CYCLIC LOAD ENERGY SAVER BY USING DELTA STAR CONVERTER

Shalet P. Abraham*,A.Sakthivel**
*PG Scholar,M.P.N.M.J Engineering College,Erode,Tamilnadu,India.
**Assistant Professor,M.P.N.M.J Engineering College,Erode,Tamilnadu,India.

***Abstract*— Power is the basic necessity for the economic development of a country. The power should be handled in an efficient manner to meet the power requirement. The paper presents the effective usage of star – delta starter in a power saving way in particular applications. Delta star Converter Module is the system to be interfaced with the existing Star Delta starter. When the load on the motor is less than 50% of full load, it switches the motor to operate in STAR to SAVE ENERGY. When the load increases beyond 50%, it automatically switches the motor to operate in DELTA without disturbing the working of motor. This module is recommended for applications where load changes are not too fast. This is suitable for any capacity motor by using appropriate Current Transformer and calibrating the same. By implementing this energy saving is possible. Reduction in KVA, contributing to reduction in maximum demand and reduction in power factor are the effective outcomes of this project implementation.**

***Index Terms*— Star-Delta starter, power factor, Energy saving, Maximum demand reduction.**

I. INTRODUCTION

In recent years, the power demand has increased in a drastic manner. But the expansion of power generation and transmission has been limited due to limited resources and environmental restrictions. The increasing demand for power has led to considerable fossil fuels burning which has in turn had an adverse impact on environment. In this situation efficient managing of energy is very important. It has been estimated that nearly 25,000 MW can be saved by implementing end-use energy efficiency and demand side management measures throughout India. Efficient use of energy and its conservation assumes even greater importance in view of the fact that one unit of energy saved at the consumption level reduces the need for fresh capacity creation by 2 times to 2.5 times. Moreover, such saving through proper usage of energy can be achieved by at less than $1/5^{th}$ the cost of fresh energy [5]. Therefore conservation and proper management of energy saving is very important thing.

In industries, more than 80% of the motors are AC induction motors. An AC induction motor can be single phase, poly-phase, brushed, or brushless. Since industries are consuming major part of the power, we have to concentrate on energy saving from this area. Here in this project a proposal for energy saving in induction motors is introducing apart from reducing fossil fuel consumption[2].

The proposed system will help energy saving and increasing the life span of the induction motors are prime things. In order to achieve these needs, we are implementing a change in the conventional star – delta starter. Delta star converter module is the system to be interfaced with the existing Star Delta starter. When the load on the motor is less than 50% of full load, it switches the motor to operate in STAR to SAVE ENERGY[4]. When the load increases beyond 50%, it automatically switches the motor to operate in DELTA. Since the power consumption in Delta is 3 times greater than Star, this will directly leads to power saving.

II. CONVENTIONAL STAR-DELTA STARTER

The star delta starting is a very common type of starter. Star delta starter is used more than any other type of starters [1]. This method uses the reduced supply voltage in starting. This is achieved by low starting current by first connecting the stator winding in star configuration, and then after the motor reaches a certain speed, throw-switch changes the winding arrangements from star to delta configuration. While starting the motor in star, the starting current can be reduced one-third of the current with compared to delta connection [3]. Since the windings are connected in star in the starting, the windings will get the line voltage across it [4]. Since the torque developed by an induction motor is proportional to the square of the applied voltage, star- delta starting reduced the starting torque by one – third that obtainable by direct delta starting [3].

