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Operating Three Phase Induction Motor on Single Phase Supply (For Star Connection)

Sambhaji B. Mali[1], Rohit Y. Hiware[2], Dhairyasheel S. Patil[3], Dhanaji Y. Shirke[4], Prof. Y.N. Burali[5]
[1,2,3,4,5]*Electrical Engineering Department, NMCOE, Shivaji University Kolhapur, India.*

Abstract: ***This research is purposed to established a new method is simple and good to operate the three phase induction motor on single phase power by using capacitor. The research was conducted at laboratory of "AG ELECTRO SERVICES, KARAD. This project is sponsored by AG ELECRO SERVICES, KARAD". Also the electrical engineering department of NANASAHEB MAHADIK COLLEGE OF ENGINEERING, PETH. The object used in this research was three phase induction motor that has the standard of 2 HP, 440 volt, Wye connection, 2 Pole, 50 Hz, 3000 RPM, 3.08 Amp. The result of this research showed that the method could work well to control the motor to operate properly to load 85% of the full load. In general the motor has better performance when operating on single phase power system in all load cases (low at high load). The motor could operate with power factor close to unity, higher speed and better efficiency. The motor operated with higher current harmonic distortion with low loads but lower current harmonic distortion at high loads. There for it is very good to operate the motor at high load up to 85% of its full load.***

Keywords: Designing of 2 HP, 3-phase induction motor, capacitor circuit, apparent power of motor, power factor.

I. INTRODUCTION

The three phase induction motor has three coils identities are separated from each other across 120^0 electricity that powered by Three phase power system. They will produce resultant magnetic flux that rotates like poles actual magnets spinning mechanism. RMS voltage developed in coils of motor is shown in below fig-1.

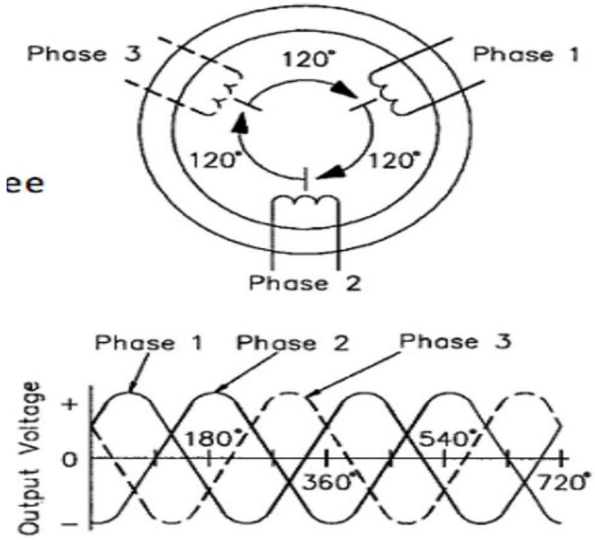

Fig-1.RMS voltage developed in coils of motor.

If the starting torque is not enough, it can be improved by adding a motor star capacitor with a capacitance value of approximately two times the pointed. This capacitor must be evaluated after having carried out test of real application test. The three phase motor can operate in single phase power supply with the help of permanent CAPACITOR. This small thing (capacitor) very helpful to make three phase motor running on single phase power supply.

Normally three phase induction motor operates on three phase power system, to improve the starting torque of the motors; they can operate on a single phase supply.

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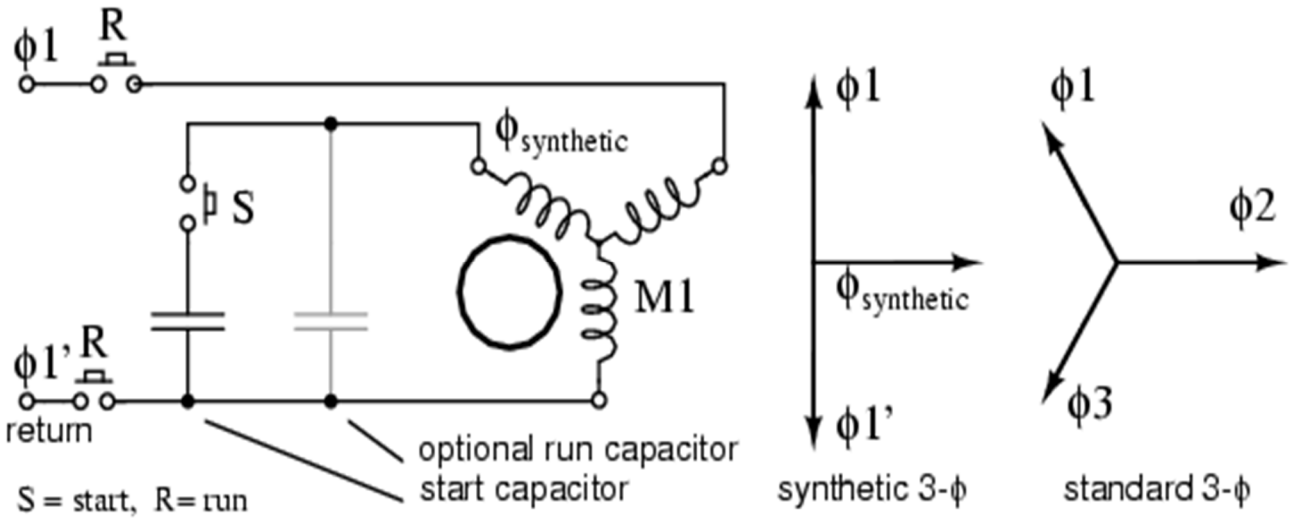

