



“ RESEARCH PAPER ON DESIGN AND DEVELOPMENT OF SIMULATION MODEL FOR THREE PHASE.

Mr. Roshan Upare¹, Mr. Roshan Bhatwalkar², Mr. Sudhanshu Ghotekar³, Mr. Aman Patil⁴.

Prof. Sameer S. Raut⁵, Prof. Shradha Waghade⁶,

(UG Student SSCET Bhadravati¹²³⁴, Assistant Professor Dept of Electrical Engg ,SSCET Bhadravati^{5,6})

ABSTRACT

This project shows how to create a simulation model to study how well a three-phase induction machine starts. The main goal is to study how motors behave when they start, look at different ways to start them, and improve important factors like starting current, torque, and voltage drop. We used MATLAB/Simulink to create simulations of different starting methods for motors. These methods include direct-on-line (DOL), star-delta, and auto-transformer starters. We compared how they perform. The simulation results show how the machine behaves when the load and supply conditions change. The model created is a useful tool for learning about how people move. It helps improve designs and combine systems in industrial uses.

INTRODUCTION

Three-phase asynchronous machines, also known as induction motors, are very important in today's industrial systems. They are popular because they are simple, durable, affordable, and easy to maintain. These machines are used a lot in different areas like making things, moving stuff, farming, and home use. Even though asynchronous machines have benefits, they have a big problem when it comes to starting up.

When they start up, induction motors use much more electricity than they normally do, which can cause a drop in voltage, put too much stress on the machinery, and shorten the life of the equipment if not handled correctly. To solve these problems, different motor starting methods have been created, and each one has its own benefits and drawbacks. Some common methods for starting motors are Direct-On-Line (DOL) starting, Star-Delta starting, and Autotransformer starting. Choosing the right method depends on things like motor power, load details, budget limits, and how much the supply network can handle.

This project plans to create a simulation model to look at and compare how different starting methods work for

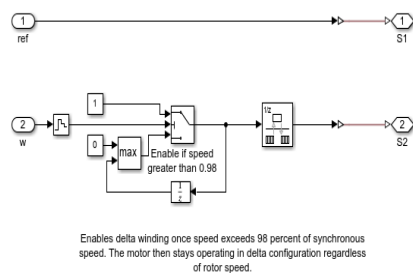
three-phase asynchronous machines. Thanks to new computer tools, simulation is now a cheap and effective way to study complex electrical systems without needing to build physical models. In this project, we use MATLAB/Simulink to create a simulation setup that lets us test and study different ways to start motors. This setup is flexible and allows us to control the conditions of the tests. The simulation model is created using mathematical equations that explain how induction motors work. These include the movements of the stator and rotor, the electromagnetic force, and how they interact with mechanical loads. By trying out different starting methods, the model helps us look at and compare important performance measures like starting current, torque, speed changes, and energy losses. The goal of this study is to improve our understanding of how induction motors start and to help choose the best starting method for different uses. The simulation model is a helpful tool for learning and research. It provides useful information about how motors behave, helps make better design choices, and aids in creating energy-efficient motor controls.

OBJECTIVES

1. To understand how three-phase asynchronous motors work, we will look at how the electrical and mechanical parts help start the motor.
2. To look into and study different common ways to start things, including:
 - Starting with Direct-On-Line (DOL)
 - Star-Delta starting
 - Starting with an autotransformer
3. Create a detailed simulation model in MATLAB/Simulink that shows how an induction motor behaves when it starts up. This model should include

7. To show that using simulations to study how electrical machines work is cost-effective and flexible, which means we rely less on making physical prototypes and doing experiments.

METHODOLOGY



The methodology for this project involves a step-by-step approach to model, simulate, and analyze different starting methods of a three-phase asynchronous (induction) machine. The major steps are as follows:

1. Problem Definition

- Identify the problems associated with starting three-phase induction motors, such as high inrush current, mechanical stress, and voltage dips.
- Define the objective of simulating and analyzing different starting methods to reduce these effects.

