Electric generator

The electric generator converts mechanical energy (such as the motion of the rotors of a wind turbine) to electricity for transmission and distribution over power lines to domestic, commercial, and industrial customers.

The mechanical power for an electric generator is usually obtained from a rotating shaft and is equal to the shaft torque multiplied by the rotational, or angular, velocity. The mechanical power may come from a number of sources: hydraulic turbines at dams or waterfalls; wind turbines; steam turbines using steam produced with heat from the combustion of fossil fuels or from nuclear fission; gas turbines burning gas directly in the turbine; or gasoline and diesel engines.

The synchronous generator is designed to produce the shape of sine wave, which has the shape shown in Figure 1. This has been chosen because it is the only repetitive shape for which two waves displaced from each other in time can be added or subtracted and have the same shape occur as the result. The ideal is then to have all voltages and currents of sine shape, as accurately as is practical, this will become apparent as the major components and characteristics of such a generator are Rotor, Stator.

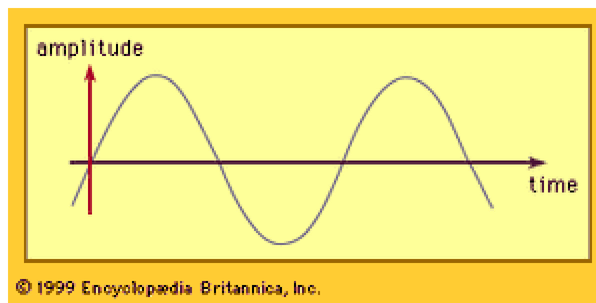

Figure 1: Sine wave

Rotor

An elementary synchronous generator is shown in cross section in Figure 2. The central shaft of the rotor is coupled to the mechanical prime mover. The magnetic field is produced by conductors, or coils, wound into slots cut in the surface of the cylindrical iron rotor. This set of coils, connected in series, is thus known as the field winding. The

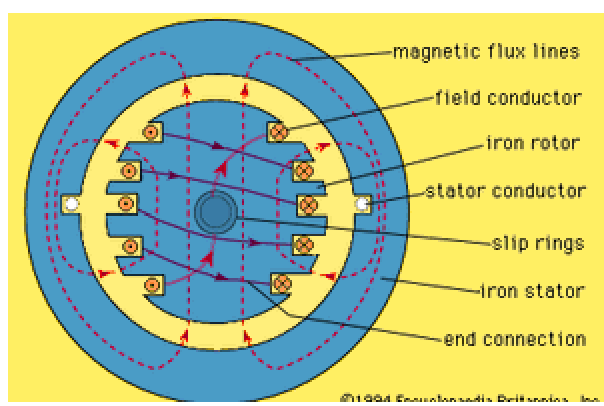

Figure 2: Rotor

position of the field coils is such that the outwardly directed or radial component of the magnetic field produced in the air gap to the stator is approximately sinusoidally distributed around the periphery of the rotor. In Figure 2, the field density in the air gap is maximum outward at the top, maximum inward at the bottom, and zero at the two sides, approximating a sinusoidal distribution.

Stator

The stator of the elementary generator in Figure 2 consists of a cylindrical ring made of iron to provide an easy path for the magnetic flux. In this case, the stator contains only one coil, the two sides being accommodated in slots in the iron and the ends being connected together by curved conductors around the stator periphery. The coil normally consists of a number of turns.

When the rotor is rotated, a voltage is induced in the stator coil. At any instant, the magnitude of the voltage is proportional to the rate at which the magnetic field encircled by the coil is changing with time—i.e.,the rate at which the magnetic field is passing the two sides of the coil. The voltage will therefore be maximum in one direction when the rotor has turned 90° from the position shown in Figure 2 and will be maximum in the opposite direction 180° later. The waveform of the voltage will be approximately of the sine form shown in Figure 1.