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COMPARISON & POWER QUALITY IN DOL & SD STARTER OF IM

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Abstract:

This paper shows that an individual work on Direct-On-Line and star-delta starter for induction motor by using hardware and MATLAB Simulink .The purpose of this paper is tofind out the good starter during the starting of induction motor or on-load condition.These two basic starting methods which are different but commonly used for squirrelcage induction motor. This project is done by including MATLAB simulation as wellas Direct On-Line starter on hardware. After the simulation, the two different startingmethods for starting of a rotating transformer or asynchronous machine are beingindividually deliberate to conclude the most appropriated and starting method of three phase induction motor.

Index Terms: Induction Motor (IM), Direct On-line (DOL), Star-Delta (SD), Overload Protection (OLP) & Moulded Case Circuit Breaker (MCCB)

1. Introduction:

A 3-ϕ IM is self-starting at the time of starting. If we started directly it will draw large amount of current which damages to connecting equipment's. So, a starter is needed in order to limit the starting current [2]. An IM there are several starting methods available in the market, those are the DOL, SD, auto-transformer, and soft starter. But we are using only two methods of starting i.e. DOL and SD starter and comparative study of IM starters using hardware &MATLAB Simulink. The DOL starter consists of a MCCB, contactor and an overload relay for protection. Electromagnetic contactor which can be opened by the overload relay under fault conditions. Typically, the contactor will be controlled by separate start and stop button, and an auxiliary contact is used, across the start button, as a hold in contact i.e. the contactor is electrically latched while the motor is operating. Electrical power quality plays a vital role in supplying electricity effectively to the customers. Now days both of electric utilities and end users of electric power are increasing concerned/ interested about the power quality. There are various power quality problems occurs are voltage sag/dip, over voltage, voltage flicker, voltage and current harmonic distortion, short interruption and power frequency variation one of the most common power quality problems presents days is voltage dip [5]. Power quality mainly focus on the issues of avoiding voltage fluctuation when it is connected to a load, factors like noise, distortion also affect the power quality of our system. When we connected a rotating transformer, sudden reduction in voltage will cause voltage dip problem. Behind it current also increases which may a reason be for the damage or burning of winding of a three phase asynchronous machine. When the RMS voltage reduces 10 % to 90%, this condition comes under voltage dip/sag. [7]

2. Starter:

Starter is a device which connects with motor in series to decrease the current at starting time and increase current after starting the motor and provide O.L.P. A Starter is a device that controls the use of electrical power to equipment, usually a motor. As the name implies, starters "start" motors. They can also stop them, reverse them, and protect them. Starters are made from two building blocks, Contractors and O.L.P. [1]

- ✓ Contactors control the electric current to the motor. Their function is to repeatedly establish and interrupt an electrical power circuit.
- ✓ O.L.P. protects motors from drawing too much current, overheating, and from literally "burning out".

A starter turns an electric motor or motor controlled electrical equipment on or off, while providing O.L.P. Starters represent another evolution in motor control applications.

2.1 Necessity of Starters: When the motor is at rest, there is, as yet, obviously no back Emf developed in the armature. The necessity of starter is only there in big motors, in small motors starter is not required. For starting 3 Phase IM if rated voltage is given to the starter of motor very high. Starting current will flow through the motor winding. (i.e. 5 to 6 times the Running Current).[3] This Starting or initial high current is objectionable, because it will produce large line voltages drop, which in turn will affect the operation of other electrical Equipment and line connection to the same line. The Starting current is controlled by apply a reduced voltage to

the Stator winding during the Starting time, and then full normal voltage is applied, when the motor has run up to speed.

2.2 Types of Starters:

- ✓ Starter for squirrel cage rotor type induction motor: Star-Delta, DOL, Auto Transformer, Reactor, Saturable Reactor, Part Winding, and Ac Voltage Controller Starters
- ✓ Starter for wound rotor type induction motor: Rotor Resistance Starter

2.3Advantages of DOL Starter:

- ✓ Most Economical and Cheapest Starter
- ✓ Simple to establish, operate and maintain
- ✓ Simple Control Circuitry
- ✓ Easy to understand and trouble-shoot.
- ✓ It provides 100% torque at the time of starting.
- ✓ Only one set of cables is required from starter to motor.
- ✓ Motor is connected in delta at motor terminals.

