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AC generators are widely used to produce AC voltage. To understand how these generators operate, the basic theory of operation must first be understood.

EO 1.2 Given the speed of rotation and number of poles, CALCULATE the frequency output of an AC generator.

EO 1.3 LIST the three losses found in an AC generator.

EO 1.4 Given the prime mover input and generator output, DETERMINE the efficiency of an AC generator.

Theory of Operation

A simple AC generator consists of: (a) a strong magnetic field, (b) conductors that rotate through that magnetic field, and (c) a means by which a continuous connection is provided to the conductors as they are rotating (Figure 3). The strong magnetic field is produced by a current flow through the field coil of the rotor. The field coil in the rotor receives excitation through the use of slip rings and brushes. Two brushes are spring-held in contact with the slip rings to provide the continuous connection between the field coil and the external excitation circuit. The armature is contained within the windings of the stator and is connected to the output. Each time the rotor makes one complete revolution, one complete cycle of AC is developed. A generator has many turns of wire wound into the slots of the rotor.

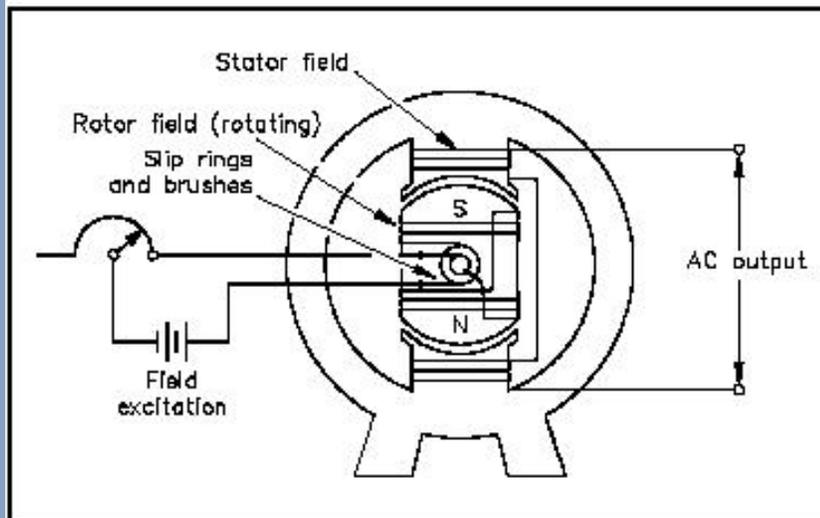


Figure 3 Simple AC Generator

The magnitude of AC voltage generated by an AC generator is dependent on the field strength and speed of the rotor. Most generators are operated at a constant speed; therefore, the generated voltage depends on field excitation, or strength.

The frequency of the generated voltage is dependent on the number of field poles and the speed at which the generator is operated, as indicated in Equation (10-1).

$$f = \frac{NP}{120} \quad (10-1)$$

where

f	=	frequency (Hz)
P	=	total number of poles
N	=	rotor speed (rpm)
120	=	conversion from minutes to seconds and from poles to pole pairs

The 120 in Equation (10-1) is derived by multiplying the following conversion factors.

$$\frac{60 \text{ seconds}}{1 \text{ minute}} \times \frac{2 \text{ poles}}{\text{pole pair}}$$

In this manner, the units of frequency (hertz or cycles/sec.) are derived.

Losses in an AC Generator

The load current flows through the armature in all AC generators. Like any coil, the armature has some amount of resistance and inductive reactance. The combination of these make up what is known as the *internal resistance*, which causes a loss in an AC generator. When the load current flows, a voltage drop is developed across the internal resistance. This voltage drop subtracts from the output voltage and, therefore, represents generated voltage and power that is lost and not available to the load. The voltage drop in an AC generator can be found using Equation (10-2).

$$\text{Voltage drop} = I_a R_a + I_a X_{L_a} \quad (10-2)$$

where

- I_a = armature current
- R_a = armature resistance
- X_{L_a} = armature inductive reactance

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