VOLTAGE FLUCTUATION AND HARMONIC EMISSION RELATED TO LIGHT EMITTING DIODE LAMPS

TAN TECK YING

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To my beloved family members

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ABSTRACT

The energy management issue has become crucial at this moment as the power demand has increased rapidly as time goes on. Therefore, a proper usage of energy is more concerned and the energy efficient lighting system had introduced and being widely used to reduce the power demand. However, at the same time, the Power Quality issues have been raised. Lighting system considering as one of the biggest energy consumption from the overall energy consumption of the system especially for commercial building. Most of the energy efficient lighting system are consider as the non-linear load will be creating disturbances to the power system. The relation of active power, price of LED lamps and harmonic current emission will be investigate in this project and at the end of the project, the characteristics of LED lamps with lowest contribution of power quality issue will be proposed. In this project, the focus will be on waveform distortion and voltage fluctuation only. From various type of Light Emitting Diode (LED) lamps available in the market, the LED lamps with active power less than 25W will be studied as there is no dedicated standard requirement for energy efficient lighting system with active power less than 25W. An individual lighting and a group of lighting will be observed on their behavior and the effect of Power Quality issues on voltage fluctuation and harmonic current emission. The measurement of waveform distortion from a LED lamp will be evaluated as specified in MS IEC 61000-3-2. Methodology and test condition specified in MS IEC 61000-3-2 and MS IEC 61000-4-14 will be adopted for measurement of waveform distortion and inject voltage fluctuation waveform in this project. The results show that there is no relation between active power, price of LED lamps and harmonic current emission. The LED lamps with active power of 18W and colour temperature of 6400K have the lowest contribution in power quality issues.

ABSTRAK

Isu pengurusan tenaga telah menjadi penting pada masa kini kerana permintaan kuasa telah meningkat dengan pesat dari masa ke semasa. Oleh itu, penggunaan tenaga secara pengurusan adalah lebih prihatin dan sistem lampu cekap tenaga telah diperkenalkan dan banyak digunakan untuk mengurangkan permintaan kuasa. Walau bagaimanapun, pada masa yang sama, isu-isu pencemaran kepada tenaga elektrik telah dibangkitkan. Sistem lampu mengingati adalah salah satu daripada penggunaan tenaga yang terbesar dari keseluruhan penggunaan elektrik terutamanya untuk bangunan komersial. Kebanyakan sistem lampu cekap tenaga adalah dianggap sebagai beban tidak linear yang menghasilkan gangguan kepada sistem kuasa elektrik. Hubungan kuasa aktif, harga lampu LED dan pelepasan arus harmonik akan disiasat dalam projek ini dan pada akhir projek, ciri-ciri lampu LED yang mempunyai sumbangan terendah dalam isu kualiti kuasa akan dicadangkan. Dalam projek ini, tumpuan akan diberikan kepada herotan bentuk gelombang dan turun naik voltan sahaja. Dari pelbagai jenis Diod Permancar Cahaya (LED) lampu yang terdapat di pasaran hari ini, lampu LED yang berkuasa kurang daripada dua puluh lima watt akan dikaji kerana setakat hari ini tidak ada keperluan standard untuk dirujukkan. Lampu individu dan golongan pencahayaan akan diperhatikan pada kesan mereka kepada isu-isu kualiti kuasa turun naik voltan dan pelepasan harmonik. Pengukuran herotan bentuk gelombang dari lampu LED akan dinilai sebagaimana yang dinyatakan dalam MS IEC 61000-3-2. Metodologi dan ujian syarat yang dinyatakan dalam MS IEC 61000-3-2 dan MS IEC 61000-4-14 akan diikuti untuk mengukur herotan bentuk gelombang dan menyutik bentuk gelombang turun naik voltan dalam projek ini. Keputusan menunjukkan bahawa tidak terdapat hubungan antara kuasa aktif, harga lampu LED dan pelepasan harmonik . Lampu LED dengan kuasa aktif 18W dan suhu warna 6400K memberi sumbangan yang terendah dalam isu kualiti kuasa.

