EE3014 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

UNIT II

ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION

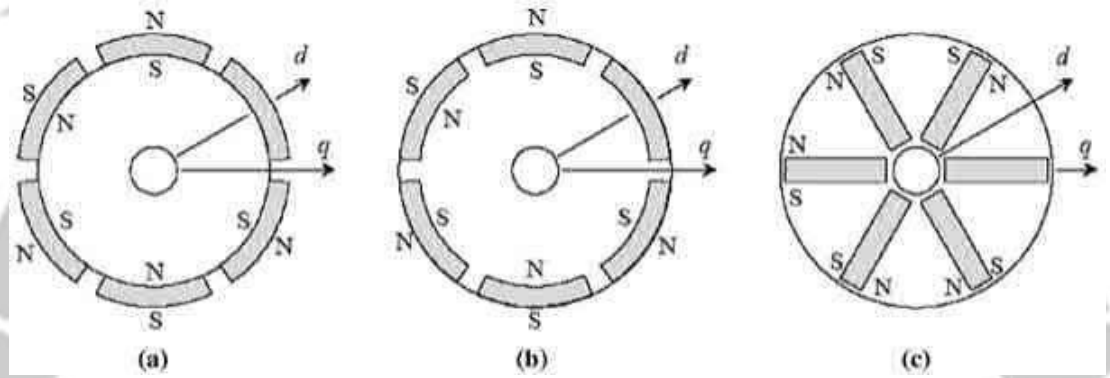
2.3-PMSG

PERMANENT MAGNET SYNCHRONOUS GENERATORS (PMSG)

Introduction

A permanent magnet synchronous generator is a generator where the excitation field is provided by a permanent magnet instead of a coil. The term synchronous refers here to the fact that the rotor and magnetic field rotate with the same speed, because the magnetic field is generated through a shaft mounted permanent magnet mechanism and current is induced into the stationary armature Synchronous generators are the majority source of commercial electrical energy. They are commonly used to convert the mechanical power output of steam turbines, gas turbines, reciprocating engines and hydro turbines into electrical power for the grid. Some designs of Wind turbines also use this generator type.

Construction



Types of PMSG rotor construction

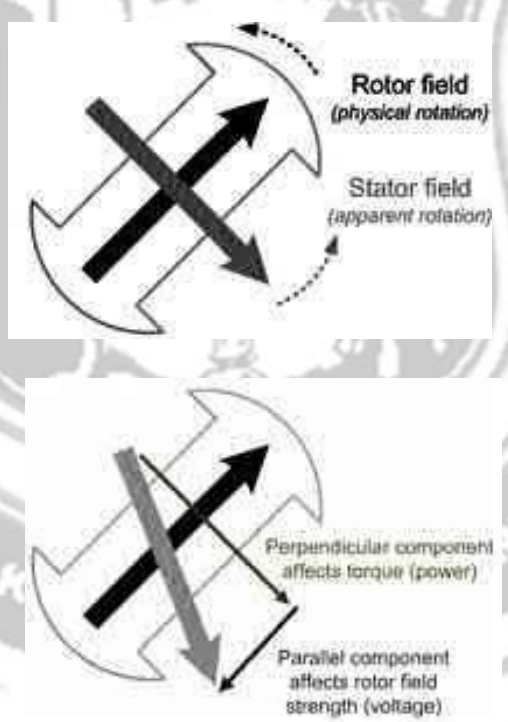
(a) Surface mounted; (b) inset; (c) Interior PM motor

A Permanent Magnet Synchronous Generator is a generator where the excitation

field is provided by a permanent magnet instead of a coil. The rotor contains the permanent magnet and the stator is the stationary armature that is electrically connected to a load. A set of 3 conductors make up the armature winding in standard utility equipment, placed 120^0 apart in space, this provides for a uniform force or torque on the generator rotor. The uniformity of the torque arises

because the magnetic field resulting from the currents in the three conductors of the armature winding combine spatially in such a way as to resemble the magnetic field of a single rotating magnet. The stator magnetic field appears as a steady rotating field and spins at the same frequency as the rotor when the rotor contains a single dipole magnetic field. The two fields move in _synchronicity' and maintain a fixed position with respect to each other as they rotate. The armature MMF combines vectorically with the persistent flux of the permanent magnets, which leads to higher air-gap flux density and eventually core saturation. In PMSG, the output voltage is proportional to the speed.

Operation



In the majority of designs the rotating assembly in the center of the generator called "rotor" contains the magnet, and the "stator" is the stationary armature that is electrically connected to a load. As shown in the diagram, the perpendicular component of the stator field affects the torque while the parallel component affects the voltage. The load supplied by the generator determines the voltage. If the load is inductive, then the angle between the rotor and stator fields will be greater than 90 degrees which corresponds to an increased generator voltage. This is known as an overexcited

generator.

The opposite is true for a generator supplying a capacitive load which is known as an under excited generator. A set of three conductors make up the armature winding in standard utility equipment, constituting three phases of a power circuit that correspond to the three wires we are accustomed to see on transmission lines. The phases are wound such that they are 120

degrees apart spatially on the stator, providing for a uniform force or torque on the generator rotor. The uniformity of the torque arises because the magnetic fields resulting from the induced currents in the three conductors of the armature winding combine spatially in such a way as to resemble the magnetic field of a single, rotating magnet. This stator magnetic field or "stator field" appears as a steady rotating field and spins at the same frequency as the rotor when the rotor contains a single dipole magnetic field. The two fields move in "synchronicity" and maintain a fixed position relative to each other as they spin.

Advantages and disadvantages of PMSG

Advantages

- Light weight and small size in construction.
- Low losses and high efficiency
- No need of external excitation current.
- No need of gearbox.

Disadvantages

- It is useful for small wind turbines, but for large wind turbines the size of the magnethas to be increased.
- Demagnetization of permanent magnet due to atmospheric conditions is a bigproblem