CONDITION MONITORING OF ELECTRIC MOTOR

ZURAIDAH BINTI NGADIRON

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

BORANG PENGESAHAN STATUS TESIS♦

JUDUL : CONDITION MONITORING ON ELECTRIC MOTOR

SESI PENGAJIAN : 2007/2008

Saya ZURAIDAH BINTI NGADIRON

(HURUF BESAR)

mengaku membenarkan tesis (PSM Sarjana/~~Doktor Falsafah~~)* ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut :

1. Tesis adalah hak milik Universiti Tun Hussein Onn Malaysia.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran di antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi badan di mana penyelidikan dijalankan)
✓	TIDAK TERHAD	

Disahkan oleh:

(TANDATANGAN PENULIS) (TANDATANGAN PENYELIA)

Alamat Tetap:

NO. 20, KAMPUNG SRI LAMBAK,
86000 KLUANG, JOHOR.

PROF. MADYA DR. ZAINAL ALAM BIN HARON.
(Nama Penyelia)

Tarikh : 26 NOVEMBER 2007

Tarikh : 26 NOVEMBER 2007

CATATAN : * Potong yang tidak berkenaan.
** Jika Tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.
♦ Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM)

"I/~~We~~ hereby declare that I/~~We~~ have read this thesis and in my/~~our~~ opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Master of Engineering (Electrical)".

Signature : ....
Name of Supervisor : Assoc. Prof. Dr. Zainal Alam Bin Haron
Date : 26 NOVEMBER 2007

CONDITION MONITORING OF ELECTRIC MOTOR

ZURAIDAH BINTI NGADIRON

A thesis submitted in fulfillment of the
requirements for the award of the degree of
Master of Engineering (Electrical)

Faculty of Electrical and Electronic Engineering
Universiti Tun Hussein Onn Malaysia

26 NOVEMBER 2007

"I hereby declare that this thesis entitled 'Condition Monitoring of Electric Motor' is the result of my own research except those cited in references".

Signature : ....

Name of Author : Zuraidah Binti Ngadiron

Date : 26 NOVEMBER 2007

To my caring and beloved husband,
Amir,

To my son,
Afiq

ACKNOWLEDGEMENT

First and foremost, all praise and thanks to Allah s.w.t who has given me the strength and blessings to make it possible to complete this thesis title of **Condition Monitoring of Electric Motor**.

Special thank and appreciation to Assoc. Prof. Dr. Zainal Alam Bin Haron for his gratitude, advice, guidance and critical comments. His excellent supervision throughout this project will always be remembered and as a guidance in the future.

I would like to thank all lecturers, UTHM staff, friends, organization and individuals whom directly or indirectly have assisted me to make this Master project possible.

Lastly, I must thank my husband, Amir Khalid for his support and encouregement. May Allah forgive us and bless us all.

ABSTRACT

Condition monitoring on electric motor is a preventive maintenance in order to avoid problems and hazard from happening to the machinery, also to prevent personal injury with the major factor is insulation resistance. In this thesis, to further discuss this issue, the developed experiment with the measuring technique of the condition of electric motor on insulation resistance is used. Then, the experiment rig was developed applied to Thrige Odense Denmark 3-phase induction motor for case study to observe the condition monitoring on insulation resistance. The validity of the data was then taken using the megohmmeter and temperature indicator. The experiment is to monitor the Denmark manufactured motor condition of insulation whether is good, fair, poor or bad by following the IEEE standard procedure. This preventive maintenance test can be done on a monthly, semiannual or annual basis as conditions demand. The data from the test is plotted to graph to get the trended data of the insulation. The theoretical and experiment studies include the effect of the humidity and temperature to the insulation. Tests rig for the experimental work are developed using IEEE Standard 43-2000, *IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery* and *A Guide To Diagnostic Insulation Testing Above 1kV by* Megger Ltd, Second Edition 2002. The results have been compared to the standard and analyses are presented in graph. From the developed procedure and methods prove that the temperature affects the insulation winding at 3-phase induction motor (2 speed : 2 winding). For case study, the motor has been soaked for three days to apply flooded condition. The result shows that the motor insulation condition is even better after comparison with the standard manufactured data at 821 MΩ and 893 MΩ change to more than 999 MΩ for both winding condition after drying out experiment.

ABSTRAK

Pengawasan keadaan ke atas motor elektrik merupakan penyenggaraan cegahan bagi mengelakkan masalah yang mengundang bahaya berlaku ke atas jentera serta mengakibatkan kecederaan ke atas manusia yang mana faktor penyumbang utama adalah rintangan penebatan. Dari itu, ujikaji dibangunkan berdasarkan teknik pengukuran keadaan rintangan penebatan motor elektrik. Pelantar ujikaji dijalankan ke atas motor aruhan 3 fasa Thrige Odense Denmark untuk kajian kes mencerap pengawasan keadaan terhadap penebatan rintangan. Data sah diambil menggunakan megohmmeter dan pengesan suhu untuk memantau keadaan penebatan motor buatan Denmark samada berkeadaan baik, memuaskan, lemah atau tidak memuaskan dengan mematuhi tatacara piawai IEEE. Ujian penyenggaraan cegahan boleh dilakukan samada sebulan sekali, enam bulan sekali atau setahun sekali. Data tersebut diplotkan ke dalam graf bagi mendapatkan '*trend*' terhadap penebatan. Pemelajaran dari ujikaji dan teori termasuklah kesan penebatan terhadap suhu dan kelembapan. Pelantar ujian bagi menjalankan kerja-kerja pengujian dibangunkan berdasarkan piawai IEEE 43-2000, *IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery* dan *A Guide To Diagnostic Insulation Testing Above 1kV* oleh Megger Ltd, edisi kedua 2002. Tatacara dan kaedah yang dibangunkan membuktikan bahawa suhu memberi kesan terhadap belitan penebatan pada motor aruhan 3 fasa (2 kelajuan:2 belitan).Untuk mengaplikasi keadaan banjir dalam kajian kes, motor telah direndam selama 3 hari. Hasil keputusan menunjukkan keadaan penebatan motor adalah lebih bagus selepas perbandingan dibuat dengan data piawai pengilang pada 821 MΩ dan 893 MΩ berubah lebih daripada 999 MΩ bagi kedua-dua keadaan belitan selepas ujikaji pengeringan.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

