4.7 Computer program: Design of slip-ring rotor

Problem:

Design a 30HP, 3 phase, 440V, 960 r.p.m, 50Hz, delta connected squirrel cage induction motor. Assume specific electric loading 25000, specific magnetic loading .46 Wb /m^2full load effeciency 86% power factor = 0.87 calculate the following

i) Stator core dimension D and L

ii) Number of stator slots and winding turns

Solution:

Po = 30HP = 30*.746kw

eff = 86% = 0.86

p.f. = .87

therefore input k.V.A = 30*.746/(.86*.87) = 29.92k.V.A

We also have ac = 25000

Bav = .46Wb

Kw = .9 as always

Co = 1.11*pi2*Bav*ac*Kw*10-3 = 1.11*3.14*3.14*.46*25000*.9*10-3 = 120.3

Now as N = 960r.p.m so Ns = N/60 = 16.67 r.p.s

So number of poles = 2f/Ns = 6

kVA = Co*Ns*D2*L

so D2L = 29.91/(120.3*16.67) = .015m3

$L/\tau = 1$ considering a good overall design

where τ = pi*D/Pole

L*Pole/(pi*D) = 1

Substituting L = .015/D2 and rearranging

we have D3 = .015*6/3.14 = .028m3

So D = .3m

hence L = .015/D2 = .16m

So we get peripheral speed Va = pi*D*Ns = 3.14*.3*16.67 = 15.6m/sec

so as Va is less than 30m/sec hence these dimensions are permissible.

Now Bav = Pole*Φm/(pi*D*L) giving us

Φm = Bav*pi*D*L/Pole = .46*3.14*.16*.3/6

Φm = .0115Wb

Number of stator turns Ts = Es/(4.44*f*Φm*Kws) = 440/(4.44*50*.0115*.955) so Ts = 180

Total number of stator pole per phase per pole Ss = 3*pole*phase = 3*6*3 = 54

Slot pitch = Yss = pi*D/Ss = 3.14*.3/54 = .017

So Zss = 6*Tph = 1080

Number of slot = 1080/54 = 20

Program:

```
function design_squirrel_cage_induction_motor

Po = 30*.746; %kw

Vin = 440;

N = 960;

Ns = N/60;

f = 50;

Bav = .46;

pf = .87;
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```
eff = .86;

ac = 25000;

Kws = .955;

phase = 3;

%rating in kVA

Q = Po/(eff*pf);

Kw = .9;

fprintf('\nProgram to design squirrel cage induction motor');

fprintf('\n————————————————————————————');

Co = 1.11*pi*pi*Bav*ac*Kw*(10^-3);

%number of poles

pole = (2*f)/Ns;

%Q = Co*Ns*D2L

fprintf('\nInput power or rating power = ');

disp(Q);

D2L = Q/(Co*Ns);

%for good overall design

%L/tow = 1

%L*pole/pi*D

D3 = (Q*pole)/(Co*Ns*pi);

D = D3^(1/3);

fprintf('\nHence Diameter D = ');

disp(D);
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fprintf('\nHence Length L = ');

L = pi*D/(pole);

disp(L);

%peripheral speed Va

Va = pi*D*Ns;

fprintf('\nPeripheral speed = ');

disp(Va);

if(Va<30)

fprintf('\nAs Peripheral speed is less than 30m/secs so dimensions are permissable');

else

fprintf('\nAs Peripheral speed is not less than 30m/sec the dimensions are not mpermissabel. But still the dimensions will be');

end

phim = Bav*pi*D*L/pole;

fprintf('\nFlux density phim = ');

disp(phim);

%number of stator turns Ts

Ts = Vin/(4.44*f*phim*Kws);

fprintf('\nNumber of stator turns Ts = ');

disp(round(Ts));

%total number of stator slot per phase per pole Ss

Ss = 3*pole*phase;

fprintf('\nTotal number of stator slot per phase per pole Ss');
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```
disp(Ss);
fprintf('\nSlot pitch Yss = ');
Yss = pi*D/Ss;
disp(Yss);
Zss = 6*round(Ts);
fprintf('\nTotal Coonductors Zss = ');
disp(Zss);
fprintf('\nNumber of Slots = ');
noofslots = Zss/Ss;
disp(noofslots);
end
```

Output:

Input power or rating power = 29.9118

Hence Diameter D = 0.3201

Hence Length L = 0.1609

Peripheral speed = 16.0904

As Peripheral speed is less than 30m/secs so dimensions are permissable

Flux density phim = 0.0119

Number of stator turns Ts = 174

Total number of stator slot per phase per pole Ss 56.2500

Slot pitch Yss = 0.0179

Total Coonductors Zss = 1044

Number of Slots = 18.5600