Answer on Question #49197-Physics-Electromagnetism

Write a paragraph describing how a generator functions to generate power. Use common electromagnetic physics terms, such as induction, coil, and current.

Answer

An electric generator use mechanical energy to generate electricity. At the heart generators is a wire coil in a magnetic field.

When we use the device as a generator, the coil can be spun, inducing a current in the coil.

An AC (alternating current) generator utilizes Faraday's law of induction, spinning a coil at a constant rate in a magnetic field to induce an oscillating emf. The coil area and the magnetic field are kept constant, so, by Faraday's law, the induced emf is given by:

$$\varepsilon = -\frac{N\Delta\Phi}{\Delta t} = -\frac{N\Delta(\mathrm{BA}\cos\theta)}{\Delta t} = -\frac{NBA\Delta(\cos\theta)}{\Delta t}.$$

If the loop spins at a constant rate, $A = \omega t$. Using calculus, and taking the derivative of the cosine to get a sine (as well as bringing out a factor of $-\omega$), it's easy to show that the emf can be expressed as:

$$\varepsilon = NBA\omega \sin\omega t.$$

The combination $NBA\omega$ represents the maximum value of the generated voltage (i.e., emf) and can be shortened to ε_0. This reduces the expression for the emf to:

$$\varepsilon = \varepsilon_0 \sin\omega t.$$

In other words, a coil of wire spun in a magnetic field at a constant rate will produce AC electricity.

A coil turning in a magnetic field can also be used to generate DC power. A DC generator uses the same kind of split-ring commutator used in a DC motor. Unlike the AC generator, the polarity of the voltage generated by a DC generator is always the same. In a very simple DC generator with a single rotating loop, the voltage level would constantly fluctuate. The voltage from many loops (out of synch with each other) is usually added together to obtain a relatively steady voltage.

Rather than using a spinning coil in a constant magnetic field, another way to utilize electromagnetic induction is to keep the coil stationary and to spin permanent magnets (providing the magnetic field and flux) around the coil. A good example of this is the way power is generated, such as at a hydro-electric power plant. The energy of falling water is used to spin permanent magnets around a fixed loop, producing AC power.