5.3 PHASOR DIAGRAM OF SYNCHRONOUS RELUCTANCE MOTOR

The synchronous reluctance machine is considered as a balanced three phase circuit, it is sufficient to draw the phasor diagram for only one phase. The basic voltage equation neglecting the effect of resistance is

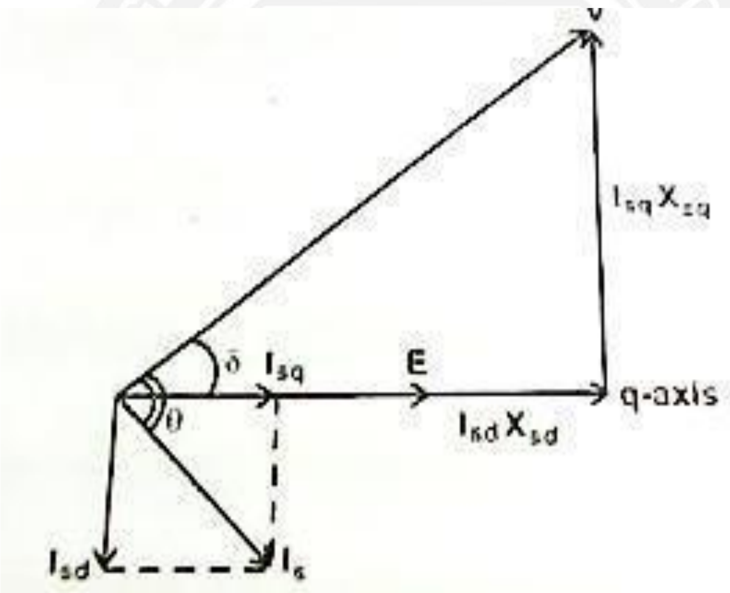

Figure 5.3.1 Phasor diagram of synchronous reluctance motor

[Source: "special electric machines" by Srinivasan page:1.3]

– j IsdXsd – j Isq ……..(1.1)

Where

V is the Supply Voltage Is is the stator current

E is the excitation emf

δ is the load angle

Φ is the phase angle

Xsd and Xsq are the synchronous reactance of direct and quadrature axis Isd and Isq are the direct and quadrature axis current

I = Isd + Isq … .... (1.2)

Isd is in phase quadrtur with E and Isq is in phase with E.

V = E – j IsdXsd – j IsqXsq From phasor diagram
V cosδ = E + Isd + Xsd .... (1.3)

Isd = $\frac{Vcos-E}{Xsd}$

IsqXsq = V sinδ

Isq = $\frac{V\ sin}{Xsq}$ ....(1.4)

Is cos = Isq cosδ - Isd sin .... (1.5)

Where

Xsd and Xsq are synchronous reactance of d and q axis.

Sub (3) and (4) in Equ (5)

Is cos ɸ = $\frac{E}{Xsd}$ sin + 2 $\frac{Xsd-Xsq}{2\ Xsd\ Xsq}$ .... (1.6)

P = 3 Vis cos ɸ . . . . (1.7)

Sub equ (6) in equ (7)

Pm = 3 [$\frac{VE}{Xsd}$ sin +V ^{2} $\frac{(Xsd - Xsq)}{2\ Xsd\ Xsq}$ sin2 δ]

Pm = T ω_S

T = Pm/ω_S

= $\frac{3}{ws}$ [$\frac{VE}{Xsd}$ sinδ + $\frac{v2(Xsd-Xsq)}{2\ Xsd\ Xsq}$ sin 2δ] ....(1.8)

Sub E = 0

T = $\frac{3}{\omega s}$V^2 [$\frac{Xsd-xsq}{2Xsd\ Xsq}$] sin 2δ ....(1.9)

Equation (9) is the torque equation of synchronous reluctance motor.

