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A Review on Different Types of Starter Used For Induction Motor

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Abstract- *The basic requirement for studying starting of Induction motor are the starting current of Induction motor and the voltage flicker during start up. This paper will summarize several common methods and provide application guidelines for proper selection of starting devices. Starting method reviewed will include different types of starters, comparative study for DOL starter & autotransformer starter, obtained for different cable length, with & without capacitor connected across motor itself. Finally it is concluded that starting current is less in case of autotransformer starter. Starting current & starting time can be further reduced and voltage profile can be improved with the use of capacitor at the motor terminal as a compensating device.*

Keywords: starter, starting current, starting torque, starters for squirrel cage and wound rotor induction motor, need for starters.

1. INTRODUCTION

Induction motors are widely used as an electric drives in various industrial applications like industrial motion control systems & to drive various machines, such as pumps, fans, compressors, conveyors, spindles, as well as in main powered home appliances. Electric drives can be classified basically as DC drives & AC drives. The rectifier unit increases the cost of the unit used for DC drives. Simple and rugged design, low-cost, low maintenance and direct connection to an AC power source are the main advantages of using AC induction motors. For variable speed the industries use the asynchronous motor i.e. Induction motor. Induction motors are the most common motors used in industrial motion control systems & to drive various machines, such as pumps, fans, compressors, conveyors, spindles, to name just a few, as well as in main powered home appliances. Induction motors are widely used in industry.

1. STAR-DELTA STARTER

In the star-delta starting method, the wiring connection from the power supply source to the motor is connected from star (wye) to the delta connection. The motor is started in star configuration and then it is transferred to the delta Configuration, allowing the full voltage to be applied to the motor during its running so as to get the full torque output. This can be further explained that in a Star-Delta starter, the motor is started as star connection and when the motor starts running the connection is changed to delta. With star connection, the motor takes root 3 times less voltage. However, as the torque is proportional to square of the voltage, the starting torque also reduces.

This type is used for the induction motor, the stator winding of which is nominally delta-connected. This is a simple starter, which can be easily reconfigured.

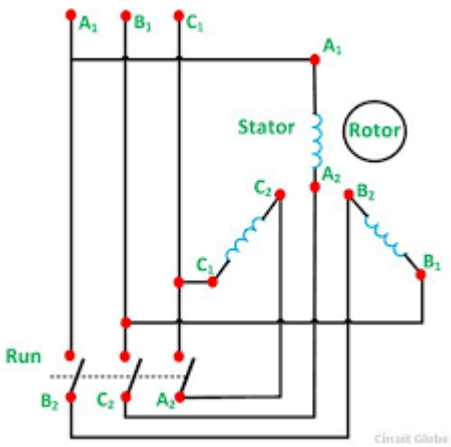

Fig :- 1 Star Delta Starter

As the voltage per phase in delta connection is , the phase current in each stator winding is (), where is the impedance of the motor per phase at standstill or start (stator impedance and rotor impedance referred to the stator, at standstill). The line current or the input current to the motor is which is the current, if the motor is started direct-on-line (DOL). Now, if the stator winding is connected as

star, the phase or line current drawn from supply at start (standstill) , which is of the starting current, if DOL starter is used. The voltage per phase in each stator winding is now so, the starting current using star-delta starter is reduced by 33.3%. As for starting torque, being proportional to the square of the current in each of the stator windings in two different connections as shown earlier, is also reduced , as the ratio of the two currents is , same as that (ratio) of the voltages applied to each winding as shown earlier. So, the starting torque is reduced by 33.3%, which is a disadvantage of the use of this starter.

The load torque and the loss torque, must be lower than the starting torque, if the motor is to be started using this starter. The advantage is that, no extra component, except that shown in Fig. 33.2c, need be used, thus making it simple. As shown later, this is an auto-transformer starter with the voltage ratio as 57.7%.

2. AUTO-TRANSFORMER STARTER

The autotransformer reduced-voltage starter places the motor on the secondary of the autotransformer while starting. The taps on the autotransformer limit the voltage applied to the motor to 50%, 65% or 80% of the nominal voltage. With autotransformer starting, the line current is always less than the motor current during starting because the motor is on the secondary of a transformer during acceleration. If a motor is connected to the 50% tap of the autotransformer, the motor current would be reduced to 50% of the normal starting value, but the line current would be only 25% of the normal starting current. The difference between line and motor current is due to the transformer in the circuit.

AUTO TRANSFORMER STARTER

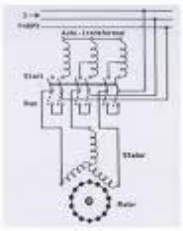

Fig :- 2 Auto Transformer Starter

The lower line current is the reason the Auto transformer starter is a very popular type of reduced-voltage starter. Since the motor starting current is greater than the line current with an autotransformer starter, the starter produces more torque-per-ampere of line current than any other type of reduced-voltage starter. Most motors can be started at 65% of line voltage. If the torque that the motor supplies to the driven equipment is not sufficient on the 65% voltage tap, a higher torque on the 80% tap is available. Similarly, if too much torque is applied to the load with 65% voltage, or if the voltage dip associated with 65% starting is too high, the 50% tap is available. This versatility makes the autotransformer starter very popular. The typical schematic diagram for a two coil autotransformer starter. The circuit for a three coil autotransformer starter is similar except that an additional transformer winding would be inserted in the L2 leg. It should be pointed out that there are no significant disadvantages to using a two coil autotransformer design since the starting currents will be approximately balanced in each phase.

