

part winding starting of the three phase induction motor

part winding starting of the three phase induction motor is a common method used to reduce the starting current and torque in three-phase induction motors. This technique is particularly useful in applications where the motor starts under light loads or where electrical supply limitations exist. The part winding starting method involves connecting only a portion of the stator winding initially and then switching to the full winding after the motor reaches a certain speed. This article explores the principles, working, advantages, and practical applications of part winding starting in three-phase induction motors. It also compares this method with other starting techniques, providing a comprehensive understanding of its role in motor control and efficiency improvement.

- Principle of Part Winding Starting
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- Advantages of Part Winding Starting
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Principle of Part Winding Starting

The principle behind part winding starting of the three phase induction motor is to reduce the initial inrush current by energizing only a fraction of the total stator winding during startup. Typically, the stator winding is divided into two equal parts or sections. At the moment of starting, only one part is connected to the supply, which significantly lowers the starting current and torque. After the motor accelerates to a predetermined speed, the second winding section is connected, allowing the motor to run at full power.

This controlled application of voltage and current helps in minimizing electrical stresses on the motor and the supply network. The technique utilizes the inherent characteristics of the induction motor's stator winding to facilitate a smooth and economical startup.

Working Mechanism of Part Winding Starting

Stator Winding Configuration

In part winding starting, the stator winding of the three-phase induction motor is split into two separate windings, commonly referred to as the main and auxiliary windings. Each winding typically carries half of the rated current. The windings are designed so that each can produce a rotating magnetic field independently, but at a reduced strength compared to the full winding.

Starting Process

During startup, only one winding is connected to the three-phase supply. This results in a reduced magnetic flux and consequently a lower starting torque and current. The motor begins to accelerate under these reduced conditions. Once the motor attains a speed generally around 70-80% of the rated speed, the second winding is switched in, either manually or through an automatic switching device such as a centrifugal switch or relay. At this stage, the motor develops full torque and runs at its rated speed.

Control Circuitry

The control circuit for part winding starting is relatively simple. It includes contactors or switches that engage the windings in sequence. The timing or speed detection for switching the second winding can be achieved by mechanical means like centrifugal switches or electrical sensors designed to detect motor speed or current.

Advantages of Part Winding Starting

Part winding starting of the three phase induction motor offers several benefits over direct-on-line (DOL) starting and other reduced voltage starting methods. These advantages contribute to its popularity in specific industrial and commercial applications.

- **Reduced Starting Current:** By energizing only half of the winding initially, the starting current is approximately halved compared to DOL starting, minimizing voltage dips and electrical disturbances in the supply system.
- **Lower Starting Torque:** The starting torque is also reduced, which is beneficial for applications where high starting torque is unnecessary or may cause mechanical stress.
- **Cost-Effectiveness:** The method is simpler and less expensive than star-delta or autotransformer starters, requiring fewer components and simpler control.

- **Improved Motor Life:** Reduced electrical and mechanical stresses during startup enhance the longevity of the motor windings and bearings.
- **Energy Efficiency:** Less power is drawn during startup, contributing to energy savings and improved overall system efficiency.

Applications of Part Winding Starting

Part winding starting is suitable for a variety of industrial motors and applications where the load during startup is light or where the electrical supply has limitations on current draw. Its implementation is common in specific scenarios due to its simplicity and effectiveness.

- **Fans and Blowers:** These machines typically have low starting torque requirements, making part winding starting ideal to reduce electrical stress.
- **Pumps:** Small to medium-sized centrifugal pumps benefit from reduced starting current when part winding starting is employed.
- **Compressors:** Air compressors with moderate starting loads utilize this method to protect electrical infrastructure.
- **Conveyors:** Conveyors with light initial loads can employ part winding starting to minimize power surges.
- **General Industrial Motors:** Motors in industries where supply constraints exist or where simple starting methods are preferred often use part winding starting.

Comparison with Other Starting Methods

Direct-On-Line (DOL) Starting

DOL starting connects the motor directly to the full supply voltage, resulting in a high starting current (typically 6 to 8 times the rated current). Though simple and inexpensive, DOL causes significant voltage drops and mechanical stresses. Part winding starting reduces these issues by limiting the initial current.

Star-Delta Starting

Star-delta starting is another reduced voltage method involving switching the motor from a star to a delta connection after startup. It reduces starting current to approximately one-third of the DOL current, which is typically lower than the part winding starting current. However, star-delta starters are more complex and require additional components.

Autotransformer Starting

Autotransformer starters use a transformer to apply a reduced voltage during startup. This method offers smooth starting with adjustable voltage levels but is more expensive and bulky compared to part winding starting. Part winding starting provides a simpler and less costly alternative where moderate reduction is sufficient.

