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COMPARATIVE STUDY OF INDUCTION MOTOR STARTERS USING MATLAB SIMULINK

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Abstract— This paper presents a comparison between the Direct-On-Line (D.O.L.), and Soft Starter by using MATLAB Simulink .The purpose of this project is to find out the theoretical and actual characteristics of Induction motor. These three basic starting methods which different the irrespective wiring connection are the most applicable and widely-used starting method in the industrial area due to its economic reasons. This project is done by analyzing the characteristics during the motor starting by using the MATLAB Simulation to capture the waveforms of these events. After the Simulation, the three different starting method are being compared to conclude the most suitable and applicable starting method.

Keywords— D.O.L., Star-Delta, soft Starter.

I.INTRODUCTION

A 3-phase induction motor is theoretically self starting. The stator of an induction motor consists of 3-phase windings, which when connected to a 3-phase supply creates a rotating magnetic field. This will link and cut the rotor conductors which in turn will induce a current in the rotor conductors and create a rotor magnetic field. The magnetic field created by the rotor will interact with the rotating magnetic field in the stator and produce rotation. Therefore, 3-phase induction motors employ a starting method not to provide a starting torque at the rotor, but because it reduce heavy starting currents and prevent motor from overheating, Provide overload and no-voltage protection. There are many methods in use to start 3-phase induction motors. Some of the common methods we are using is Direct On-Line Starter (DOL), Star-Delta Starter and Soft Starter.

1. Direct-On-Line Starter (D.O.L) Starting Method

This is by far the most common starting method available on the market. The starting equipment consists of only a main contractor and thermal or electronic overload relay. The disadvantage with this method is that it gives the highest possible starting current. A normal value is between 6 to 7 times the rated motor current but values of up to 9 or 10 times the rated current exist. Besides the starting current there also exists a current peak that can rise up to 14 times the rated current since the motor is not energized from the first moment when starting.

The values are dependent on the design and size of the motor, but in general, a smaller motor gives higher values than a larger one. During a direct-on-line start, the starting torque is also very high, and is higher than necessary for most applications. The torque is the same as the force, and an unnecessary high force gives unnecessary high stresses on couplings and the driven application. Naturally, there are cases where this starting method works perfectly and in some cases also the only starting method that works.

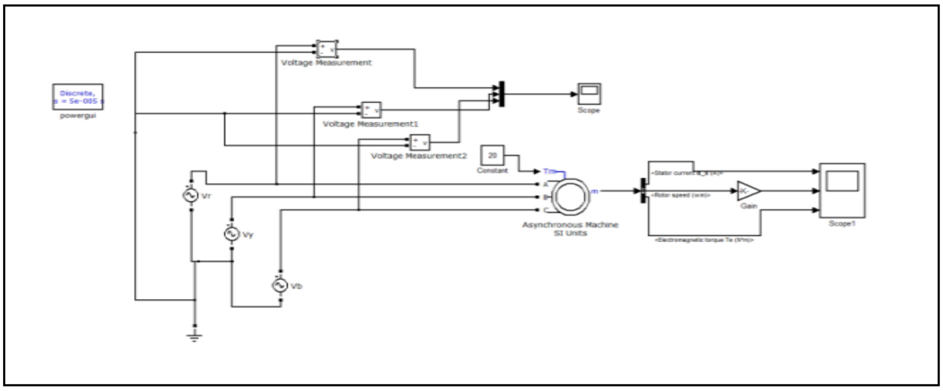

Fig 1.1 Simulink Model of DOL starter

This is a starting method that reduces the starting current and starting torque. The device normally consists of three contactors, an overload relay and a timer for setting the time in the star-position (starting position). The motor must be delta connected during a normal run, in order to be able to use this starting method. The received starting current is about 30 % of the starting current during direct on line start and the starting torque is reduced to about 25 % of the torque available at a D.O.L start. This starting method only works when the application is light loaded during the start. If the motor is too heavily loaded, there will not be enough torque to accelerate the motor up to speed before switching over to the delta position. 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.

2. **Star-Delta Starting Method**

Most induction motors are started directly on line but when very large motors are started that way, they cause a disturbance of voltage on the supply lines due to large starting current surges. To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run up to near rotated speed. Two methods are used for reduction of starting voltage is star delta starting.

Star/Delta starters are probably the most common reduced voltage starters in the 50Hz world. (Known as star/delta starters in the60Hz world). They are used in an attempt to reduce the start current applied to the motor during start as a means of reducing the disturbances and interference on the electrical supply component. The Star/Delta starter is manufactured from the contactors, a timer and a thermal overload. The contactors are smaller than the single contactor used in a Direct on Line starter as they are controlling winding currents only. The currents through the winding are $1\sqrt{3} = 0.58$ (58%) of the current in the line. this connection amounts to approximately 30% of the delta values. The starting current is reduced to one third of the direct starting current.

