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Electrical Machines II Assignment 3

EEE 326

Question 1

Effects of harmonics on synchronous Machines : Harmonics current generated by any non-linear load flows from the load into the power system. These harmonics currents degrade the power system performance and reliability and could also cause safety problem. Harmonics need to be clearly located, sources identified and corrective measures taken to prevent these problems.

Source of harmonics: (1) Transformers under no load and light loads (2) Saturated Reactors (3) Thyrister controlled motor drives (4) Arc Furnaces (5) Arc Welders (6) Conduction Furnaces (7) Gas discharging lighting-low pressure/ high pressure Sodium vapour lamps (8) High-pressure Mercury vapor lamps (9) CFL/fluorescent tube lights (10) Energy conservation devices e.g. soft starters, electronics ballast and fan regulators (11) Rectifiers (12) UPS (13) Static VAR compensator (14) HVDC transmission system (15) Solar power conversion.

Harmonic effects on various components

1. **Transformers:**Harmonics in transformers cause an increase in the iron and copper losses. Voltage distortion increase losses due to hysteresis and eddy currents and causes overstressing of the insulation material used. The primary effect of power line harmonics in transformer is, thus the additional heat generated. Other problems include possible resonance between the transformer inductance and the system capacitance, thermal fatigue due to temperature cycling and possible core vibrations.

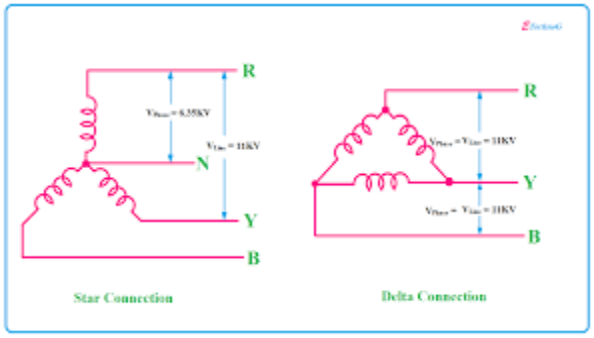
2. **Motor and generators:**Harmonic voltage and current cause increased heating in rotating machines due to additional iron and copper losses at harmonic frequencies. This lowers the machine efficiency and affects the torque developed. The flow of harmonic currents in the stator induces current flow in the rotor. This results in rotor heating and pulsating or reduced torque. Rotor heating reduces the efficiency and life of the machinery whereas pulsating or reduced torque results in mechanical oscillation causing shaft fatigue and increased ageing of mechanical parts.

Question 2.

The armature winding of the alternator is generally connected in star because of two main reasons: 1. The phase voltage is 0.577 times the line voltage which results in lesser voltage stress and hence lesser insulation cost. 2. 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.

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.

It is very important for an alternator to have a neutral point. This neutral point is to be grounded through a resistor, for stability purposes. The neutral allows a path for circulating currents under unbalanced loaded conditions, and also during faults. If there was no path for the flow of fault current, and a line to ground fault occurs in one of the three phases, there would be a rise in voltages in the other two healthy phases and eventually, it would cause insulation failure in the other two phases and the line to ground fault would lead to a 3 phase fault. A neutral point would avoid all this and limit the fault condition to one phase only. Insulation would be protected, and the lines can be operational after fault isolation. If For all this to happen, star connection in the stator is absolutely necessary.

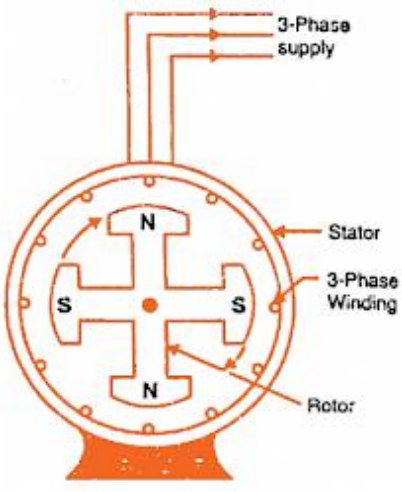


Question 3.

The field winding of an alternator is placed on the rotor and is connected to DC supply through two slip rings.

Armature of Alternator

The 3-phase armature winding is placed on the stator. This arrangement has the following advantages:



1. It is easier to insulate stationary winding for high voltages for which the alternators are usually designed. It is because they are not subjected to centrifugal forces and also extra space is available due to the stationary arrangement of the armature.
2. The stationary 3-phase armature can be directly connected to load without going through large, unreliable slip rings and brushes.
3. Only two slip rings are required for d.c. supply to the field winding on the rotor. Since the exciting current is small, the slip rings and brush gear required are of light construction.
4. Due to the simple and robust construction of the rotor, the higher speed of rotating DC field is possible. This increases the output obtainable from a machine of given dimensions.

Question 4.

Future power plants are expected to be more efficient, simpler to service, requiring less maintenance and being more capable of withstanding transients imposed by the power grid. Electric machines have improved a lot during the last decades due to new permanent magnet materials and improvedpower electronic devices. However, the hydro power industry and other industries operating synchronous generators have not been proactive to these new technologies yet. The brushless excitation system is a well-established technology that eliminates the use of carbon brushes and slips rings that would be required in a static excitation system. However, the rotating diode bridge on the shaft of the brushless system has no direct control opportunity and cannot apply negative field voltages for fast demagnetization of the synchronous generator. A slow step response of the generator field curren is what has caused the brushless system to be a non-attractive alternative for larger synchronous generators [1]. Generally, PM machines are utilized as PMG pre-exciters in a 3-stage brushless excitation system [2]. By replacing the stator field winding of the main exciter with permanent magnets, a 2-stage brushless excitation system is feasible

On the other hand, brushless alternators are better suited for more long-term, constant usage because there are no brushes to replace or fix, and have fewer internal parts that can be damaged. You may be asking yourself, “How do they move the electrical current then?” A brushless alternator has two sets of

rotors that spin together to generate and transfer the electrical current. But how does it accomplish moving the current without brushes? A brushless alternator has a second, smaller generator on the end of the equipment instead of brushes, which it uses to transfer any electrical current. This is an immediate advantage over a brushed alternator because there are no brushes to replace or repair, saving you long term money and time. A disadvantage of a brushless alternator, however, is the much higher initial cost, as opposed to a brushed alternator. This is mostly because of the higher amount of materials used in a brushless alternator. Brushless alternators, however, are also more suited to be your primary alternator/generator and are more capable of long-term use. In the long run, you will save money by buying a brushless alternator, but keep in mind that it's an investment because of the higher cost when compared to a brushed alternator.

Whether you're looking for a quick and cheap short-term brushed alternator, or a more advanced and expensive long-term solution brushless alternator, always keep in mind how much power you need to generate as well as your budget. You shouldn't feel pressured into spending more money just for a long-term alternator, but the worst-case scenario is underestimating just how much power your job requires. Use our power calculator to determine your power needs, or contact a trained Absolute Generators specialist to determine if a brushed or a brushless generator is right for your operation.