NOMENCLATURE

V	voltage

Greek letters

Ω	resistance, ohm
δ	loss angle
θ	phase angle

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.0 Background of the Study

The normally quiescent state of electrical transmission and distribution system plant does not draw attention to incipient faults which may develop from the gradual deterioration of equipment. This fault may be detected during routine maintenance, but the ability to have detailed information on the state-of-health of transmission and distribution system equipment prior to carrying out maintenance work or alterations becomes a significant asset and adds an element of preventive maintenance to the operation of such assets.

Condition monitoring is a technique which may be adopted to reduce non-planned downtime and increase plant availability. To be successful it must be self sufficient and did not require manual intervention or detailed analysis. It must be capable of detecting gradual or sudden deterioration and trends and have predictive capabilities to permit alarming insufficient time to allow appropriate action to be taken and avoid major failure. It must be reliable and not reduce the integrity of the system, it must not require undue maintenance itself and must be a cost effective solution.

Condition monitoring may be formally defined as a predictive method making use of the fact that most equipment will have a useful life before maintenance is required. It embraces the life mechanism of individual parts of or the whole equipment, the application and the development of special purpose equipment, the means of acquiring the data and the analysis of that data to predict the trends .Certain key words are useful to recall from this definition: p*redictive, useful life, maintenance, application and development of special purpose of equipment, acquiring the data, analysis of that data, predict the trends [1].*

In more practical terms, the initial stage of a condition monitoring programmed consists of establishing_the baseline parameter and then recording the actual baseline or fingerprints values. The next stage is the establishment of routine tours of equipment observing the running condition and assessing the parameter previously determined for the baseline. These readings are then compared with the fingerprint and the trends determined. The state of the present equipment condition can be determined from the absolute figures. The rate of degradation and an assessment of the likely time to failure can be estimated from the trend. The resources committed to monitoring the condition of equipment will depend on the numbers and on the service experienced and reliability.

1.1 Statement of Problem

Most of the electric motor around the world exceeding their designed life. Insulation is the major component, which plays an important role in the life expectancy of the electric motor. To determine the performance and aging of the asset, insulation behavior is a main indicator. In the absence of insulation monitoring and assessment, good number of electric motor failed due to insulations problems, before reaching to their designed technical life. A good number of aged electric motor are still performing well, it is important to monitor the insulation behavior rather than replacing with new one.

Table 1.1 : Specification for Thrige Odense Denmark 3-phase induction motor

Type	NAS 62
Horse Power	10
Rotor V	350 Y
RPM	1440
V	400A
A	14
Frequency	50Hz

Insulation failure can cause electrical shocks, creating a real hazard to personal and machinery. While there are cases where the drop in insulation resistance can be sudden, such as when equipment is flooded, it usually drops gradually, giving plenty of warning if tested periodically. A regular program of testing insulation resistance is strongly recommended to prevent this danger, as well as to allow timely maintenance and repair work to take place before catastrophic failure. Not only motor but new equipment, transformers, switch gears and wiring also should be tested before being put into service. This test record will be useful for future comparisons in regular maintenance testing.

Without a periodic testing program all failures will come as a surprise, unplanned, inconvenient also quite possibly very expensive in time and resources, therefore, money to rectify. For instance, take a small motor that is used to pump material, which will solidify if allowed to stand, around a processing plant. Unexpected failure of this motor will cost tens maybe even hundreds of thousands of ringgit to rectify if downtime of the plant is also calculated. However, if diagnostic insulation testing had been included in the preventive maintenance program it may have been possible to plan maintenance or replacement of the failing motor at a time when the line was inactive thereby minimizing costs. Indeed, it may have been that the motor could have been improved while it was still running.

If advanced insulation degradation goes undetected there is an increase in the possibility of electrical shock or even death for personnel: there is an increase in the possibility of electrically induced fires; the useful life of the electric motor can be reduced and/or the facility can face unscheduled and expensive downtime. Measuring insulation quality on a regular basis is a crucial part of any maintenance program as it helps predict and prevent electric motor breakdown.

For most motors, the expected life of a stator winding depends on the ability of the electrical insulation to prevent winding faults. That is the need for a stator rewind is almost always determined by when the electrical insulation is no longer able to fulfill its purpose, rather than, for example, being determined by a problem with the copper conductors. This follows from the fact that the electrical insulation has a large organic content, a lower melting temperature and a lower mechanical strength that the copper and the core steel.