Similarity Check-Comparison of three phase induction motor start using DOL, Star Delta and VSD Altivar61

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Abstract. In general, induction motors can be operated by connecting the motor directly to the supply circuit or by using a voltage that has been reduced to the motor during the start period. The obstacle of using a 3 phase induction motor is when starting, where the motor requires more current, which is about 5 to 7 times the nominal current, causing the voltage on the system to drop which can interfere with other equipment. In this study the researchers analysed the starting of a 3 phase induction motor using the direct on line system (DOL), star delta, and variable speed drive (VSD) both when the motor is free of charge and when the motor is loaded. Through this research can be seen the difference in the magnitude of current, voltage, power and THD. From the results of observations on the three types of 3 phase induction motor starting methods, it was shown that using a variable speed drive (VSD) altivar61 gave the largest decrease in current when compared to other systems.

1. Introduction

In the industry of 3 phase induction motor is the type of motor that is most widely used for example wood processing, textile, and other industries. This type of motor is preferred because of its simple, reliable construction, easy operation and maintenance. In general, industries use many motors with capacities that vary from small to large according to load requirements. In its operation, the installation of these motors can be individually or in groups. In the operation of an induction motor it is very important to pay attention to the initial current when the motor is running. Full voltage sampling carried out with a high load on large motors causes the motor to draw very large currents, which will cause voltage dip in other loads [1, 2]. Besides that, this large current can also damage the induction motor itself.

In general, induction motors can be operated by connecting the motor directly to the supply circuit or by using a voltage that has been reduced to the motor during the start period. The obstacle of using a 3 phase induction motor is when starting, where the motor requires more current, which is about 5 to 7 times the nominal current, causing the voltage on the system to drop which can interfere with other equipment [3, 4].

In this study the researchers analysed the starting of a 3 phase induction motor using the direct on line system (DOL), star delta, and variable speed drive (VSD) both when the motor is free of charge and when the motor is loaded. Through this research can be seen the difference in the magnitude of current, voltage, power, and THD.

2. Literature review

Motor in the world of electricity is a machine used to convert electrical energy into mechanical energy. One common electric motor used in many applications is an induction motor. Induction motor is one of the asynchronous machines (asynchronous motor) because this motor operates under synchronous speed.

2.1. Induction motor

The synchronous speed itself is the rotational speed of the magnetic field in the motor. This synchronous speed is affected by the frequency of the motor and many poles on the motor. Induction motors always rotate under synchronous speed because the magnetic field generated at the stator will produce flux in the rotor so that the rotor can rotate. However, the flux generated at the stator lags behind the stator-generated flux so that the rotor speed will not be as fast as the rotation speed of the stator magnetic field. Induction motors are distinguished based on the supply in two: One phase Induction Motor and 3 phase Induction Motor. Of the two types of motorcycles that distinguish this is a single phase induction motor cannot start itself while the 3 phase induction motor can own stats. In its use, phase induction motors are more widely used than single phase induction motors. The 3 phase induction motor outline consists of a stator and rotor. The stator is the silent part and the rotating part is usually coupled to the load. The rotor is divided into two parts, namely the rotor lift and rotor windings. Because the construction is very simple, the operation and maintenance are also easy. The use of 3 phase induction motors is most widely used as a driver in industries. In the operation of the three phase induction motor according to (PUIL, 2000) motor capacity below 5 KW can be connected directly to the supply (DOL system). Whereas the power above 5 KW must use a starting aid, because the start current of the induction motor is very large (2 to 7 x I n) [5-7].

The working principle of a 3 phase induction motor is the presence of electromagnetic induction, namely the influence of induction from a magnet formed by the presence of alternating current (AC) flowing on a conductor. AC current from the 3 phase source is flowed to the coil at the stator motor, consequently the shape of the coil in such a way will form a north-south pole (NS) pair and magnetic lines emerge which change according to the frequency of the voltage source 3 phase. The change in the magnetic force line is then called the magnetic swivel field with the speed value determined by the formula:

$$Ns = \frac{120f}{p} \quad (1)$$

Ns = speed (RPM);
f = electric frequency (Hz);
p = number of poles on the motor.