2.4 Disadvantages of DOL Starter:

- ✓ It does not reduce the starting current of the motor.
- ✓ High Starting Current: Very High Starting Current (Typically 6 to 8 times the FLC of the motor).
- ✓ Mechanically Harsh: Thermal Stress on the motor, thereby reducing its life.
- ✓ Voltage Dip: There is a big voltage dip in the electrical installation because of high in-rush current affecting other customers connected to the same lines and therefore not suitable for higher size squirrel cage motors
- ✓ High starting torque: Unnecessary high starting torque, even when not required by the load, thereby increased mechanical stress on the mechanical systems such as rotor shaft, bearings, gearbox, coupling, chain drive, connected equipment's, etc. leading to premature failure and plant downtimes.

2.5 Advantages of SD Starter:

- ✓ The operation of SD method is very simple and rugged.
- ✓ It is relatively cheap compared to other reduced voltage method.
- ✓ Good torque/ current performance.
- ✓ It draws 2 times starting current of the full load ampere of the motor connected.

2.6 Disadvantages of SD Starter:

- ✓ Low Starting torque (torque = (Square of Voltage) is also reduce).
- ✓ Break in Supply – Possible Transients
- ✓ Six Terminal Motor Required (Delta Connected).
- ✓ It requires 2 set of cables from starter to motor.
- ✓ It provides only 33% starting torque and if the load connected to the subject motor requires higher starting torque at the time of starting than very heavy transients and stresses are produced while changing from star to delta connections, and because of these transients and stresses many electrical and mechanical break-down occurs.
- ✓ In this method of starting initially motor is connected in star and then after change over the motor is connected in delta. The delta of motor is formed in starter and not on motor terminals.
- ✓ High transmission and current peaks: When starting up pumps and fans for example, the load torque is low at the beginning of the start and increases with the square of the speed. When reaching approx. 80-85 % of the motor rated speed the load torque is equal to the motor torque and the acceleration ceases. To reach the rated speed, a switch over to delta position is necessary, and this will very often result in high transmission and current peaks. In some cases, the current peak can reach a value that is even bigger than for a D.O.L start.
- ✓ Applications with a load torque higher than 50 % of the motor rated torque will not be able to start using the start-delta starter.
- ✓ Low Starting torque: The SD (wye-delta) starting method controls whether the lead connections from the motor are configured in a star or delta electrical connection. The initial connection should be in the star pattern that results in a reduction of the line voltage by a factor of $1/\sqrt{3}$ (57.7%) to the motor and the current is reduced to 1/3 of the current at full voltage, but the starting torque is also reduced 1/3 to 1/5 of the DOL starting torque.
- ✓ The transition from star to delta transition usually occurs once nominal speed is reached, but is sometimes performed as low as 50% of nominal speed which make transient Sparks.

3. Power Quality:

Power quality is simply the interaction of electrical power with electrical equipment. If electrical equipment operates correctly and reliably without being damaged or stressed, we would say that the electrical power is of good quality. On the other hand, if the electrical equipment malfunctions, is unreliable, or is damaged during normal usage, we would suspect that the power quality is poor. [4]

Quality = Proper equipment operation & longevity
Power Quality = Finacial Problem

3.1 Causes of Power Quality Problems: The causes of power quality problems can be many. It is often difficult to point an exact cause for a specific problem. Power quality monitoring equipment's comes to aid in such situations. [6] Most of the causes of power quality problem can be divided into two categories

- ✓ **Internal Causes:** Approximately 80% of electrical problems originate within a business facility. Potential culprits may include large equipment's start or shut down, improper wiring and grounding, overloaded circuits or harmonics.
- ✓ **External Causes:** About 20% of power quality problems originate with the utility transmission and distribution system. The most common cause is a lightning strike; other possibilities include equipment's failure, vehicle accidents, weather conditions, neighbouring business and even normal operation of utility equipment's.

3.2 Disturbance in Power System: The common disturbances in a power system are

- ✓ Voltage Sag
- ✓ Voltage Swell
- ✓ Momentary Interruptions
- ✓ Transients
- ✓ Voltage Unbalance
- ✓ Harmonics
- ✓ Voltage Fluctuations

4. Comparison between DOL and SD Starter:

DOL Starter	Star Delta Starter
It doesn`t decrease the starting current.	It decreases the starting current 58% of the rated current.
It is cheap.	It is costly.
It can be connected directly with supply on full load.	It can be connected with supply either on no-load or lightly load condition.
There is no sparking problem.	There is a sparking problem during switching.
Does not decrease the starting current	Decrease the starting current by 1/3 times
It connects directly the motor with supply for starting as well as for running	It connects the motor first in star at the time of starting in delta for running
a. Available starting Current:100% b. Peak starting current: 6-8 times of full load current c. Peak starting torque:100%	a. Available starting Current:33% b. Peak starting current: 1.3-2.6 times of full load current c. Peak starting torque:33% of full load torque

5. Results:

Direct On-line Starter is a most economical and cheapest Starter; Simple to establish, operate and maintain; Simple Control Circuitry; Easy to understand and trouble-shoot; It provides 100% torque at the time of starting; Only one set of cables is required from starter to motor; Motor is connected in delta at motor terminals.