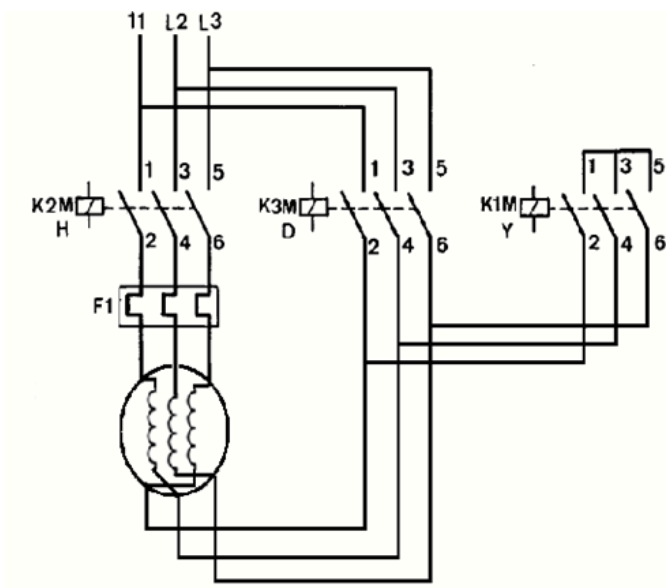

Fig.1. Star- Delta starter

ISSN: 2278 – 7798

III. POWER RELATIONSHIP IN STAR AND DELTA CONNECTION

Let‘s suppose V_s be the supply voltage per phase. So the line voltage of the supply will be $\sqrt{3}V_s$.

For Delta connected load:

Power per phase, $P_D = I_2R$ $I = \sqrt{3}V_s/R$ {as line voltage of the supply is directly applied to the phase of the delta load}

$$\mathbf{P_d = (\sqrt{3}V_sV_s/R)_2R = 3V_{s2}/R \text{ watts per phase.}}$$

For 3 phases:

$$\mathbf{P_{3D} = 3P_d = 3*3V_{s2}/R = 9V_{s2}/R \text{ watts.}}$$

For Star connected load:

$$\mathbf{P_S = I_2R = (V_s/R)_2R = V_{s2}/R \text{ watts}}$$

For 3 phases:

$$\mathbf{P_{3S} = 3P_S = 3\ V_{s2}/R \text{ watts}}$$

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

IV. PERFORMANCE OF PROPOSED CYCLIC LOAD ENERGY

Cyclic load energy saver is equipment developed to save power on variable load machines especially for which are running in no-load or partial load for long time. Using delta to star change over during no-load or partial load, the power can save up to 30 to 40% of the no-load power. Cyclic Load Energy saver is the advanced version of the fully automatic Star Delta starter. This unit save power during the A conventional Star-delta starter is used to make three-phase motors start and run efficiently. The three windings inside a three phase motor can be connected in one of two different ways: either in "star" or in "delta"[1]. During motor start-up a way must be found to make the connections change over from star to delta at the right time. One way is to use a special circuit called a "star-delta motor starter”.

The starting current of any heavy electric motor can be more than 4 times the normal load current it draws when it has gained speed and has reached its normal running output power and temperature. So, if it were started simply when connected in DELTA, the starting current would be huge. So we would require large circuit breakers, big enough to allow the start-up surge current to pass without immediately shutting it off. If the windings of a 3-phase motor are connected in STAR: the voltage applied to each winding is reduced to only (1 /3) [1 divided by root three] of the voltage applied to the winding when it is connected directly across two incoming power service line phases in DELTA. The current per winding is reduced to only (1 /√3) [1 divided by root three] of the normal running current taken when it is connected in DELTA. So, because of the Power Law V [in volts] x I [in amps] = P [in watts], the total output power when the motor is connected in STAR is: PS = [VL x (1/√3)] x [ID x (1/.√3)] = PD x (1/3) [one third of the power in DELTA] where: VL is the line-to-line voltage of the incoming 3-phase power service ID is the line current drawn in DELTA PS is the total power the motor can produce when running in STAR PD is the total power it can produce when running in DELTA.[5] Another disadvantage when the motor is connected in STAR is that the total output torque is only 1/3 of the total torque it can produce when running in DELTA.

V. METHODOLOGY

During partial load or no-load period motor is supplied with 400/440v as that much power can be saved. Normally motors run in delta mode. l .e. full voltage is applied to the motor. So by making the motor to run in start mode during these no-load only 1/√3 times the line voltage is applied to the each phase winding of the motor which reduces the power input to the motor. Current sensor continuously monitors the current variations & provides the necessary feedback as per the design. Based on the feedback from current sensor the Delta Star module performs as a Energy saver to avoid the frequent unwanted switching‘s the output from the sensor will monitor by using a additional timer and this period can be varied manually as per the requirement. The control circuit of the proposed system is shown below.