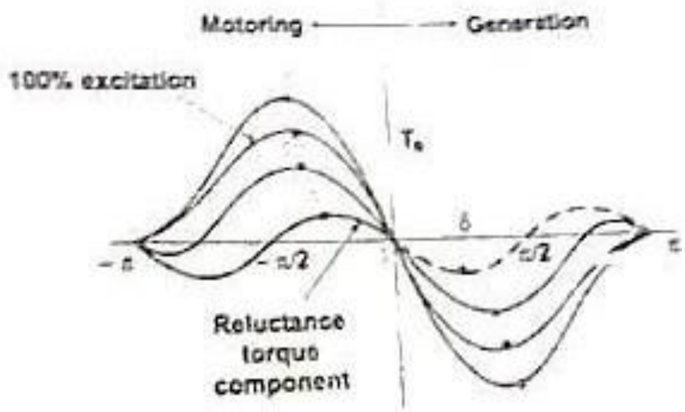

Figure 5.3.2 Torque Angle characteristics of salient pole

[Source: "special electric machines" by Srinivasan page:1.3]

Plotting the equation (9) as shown in fig indicates that the stability limit is reached at δ =± π /4

And by increasing g load angle torque also increases.

$$V^2 \left[\frac{Xsd}{2\, XsdXsq} - Xsq\right] \sin 2\delta = \text{reluctance Power}$$

In synchronous reluctance motor, the excitation emf(E) is zero.

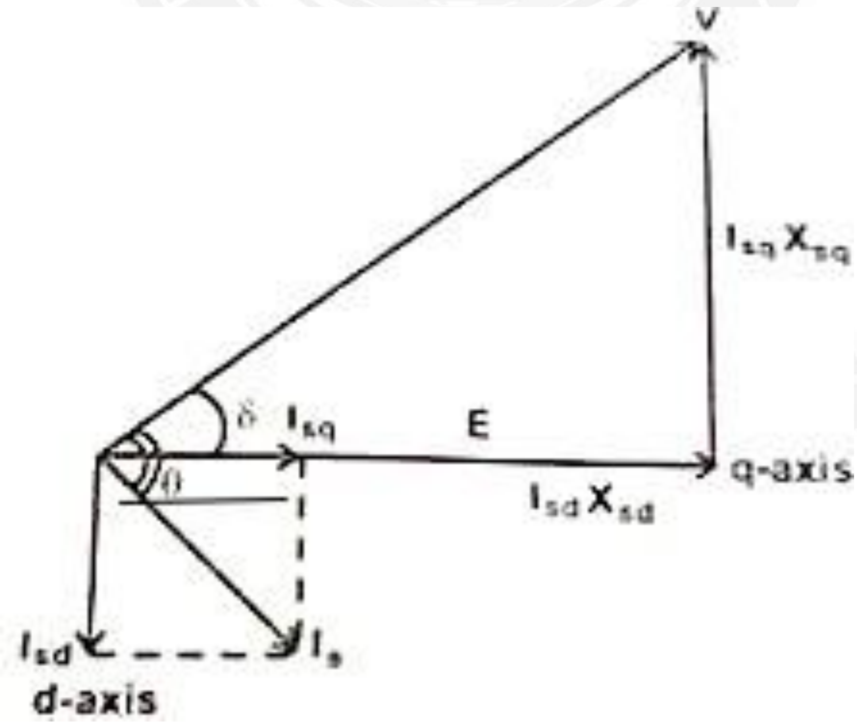

Fig 1.14 Phasor Diagram of Synchronous Reluctance Motor with E=0

ADVANTAGES AND DISADVANTAGES OF SYNCHRONOUS RELUCTANCE MOTOR

Advantages

1. There is no concern with demagnetization; hence synchronous reluctance machines are inherently more reliable than PM machines.
2. There need not be any exciting field as torque is zero, thus eliminating electromagnetic spinning losses.
3. Synchronous reluctance machine rotors can be constructed entirely from high strength, low cost materials.

Disadvantages

1. High cost than induction Motor.
2. Need Speed synchronization to inverter output frequency by using rotor position sensor and sensor less control.
3. Compared to induction motor it is slightly heavier and has low power factor.
4. By increasing the saliency ratio L_{ds}/L_{qs}, the power factor can be improved.