

PERFORMANCE OF SIX PHASE INDUCTION MOTOR USING SPECIAL TRANSFORMER CONNECTION

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Abstract

For machine drive applications, multiphase induction motor could potentially meet the demand for high power electric drive systems which are both rugged and energy efficient. High phase number drives possess several advantages over conventional three phase drives such as high torque, higher reliability, higher efficiency and increased power. Multiphase induction motors have found many applications such as electric/hybrid vehicles, aerospace applications, ship propulsion etc.

Keywords-six phase transformer design, Circle Diagram, Torque and efficiency comparison.

I. INTRODUCTION

Six phase induction motor works on six phase supply. So we have to make six phase supply. For that purpose we convert three phase supply into six phase supply by using Transformer. For use of six phase induction motor it is necessary to develop a six phase supply by using special connection of Transformer. For Transformation of three to six phase connection we have to make this type of Transformer with special guide. The Transformer output has six phases and every phase has 60 degree phase angle.

II. CONNECTION OF INDUCTION MOTOR

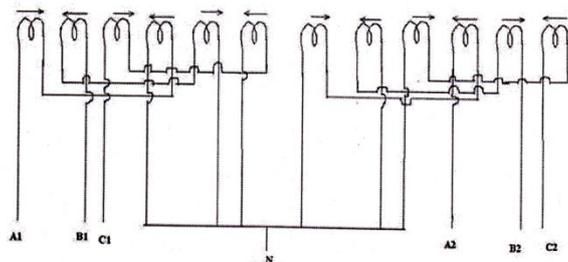


Fig. Connection diagram of six phase I.M.

A poly phase induction motor consists essentially of two major parts, the stator and the rotor. The construction of each one is basically a laminated core provided with slots which house windings. When one of the windings is excited with AC voltage, a rotating field is set up. This field produces an emf (Electromotive Force) in the other winding by transformer action which in turn circulates current in the later if it is short circuited. The currents flowing in the second winding interact with the field produced by the first winding thereby producing a torque which is responsible for the rotation of the rotor. As shown in fig. 12 coils are used in the connection of motor winding. End point of first coil is connected to End of forth coil. Start point of first coil for input A1. Start point of second coil is connected to the start of fifth coil and end point of second coil for input B1. End point of third coil is connected to end of sixth coil. Start point of third coil for input C1. Start point of 3rd, 5th, 7th, 9th and end point of 4th, 6th, 8th coils are connected to the common Neutral. End point of 10th coil is connected to End of 7th coil. Start point of 10th coil for input A2. Start point of 11th coil is connected to the start of 8th coil and end point of 11th coil for input B2. End point of 12th coil is connected to End of 9th coil. Start point of 12th coil for input C2..



Fig.6 Phase Induction Motor

III. CONNECTION OF SIX PHASE TRANSFORMER

As shown in fig. the Transformer contain total six coil. Each coil has three terminals start, tap and end. Bottom coil of each limb tapping are get connected to neutral. The top coil of each limb is start point for input supply. Top coil of each limb tap and start of each limb of bottom coil are output of Transformer and those are six phase input supply of six phase induction MOT

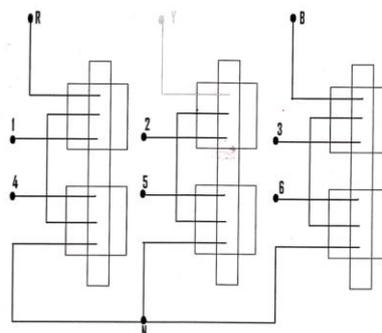


Fig. Connection diagram of six phase Transformer

IV. DESIGN SPECIFICATIONS FOR TRANSFORMER CORE

Q =output=5 Kva

K =constant= 0.4500

E_t =voltage per turn=1.006v

B_m =maximum flux density=1.2000 wb/m²

A_i =Net iron area= 0.0038 m²

d =diameter of circumscribed circle = 0.0916

A_{gi} =gross iron area=0.0042

k_v =kilo volt=1.1100

K_w =window space factor=0.2893

Δ =current density=1.5000

A_w =area of window= 15.2678

W_c =width of core= 0.0648

D =Distance between two adjacent cores= 0.1620

W_w =Width of window= 0.0704



Fig. Transformer

V. Performance Calculations

For 3 Phase Induction Motor:

