

Analysis of The Influence of Star Delta System in Reduce Electric Starting Surge in 3 Phase Motors

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Intisari — Pengoprasian yang terdapat di industri saat ini banyak menggunakan motor induksi. Terdapat beberapa macam motor induksi, salah satunya merupakan motor induksi 3 phase. Pada pemakaian motor induksi 3 phase terdapat beberapa permasalahan diawal, salah satunya terdapat lonjakan arus pada starting yang diterima oleh lilitan atau rotor pada motor induksi 3 phasa yang akan menyebabkan kerusakan pada belitan motor. Pada penelitian sebelumnya, telah dilakukan penelitian untuk mengurangi lonjakan starting listrik pada motor 3 phase dengan cara menurunkan frekuensi dalam penelitian yang berjudul “Pengaturan Kecepatan Motor Induksi 3 Fasa Dengan Mengubah Frekuensi Menggunakan Inverter ALTIVAR 12P” ditemukan bahwa frekuensi tegangan yang diatur rendah dan stabil untuk meminimalkan terjadinya lonjakan arus pada 3- fase motor mulai. Oleh karena itu, dilakukan penelitian mengenai suatu sistem yang dapat mengurangi permasalahan tersebut, yaitu digunakananya sistem star delta pada motor 3 phasa untuk engurangi lonjakan starting listrik pada motor 3 phasa. Pada penelitian ini didapat nilai arus listrik sebesar 0, 59 A, nilai tegangan hubung bintang sebesar 219,65 V, dan nilai arus hubung singkat 1,01 A.

Kata kunci — Motor Induksi, Arus, Tegangan, Star and Delta Circuits

Abstract — Operations in the industry today use induction motors. There are several types of induction motors, one of which is a 3- phase induction motor. In the use of a 3-phase induction motor, there are several problems at the beginning, one of which is that there is a current surge in the starting received by the windings or rotor of a 3-phase induction motor which will cause damage to the motor windings. In previous research, research has been carried out to reduce electric starting spikes in 3 phase motors by lowering the frequency in a study entitled "Adjusting the Speed of a 3 Phase Induction Motor by Changing the Frequency Using the ALTIVAR 12P Inverter" it was found that the frequency of the regulated voltage was low and stable to minimize inrush current in 3-phase motor starting. Therefore, research was conducted on a system that can reduce these problems, namely the use of a star-delta system on a 3-phase motor to reduce electrical starting spikes in a 3-phase motor. In this study, the electric current value was 0.59 A, the star-circuit voltage value was 219.65 V, and the short-circuit current value was 1.01 A.

Keywords — Induction Motor, Current, Voltage, Star and Delta Circuits

I. INTRODUCTION

Operations in the industry today use induction motors. There are several types of induction motors, one of which is a 3-phase induction motor. The 3-phase induction motor is a driving tool that is widely used in both large and small-scale industries, this is because the 3-phase induction motor has a sturdy, simple construction, and an economical price. In the use of a 3-phase induction motor, there are several problems at the beginning, one of which is that there is a current surge in the starting received by the windings or rotor of a 3-phase induction motor which will cause damage to the motor windings. Starting current drawn by a 3-phase motor can reach 5-7 times the nominal current. However, there are several ways to overcome these problems, one of which is by using the Star Delta system. The Star Delta system can be applied to all types of 3-phase motors.

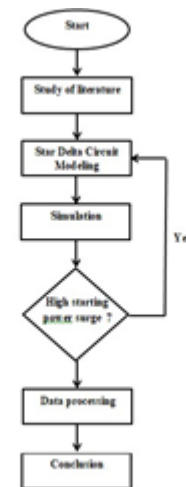
As in previous studies, Elvy Sahnur conducted a study to reduce the electric starting spike in a 3-phase motor by lowering the frequency. in a study entitled "Setting the Speed of a 3-Phase Induction Motor By Changing the Frequency Using the ALTIVAR 12P Inverter" it was found that the frequency of the regulated voltage is low and stable to minimize the occurrence of current surges in the 3-phase motor starting [1]. there is also research related to "STARTING ANALYSIS OF THREE PHASE INDUCTION MOTORS USING PROGRAMMABLE LOGIC CONTROLLER (PLC)" by Sandhy Nuari.

