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1. **EFFECTS OF HARMONICS ON SYNCHRONOUS MACHINES**

There are harmonics that has an effect on synchronous machines, they are;

* **SKIN EFFECT**

In case of AC Current, Current flows in Periphery or Skin of Transmission Lines due to Self-Inductance in Conductors. At higher Frequency Skin Effect increases. Due to Skin Effect, Effective Resistance increases. This increases Loss and increase in Temperature.

* **INCREASE IN IRON LOSS IN TRANSFORMERS CONNECTED TO A GENERATOR**

Iron Loss consists of Hysteresis Loss and Eddy Current Loss. Hysteresis Loss ∝ f and Eddy Current Loss ∝ f². Thus Iron Loss increases resulting in Higher Loss in Core of Transformer and Temperature is increased.

* **RETARDING TORQUE IN AN INDUCTION MOTOR**

5th Harmonic produces flux rotating in opposite direction to Main Flux in Induction Motor. This Flux produces Retarding Torque in Induction Motor.

* **CRAWLING IN AN INDUCTION MOTOR**

7th Harmonic creates dip in Torque Speed Curve of Induction Motor at 1/7th the Synchronous Speed. This may result in Induction Motor running at 1/7th the Synchronous Speed. This is called Crawling.

The armature winding of the alternator is generally connected in star because;

* The phase voltage is 0.577 times the line voltage which results in lesser voltage stress and hence lesser insulation cost.
* The availability of the neutral point which can be grounded and thus provide a path for circulating current in case there is any unbalance in the load end or some fault occurs.
* In star connection there is a neutral availability if there is any problem. And another one is it reduces the high voltage values.
* The armature winding of alternator have a six output terminal, in which three terminal short (make neutral point) and remaining three gives output which are possible only in star connection. So we are connected in star
* Alternators are connected primarily in star to achieve the following motives:
* Lesser stress on insulation and Copper saving: Voltage per phase is less for a given line voltage which reduces insulation requirement and this also reduces the number of turns hence copper is also saved.
* Easy protection: Neutral grounding is necessary to allow zero sequence currents to flow to the ground in case of a fault.
* Elimination of harmonics: Star connection facilitates a neutral connection which is instrumental in eliminating triple harmonics.
* No circulating currents: In star connection we don't have circulating parasitic currents like in delta which lead to heating losses.

**3.**

The following are reasons why the armature for large machines are stationary;

* It is easier to collect current through brushes from stationary armature in case of generators.
* When armature winding is stationary and field winding rotates we get more output as field winding is quite lighter than armature winding.
* There is less chances of sparking in stationary arm. Winding comparatively to stationary rotor.
* Commutation is a problem in rotatory armature.
* As armature winding is stationary the natural cooling is more effective.
* As rotating winding is field winding which is comparatively light so chances of wear and tear is less.

**4.**

Here is reason why brushless generators undergo less maintenance;

* There are no brushes to replace or fix, and have fewer internal parts that can be damaged.