AC Theory, Circuits, Generators & Motors

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TERMINAL OBJECTIVE

1.0 Given an alternating current (AC) waveform, **DESCRIBE** the relationship between average and RMS values of voltage and current, and the angular velocity within that waveform.

LEARNING OBJECTIVES

1.1 **DESCRIBE** the construction and operation of a simple AC generator.

1.2 **EXPLAIN** the development of a sine-wave output in an AC generator.

1.3 **DEFINE** the following terms in relation to AC generation:
- a. Radians/second
- b. Hertz
- c. Period

1.4 **DEFINE** effective value of an AC current relative to DC current.

1.5 Given a maximum value, **CALCULATE** the effective (RMS) and average values of AC voltage.

1.6 Given a diagram of two sine waves, **DESCRIBE** the phase relationship between the two waves.

AC GENERATION

An understanding of how an AC generator develops an AC output will help the student analyze the AC power generation process.

EO 1.1 DESCRIBE the construction and operation of a simple AC generator.

EO 1.2 EXPLAIN the development of a sine-wave output in an AC generator.

The elementary AC generator (Figure 1) consists of a conductor, or loop of wire in a magnetic field that is produced by an electromagnet. The two ends of the loop are connected to slip rings, and they are in contact with two brushes. When the loop rotates it cuts magnetic lines of force, first in one direction and then the other.

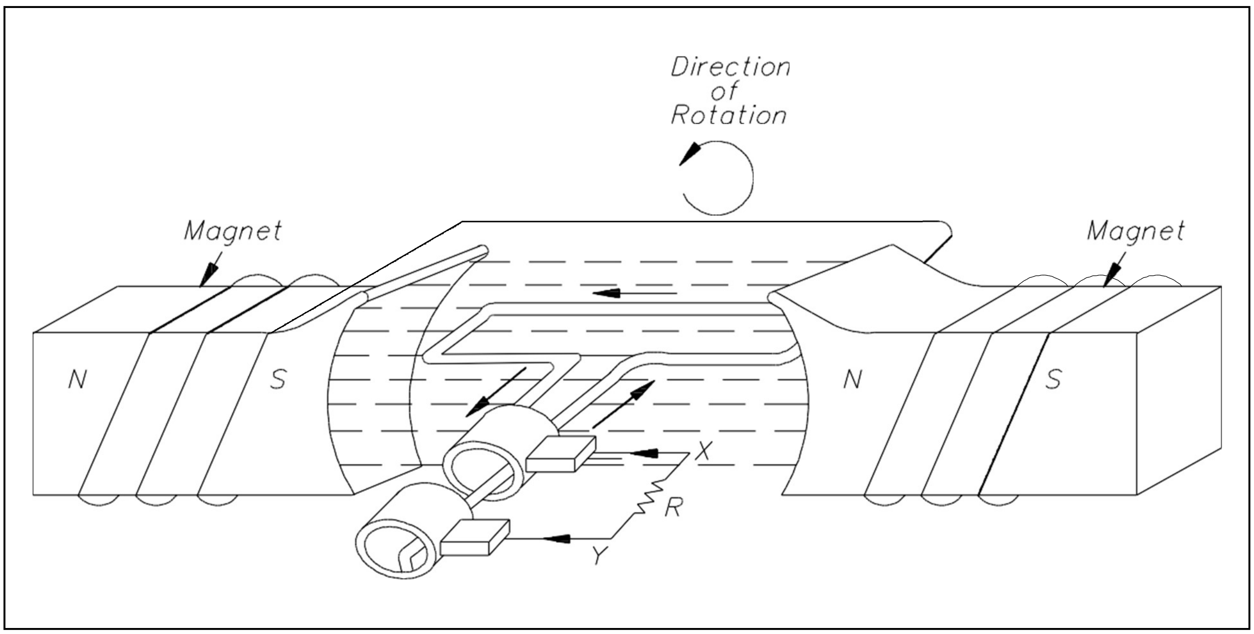

Figure 1 Simple AC Generator

Development of a Sine-Wave Output

At the instant the loop is in the vertical position (Figure 2, 0°), the coil sides are moving parallel to the field and do not cut magnetic lines of force. In this instant, there is no voltage induced in the loop. As the coil rotates in a counter-clockwise direction, the coil sides will cut the magnetic lines of force in opposite directions. The direction of the induced voltages depends on the direction of movement of the coil.

The induced voltages add in series, making slip ring X (Figure 1) positive (+) and slip ring Y (Figure 1) negative (-). The potential across resistor R will cause a current to flow from Y to X through the resistor. This current will increase until it reaches a maximum value when the coil is horizontal to the magnetic lines of force (Figure 2, 90º). The horizontal coil is moving perpendicular to the field and is cutting the greatest number of magnetic lines of force. As the coil continues to turn, the voltage and current induced decrease until they reach zero, where the coil is again in the vertical position (Figure 2, 180º). In the other half revolution, an equal voltage is produced except that the polarity is reversed (Figure 2, 270º, 360º). The current flow through R is now from X to Y (Figure 1).