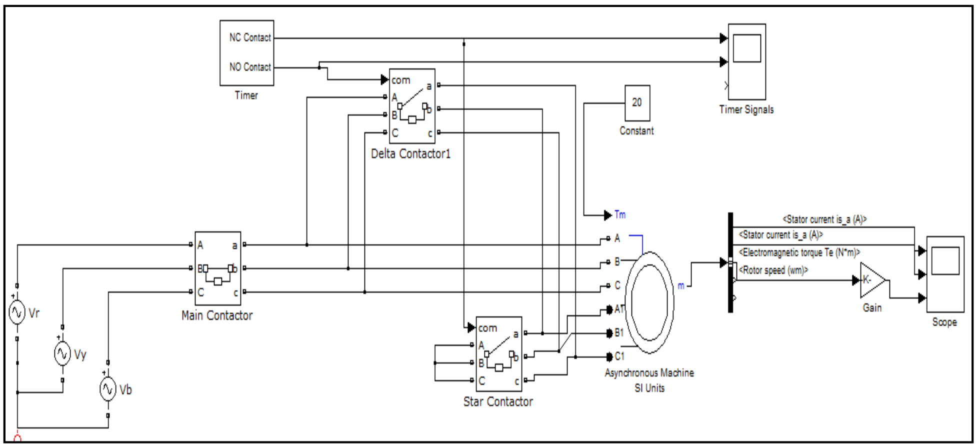

Fig 1.2. Simulation of star delta starter

3. Soft Starter Starting Method

(IGBTs) are well suited components forThe performance of a soft starter is crucially dependent on the performance of the motor it controls. Therefore, it is essential to understand motor characteristics in order to understand soft starter applications. Soft Starters have been providing precise controlled AC motor starting and stopping for decades. A motor soft starter is a device used with AC electric motors to temporarily reduce the load and torque in the power train of the motor during startup. This reduces the mechanical stress on the motor and shaft, as well as the electro dynamic stresses on the attached power cables and electrical distribution network, extending the lifespan of the system. Motor soft starters can consist of mechanical or electrical devices, or a combination of both. Mechanical soft starters include clutches and several types of couplings using a fluid, magnetic forces, or steel shot to transmit torque, similar to other forms of torque limiter. Electrical soft starters can be any control system that reduces the torque by temporarily reducing the voltage or current input, or a device that temporarily alters how the motor is connected in the electric circuit. Electrical soft starters can use solid state devices to control the current flow and therefore the voltage applied to the motor. They can be connected in series with the line voltage applied to the motor, or can be connected inside the delta (Δ) loop of a delta-connected motor, controlling the voltage applied to each winding. Solid state soft starters can control one or more phases of the voltage applied to the induction motor with the best results achieved by three-phase control. Typically, the voltage is controlled by reverse-parallel connected silicon-controlled rectifiers , but in some circumstances with three-phase control, the control elements can be a reverse-parallel-connected SCR and diode.
Modern semiconductor switches such as MOSFETs or Insulated-gate bipolar transistors high efficiency controllers. Efficiency of 70 – 80 % can be achieved for AC motors. By using additional passive electronic filters, the pulse train can be smoothed and average analog waveform is obtained Simulink.