2. Theoretical Analysis

- Study the working principles of three-phase asynchronous machines.
- Understand the mathematical modeling of induction motors including stator and rotor dynamics.
- Review the different starting methods:
 - Direct-On-Line (DOL)
 - Star-Delta
 - Autotransformer

3. Software Selection

- Select MATLAB/Simulink as the simulation platform due to its flexibility, accuracy, and availability of pre-built electrical machine libraries.

4. Motor Parameter Selection

- Choose or define the specifications of the three-phase induction motor used in the simulation, including:
 - Rated voltage and frequency
 - Rated power
 - Number of poles
 - Stator and rotor resistance and inductance
 - Inertia and friction coefficients

5. Model Development in MATLAB/Simulink

- Develop the base model of a squirrel cage induction motor using:
 - MATLAB Simulink blocks or
 - The built-in Asynchronous Machine block from Simscape Electrical.
- Model different starting methods as separate subsystems.

6. Implementation of Starting Methods

- **DOL Starting:** Direct connection of motor terminals to the supply.
- **Star-Delta Starting:** Initially connect the motor in star and switch to delta after a preset time.
- **Autotransformer Starting:** Use of a tapped autotransformer to apply reduced voltage during startup.

7. Simulation and Testing

- Simulate each starting method under similar load conditions.
- Measure and record performance parameters:
 - Starting current
 - Electromagnetic torque
 - Rotor speed
 - Voltage levels
 - Acceleration time

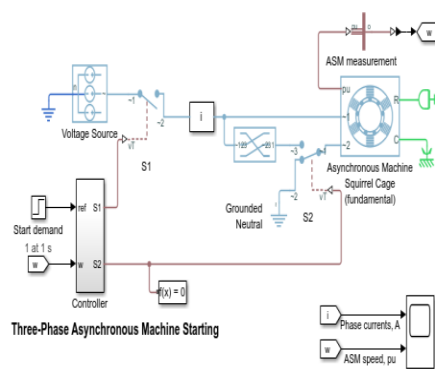
8. Result Analysis and Comparison

- Analyze the time-domain responses (current, speed, torque) for each starting method.
- Compare the effectiveness of each method in minimizing starting current and torque spikes.
- Identify the advantages and limitations of each method.

9. Conclusion and Recommendations

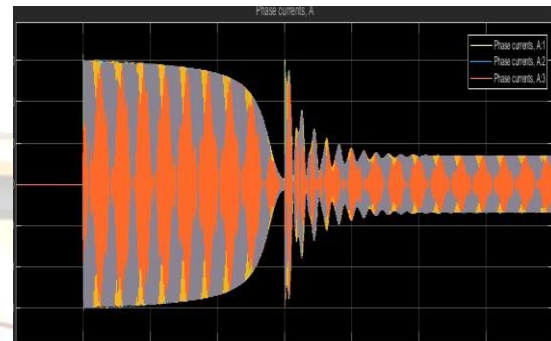
- Summarize the findings of the simulation study.
- Recommend the most suitable starting method based on the application scenario.
- Suggest future enhancements, such as adding soft starter or VFD (Variable Frequency Drive) simulation.

SIMULATION MODEL

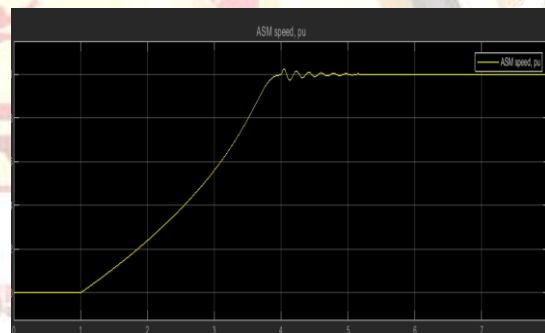


SIMULATION RESULTS

a) Phase Current, A



b) ASM Speed, pu



LITERATURE SURVEY

[1] Krause, P. C., Wasynczuk, O., Sudhoff, S. D. (2002)- Analysis of Electric Machinery and Drive Systems Presents mathematical models of induction motors using d-q axis transformation. Formulates complete electrical and mechanical dynamic models.

Foundation for most simulation-based approaches in MATLAB/Simulink.