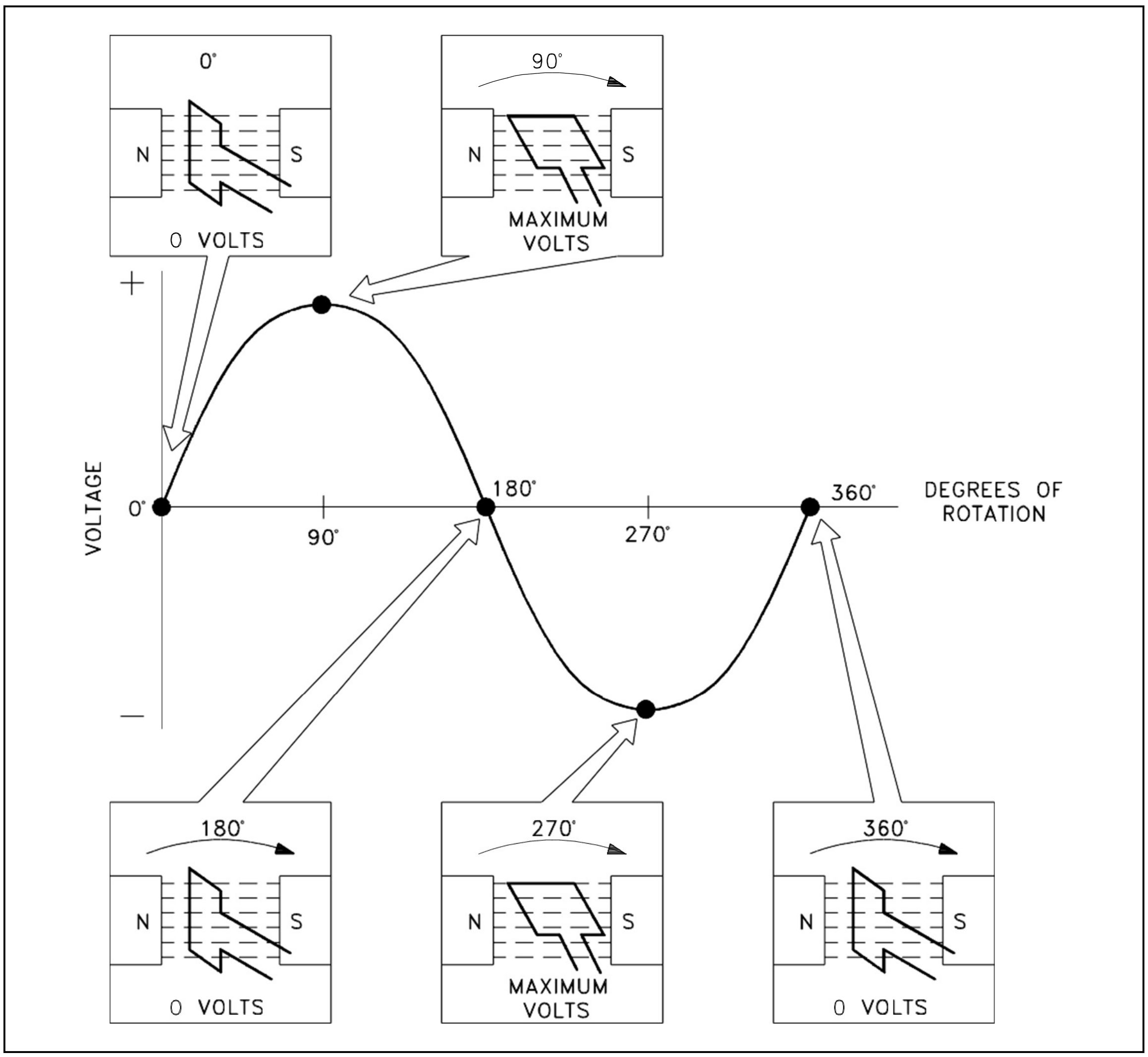

Figure 2 Developing a Sine-Wave Voltage

The periodic reversal of polarity results in the generation of a voltage, as shown in Figure 2. The rotation of the coil through 360° results in an AC sine wave output.

Summary

AC generation is summarized below.

AC Generation Summary

- A simple generator consists of a conductor loop turning in a magnetic field, cutting across the magnetic lines of force.
- The sine wave output is the result of one side of the generator loop cutting lines of force. In the first half turn of rotation this produces a positive current and in the second half of rotation produces a negative current. This completes one cycle of AC generation.