

Three PHASE Induction Motors-principle, Starting of squirrel cage and slip ring rotor type induction machine, Losses and efficiency of three phase induction machine

Introduction:

Three-phase induction motors are widely used in various industrial and commercial applications due to their robustness, simplicity, and cost-effectiveness. These motors work on the principle of electromagnetic induction, where a rotating magnetic field induces currents in the rotor windings, resulting in the production of torque. This article will delve into the working principle of three-phase induction motors, different starting methods for squirrel cage and slip ring rotor types, and discuss the losses and efficiency associated with these machines.

Working Principle:

The working principle of a three-phase induction motor is based on the interaction between the stator's rotating magnetic field and the rotor. The stator consists of three-phase windings, which are supplied with alternating currents displaced by 120 degrees. As a result, a rotating magnetic field is produced. This rotating magnetic field cuts across the conductors of the rotor, inducing currents due to electromagnetic induction. The interaction between the rotating magnetic field and these induced currents generates a torque, causing the rotor to rotate.

Starting of Squirrel Cage Rotor Induction Motor:

Squirrel cage rotor induction motors are the most commonly used type due to their simplicity and rugged construction. There are several methods employed to start these motors:

Direct-On-Line (DOL) Starting: In this method, the motor is directly connected to the three-phase power supply. It is suitable for small

motors where the starting current is within the acceptable range. However, the high starting current can cause voltage dips in the supply system and mechanical stresses on the motor.

Star-Delta Starting: This method involves connecting the motor windings in a star configuration during starting and then switching to a delta configuration once the motor reaches a certain speed. Star-delta starting reduces the starting current but may result in reduced torque during starting.

Auto-Transformer Starting: An autotransformer is used to reduce the voltage applied to the motor during starting, thereby reducing the starting current. This method provides smooth acceleration and lower starting current compared to DOL starting.

Starting of Slip Ring Rotor Induction Motor:

Slip ring rotor induction motors, also known as wound rotor motors, offer advantages such as high starting torque and adjustable speed. The starting methods for slip ring rotor motors include:

Rotor Resistance Starting: External resistors are connected to the rotor windings to limit the starting current and increase the starting torque. The resistance is gradually reduced as the motor accelerates.

Rotor Voltage Control: By using variable resistors or autotransformers, the voltage applied to the rotor windings can be adjusted, allowing control over the starting torque and current.

Losses and Efficiency:

Three-phase induction motors exhibit various losses during operation, which affect their overall efficiency. The major losses include:

Copper Losses: These losses occur due to the resistance of the stator and rotor windings, resulting in the generation of heat. Copper losses are proportional to the square of the current and can be minimized by using larger conductor sizes.

Iron Losses: Also known as core losses, these losses occur in the stator and rotor cores due to hysteresis and eddy current losses. The core losses depend on the magnetic properties of the materials used and the frequency of the supply.

Mechanical Losses: These losses arise from friction and windage, such as bearing friction and air resistance. Mechanical losses can be reduced by using efficient bearing systems and streamlined motor designs.

The efficiency of a three-phase induction motor is calculated as the ratio of output power to input power. It is affected by the losses mentioned above. Higher copper and iron losses reduce the efficiency, while minimizing mechanical losses can improve it. Motor efficiency is a crucial factor in determining energy consumption and operating costs.

Conclusion:

Three-phase induction motors are essential components in various industrial applications. Understanding their working principle, different starting methods for squirrel cage and slip ring rotor types, as well as the losses and efficiency associated with these machines, is crucial for selecting and operating them efficiently. By considering the specific requirements of the application and implementing appropriate starting methods and design considerations, the performance and energy efficiency of three-phase induction motors can be optimized.