[2] Boldea, I., & Nasar, S. A. (1992)- Vector Control of AC Drives. Discusses dynamic modeling of induction motors using field-oriented control. Describes the effects of flux, torque, and speed interaction during motor starting.

[3] Mohan, N., Undeland, T. M., & Robbins, W. P. (2003)- Power Electronics: Converters, Applications, and Design. Covers simulation of motor drive systems using power electronics.

Explores soft-start techniques using thyristors and inverters.

[4] M. A. Rahman, A. Chiba, and T. Fukao (2004)- “Super high-speed electrical machines—Summary,” IEEE Transactions on Industrial Electronics. Discusses modeling of high-speed induction machines. Emphasizes the impact of accurate simulation for startup transients.

[5] Kumar, A., & Bansal, R. C. (2007)- “Modeling and Simulation of Induction Motor Using MATLAB/Simulink”

Detailed simulation approach using MATLAB/Simulink. Validates model against experimental data.

[6] Zadehbagheri, M. (2015)- "Simulation and Analysis of Three Phase Induction Motor Starting Methods Using MATLAB/Simulink"

Compares DOL, star-delta, autotransformer, and soft starter methods. Highlights torque pulsations and energy savings.

[7] Sahoo, N. C., & Panda, S. K. (2003)- “Fuzzy logic-based starting controller for induction motor”

Integrates AI with simulation models for smoother motor starting. Reduces starting current and torque pulsation.

FUTURE SCOPE.

1. Integration of Advanced Starting Techniques

Add Soft Starters and Variable Frequency Drives (VFDs) to the simulation model to see how they help lower inrush current, boost energy efficiency, and extend motor life. Look at today's control methods such as scalar (V/f) control and vector (field-oriented) control.

2. Real-Time Hardware Implementation (HIL)

Expand the simulation to include Hardware-in-the-Loop (HIL) systems by using real-time simulators such as dSPACE or OPAL-RT. Lets you test control algorithms using real hardware like controllers and contactors to see if they work in the real world.

3. Incorporation of Fault Detection and Protection Mechanisms

Add parts to mimic common motor problems like losing a phase, rotor bar failure, and insulation issues. Set up and

check safety features like overcurrent, under-voltage, and heat protection in the model.

4. Energy Consumption and Cost Analysis

Improve the simulation by adding power quality, energy use, and cost analysis of different starting methods. Helps businesses find affordable options.

5. Modeling Under Variable Load Conditions

Add more simulations to test how motors work when faced with changing loads, like in conveyors, pumps, and compressors. Assists in creating strong starters for real-world industrial use.

6. Remote Monitoring and IoT Integration

Look into using IoT monitoring systems to manage and check the starting behavior of motors from a distance. Helpful in smart industries and forecasting maintenance needs.

7. Educational and Training Applications

Improve the model to create an easy-to-use simulation tool for schools to use in motor control labs. Add visuals and interactive tools to help students and trainees understand better.

8. Comparison with Other Motor Types

Expand the study to include simulations and comparisons of three types of motors: synchronous motors, brushless DC motors (BLDC), and permanent magnet synchronous motors (PMSM). Aids in picking the right kind of motor for various industrial uses.

9. Environmental and Sustainability Impact Analysis

Include sections to evaluate the environmental advantages of starting motors efficiently, like less energy waste and better power factor. Matches goals for green energy and sustainability.

CONCLUSION

We created a simulation model to study how three-phase asynchronous machines start up. This has helped us understand how induction motors behave when they are first turned on. Using MATLAB/Simulink, we created a detailed and flexible platform to simulate and analyze

different starting methods like Direct-On-Line (DOL), Star-Delta, and Autotransformer starting.

The simulation results show clear differences in how well the starting techniques perform. This includes variations in starting current, torque, and acceleration time. These observations are important for choosing the best starting method depending on the needs of the application, the load conditions, and the limits of the system.

The simulation approach has many advantages, such as being safe, saving money, and being easy to change. This makes it a useful tool for schools and businesses. However, it also has some limits, like unrealistic assumptions and no real physical interactions. This shows that we need to test hardware in real-life situations.

This project is an important first step in understanding and improving how induction motors start up. It also sets the stage for future advancements like soft starters, real-time control, and smarter control systems.

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