Limitations and Considerations

Despite its benefits, part winding starting of the three phase induction motor has certain limitations that must be considered when selecting a starting method.

- **Reduced Starting Torque:** The initial torque is roughly half of the rated torque, which may be insufficient for heavy load starting.
- **Switching Complexity:** The transition between part winding and full winding must be carefully timed to avoid electrical and mechanical shocks.
- **Not Suitable for All Motors:** Some motor designs and applications may not support splitting the winding into equal parts.
- **Speed Detection Requirement:** Reliable methods for detecting the motor speed or timing the switching are necessary for smooth operation.

Proper design and implementation of the part winding starting system ensure effective performance and protection for both the motor and the electrical supply network.

Frequently Asked Questions

What is part winding starting in a three phase induction motor?

Part winding starting is a method used to reduce the starting current of a three phase induction motor by initially energizing only a portion of the stator winding, and then switching on the remaining winding after the motor reaches a certain speed.

Why is part winding starting used in three phase induction motors?

Part winding starting is used to limit the high inrush current during motor startup, which helps in reducing electrical stress on the motor and supply network, and minimizes mechanical stress on the motor components.

How does part winding starting reduce the starting current of a three phase induction motor?

By initially energizing only half or a part of the stator winding, the motor draws less current compared to full voltage starting. Once the motor gains speed, the remaining winding is connected, allowing the motor to run at full capacity.

What are the typical applications of part winding starting in three phase induction motors?

Part winding starting is commonly used in applications where the motor has a low starting torque requirement, such as pumps, fans, and blowers, where reduced starting current is desirable without the need for complex starting methods.

What are the advantages and disadvantages of part winding starting?

Advantages include reduced starting current and simple control circuitry. Disadvantages include limited starting torque since only part of the winding is energized initially, making it unsuitable for high starting torque applications.

Additional Resources

1. Starting Methods for Three-Phase Induction Motors: Part Winding and Beyond

This book offers a comprehensive guide to various starting techniques for three-phase induction motors, with a special focus on part winding starting. It explains the principles behind part winding starting, its advantages, and practical implementation details. Engineers and students will find the step-by-step procedures and case studies very useful for real-world applications.

2. Electric Motor Control: Part Winding Starting of Induction Motors

A detailed exploration of motor control strategies, this book delves into the part winding starting method as an efficient way to reduce inrush current. It covers the electrical characteristics, design considerations, and operational procedures for three-phase induction motors. The text includes circuit diagrams and troubleshooting tips that help in understanding motor starting techniques.

3. Advances in Induction Motor Starting Techniques

Focusing on recent developments in motor starting, this volume addresses part winding starting among other methods such as star-delta and autotransformer starting. It provides theoretical background along with practical performance analysis. Readers gain insight into optimizing motor starting for energy efficiency and mechanical longevity.

4. Three-Phase Induction Motors: Design and Starting Methods

This book combines the fundamentals of induction motor design with in-depth coverage of starting methods including part winding starting. It explains how part winding starting reduces starting current and torque, making it suitable for specific industrial applications. The book also discusses motor protection and maintenance related to different starting techniques.

5. Practical Guide to Part Winding Starting of Induction Motors

An accessible manual aimed at technicians and engineers, this guide focuses exclusively on part winding starting. It outlines installation procedures, wiring configurations, and control circuit design. The book includes troubleshooting advice and examples of common issues encountered during part winding start-ups.

6. Industrial Motor Starting and Control: Part Winding Method

This text covers industrial motor starting applications with a dedicated chapter on part winding starting for three-phase induction motors. It explains the reduction in starting current and mechanical stress benefits, supported by performance curves and real-life case studies. The book is a valuable resource for electrical engineers working in manufacturing and process control.

7. Electrical Machines: Theory, Operation, and Starting Methods

A comprehensive textbook on electrical machines, it discusses the theory behind motor operation and various starting methods including part winding starting. The section on part winding starting highlights its use in medium-sized motors where reduced starting current is critical. Illustrations and mathematical models enhance understanding of motor behavior during starting.

8. Energy Efficient Motor Starting Techniques

This book emphasizes methods for reducing energy consumption during motor starting, featuring part winding starting as a key technique. It provides comparative analysis with other starting methods and discusses selection criteria based on application needs. The text is ideal for energy auditors and engineers aiming to optimize motor-driven systems.

9. Control of Electric Motors: Starting, Speed, and Torque

Covering a broad spectrum of motor control topics, this book includes a detailed examination of part winding starting for three-phase induction motors. It explains control strategies, circuit design, and impact

on motor performance and lifespan. The book also explores integration with modern control systems and automation technologies.

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