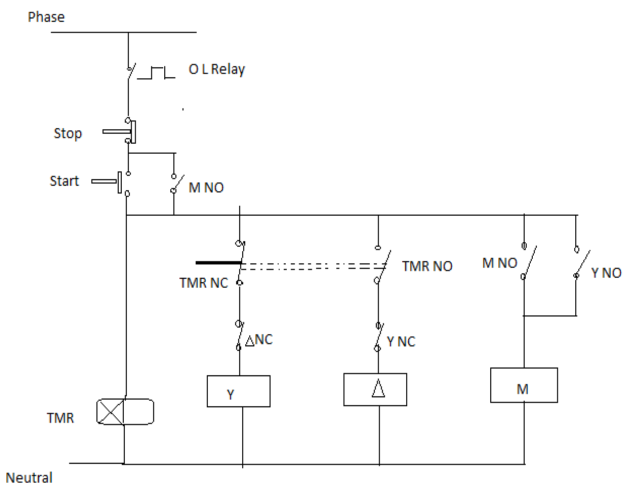


Fig. 2 Control Circuit diagram for Automatic star-delta starter

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

When the start push button is pressed contactor star gets energized connecting the stator terminal in star. The winding get three phase supply through the contactor main which is now energized due to the closing NO contact of star contactor. The motor will start rotating with its stator windings star connected. When the motor peaks up normal speed (say in 10 sec) the time delay contacts will open and de-energies the star contactor. NO contact of contactor star will close and therefore delta contactor will get energized connecting the winding terminals in delta across the supply. For interlocking between the two contactors star and delta, one NC contact of star contactor has been connected in series with delta contactor and one NC contact of delta contactor has been connected in series with star contactor.

2.2 Proposed Star-Delta-Star Starter

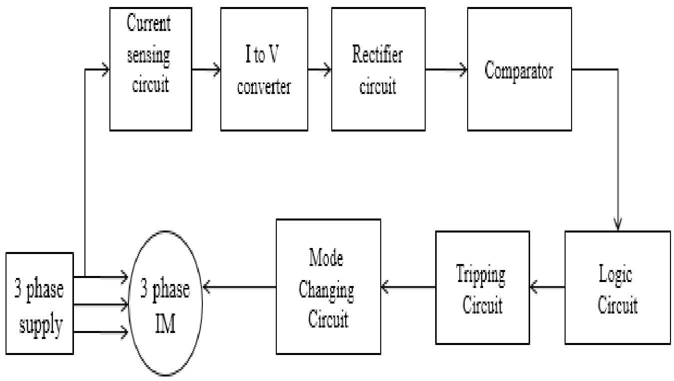


Fig.3: Block Diagram of Proposed Starter

It is a device which saves electrical energy during variable load conditions in three phase induction motor. The 3 phase winding inside the motor can be connected in star or delta. If the windings of a 3 phase motor are connected in star the voltage applied across per phase winding is reduced to only (1/√3) of the voltage applied to the winding when it is connected directly across supply line phases 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,

V [in volts]* I [in amps] = P [in watts],

The total output power when the motor is connected in star is,

$P_S = [V_L*(1/\sqrt{3})] * [I_D*(1/\sqrt{3})] = P_D*(1/3)$ [i.e. one third of the power in delta]

$$P_s = \frac{1}{3} P_D$$

Relation in Star:

$$I_{st}\text{/Phase} = I_{st}\text{/Line} = \frac{V_{ph}}{\sqrt{3}Z}$$

Relation in Delta:

$$I_{dt}\text{ /Phase} = \frac{V_{ph}}{Z}$$

$$I_{dt}\text{/Line} = \frac{\sqrt{3}V_{ph}}{Z}$$

$$I_{st}\text{/Line at start} = \frac{1}{3} I_{dt}\text{/Line}$$

Abbreviations and Acronyms

I_{st} / Phase = Starting Current/phase in Star

I_{st} / Line = Starting Current/Line in Star
I_{dt} /Phase = Starting Current/ Phase in Delta
I_{dt}/Line = Starting Current/Line in Delta
Where,

V_L- The line-line voltage of the incoming 3 Phase Supply.

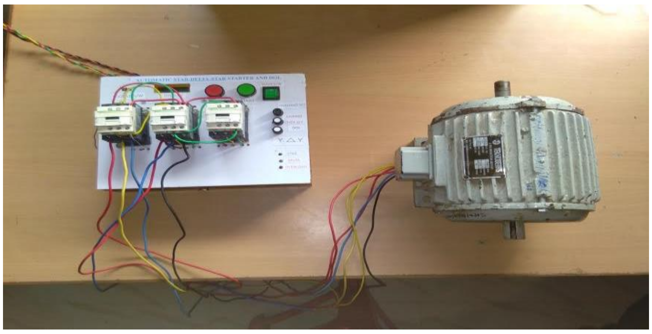
I_D- The line current drawn in delta.

P_S- The total power the motor will produce when running in star.

P_D- The total power it will produce when running in delta.

When the motor is connected in star the total output torque is only 1/3of the rated torque produce when running in delta.
During partial load or no load period motor is supplied with giving 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 depends upon load). So by making motor to run in star mode during these no load periods only 1/√3 time's line voltage is applied which reduces power input to the motor. Current sensor continuously monitors the current variations and provides the necessary feedback as per the design. Based on the feedback from current sensor the delta-star module 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. Motor 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 starter changeover connection from star to delta 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 25-30 % of energy gets saved by incorporating delta star conversion module. This is carried out by using Comparator.

Fig.4: Actual Hardware Modal



3. RESULT

Table-1: Result Analysis

Motor Rating (KW)	Motor: 5Hp,1440 RPM, 440 V,7.5A (Crompton)					
	% Load (Amp)	Winding type			Power (Watt)	Saving of Energy (Kwh)
3.7	No Load	STAR	250	1.2	180	0.22
	No Load	DELTA	440	2.6	400	
	30% load	STAR	250	2.1	560	0.59
	30% load	DELTA	440	4.4	1150	
	Full Load	DELTA	440	7.5	3715	0

4. CONCLUSION

This particular project is discussing a method to improve the total efficiency of the induction motors used in press Machines, Injection Moulding Machines, Agitators, Conveyors and Textile Mills etc. The life span of the machines also is increased by the implementation of this. Efficiency optimization is very much essential not only to electrical systems, it require all the systems. to get beneficial in terms of money and also reduction in global warming.

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