SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE504 SPECIAL ELECTRICAL MACHINES

III YEAR / Vth SEMESTER EEE

Unit 1 – PMBLDC

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Chapter: Special Electrical Machines : Permanent Magnet Brushless D.C. Motors

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EMF EQUATION OF BLPM SQW DC MOTORS

The basic torque emf equations of the brushless dc motor are quite simple and resemble those of the dc commutator motor.

The co-ordinate axis have been chosen so that the center of a north pole of the magnetic is aligned with the x-axis at $\Theta = 0$ .the stator has 12 slots and a three phasing winding. Thus there are two slots per pole per phase.

- Consider a BLPM SQW DC MOTOR

Let 'p'be the number of poles (PM)

'B_g' be the flux density in the air gap in wb/m^2.

B_k is assumed to be constant over the entire pole pitch in the air gap (180° pole arc) 'r' be the radius of the airgap in m.

'l' be the length of the armature in m.

'T_c' be the number of turns per coil.

'ω_m' be the uniform angular velocity of the rotor in mechanical rad/sec.

ω_m=2πN/60 where N is the speed in rpm.

Flux density distribution in the air gap is as shown in fig 4.14.At t=0(it is assumed that the axis of the coil coincides with the axis of the permanent magnet at time t=0).

Let at ω_{mt}=0,the centre of N-pole magnet is aligned with x-axis.

At ω_{mt}=0,x-axis is along PM axis.

Therefore flux enclosed by the coli is

Φ_{max}=B x 2πr/p x l ....(4.1)

=flux/pole

$\Phi_{max}=rl\int_0^{\pi} B(\theta)d\theta$

$=B_g\, rl[\theta]_0^{\pi}$

$=B_g rl[\pi]$

At ω_{mt}=0,the flux linkage of the coil is

Λ_{max}= (B_g x 2πr/p x l)T_c ωb-T ....(4.2)

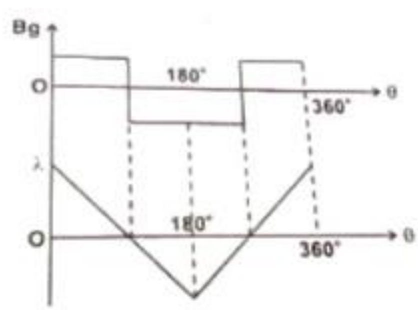


Fig 4.14 Magnetic Flux Density around the Air gap.

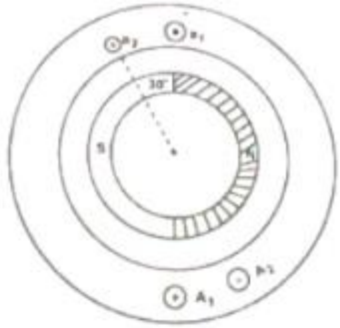


Fig 4.15 Motor Showing two Coils of One Phase.

Let the rotor rotating in ccw direction and when $\omega_{mt}=\pi/2$, the flux enclosed by the coil Φ, Therefore $\lambda=0$.

The flux linkages of the coil vary with θ variation of the flux linkage is as shown above.

The flux linkages of the coil changes from $B_g rlTc\pi/p$ at $\omega_{mt}=0$ (i.e) t= 0 t0 θ at $t=\pi/p\omega_m$.

Change of flux linkage of the coil (i.e) Δλ is

Δλ/Δt =Final flux linkage – Initial flux linkage/time.

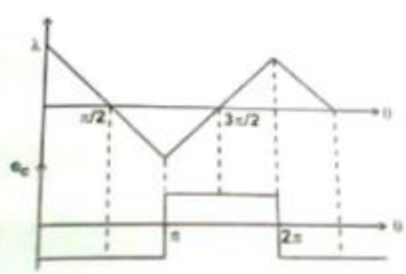
$=0-(2B_g rlTc\pi/p)/(\pi/p\omega_m)$

$= -(2B_g rlTc\omega_m)$ ....(4.3)

The emf induced in the coil $e_c = -d\lambda/dt$

$e_c = 2B_g rlTc\omega_m$ ....(4.4)

Distribution of e_c with respect to t is shown in fig 4.16



Consider two coils a1A1 and a2A2 as shown in fig 5.15.Coil a2A2 is adjacent to a1A1 is displaced from a1A1 by an angle 30^{0}(i.e.) slot angle ϒ .

The magnitude of emf induced in the coil a1A1

$e_{c2} = B_g r l T c \omega_m$ volts ....(4.6)

The magnitude of emf induced in the coil a2A2

$e_{c2} = B_g r l T c \omega_m$ volts ....(4.7)

Its emf waveform is also rectangular but displaced by the emf of waveform of coil e_{c1} by slot angle ϒ .

If the two coils are connected in series, the total phase voltage is the sum of the two separate coil voltages.

$e_{c1} + e_{c2} = 2B_g r l T c \omega_m$ ....(4.8)

Let nc be the number of coils that are connected in series per phase $n_c T_c = T_{ph}$ be the

number of turns/phase.

$e_{ph} = n_c [2B_g r l T c \omega_m]$ ....(4.9)

$e_{ph} = 2B_g r l T ph \omega m$ volts ....(4.10)