ISSN: 2634 - 8853

Journal of Engineering and Applied Sciences Technology

Review Article

Open Access

Multiphase Induction Motor

Archana Nanoty

Madhuben & Bhanubhai Patel Institute of Technology CVM University, Anand, India

ABSTRACT

Many researchers have studied multiphase Induction motor drives and output of these research shows that output Torque of these motors is superior to that of normal three phase Induction motor. Limitations on the power level of semiconductor devices establish a barrier to the increase of converter ratings. In order to get rid of this limitation, multilevel converters have been developed where switches of reduced rating are used to construct high power level converters. Instead of multilevel converters, multi-phase machines are used: By dividing the handled power between multiple phases, generally more than three, high power levels can be achieved even using limited rated power electronic converters. The aim of this research is to implement novel design and development of six phase induction motor. Also control of the same motor is carried out when fed by two, three phase inverters.

***Corresponding author**

Archana Nanoty, Madhuben & Bhanubhai Patel Institute of Technology CVM University, Anand, India. E-mail: archananantoy@yahoo.com

Received: August 26, 2022; **Accepted:** September 12, 2022; **Published:** September 21, 2022

Introduction

Basically, the six-phase induction machine was introduced with two objectives. First, the opportunity to divide the output power into two three-phase groups allows the increase in the drive system power ratings. Secondly, for use with six step inverters, the pulsating torque in a six-phase machine is lower than in a three phase machine, another reason for using six-phase systems is reliability. When a failure happens in one of the phases, in the machine or in the power converter, the system can still operate at a lower power rating since each three-phase group can be made independent from each other.

Design of Six Phase Induction Motor

Number of stator slots is given by,

S= n/2.p.[2+K] Slots (1)

Where S = no. of slots

n = no. of machine phases

p = no. of machine poles

And K = 0, 1, 2, 3…

For symmetrical ac winding: K = 0, 2, 4

For Asymmetrical ac winding: K = 1, 3, 5

In our case

S = (6/2).4.[2+1] = 36

The six-phase machine uses the same magnetic frame with the baseline machine. We have the 4-pole machine with 36 stator slots. In order to keep the leakage distribution balanced, the phases are displaced among the two stator layers. The six-phases are constructed such that one three-phase group is displaced from the other one by 30 electrical degrees.

Thus we have an asymmetrical six phase machine

where; $\theta m = 2. \theta e / p$ (2)

$\theta m = 2 . 30° / 4 = 15°$ mechanical (3)

Slot pitch = 360° / 36 = 10° mechanical (4)

Hence, the 30 electrical degrees displacement corresponds to 15°/10° = 1.5 slots. We cannot implement such a configuration and have to use an approximation. This is done as shown below: One of the three-phase groups has the same structure of the baseline machine with half of the circuits and winding distributed in 3 slots per pole per phase (qA = 3). The second group is distributed into 4 slots per pole per phase (qX = 4) but keeping the same number of conductors per pole per phase.

Table 1: Motor Specifications

Frame	CTF 132S
Stator Bore or Inner Diameter	125 mm
Stator Slots	36
Rotor Slots	28
Conductor size	22 SWG
Conductors per slot	104
No. of Turns per phase	312
Insulation	Class F

Control of Six Phase Induction Motor

Speed of an induction motor can be controlled by two methods basically: Pole changing, which is not used now and Frequency Control. For this the model of six phase induction motor in d-q axis reference is required. The laboratory test set up consists of a 3 hp, 50 Hz four pole 36 stator slots six phase induction machine supplied from two PC based separate inverters synchronized properly with specially designed D2 card for phase shift. One inverter acts as a Master and other as a slave or follower. Standard software "NXP00002V178.VCN" was downloaded for two similar rating NXP drives.

DOI: doi.org/10.47363/JEAST/2022(4)156

Figure 1: Actual Photograph of Test Set up

Figure 2: Motor Winding

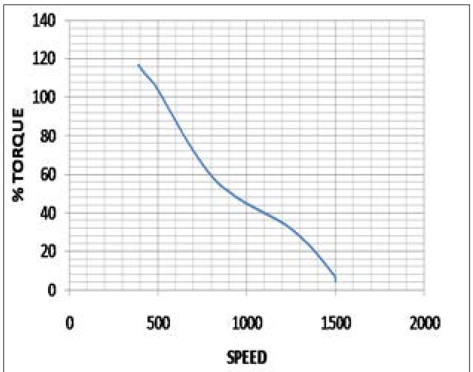

Figure 3: a) Speed Torque Curve

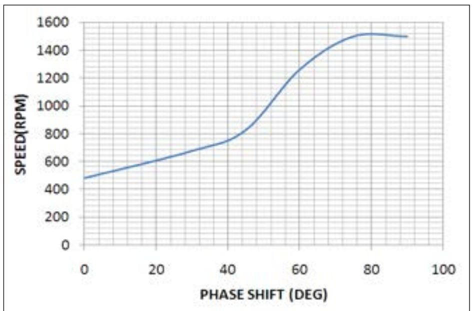

Figure 3: b) Phase Shift-Speed Curve for Frequency Control

Results and Discussion

Figure 1 shows the test set up at Vacon-India Ltd. Chennai. Figure 2 shows the actual photograph of six phase induction motor at the time of winding. Figure 3a) and b) shows the speed-torque curve and Phase shift-speed curve for frequency control mode while Figure 4 a) and b) shows the speed-torque curve and Phase shift-Speed curve for Speed control mode. it is clear that speed control mode waveform is superior to frequency control. The base speed is 490 rpm and torque is almost 1.5 times more than that of equivalent three phase induction motor.

Conclusions

Advantages of the scheme are: Applicable to six phase machine with any arbitrary angle of displacement between the two three phase winding sets whereas all vector control schemes have been developed for 30 degrees displacement. The same design can be extended for any multiples of 3, like 9 phases, 12 phases etc. The d-q axis model of six phase IM is used. By varying the phase shift between two, three phase sets, magnetic field is varied and hence speeds and torque. Thus there is no criterion of 30 deg. Phase shift, it is frequency control and speed control as well as arbitrary phase displacement [1-5].

References

1. Emil Levi (2006) Recent Developments in High Performance Variable-Speed Multiphase Induction Motor Drives. Sixth International symposium nikola tesla, Belgrade, SASA, Serbia.
2. Romeral L (2004) Motion Control for Electric Drives. Departament d'Enginyeria Electrònica. Universitat Politécnica de Catalunya 26-30.
3. Bose BK (2019) Modern Power Electronics and Ac Drives Prentice Hall Publication.
4. Mohapatra KK, Gopakumar K, Somasekhar VT, Umanand L (2002) A novel modulation scheme for a six phase induction motor with open-end windings. IEEE 2002 28th Annual Conference of the Industrial Electronics Society. IECON 1: 810-815
5. Sawhney AK (2006) Electrical Machine Design.