5.5 ESTIMATION OF AIR GAP LENGTH

Length of the air gap:

Length of the air gap is a very important parameter as it greatly affects the performance of the machine. Air gap in synchronous machine affects the value of SCR and hence it influences many other parameters. Hence, choice of air gap length is very critical in case of synchronous machines.

Following are the advantages and disadvantages of larger air gap.

Advantages:

(i) Stability: Higher value of stability limit

(ii) Regulation: Smaller value of inherent regulation

(iii) Synchronizing power: Higher value of synchronizing power

(iv) Cooling: Better cooling

(v) Noise: Reduction in noise

(vi) Magnetic pull: Smaller value of unbalanced magnetic pull

Disadvantages:

(i) Field MMF: Larger value of field MMF is required

(ii) Size: Larger diameter and hence larger size

(iii) Magnetic leakage: Increased magnetic leakage

(iv) Weight of copper: Higher weight of copper in the field winding

(v) Cost: Increase overall cost.

Hence length of the air gap must be selected considering the above factors.

Estimation of air gap length

Length of the air gap is usually estimated based on the ampere turns required for the air gap. Armature ampere turns per pole required $ATa = 1.35\ T_{ph} kw\ /p$

Where

Tph = Turns per phase,

Iph = Phase current,

kw = winding factor,

p = pairs of poles

No load field ampere turns per pole ATfo = SCR x Armature ampere turns per pole

$$ATfo = SCR \times ATa$$

Suitable value of SCR must be assumed.

Ampere turns required for the air gap will be approximately equal to 70 to 75 % of the no load field ampere turns per pole.

$$ATg = (0.7 \text{ to } 0.75)\ ATfo$$

$$\text{Air gap ampere turns } ATg = 796000\ Bgkglg$$

Air gap coefficient or air gap contraction factor may be assumed varying from 1.12 to 1.18.

As a guide line, the approximate value of air gap length can be expressed in terms of pole pitch

For salient pole alternators:

$$lg = (0.012 \text{ to } 0.016) \times \text{pole pitch}$$

For turbo alternators:

$$lg = (0.02 \text{ to } 0.026) \times \text{pole pitch}$$

Synchronous machines are generally designed with larger air gap length compared to that of Induction motors.