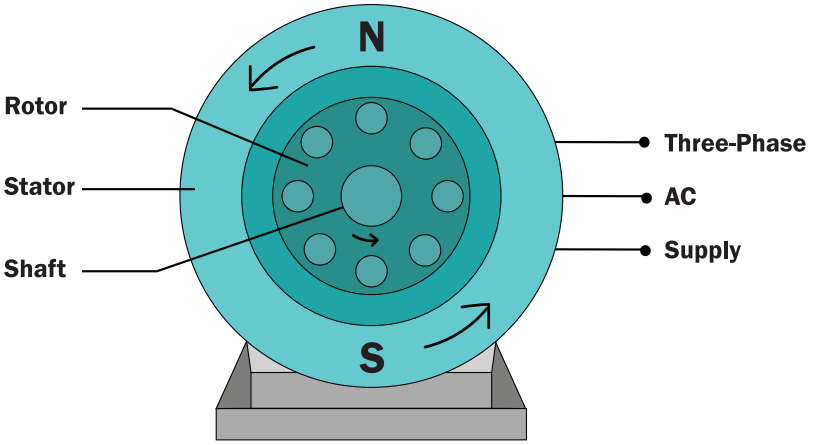
Illuminate NEBRASKA
POWERED BY NEBRASKA PUBLIC POWER DISTRICT

ELECTROMAGNETIC WAVES

AC FREQUENCY & THREE-PHASE

CONCEPT AC frequency refers to the number of cycles per second of alternating current (AC) power. It is measured in hertz (Hz) and determines the rate at which the current alternates direction. In most countries, the standard AC frequency for power grids is 50 or 60 Hz.

Three-phase AC refers to a type of AC power that uses three voltage waveforms that are 120 degrees out of phase with each other. Three-phase AC systems are typically used in motors, pumps and other equipment requiring high power output.



Three-Phase AC motor

TERMINOLOGY

AC GENERATORS: These are devices that convert mechanical energy into AC electrical energy. They are the primary source of AC power in most power grids.

FREQUENCY CONVERTERS: These are devices that convert AC power from one frequency to another. They are used to match the frequency of AC power to the requirements of specific devices or systems.

TRANSFORMERS: These devices are used to change the voltage level of AC power. They are an essential component of power grids, allowing for the efficient transmission of power over long distances.

BACKGROUND

The history of AC frequency and three-phase AC dates back to the late 1800s and early 1900s, when Nikola Tesla and other inventors developed AC generators and transformers that allowed for the efficient transmission of AC power. The invention of frequency converters and three-phase AC motors in the early 20th century further revolutionized the way AC power was used, allowing for high power output and increased efficiency. Today, these technologies are critical components of modern power systems, enabling the generation, transmission, and utilization of AC power for a wide range of industrial, commercial and residential applications.

APPLICATION

Make sure it measures up

One application of AC frequency and three-phase AC is in the design and operation of industrial motor control systems. These systems use three-phase AC motors to control the speed and direction of machinery in factories and other industrial facilities. By varying the frequency of the AC power supplied to the motor, the speed of the motor can be controlled with great precision.

One example of an industrial motor control system is in the manufacturing of steel products. In steel mills, powerful three-phase AC motors drive the rolling mills that shape the steel into various forms. By controlling the frequency of the AC power supplied to the motors, the speed of the rolling mills can be adjusted to produce the desired thickness and shape of the steel product.

REAL WORLD CONNECTIONS

Public power entities in Nebraska can benefit from AC frequency and three-phase AC by using these technologies to provide reliable, sustainable power to customers. Public power entities can also use frequency converters and transformers to improve the resilience of their power systems during natural disasters and other emergencies.

FORMULAS

FREQUENCY FORMULA: The frequency of an AC signal is given by the formula $f = 1/T$, where f is the frequency in hertz (Hz) and T is the period of the signal in seconds (s). In most countries, the standard frequency for power grids is 50 or 60 Hz.

THREE-PHASE POWER FORMULA: The power delivered by a three-phase AC system is given by the formula $P = \sqrt{3} * V * I * \cos(\theta)$, where P is the power in watts (W), V is the voltage in volts (V), I is the current in amperes (A), and $\cos(\theta)$ is the power factor (a measure of the efficiency of the system). The constant $\sqrt{3}$ represents the square root of three.

TRANSFORMER FORMULA: The voltage transformation ratio of a transformer is given by the formula $V2/V1 = N2/N1$, where V1 and V2 are the primary and secondary voltages, and N1 and N2 are the number of turns in the primary and secondary coils, respectively.

THREE-PHASE MOTOR EFFICIENCY HEURISTIC: Three-phase AC motors are typically more efficient than single-phase motors because they provide a smoother power output. This means they require less maintenance and have a longer lifespan than single-phase motors.

Illuminate NEBRASKA
POWERED BY NEBRASKA PUBLIC POWER DISTRICT

powered by: Nebraska Public Power District
Always there when you need us