His research stated that the starting of a three- phase induction motor 10 Horse Power (HP) with the method of starting direct on line (DOL) with a star connection of 50.531 Amperes, the starting method of star-delta of 29.301 Amperes, the method of starting autotransformer with a 50% star connection of 12.792 Amperes, 65% of 21.618 Amperes, 80% of 32.747 Amperes, and the starting direct on line (DOL) torque value of the star connection is

49.479 Nm, the starting star- delta is 16.637 Nm, the starting autotransformer star connection is 50% 12.684 Nm, 65% is 21.436 Nm and 80% of 32.471 Nm [2]. and for the first time, an analysis of the Star Delta System was carried out to reduce the Electric Starting Surge on the 3 PHASA Motor at the Karawang Job Training Center.

II. METHOD

This research is a development of existing research, as well as to solve problems related to electric starting spikes in 3-phase motors. The study also carried out the star delta method to analyze the starting spike experienced by a 3-phase motor. The researcher uses an analytical method that adopts the existing star delta model design. The research flow is shown in the following figure:



Fgr.1 Research Method Flow

This method serves as a reference for data obtained through books, journals, or manuals with experimental data as well as data collected based on direct observations in the field. From the simulation data, the data will be processed and analyzed to conclude from the results of the star delta experiment. If the starting current surge value is still relatively high, it is still possible to find an efficient value, then the data retrieval step will be carried out again.

Then for the flow of data collection can be seen in the following figure:



Fgr.2 Data Collection Method

III. STUDY LITERATURE

A. 3 Phase Induction Method

The 3-phase induction motor is a driving tool used in the industrial sector, this is because the 3-phase induction motor has a simpler construction, relatively cheap price, sturdy, and

easy maintenance [3]. The 3- phase induction motor can produce a balanced rotating magnetic field, has a high power capacity, rotor winding and automatic ignition. 3-phase induction motors are commonly used for pumps, compressors, power lines, belt conveyors to grinders. However, the 3-phase induction motor also has disadvantages, including: large starting current, speed regulation that is difficult to implement and has a fairly low power factor, especially when carrying light loads. The 3 phase induction motor used has the following specifications [4-6]:

Table. 1 Motor Specification

Type	73211
	CLASS 0,3
Y/ Δ	692/400 V
Current	0,58/1,0A
Frequencies	50 Hz
Cos phi	0,7
Power	0,27 kW



Fgr.3 Motor 3 Phase

B. Magnetic Contactor

Magnetic contactor is a switch that can work with the principle of magnetism, where the switch works if there is a magnetic force in the contact puller. The magnet in this contactor functions to attract and release the contacts with the help of a spring pusher [7]. The contactor is capable of flowing and breaking current under normal operating conditions. On the tor contact there are several contacts, namely normally open contacts or Normally Open (NO) as a magnetic contactor that has not worked its position is open and if the contactor is working then the contactor will be closed/connected and there is also a normally closed or Normally Closed (NC) contact [8,9].

Contactor that has not worked if the contact has not been opened in the sense that in the initial position the NC contact is closed /

connected and will open after current is flowing. In the magnetic contactor there is also a coil or coil which when given a voltage will cause magnetization and attract the contacts so that the contactor will work. Electromagnetically operated contactor is a useful mechanism for closing and opening [10-11].