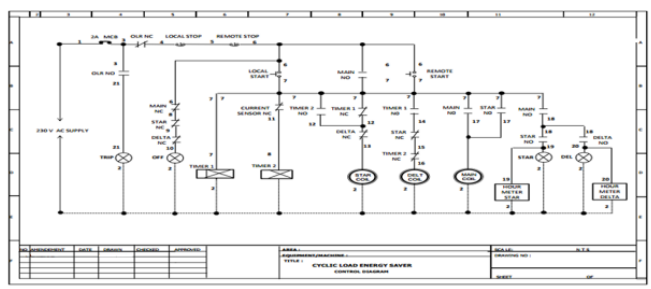

Fig. 2. Control circuit of cyclic load energy saver

Start in star and changeover to Delta and then operate in Star or delta, based on load. Start in Delta and changeover to star when the load is less than 50% (for motors with high starting torque requirement). Changeover from Star to Delta based on current instead of time.(It is likely 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. Hence this facility will take care of this problem.

VI. SIMULATION RESULTS

The simulation of the proposed system is done in the PLC simulation software. The simulation results clearly explain the working of the system in different load conditions.

The control circuit is implemented in the PLC simulator software.

ISSN: 2278 – 7798

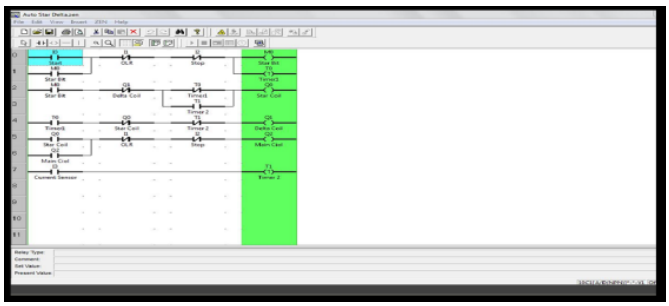

Fig 3: Cyclic load energy saver by using star delta starter-PLC ladder program

When the supply is switched ON, then the supply will be available at I2, T0, T1 and I2.the green color in Fig:4 shows the current flow.

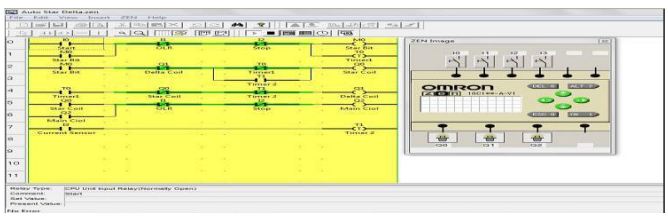

Fig 4: Supply switched On

Now, the START button (I0) is pressed, then the supply will available across the timer1, star coil and main coil. Fig:5 shows the details. Green color in the diagram shows the activated regions. Q0 and Q2 are the STAR and MAIN coil indicators.

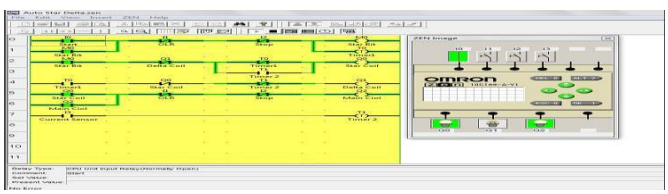

Fig 5 :START button pressed

Now the motor started running, then the STAR coil get released and DELTA COIL will get connected. Fig :6 indicated this, Q1 Is the indication of Delta coil.