3. ROTOR RESISTANCE STARTERS FOR SLIP-RING (WOUND ROTOR) IM

In a slip-ring (wound rotor) induction motor, resistance can be inserted in the rotor circuit via slip rings , so as to increase the starting torque.

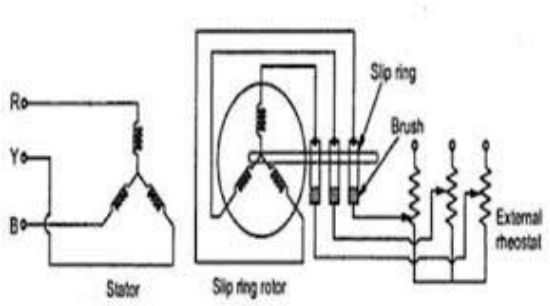

Fig :- 3 Rotor Resistance Starter

The input (stator) current is proportional to the rotor current as shown earlier. The starting current (input) reduces, as resistance is inserted in the rotor circuit. But the starting torque, increases, as the total resistance in the rotor circuit is increased. Though the starting current decreases, the total resistance increases, thus resulting in increase of starting torque as shown in Fig. 32.2b, and also obtained by using the expression given earlier, for increasing values of the resistance in the rotor circuit. If the additional resistance is used only for starting, being rated for intermittent duty, the resistance is to be decreased in steps, as the motor speed increases. Finally, the external resistance is to be completely cut out, i.e. to be made equal to zero (0.0), thus leaving the slip-rings short-circuited. Here, also the additional cost of the external resistance with intermittent rating is to be incurred, which results in decrease of starting current, along with increase of starting torque, both being advantageous. Also it may be noted that the cost of a slip-ring induction is higher than that of IM with cage rotor, having same power rating. So, in both cases, additional cost is to be incurred to

obtain the above advantages. This is only used in case higher starting torque is needed to start IM with high load torque.

4. DIRECT ON LINE STARTER

Induction motors can be started Direct-on-Line (DOL), which means that the rated voltage is supplied to the stator, with the rotor terminals short-circuited in a wound rotor (slip-ring) motor. For the cage rotor, the rotor bars are short circuited via two end rings.

A Direct On Line (DOL) or across the line starter applies the full line voltage to the motor terminals. This is the simplest type of motor starter. A DOL motor starter also has protection devices and, in some cases, condition monitoring. Smaller sizes of direct on-line starters are manually operated; larger sizes use an electromechanical contactor (relay) to switch the motor circuit. Solid-state direct on line starters also exist.

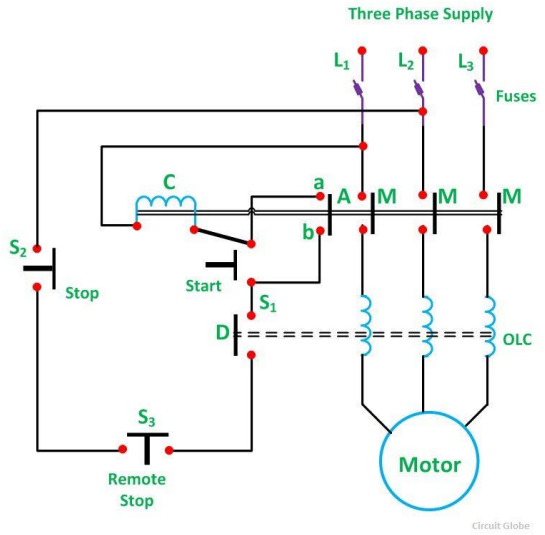

Fig :- 4 Direct Online Starter

A direct on line starter can be used if the high inrush current of the started motor does not cause excessive voltage drop in the supply circuit.

The maximum size of a motor allowed on a direct on line starter may be limited by the supply utility for this reason. For example, a utility may require rural customers to use reduced-voltage starters for motors larger than DOL starting is sometimes used to start small water pumps, compressors, fans and conveyor belts In the case of an asynchronous motor, such as the 3-phase squirrel-cage motor, the motor will draw a high starting current until it has run up to full speed.

This starting current is typically 6-7 times greater than the full load current. To reduce the inrush current, larger motors will have reduced-voltage starters or variable speed drives in order to minimize voltage dips to the power supply, or series resistance and inductance can be added. 4KW (5HP)

4. COMPARISION

Criteria	Direct on line	Star delta	autotransformer	Rotor Resistance Starters
Inrush current	**High**	**Low**	**Low**	**Low**
Voltage Sags	**Severe >0.5 p.u.**	**Less Severe <0.2 p.u.**	**Less severe<0.2 p.u.**	**Less severe<0.2p.u.**
Harmonics	**Less (THD< 1%)**	**Less(THD<1 %)**	**Severe during starting (THD=18.9%)**	**Severe during starting (19.5%)**
Transients	**Severe**	**Less Severe**	**Severe**	**Less severe**

CONCLUSION

Hence from this paper it can be concluded that most of the motors need the external starters for its starting application, only for initial 5 to 6 sec and then these starters can be later cut off .starters provides a protected start up supply voltage from zero to rated voltage .it also limits the starting current to a safe value till the motor achieves rated speed and torque.

The same process could even the repeated during the stop of a motor so as to insure smooth , jerk free ,control starting as well as stopping of motor .

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