Fgr.4 Magnetic Contactor

C. Star-Delta Method

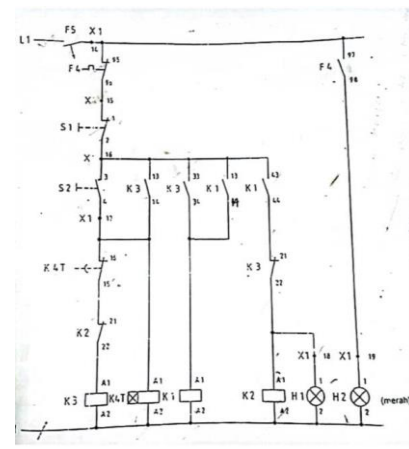
Star-Delta is a type of starter that can reduce spikes in torque and current at start. This method consists of a Star Contactor, Delta Contactor, and Main contactor, a timer used to transfer Star to Delta and an Overload Relay [12]. At the start position or when the stator is in a star circuit, the current in the motor only takes one third of the motor current if the motor is started using another method [13]. In the Star-Delta motor circuit, the three-phase induction motor consists of three contactors, where contactor one and contactor three can run the motor with the Star method and contactors one and two can run the motor with the Delta method [10].

IV. RESULT AND DISCUSSION

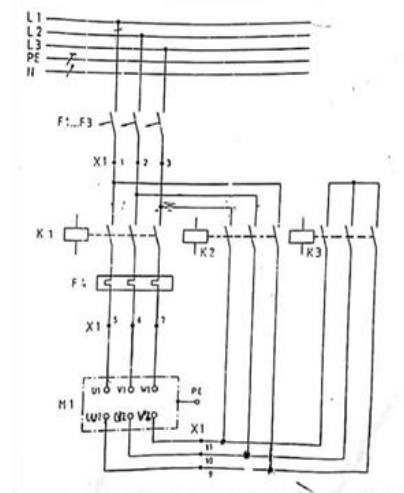
A. Star Delta Circuit on 3 Phase Motors

The circuit of a three-phase induction motor for the star delta method consists of three contactors, of which contactor one and contactor

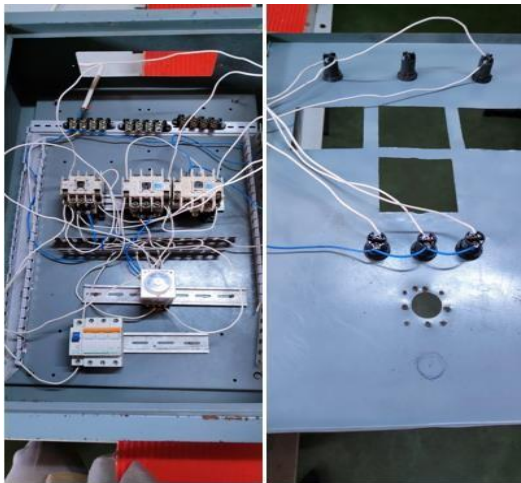
three function to run the motor in a star mode while contactors one and two function to run the motor in a delta manner. When the motor is star connected, contactor one and contactor three are ON, while contactor two is OFF. Some time after the timer is active (can be set as desired), the timer will turn off contactor three. On the other hand, if the motor is connected in delta, contactor one and contactor two are ON while contactor three is OFF. PB NO (green) is used to turn on the motor, while to turn off all circuits on the motor, PB NC (red) is used [14]. In the motor power control circuit with the Star Delta method, a relay is added as a safety in the event of an overload by adding 1 indicator light as information to the user.



Fgr.5 Wiring diagram of Star Delta Method Motor Power Control



Fgr.6 Star Delta Connection Motor Wiring Diagram



Fgr.7 Motor Power Control Circuit Star Delta Connection on the box panel



Fgr.8 The results of the current value through measurements using a Clamp Meter

B. Power Circuit Test Results

It can be seen in table 2 Power Circuit Testing, the control system of the star delta method is a system that changes the starting from a star / star connection with a voltage of 220 V to a starting voltage of a triangle / delta which has a voltage of 380V [9], where when the voltage is The input from PLN is that the condition of the first contactor is ON, the second contactor is ON, while the third contactor is OFF and the motor is in a star connection.

After 5 seconds (tripping timer) contactor one remains in the ON state, contactor two is replaced by contactor three which is ON with the motor in a star circuit. When PB OFF/NC is pressed, all contactors are OFF and the motor is

OFF. If there is a problem / overload then the circuit will automatically turn off.