Fig-2 shows method of installation the capacitor circuit to the coil of motor to operate the motor on single phase power

We must consider the output of motor when we converted from the three phase to single phase power supply to match and suitable with our application. But we cannot get the actual value due to many aspects, we must calculate and it's so complicated. So we can estimate the approximate value of motor output as per percentage (%) below. Values that can be expected from a three phase connected to a single phase network are those following:

Starting torque: From the 25-30% of the rated one

Maximum voltage: from 70-80% of the rated power

II. DESIGN OF INDUCTION MOTOR

For this research first we design 2 HP, 440 V, 2 Pole, 50 Hz, 3000 RPM, 3.08 A motor.

The main purpose of designing an induction motor is to obtain the complete physical dimensions of all the parts of the machine as mentioned below

A. The Following Design Details are Required

1) The main dimensions of the stator.
2) Details of stator windings.
3) Design details of rotor and its windings
4) Performance characteristics.

In order to get the above design details the Rated output power, rated voltage, number of phases, speed, frequency, connection of stator winding, type of rotor winding, working conditions, shaft extension details etc are needed.

In addition to the above, the details regarding design equations based on which the design procedure is initiated, information regarding the various choice of various parameters, information regarding the availability of different materials and the limiting values of various performance parameters such as iron and copper losses, no load current, power factor, temperature rise and efficiency are also needed.

B. Design Parts of Motors are

1) Stator
2) Rotor
3) Winding of stator and rotor
4) Yoke

To design the calculation manually for the induction motor is time consuming and very difficult to get the accurate value. For construction of induction motor the values must be accurate, so by using the MATLAB programming the calculation becomes very simple and the time taken will be less with accurate values.

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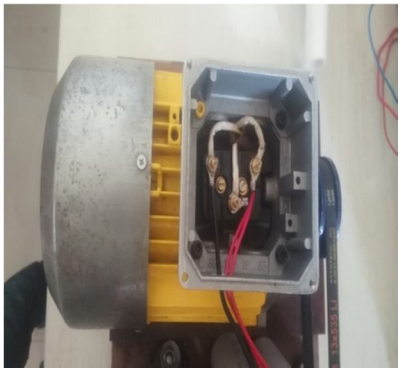

Fig.1 Motor assembly and testing

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III. SELECTION OF CAPACITOR

The first step is to select the capacitor sizes that will be needed. The capacitor sizes will depend on the motor. Keep in mind that you can make a capacitor smaller or larger by combining it with other capacitors. Two capacitors connected in parallel will add to each other, and two capacitors in series will "get smaller".

The best solution for starting the three phase induction motor on a single phase supply. Capacitor must be at setting about 92% of the formula.

A. Apparent Power (S)

$$S = \sqrt{3} V_L I_L \quad KVA \tag{1}$$

Where, V_L is line voltage, I_L is line current.

B. Active Power (P)

$$P = \sqrt{3} V_L I_L \cos\emptyset \quad KW \quad \textbf{Or}$$

$$P = S \cos\emptyset \quad KW \tag{2}$$

Where, V_L is line voltage, I_L is line current, $\cos\emptyset$ is power factor and S is apparent power.

C. Reactive Power (P)

$$Q = \sqrt{3} V_L I_L \sin\emptyset \quad KVAR \quad \textbf{Or}$$

$$Q = \sqrt{S^2 - P^2}\, KVAR \tag{3}$$

D. Capacitive Current (I_C) Per Phase

$$I_C = \frac{Q}{V_{ph}} \quad Amp \tag{4}$$

Where, V_{ph} is phase voltage, Q is reactive power.

E. Capacitive Reactance Per Phase (X_C)

$$X_C = \frac{V_{ph}}{I_C} \quad \Omega \tag{5}$$

F. Capacitor (C)

$$C = \frac{1}{2\pi f X_C} \quad \mu F \tag{6}$$

Where, f is supply frequency, X_C Capacitive Reactance per phase.

By above calculation we can find out the start capacitor and run capacitor is half of the start capacitor.

IV. EXPERIMENTAL RESULT

The motor used in this research is the three phase induction motor of 2 HP, 440 V,2 Pole, 50 Hz, 3000 RPM, 3.08 A, star connection, power factor 0.89 lagging. During operation as on single phase capacitors used are of 50 μF as start capacitor and 25 μF as run capacitor and centrifugal water pump used as a load with belt driven mechanism.

