# DESIGN OF 6 PHASE INDUCTION MOTOR & ANALSIS BY USING 6 PHASE TRANSFORMER

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***Abstract***: This paper represents a model of 6 phase 4 pole induction motor & 6 phase transformer. The circle diagram are drawn after observing performance of motor under no load and full load condition which shows that 6 phase induction motor has more efficiency, more torque density, good reliability as compared to 3 phase induction motor. By the help of 6 phase induction motor various testing can be performed on electric vehicle, agriculture appliances and ship propulsion etc.

***Keywords: Circle Diagram, 6 Phase 4 Pole Induction Motor, Torque, Efficiency.***

## INTRODUCTION

The 6 phase induction motor works on 6 phase supply for this it is required to develop 6 phase supply by using special type of transformer connection. Transformer as regular phase shift is 120° but 6 phase supply is required so phase shift can be divided and after that transformer output achieve which has 6 phase and every phase has 60° phase shift. And to the multi winding transformer output is given to the 6 phase induction motor to drive the 6 phase induction motor.


**Fig.1.Block Diagram**

## I. CONSTRUCTINAL DETAILS

A 6 phase induction motor consists essential 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 exited with AC voltage, a rotating field is setup. 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 current is flowing in the second winding interact with the field produced by the first winding there by producing a torque which is responsible for the rotation of the rotor. As shown in fig.2, 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, 9$^{th}$ and end point of 4th,6th,8$^{th}$ coils are connected to the common Neutral. End point of 10$^{th}$ coil is connected to End of 7$^{th}$coil.Start point of 10$^{th}$ coil for input A2.Start point of 11$^{th}$ coil is connected to the start of 8$^{th}$ coil and end point of 11$^{th}$ coil for input B2.End point of12$^{th}$ coil is connected to End of 9$^{th}$ coil. Start point of12$^{th}$ coil for input C2.

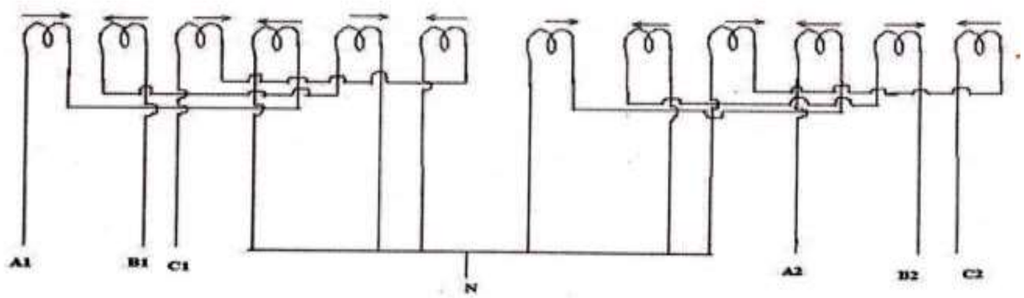


**Fig.2. Winding Connection Of Transformer**

## II. DESIGN CALCULATION OF 6 PHASE INDUCTION MOTOR

The designing main dimensions of 3H P(2.338KW), 200Volts, 6phase, 4pole induction motor(assuming efficiency η = 82%, power factor cosΦ= 0.85lagging

$Q=\frac{output\ in\ KW}{\eta x\cos\Phi}$

$Q= \frac{2.338}{0.82*0.85}$= 3.5KVA

Also Q=C0D2Lns And C0=11BavacKw10-3

Kw=Window space factor for 6 phase =1

Assuming Specific magnetic loadings Bav=0.69wb/m2 Specific electric loading ac=12000Ampere conductors

C0=11x0.69x12000x1x103=91.08

Putting the value of C0 from in We get ,D = 0.125m= 125mm ,Taking overall good design condition, i.e. $\frac{L}{T}$

Where, Γ= pole pitch=$\frac{\pi D}{p}$

Thus L= 0.1m =100mm

Similarly turns per phase,

$Tph=\frac{Eph}{4.44\varphi Kw}$=312

Total conductors=Zss=2mTph

Stator slots Ss = 36, no. of phases m = 6

Thus Total conductor = 3744

Conductor per slot $Zs=\frac{Zss}{Ss}=\frac{3744}{36}$=104

Thus the specifications of six phase induction motor areas given below:

**Stator Dimensions:-**

Stator Bore Diameter = 125mm

Number of Stator Slots = 36

Stack length of stator=100mm

**Rotor Dimensions:-**

Rotor Outer Diameter = 125mm

Number of Rotor Slots = 28

Stack length of Rotor = 100mm

Rotor Conductor size = 22SWG

Rotor Conductors per slot = 104

No. of Turns per phase=312

Insulation used to rotor winding = Class F

## III. FOLLOWING ARE THE STEPS OF DESIGN TRANSFORMER

### 1. CONNECTION OF SIX PHASE TRANSFORMER

As shown in fig.3 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 star to fetch limb of bottom coil are output of Transformer and those are six phase input supply of six phase induction motor.