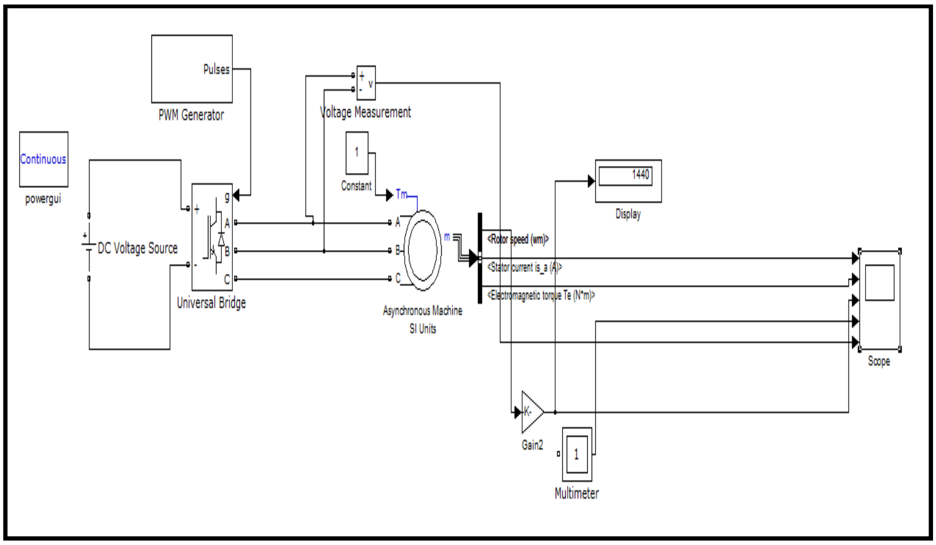

Fig 1.3. Soft starter model of induction motor using Matlab simulation

II. COMBINE OUTPUT OF STARTERS

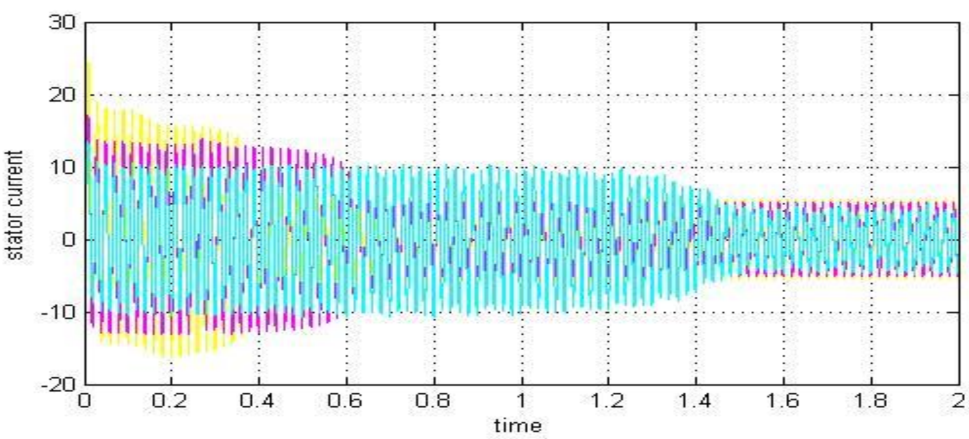

Fig 2.1.Stator current versus time characteristics

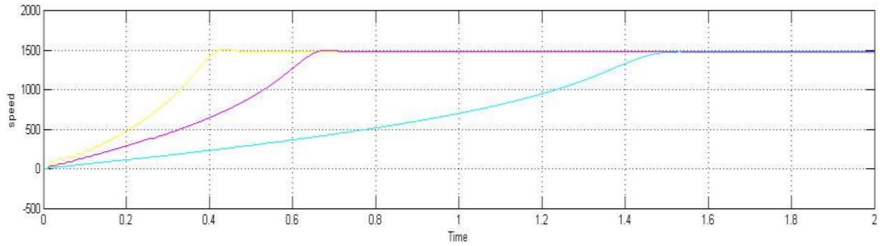

Fig. 2.2 Speed in RPM versus Time characteristics

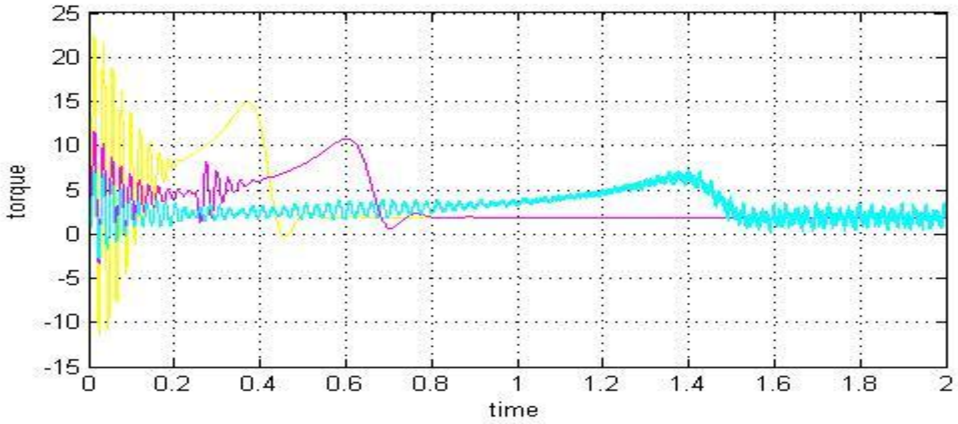

Fig. Electromagnetic Torque versus Time characteristics

III. COMARISION OF PARAMETERS

Table 3: Comparison of Parameters

Sr. No.	Parameters	D.O.L. starter	Star-Delta starter	Soft starter
1.	Current (Amp)	25 A	19 A	13 A
2.	Torque (N-m)	22 N-m	11 N-m	7 N-m
3.	Speed (RPM)	1490	1380 (Y) and 1490 (Δ)	1476

IV. CONLUSION

From the characteristics we observed that the staring current in soft starter is much less as compared with the other two starting methods also it provides higher efficiency to motors though it might have higher cost but when look as safety purpose cost doesn't matter, so soft starter is the better starting method.

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