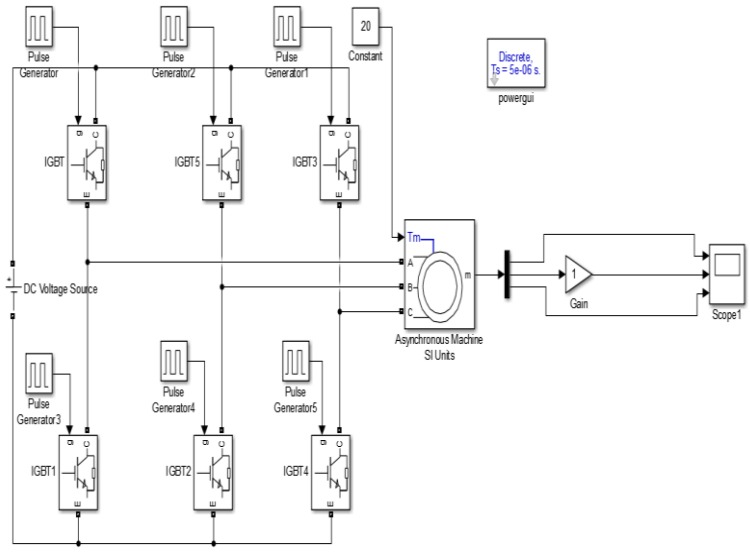

Figure 5.1: Simulation Model of DOL Starter

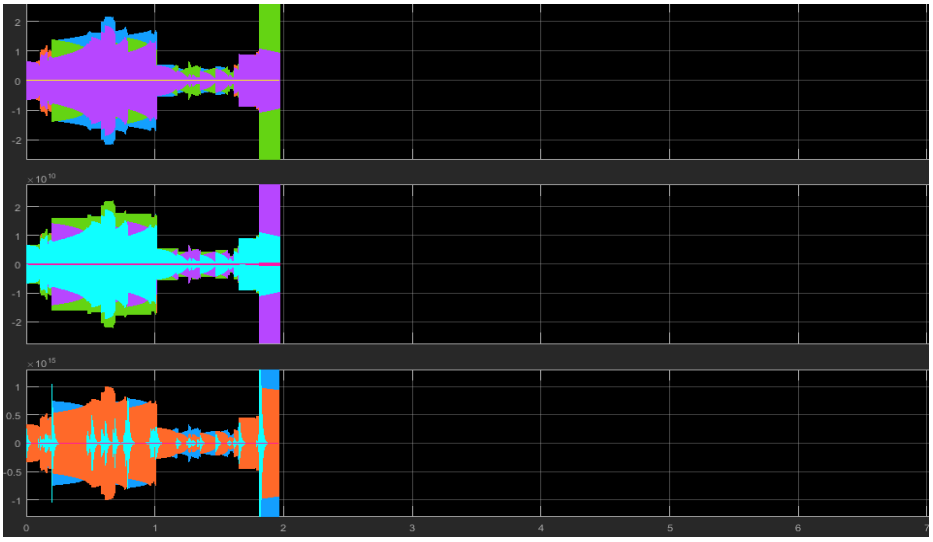

Figure 5.2:Waveform of DOL Starter

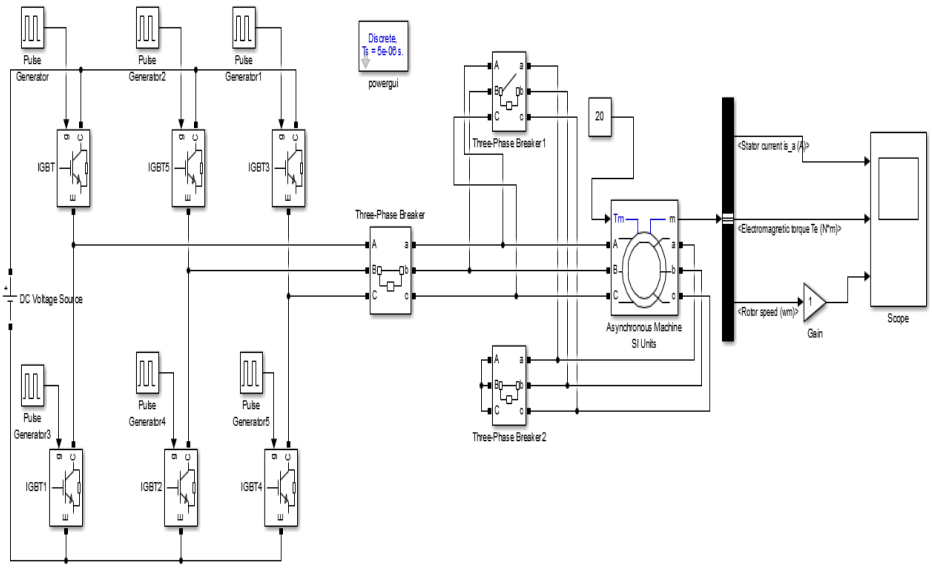

Figure 5.3: Simulation Model of SD Starter

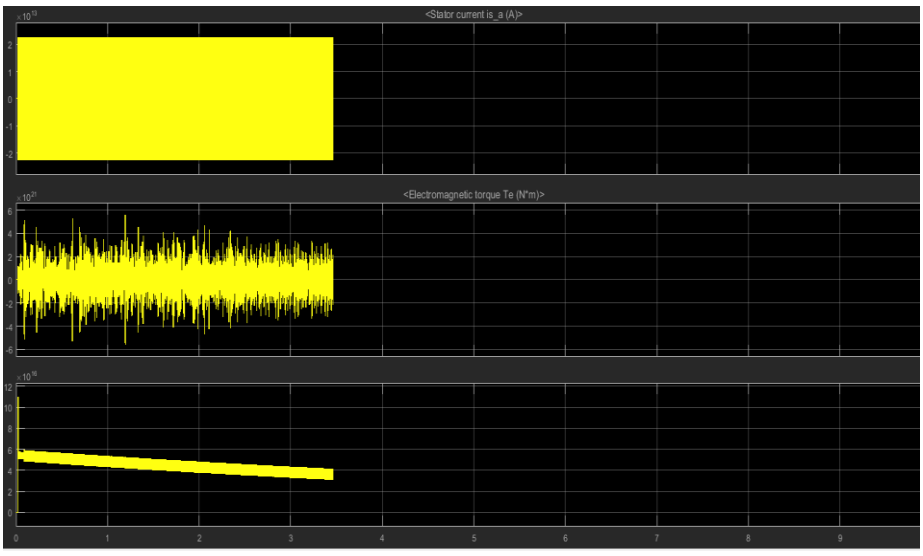

Figure 5.4: Waveform of SD Starter

Figure 5.5:R-800W, Y-200W, and B-200W

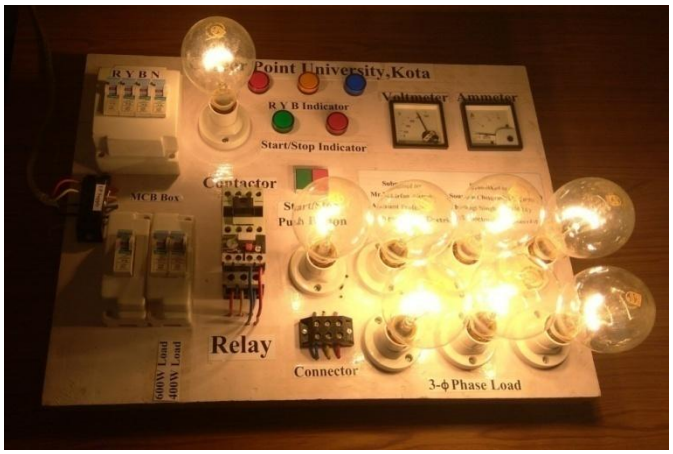

Figure 5.6:R-1200W, Y-200W, and B-200W

6. Conclusions:

Simulation model of both DOL and SDstarters for IM, which is used control starting current and protect our rotating transformer from damage. We are also showing the practical demonstration of our project using bulb per phase as a three phase load.For starting 3 Phase IM if rated voltage is given to the starter of motor very high. Starting current will flow through the motor winding. (I.e. 5 to 6 times the Running Current). This Starting or initial high current is objectionable, because it will produce large line voltages drop, which in turn will affect the operation of other electrical equipment and line connection to the same line. The Starting current is controlled by apply a reduced voltage to the Stator winding during the Starting time, and then full normal voltage is applied, when the motor has run up to speed.

7. Future Scope:

- ✓ For better power quality we can add some components like STATCOM etc.
- ✓ For improved result by adding Microprocessor, our system becomes automatic or digitalized.

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