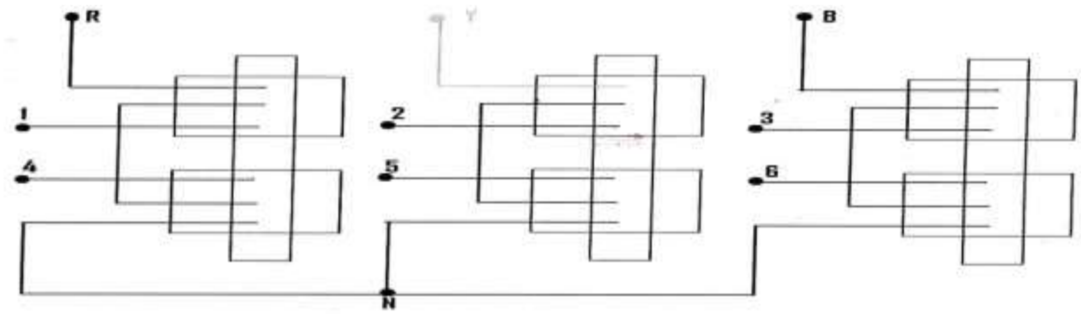


**Figure 3. Connection Diagram Of Six Phase Transformer**

### 2. DESIGN SPECIFICATIONS FOR TRANSFORMER CORE

| Parameter | Rating | unit |
|---|---|---|
| Q= transformer output | 5 | KVA |
| K= constant | 0.4500 | |
| Et= voltage per turn | 1006 | V |
| Bm= Maximum flux density | 1.2000 | wb/m² |
| Ai =net iron area | 0.0038 | m² |
| D= diameter of circumscribed circle | 0.0916 | |
| Agi = gross iron area | 0.0042 | |
| Kv= kilo volt | 1.1100 | KV |
| Kw= window space factor | 0.2893 | |
| del = current density | 1.5000 | |
| Aw= area of window | 15.2678 | |
| Wc = width of core | 0.0648 | |
| Ww= Width of window. | 0.070 | |

| | | |
|---|---|---|
| D= Distance between two adjacent cores | 0.1620 | |
| | | |

IV. **PERFORMANCE CALCULATIONS**

For 3 Phase Induction Motor:

V0= 417V

I0= 1.59A

W0=80W

Vc=139V

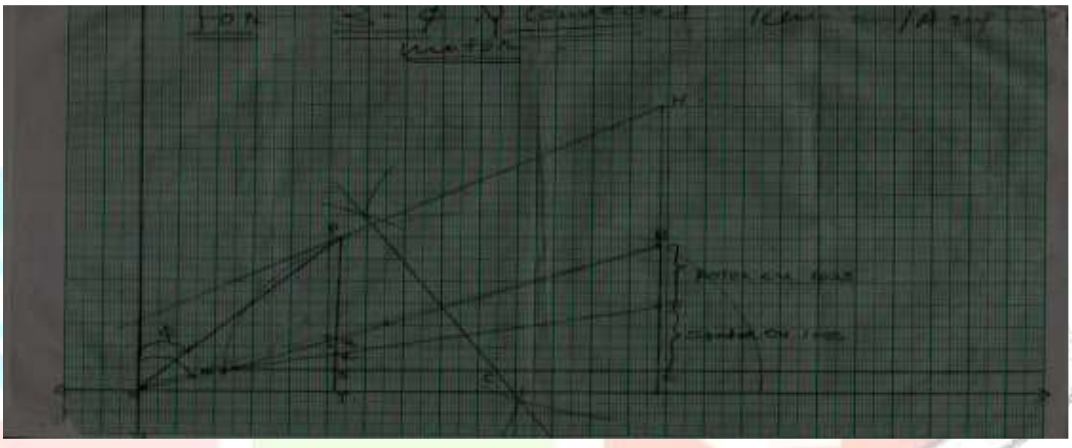

**Fig.4. circle diagram**

Full Load line current OP= 2.7cm

As per current scale,1cm=2Amp

Hence full load current= 4.67Amp

Full load Cos Φ=$\frac{PN}{OP}$= $\frac{2.6}{2.9}$= 0.89 lag

Full load torque= Rotor input=PJ= 1.55cm

As per power scale 1 cm= 1397.984W

Hence,

Full load torque= 1.55x1397.984= 2166.87 Synchronous watts

Full Load Efficiency=$\frac{PL}{PN}$= $\frac{1.55}{2.6}$= 59.61%

For 6 Phase Induction Motor:

V0=207V

I0= 0.6A

W0=120W

Vc=107V

Ic= 4.5A

Wc=640W

Φo= 73.800

Φs= 67.430

Full Load line current OP = 5.35cm

As per current scale, 1cm=1Amp

Hence full load current= 5.35Amp

Full load Cos Φ= $\frac{NH}{OH}$= $\frac{4.2}{5.35}$= 0.78lag Full load torque= Rotor input=HS= 3.5cm

As per power scale1cm= 720.53W

## V. CONCLUSION

The full load torque of 6 phase induction motor 2511.75/2156.67=1.159 also efficiency of 6 phase induction motor =67.98%, while efficiency of 3 phase induction motor=58.59%.The graphical calculation using circle diagram and theoretical calculation is compared and it's clear that the torque and efficiency of 6 phase induction motor found it approximately 1.16 more than 3 phase induction motor. The torque of 6 phase induction motor is much higher than equivalent threephase induction motor. But initial cost of 6 phase induction motor is increased due to transformer purpose as compared to 3 phase induction motor but at the same time efficiency and torque are sigficantly improve an obtain good performance.

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