Table.2 Power Circuit Test

No	Input	Input			
		Contactor			Motor
		K1 (Main)	K2 (Star)	K3 (Delta)	
1	Input Voltage 380 Volts, 50 Hz from PLN	ON	ON	OFF	Star
2	Tripping Timer After 5	ON	OFF	ON	Delta
	Seconds				
3	Push Button Off	OFF	OFF	OFF	Stop
4	Tripping Overload	OFF	OFF	OFF	Stop

C. Determining the Electric Current

$$\text{Line Current Value ()} = \frac{P}{\sqrt{3} \cdot V \cdot \cos\phi} \quad (1)$$

$$\text{Line Current Value ()} = \frac{270}{\sqrt{3} \cdot 380V \cdot 0,7}$$

$$\text{Line Current Value ()} = 460,18$$

$$\text{Line Current Value (} I_L \text{)} = 0,59 \text{ Ampere}$$

D. Determining the Current Value in the Star Circuit

to calculate the Star Circuit Voltage (V_y) can use the formula:

$$V_Y = \frac{V}{\sqrt{3}} = \frac{380}{\sqrt{3}} = 219,65 \text{ Volt} \quad (2)$$

As for the value of short circuit current can be calculated by:

$$I_Y = \frac{P}{\sqrt{3} \cdot V_Y \cdot \cos\phi} = \frac{270}{\sqrt{3} \cdot 219,65 \cdot 0,7} \quad (3)$$

for the value of the triangular current can be calculated by the following formula:

$$I_{\Delta} = I_L = 0,59 \text{ Ampere} \quad (3)$$

E. Determining the Size of the Magnetic Contactor

It is known from the specifications that the motor used has a power of 0.27 kW (270 Watt), 380V, with a cosphi of 0.70 using the star delta method, the need for a magnetic contactor is [15] :

$$\begin{aligned} P &= V \times I \times \text{Cosphi} \times \sqrt{3} \\ 270 \text{ Watt} &= 380V \times I \times 0,70 \times 1,73 \end{aligned}$$

$$I_L = 270 \text{ Watt} / 460,18$$

$$I_L = 0,59 \text{ Ampere}$$

Where :

P = Power

V = Voltage

I_L = Nominal Current

Cosphi = Power Factor

To determine the size of the contactor one and contactor two used the formula:

$$\text{Magnetic Contactor for Delta} = \frac{I_n}{\sqrt{3}} \quad (4)$$

Magnetic Contactor for Delta =

$$\frac{0,59}{\sqrt{3}} = 0,34 \text{ Ampere}$$

To determine the size of the triple contactor, use the formula:

$$\text{Magnetic Contactor for Star} = \frac{I_n}{3}$$

Magnetic Contactor for Star =

$$\frac{0,59}{3} = 0,2 \text{ Ampere}$$

V. CONCLUSIONS AND SUGGESTIONS

A. Conckusion

1. Star-Delta is a type of starter that can reduce spikes in torque and current at starting. obtained at the start position or when the stator is in the star circuit, the current in the motor only takes one third of the motor current if the motor is started using another method.

2. In the starting method, the star delta method can reduce the high starting current.
3. The star delta method when used in a system capable of changing the starting from a star/star circuit with a voltage of 220 V to a triangular/delta circuit with a voltage of 380V.
4. In measurements using a Clamp Meter, a current value of 0.4 A can be obtained, but in calculations that have been adjusted using the motor specifications, a current value of 0.59 Ampere is obtained, judging from the specifications contained in the motor with a current value of 0.58/1 A it is possible that there is an error in the measurement tool.

B. Suggestion

1. is necessary to calibrate each component and measuring instrument to avoid errors.
2. In further research, it is necessary to analyze the value of motor torque, the influence of the relationship between the parameters of current, power, voltage, and torque to determine the quality of the motor work.

ACKNOWLEDGEMENT

The authors thank the lecturers who have wholeheartedly supported in this research. To lecturers Rahmat Hidayat as research supervisor and Ridwan Satrio Hadikusuma as supervisor in writing.

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