2.2. Electromechanical starting motor

In electromechanical starting motors, the commonly used methods are Direct on Line (DOL) and Star Delta. DOL is widely used for small motor applications (<5 KW) while Star Delta is for large motors. In starting using DOL, a jump start current is 4-8 times the normal current. Whereas in the Star Delta method there is only a surge of the start current 1.8 - 2.6 times the normal current.

2.3. Starting motor electronically

In the starting motor electronically, generally use Variable Speed Drive (VSD) / often called an inverter. The principle works is to change the frequency of electricity that supposes an AC motor. By being able to adjust the electric frequency, the motor speed can be adjusted automatically [6].

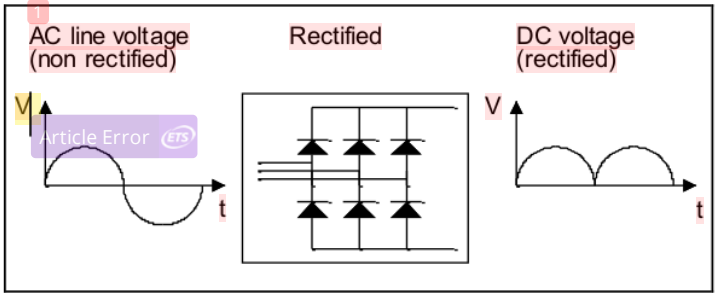

Figure 1. Rectifier principle.

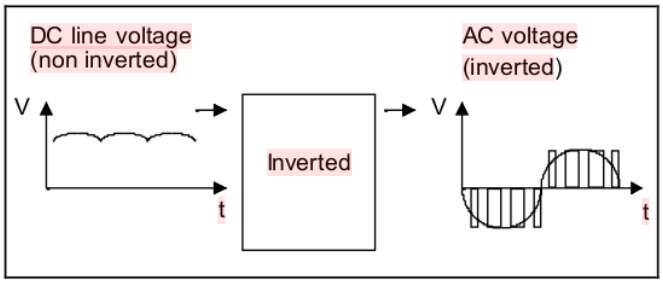

Figure 2. Inverter principle.

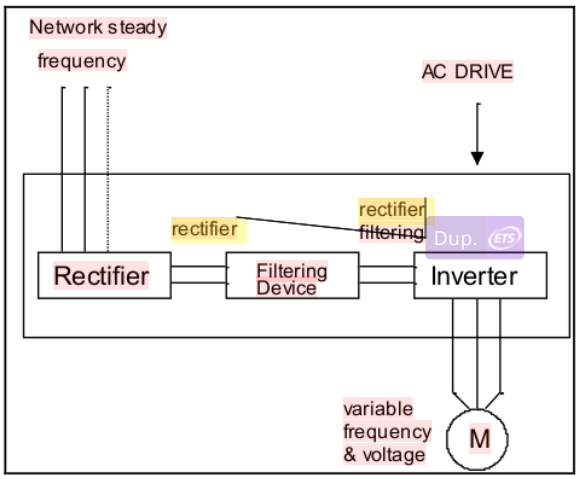

Figure 3. Variable speed drive/ inverter principle.

3. Methodology

The research design is shown as in Figure 4, Figure 5, and Figure 6. Wiring diagram three methods of starting 3 phase induction motor namely DOL circuit, star delta circuit and VSD circuit.

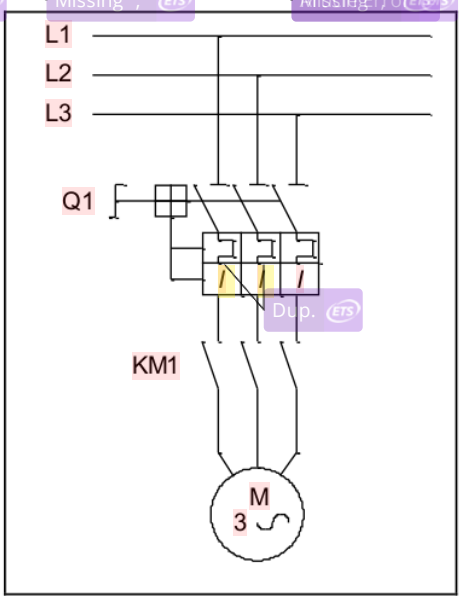

Figure 4. Power circuit for DOL.

