The Study of Magnetic Field Pattern and Induction Motors Performance during Sinusoidal and Harmonics Condition

Project report is presented in partial fulfillment for the award of the

Bachelor of Electrical Engineering (Honours)

Of

UNIVERSITI TEKNOLOGI MARA (UiTM)

SHAH ALAM, SELANGOR

MALAYSIA

MOHAMAD ZULKIFLI BIN MOHD SALIM
B. ENG (HONS) ELECTRICAL
Faculty of Electrical Engineering
UNIVERSITY TEKNOLOGI MARA (UITM)
40450, SHAH ALAM, SELANGOR DARUL EHSAN, MALAYSIA
JULY 2013

ACKNOWLEDGEMENT

I would like to express my gratitude towards Almighty ALLAH S.W.T for giving me patience and strength to successfully complete the Communication Engineering Project 2.

I wish to give a big thank to Dr. Ahmad Farid Abidin, University of Technology MARA for his comprehensive supervision, guidance and useful suggestion in developing this project. He had been my major source of consulting during completing the project.

Thanks also to postgraduate students of University of Technology MARA for their tips and information regarding this project.

Thank you all and May ALLAH blesses all of you.

Mohamad Zulkifli Bin Mohd Salim
Faculty of Electrical Engineering
Universiti Teknologi Mara (UiTM)
Shah Alam, Selangor Darul Ehsan
Malaysia.

ABSTRACT

This research deals with an analysis of magnetic field pattern in three phase stator machines during sinusoidal and harmonic condition. Harmonics component will determine the pattern of rotating magnetic field generate by machines. To evaluate the harmonic components, this paper proposes a new harmonics analysis method that considers the pattern of net rotating magnetic flux density in three phase stator. With this method, the harmonics component can be determined by analyze the pattern of magnetic field instead by frequencies, currents and voltages. In this analysis, only stator magnetic field is created. Rotating magnetic field and harmonics also have become a main concern related to motor performances. Further, finite element method (FEM) used to analyze effect of space and time harmonics to induction motors performance. Both space harmonics and time harmonic equivalent circuits are presented. These methods were powerful tools to analyze motor parameters such as harmonics current and torques. Harmonics slips and torques formulas are derived and torques versus speed graph for both types of harmonic are generated and analyzed. This analysis will be compare to the pattern magnetic field generated from previous analysis so further performance of motor can be determined by looking to the pattern of magnetic field.

Keywords: *magnetic field pattern; harmonic equivalent circuits; space harmonics; time harmonics; induction motors.*

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW OF THE PROJECT

This research deals with an analysis of magnetic field pattern in three phase stator machines during sinusoidal and harmonic condition. Harmonics component will determine the pattern of rotating magnetic field generate by machines. To evaluate the harmonic components, this thesis proposes a new harmonics analysis method that considers the pattern of net rotating magnetic flux density in three phase stator. With this method, the harmonics component can be determined by analyse the pattern of magnetic field instead by frequencies, currents and voltages. In this analysis, only stator magnetic field is created. Rotating magnetic field and harmonics also have become a main concern related to motor performances. Further, finite element method (FEM) used to analyse effect of space and time harmonics to induction motors performance. Both space harmonics and time harmonic equivalent circuits are presented. These methods were powerful tools to analyse motor parameters such as harmonics current and torques. Harmonics slips and torques formulas are derived and torques versus speed graph for both types of harmonic are generated and analysed. This analysis will be compare to the pattern magnetic field generated from previous analysis so further performance of motor can be determined by looking to the pattern of magnetic field.

The fundamental principle of AC machines operation is that if a three-phase set of current, each of equal magnitude and differing in phase by 120°, flow in a three-phase winding, then it will produce a rotating magnetic field with constant magnitude [1]. These will generate a unique pattern of magnetic field. A method of magnetic field calculation introduced by R. L. Stoll, B. Bodner and A.H.N. Al-Khoury [2], where the magnetic field pattern in a cylindrical rotor electrical machine is outlined which considers the winding currents to be explicit sources of the field, and the resulting magnetisation of the stator and rotor core and shaft surfaces as