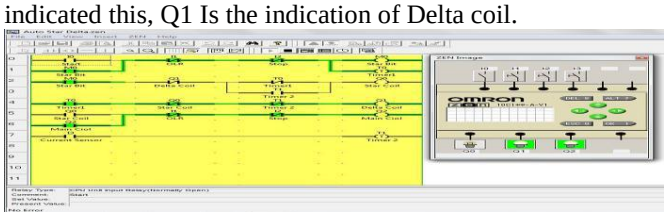

Fig: 6 DELTA coil get connected

I3 indicates the current sensor output. We can apply a current value which is less than 50% of load current, and then the timer2 will start counting down. If the low current maintains more than 2 minutes, then the DELTA coil get released and STAR coil come in action. Which is shown in Fig:7

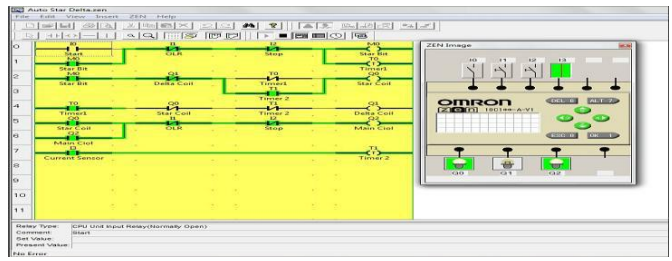

Fig .7 DELTA to STAR conversion, when I3 activated.

VI. TEST RESULTS AND SCOPE FOR SAVING:

Following parameters of the new system to be plotted as a comparison with the existing system.

1. Power savings.
2. Power factor improvement.
3. Reduction in KVA demand
4. Working time in different modes (Delta / Star)

Given below is a table showing the scope for saving energy for the motors of different capacity ranges at different loads. The actual values will vary from motor to motor and the savings can be higher or lower depending upon electrical parameters and mechanical condition of the motor

Table I Energy Saving In Different Motors

Load %	*Savings %*		
	1 TO 15 HP	*16 TO 40 HP*	*41 TO 150 HP*
NO LOAD	76%	60%	45%
10%	40%	30%	22%
20%	26%	22%	20%
30%	15%	13%	12%
40%	9%	8%	7%
50%	6%	5%	4%

ENERGY SAVING DATA FOR A 5 HP MOTOR

In tests conducted on a 5 HP motor with a full load current of 7.9 amps the savings on no load is 65.3%, reduction in operating current is upto 79.4%, reduction in demand 78.8% and improvement in power factor 60%. Please refer to the table given below .

ISSN: 2278 – 7798

Table II Energy Saving In 5 HP Motor

CURRENT		POWER FACTOR		POWER		VOLT AMPS	
Delta	Star	Delta	Star	Delta	Star	Delta	Star
3.66	0.84	0.17	0.23	367.3	128.6	2140	532
4.61	0.95	0.15	0.24	476	165	3025	641
4.68	0.99	0.15	0.34	545	233	3177	673
4.74	1.39	0.28	0.65	866	606	2961	887
5.04	2.00	0.43	0.80	1240	986	2922	1231
5.52	2.72	0.53	0.85	1741	1493	3298	1735
6.24	4.96	0.71	0.86	2691	2559	3661	2918

VII. CONCLUSION.

This particular paper 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.

First Author : Shalet P. Abrahm , P.G Scholar, M.P.N.M.J Engineering College, Erode, Tamilnadu, India ,

Second Author : A.Sakthivel , Assistant Professor, M.P.N.M.J Engineering College, Erode, Tamilnadu , India.

REFERENCES

[1] Assessment and comparison of conventional motorstarters and modern power electronic drives for inductionmotor starting characteristics.Pillay, K. ; Nour, M. ; Yang, K.H. ; Harun, D.N.D. ; Haw, L.K. Industrial Electronics & Applications, 2009. ISIEA 2009. IEEE Symposium

[2] Energy saving operationof induction motors by voltage reduction at no and low partial-loadPalit, B.B. Industry Applications Society Annual Meeting, 1989., Conference Record of the 1989IEEE DOI: 10.1109/IAS.1989.96644.

[3] Engineers and Computer Scientists 2009 Vol IIIMECS 2009, March 18 - 20, 2009, Hong Konghttp://www.thelearningpit.com/plc/psim/psim.html.

[4] Energy conservation of a novelsoft starter controlled by IGBT for induction motors with minimum currentLi Guangqiang ; Luo Guangfu ; Yu Hongxiang ; JiYanchao

[5] Energy saving operationf induction motors by voltage reduction at no and low partial-load .

ISSN: 2278 – 7798