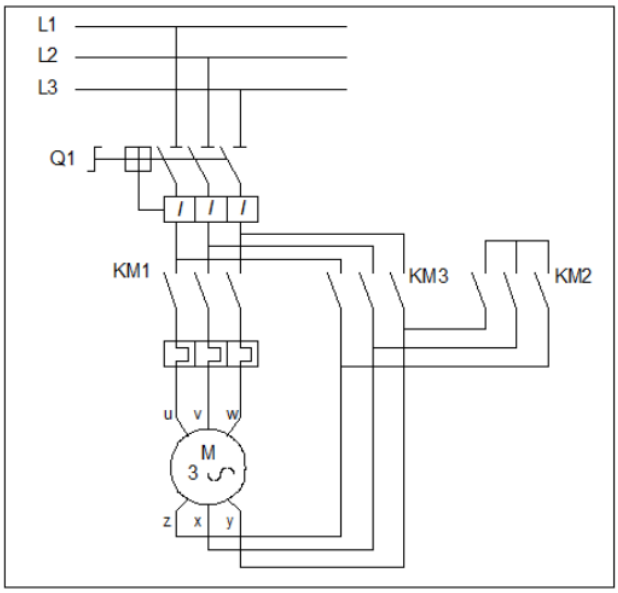

Figure 5. Power circuit for star delta.

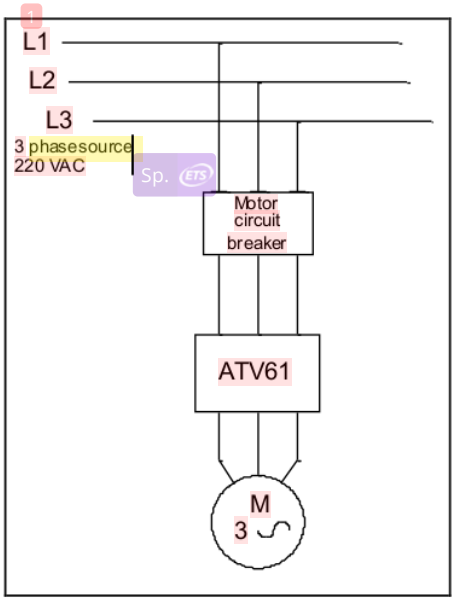

Figure 6. Power circuit for VSD.

4. Results and discussion

The induction motor data used in this study are as follows:

- 3 phase Induction Motor
- Power = 1.1 KW Voltage = 380/400 volts
- Flow = 4.5 / 2.7 Ampere Cos Q = 0.85
- Round = 1410 rpm.

In conducting data retrieval, the research was carried out by experiments in the electric machine laboratory. The Department of Electrical Engineering at the State Polytechnic of Bali with the data obtained as in table 1.

Table 1. Measuring data from starting 3 phase induction motors.

	VL-N (Volt)	VL-L (Volt)	THD VL-N (%)	THD VL-L (%)	THD I (%)	I (Amp)
DOL	226	384	1.00	1.15	2.70	4.59
	220	388	1.30	1.15	2.90	
	220	385	1.20	1.15	2.40	
Star-Delta	107	202	2.17	1.65	1.79	3.76
	124	216	1.38	1.08	1.80	
	113	178	1.90	2.05	1.81	
VSD Altivar	110	394	1.20	1.43	162.30	2.19
	114	391	1.14	1.12	123.52	
	113	391	1.16	1.10	109.60	

In the tests that have been done, the starting flow data obtained on the DOL system is 4.24 Ampere, the star delta system is 3.15 Ampere, and the VSD altivar61 system is 2 Amperes. From the three methods that have been done, it can be seen that using the VSD altivar61 method produces the smallest starting current. It is different from the DOL method which at the start of the motor torque is very large which exceeds the nominal torque of the motor and forces the motor to rotate directly. The star delta method gives a beat to the motor when the star connection changes to the delta.

5. Conclusions

The discussion and analysis that has been carried out in this study can be summarized as follows: Setting the rotation of a 3 phase induction motor can only be done using a variable speed drive (VSD). From the three methods of starting a 3 phase induction motor namely DOL, star delta and VSD Altivar61, it is seen that using VSD Altivar61 has the smallest start current. By using VSD altivar61 the acceleration of the 3 phase motor turns becomes smoother.

6. References

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