V_0 = 411 V

I_0 = 1.62 A

W_0 = 80 W

V_c = 130 V

I_s = 4.5 A

W_s = 840 W

Φ_0 = 86.02⁰

Φ_s = 34.04⁰

Power scale is 1 cm =1397.984 Watt

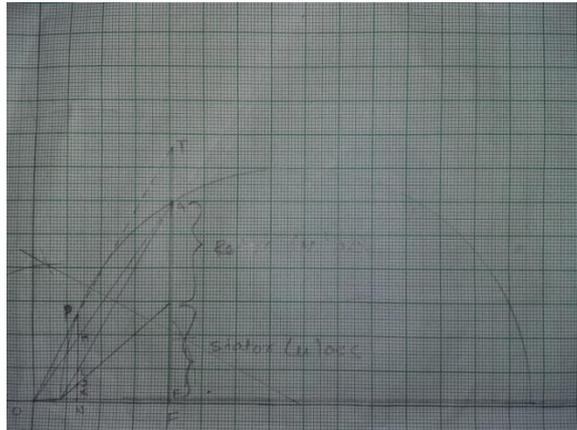


Fig. Circle Diagram of 3 Phase I.M.

Full Load line current $OP = 2.9 \text{ cm}$

As per current scale, $1 \text{ cm} = 2 \text{ Amp}$

Hence full load current = 5.8 Amp

Full load $\cos\Phi = PN / OP = 2.6 / 2.9 = 0.89 \text{ lag}$

Full load torque = Rotor input = $PJ = 1.55 \text{ cm}$

As per power scale $1 \text{ cm} = 1397.984 \text{ W}$

Hence,

full load torque = $1.55 \times 1397.984 = 2166.87 \text{ Synchronous watts}$

Full Load Efficiency = $PL / PN = 1.55 / 2.6 = 59.61 \%$

For 6 Phase Induction Motor:

$V_0 = 207 \text{ V}$

$I_0 = 0.6 \text{ A}$

$W_0 = 120 \text{ W}$

$V_c = 107 \text{ V}$

$I_c = 4.5 \text{ A}$

$W_c = 640 \text{ W}$

$\Phi_0 = 73.80^\circ$

$\Phi_s = 67.43^\circ$

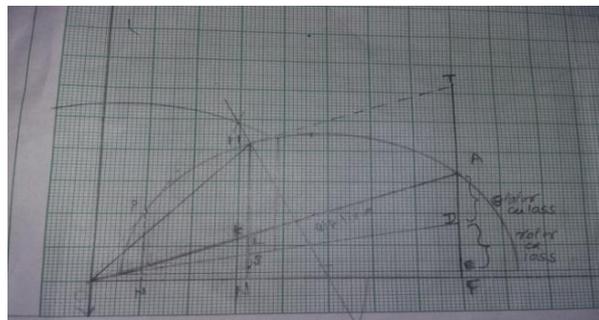


Fig. Circle Diagram of 6 Phase I.M.



Full Load line current OP = 5.35 cm

As per current scale, 1 cm = 1 Amp

Hence full load current = 5.35 Amp

Full load $\text{Cos}\Phi = \text{NH}/\text{OH} = 4.2/5.35 = 0.78 \text{ lag}$

Full load torque = Rotor input = HS = 3.5cm

As per power scale 1 cm = 720.53 W

Hence , full load torque = $720.53 \times 3.5 = 2521.85$ Synchronous watts

Full Load Efficiency = $\text{HL}/\text{HN} = 2.9/4.2 = 69.04 \%$.

VI. CONCLUSION

The full load torque of 3 HP, 4 pole, 400 volts, 3 phase induction motor is 2166.87 Synchronous Watts and full load torque of 3 HP, 4 pole, 207 volts, 6 phase induction motor is 2521.85 Synchronous Watts.

Thus, Full Load torque of 6 phase IM / Full Load torque of 3 phase IM = $2521.85/2166.87 = 1.16$. Also efficiency of 6 phase IM = 69.04% While efficiency of 3 phase IM = 59.61% .From the circle diagram and calculations it is clear that the torque of six phase induction motor is more and found to be approximately 1.16 times more than equivalent three phase motor. Also Efficiency of six phase induction motor is 1.15 times more than that of equivalent three phase induction motor. The torque of six phase induction motor is much higher than equivalent three phase induction motor. Though the initial cost of six phase induction motor is increased as compared to three phase induction motor but at the same time efficiency and torque are significantly improved.

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