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Voltage and Frequency Control of Three Phase PWM Induction Motor: A Review

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Abstract – *This dissertation presents the need of Speed Control in Induction Motors. Out of the various methods of controlling Induction motors, Voltage and Frequency Control has proven to be the most versatile. The overall scheme of implementing V/f control has been presented. One of the basic requirements of this scheme is the PWM Inverter. In this, PWM Inverters have been modeled and their outputs fed to the Induction Motor drives. The uncontrolled transient and steady state response of the Induction Motor has been obtained and analyzed. A MATLAB code was developed to successfully implement Open Loop V/f Control on a PWM-Inverter fed 3-phase Induction Motor, and the Torque was found to be constant for various rotor speeds. This was followed by a MATLAB model for Closed-Loop V/f Control on a PWM-Inverter fed 3-phase Induction Motor. It was observed that using a Closed-Loop scheme with a Proportional Controller gave a very superior way of controlling the speed of an Induction motor while maintaining a constant maximum torque.*

Key Words*: *Induction Motor, Pulse Width Modulation, Voltage, Frequency.

1.INTRODUCTION

An Induction motor is a type of asynchronous Alternating Current (AC) motor where power is supplied to the rotating device by means of electromagnetic induction. Recent developments in power electronics have widened the use of AC electrical machines instead of Direct Current (DC) electrical machines in industrial applications. Due to these factors induction motors are now the preferred choice for industries.

Electrical Energy already constitutes more than 30 % of all energy usage on Earth. And this is set to rise in the coming years. Its massive popularity has been caused by its efficiency of use, ease of transportation, ease of generation, and environment-friendliness. Part of the total electrical energy production is sued to produce heat, light, in electrolysis, arc-furnaces, domestic heating etc. Another large part of the electrical energy production is used to be converted into mechanical energy via different kinds of electric motors- DC Motors, Synchronous Motors and Induction Motors.

Induction Motors are often termed the "Workhorse of the Industry". This is because it is one of the most widely used motors in the world. It is used in transportation and industries, and also in household appliances, and laboratories. The major reasons behind the popularity of the Induction Motors are:

(i) Induction Motors are cheap compared to DC and Synchronous Motors. In this age of competition, this is a prime requirement for any machine. Due to its economy of procurement, installation and use, the Induction Motor is usually the first choice for an operation.

(ii) Squirrel-Cage Induction Motors are very rugged in construction. There robustness enables them to be used in all kinds of environments and for long durations of time.

(iii) Induction Motors have high efficiency of energy conversion. Also, they are very reliable.

(iv) Owing to their simplicity of construction, Induction Motors have very low maintenance costs.

(v) Induction Motors have very high starting torque. This property is useful in applications where the load is applied before starting the motor.

2. LITERATURE REVIEW

The various literatures associated with the topic "Voltage and Frequency Control of Three Phase PWM Induction Motor" has been surveyed in various international, national journal and conference papers. Hitesh B Hatnapure has been proposed his work which is validated by using MATLAB software in Power system harmonics which is one of the major problems in power system operation. If the harmonics can increase and decreases transmission line capacity which may cause interruption in energy supply. The main consideration of this dissertation is to control the performance of PWM based UPFC on the bases of harmonics reduction. William de Jesus Kremes presents the analysis of a single-phase bridgeless SEPIC rectifier operating in discontinuous conduction mode with two different modulation techniques. The rectifier operates with high

power factor and output voltage control. This rectifier topology has the advantage of providing high power factor with low input filtering effort, as Boost rectifiers. Abdelouahed Touhami proposes the Unified Power Flow Controller (UPFC) as a strong candidate to provide a full dynamic control of Power transmission operating parameters: voltages, line impedance, and phase angle under normal and fault conditions. Geethu S Raj presents the performance of a p-q theory based SAPF is analysed. Then a new improved control with p-q theory is used to improve control with p-q theory is used to improve the performance of SAPF during non-ideal grid voltage conditions. Thomas Friedli proposes the active six-switch buck-type PFC rectifier, and the SWISS Rectifier is used. Typical dynamic feedback control structures of the considered topologies are shown, and analytical equations for calculating the current stresses of the power semiconductors are provided which makes the system complex.

3. METHODOLOGY

The following method is proposed to study the effectiveness of voltage and frequency control of three phase PWM Induction Motor. It deals with the basics of the Induction Motor drive and presents a case for the need for an efficient speed control scheme and also deals with Pulse Width Modulation-based Inverters. Three-phase PWM Inverters are presented and simulated for different kinds of loads with V/f Control of PWM-Inverter fed Induction Motors. Uncontrolled characteristics are obtained and contrasted with controlled characteristics. Successful speed control is achieved.

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