Table No. 1

Motor Operating on three phase supply				
Sr. No	Phase	Current	Phase	Voltage
1.	R	1.6 A	R-Y	417 V
2.	Y	1.6 A	R-B	416 V
3.	B	1.7 A	Y-B	416 V

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Table No. 2

Motor Operating on single phase supply			
Sr. No.	Single phase voltage	Current before capacitor	Current after capacitor
1.	230 V	5.8 A	3.1 A
			3.0 A
			3.0 A

The motor operating on three phase supply, test results are shown in table no.1 and motor operating on single phase supply, test results are shown in table no. 2.

Fig.2 Picture of testing, final assembly and loaded with water pump.

V. CONCLUSIONS

From this research that has been done can be summarised as follows.

A. Operating three phase induction motor on single phase supply for star connection is to operate the motor by using the capacitors that are installed one in series with another as start and one in series with remaining phase as run capacitor, which is very simple and good method.

B. This method can operate three phase induction motor on both power supply (3 phases & 1 phase) very efficiently with water pump as load up to 85%.

C. This method could work well to operate the 2HP, 440 V, 2 Pole, 50 Hz, 3000 RPM, 3.08 A three phase induction motor at low

to high load up to 85% by using the run capacitor of 25 μF.

VI. ACKNOLEDGEMENT

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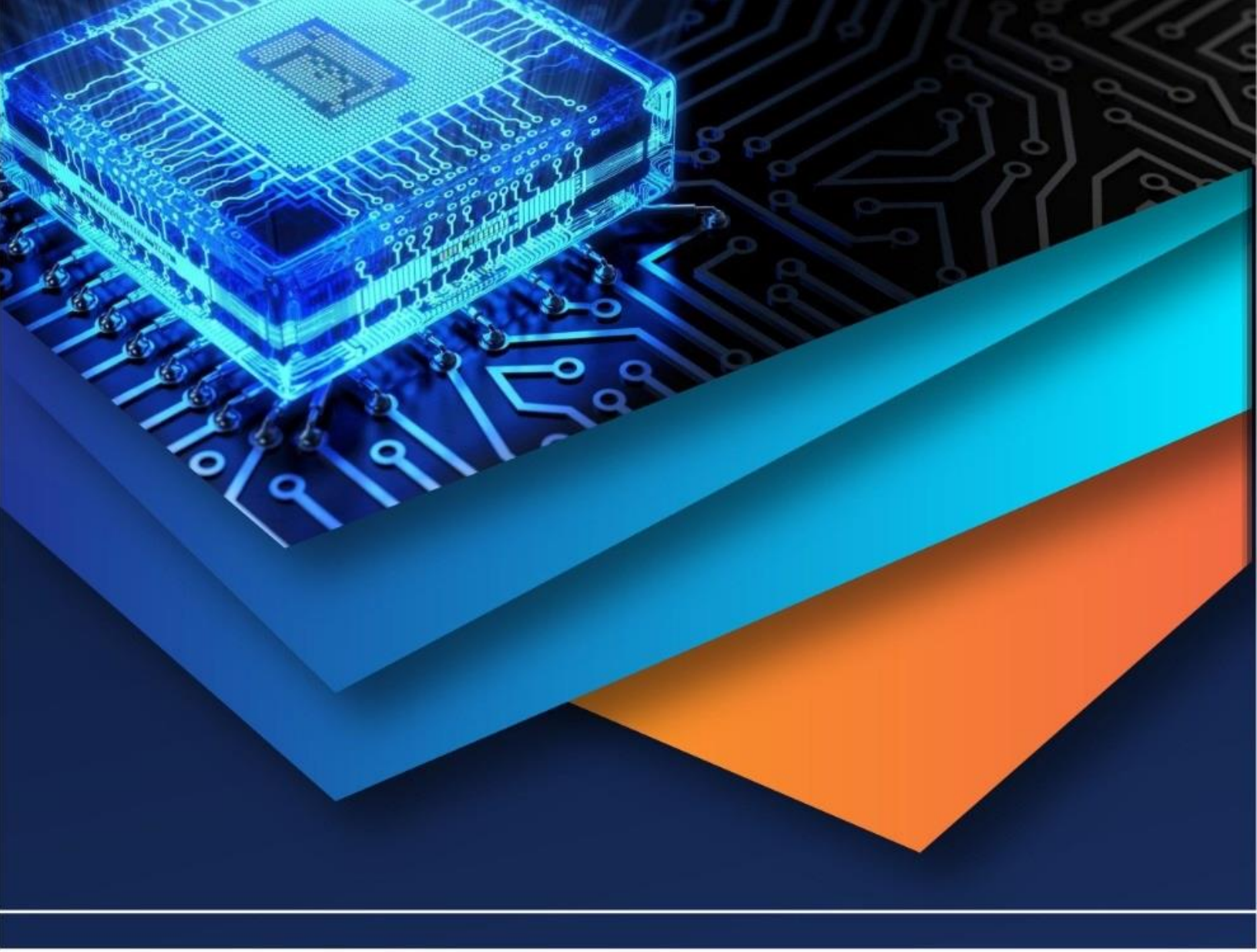

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