IMPROVEMENT OF AN EXISTING DRIVE CIRCUIT FOR A PERMANENT MAGNET DC-MOTOR

by

R. R. D. S. Siyambalapitiya

Dissertation submitted in partial fulfillment of the requirements for the Degree of Master of Engineering

Supervised By: Dr. J. P. Karunadasa

Department of Electrical Engineering
University of Moratuwa
SriLanka

2004

Abstract

The project is about a new design and construction of a drive. system for permanent magnet IX: motors used in silo applications in a ceramic tile-producing factory.

In ceramic industry, there are lot of DC motors used in polishing plants, powder-mixing plants and sorting sections, etc supporting smooth operations as required. These IX: motors are operated by speed control drive circuits based 'On power electronic applications. Most of the existing DC motor drive circuits used in silo applications of the particular factory have been seriously damaged and most of the damaged electronic components were in thyristor converter circuit and outer-speed and inner-current control circuits. The frequent occurrence of such damages resulted considerable losses in factory production line. Therefore the approach for a new design and construction of a drive system was based on finding out the exact causes for serious damages on existing drive circuits.

The visual observations and data analysis showed that the predominant cause for such serious damages was the supply of poor quality within the factory load containing harmonics, voltage sags and switching transients, etc. Therefore foundation of new design of the drive system was to improve original version of the drive circuit for both high reliability, and performance against poor quality' of input supply.

The present drive circuit is basically a single-phase thyristor controlled converter with armature current control mechanisms. This is a one-quadrant converter without regenerative breaking used for reasons of economy. The overall control circuit consists of outer-speed and inner-current control circuit with relevant PI-compensators, ± 12V OC supply rectifier circuit for electronic components, pulse generating scheme for thyristor tiring and starting circuit with relevant ramp generator.

Since there was no basic design error in above circuits, the new design was based on addition of improvements to the existing drive circuit to protect it from phenomenon of poor quality of supply. They were as follows,

- Addition of shunt capacitance in ± 12V DC supply rectifier circuit to reduce high output ripple under voltage sag conditions. .
- Addition of series inductance in thyristor converter circuit to reduce the effects under switching transients.
- Addition of harmonic trap filters tor the inputs of thyristor converter circuit and ±12V DC supply rectifier circuit to protect the circuits from harmonics.

Design parameters of above improvements were obtained from standard design procedures & theories, empherical equations and some practical assumptions. Testing for the performance of the new drive system was completed by using relevant circuit models and Electronic Workbench software. Following circuit model were simulated under pure input of supply & phenomenon of poor quality of supply, and after addition of improvements under poor quality of supply.

- Thyristor controlled converter circuit.
- ± 12V OC supply. rectifier circuit .

Finally, the investigation of poor quality of supply tor the existing drive circuits that caused series damages on electronic components was an important step. The new drive system was mainly based on improving the existing version of the circuit to protect it from phenomenon of poor quality of supply for both high reliability and performance. Theoretical analysis to obtain design parameters and performance testing of the new version of drive system were key points of the project.

Results taken from simulation of relevant circuit models showed the importance of having such a new design & construction of a drive system that improves the efficiency & effectiveness of manufacturing process of the particular industry.

Declaration

To the best of my knowledge and belief the work included in the thesis in partially or in whole has not been submitted for any other academic qualification at any institution.

R. R. D. S. Siyambalapitiya.

Certified By,

Dr. J. P. Karunadasa,
Department of Electrical Engineering,
University of Moratuwa,
SriLanka.

Preface

The project was initiated after the request of former electrical engineer of the Royal Ceramics factory, SriLanka, Mr. Janaka Kumara who observed the problem well and who knew the capacity of a study that can be done based on the relevant phenomenon.

Design and construction of a new version of drive system for permanent magnet DC motors used in silo application of the above tile producing industry is presented in this thesis.

Chapter 2 describes the complete approach and design of the new drive system. Major issues, facts, theories, concepts and inventions, etc behind the problem observation, tracing out of the existing drive system, addition of improvements & analysis reference to the new version of drive system are discussed in this chapter.

Chapter 3 shows the methods & results with necessary assumptions reference to the testing of performance of the new drive system with relevant circuit simulations. Separate equivalent circuit models are used to simulate the performance of new version of drive system using Electronic Workbench Software.

In chapter 4 of this thesis, the conclusion of the project, major issues and difficulties experienced and proposed solution for the particular industrial problem are discussed.

Chapter 5 describes the final recommendations of the research project and the suggestions for future research.

Finally the thesis consists of details of references used and appendices organized to present auxiliary figures, tables and other annexes in Appendix 1 and abbreviations, acronyms and standard symbols in Appendix 2.

I am indebted to Dr. J. P. Karunadasa for his valuable encouragement, support and direction to implement this project as the project supervisor. I sincerely thank Prof. J. R. Lucas, Dr. J. Peiris, Dr. L. Udawatta, Dr. R. A. Ranaweera, & Dr. R. Perera for their great assistance & comments regarding the project.

And I wish to thank the staff of Royal Ceramics factory in Eheliyagoda, specially Mr. A. M. C. S. Atapattu the Assistant General Manager of the factory, Mr. M. A. N.S. A. Jayatissa the factory manager, Mr. J. Kumara former electrical engineer, Mr. W. N. N. K. Wijerathne the electrical engineer of the factory for their continuous assistance and support, without them this project will not come to reality.

Finally I thank my wife Menaka for her great & continuous encouragement provided during the project.

List of Figures

List of Tables

Contents