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LIST OF ABBREVIATIONS

ac	-	Alternating Current
CEES	-	Centre of Electrical Energy System
dc	-	Direct Current
etc	-	et cetera
h	-	hour
IEC	-	International Electrotechnical Commission
IEEE	-	Institute Electrical and Electronic Engineers
PQ	-	Power Quality
rms	-	Root Mean Square
THDi	-	Total Harmonic Current Distortion
US	-	United State
UTM	-	Universiti Teknologi Malaysia

LIST OF SYMBOLS

A	-	Current
Hz	-	Hertz
I	-	Current
k	-	Kilo
K	-	Kelvin
f	-	Frequency
p.u.	-	Per unit
RM	-	Ringgit Malaysia
V	-	Voltage
VA	-	Volt-Amps (Apparent power)
W	-	Wattage

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Energy efficient lighting have been widely used in industrial and commercial buildings. The characteristics of an energy efficient lighting including Light Emitting Diode (LED) lamps have the behavior of non-linear load. Therefore, they are consider as one of the equipment that injecting harmonic current into the network [1]. This is because most of the energy efficient lighting system are using power electronics device for switching topology and achieving the same lux level with the less amount of input active power required. For a commercial building, the lighting system can be contributed around twenty percent to fifty percent of total electricity consumption. In paper [2-4] clearly show that, works have been done to achieve an energy efficient lighting system for proper energy usage and planning. At the same time, the other quality issue have raise the concern of public especially the attention from utility as these power quality issue are generated from consumer side and it affecting to the voltage supply's stability profile.

1.2 Problem Statement

Power Quality is an important issues in power system. Therefore, power quality always one of the concern of an electrical engineer. Nowadays, energy efficient lighting system have been widely used to achieve the purpose of energy

saving. Most of the energy efficient lighting system are using the topology of power electronics in switching alternating current (AC) source into direct current (DC) source as most of the energy efficient lighting system are using dc course. Hence, when these converter are altering the power supply pure sinusoidal waveform, they contributed to power quality issue. There are numbers of working committees working on various standards to make sure that these energy efficient lighting system or other equipment that connected to pubic supply are operating within the maximum allowable power quality limit. However, as for now, there is no dedicated standard or guideline are available for energy efficient lighting system with active power less than 25W. The relation of active power and price of LED lamps related to voltage fluctuation response and harmonic emission are not yet been identified.

1.3 Objectives

The objectives of this project including the following:

i. To measure harmonic contribution from different type of LED lamps.
ii. To investigate the relation of active power and price of LED lamps related to voltage fluctuation response and harmonic emission from various LED lamps.
iii. To propose the LED lamp with the lowest contribution in power quality issue.

1.4 Scope of Work

The main scope of this project is to investigate the relationship of the active power and price of LED lamp related to voltage fluctuation response and harmonic emission. Hence a study of the contribution of harmonic emission and harmonic emission during voltage fluctuation from LED lamps have been carried out. The experiment set-up for harmonic emission measurement and the test condition for measurement are adopted the measurement circuit as specified in Malaysian Standard

MS IEC61000-3-2:2009. For voltage fluctuation injected into LED lamps are accordance to Malaysian Standard MS IEC 61000-4-14:2002.

The measurement of harmonic emission is measured from various manufacturer of LED lamps to identify the relationship of power qualities issues related to active power and price of LED lamps. For LED lamps selected in this project are limited to following specification:

i. Active power less than 25W.
ii. Colour Temperature range from 4000K to 8500K.

As mentioned in previous section of this chapter, there is no dedicated standard for energy efficient lighting with active power less than 25W. Hence, in this project we covers the LED lamps with active power less than 25W only. While, for colour temperature of LED lamps selected are between the ranges of 4000K to 8500K as it is commonly used for commercial building.

1.5 Significance of Study

The first LED lamp inverted back in 1970s. Development of LED lamps are focusing on its efficiency which to produce higher lumen with lower power consumption. At the same times, the power quality issues contributed from LED lamps had raise the concern from utility side as well as consumer side. From point of view of utility side, the power quality issues distorted the power system. For customer side, they concern the power quality issues as they will get the penalty from utility if their power factor are fall below the limit.

As we know, currently most of the industry are moving toward green energy or energy efficient system. Among it, one of the most common strategy is replace all existing fluorescent lamps to LED lamps. Hence the outcome of this study will help industry to understand the relation of LED lamps related to harmonic emission and voltage fluctuation especially in LED lamps selection.

1.6 Thesis Outline

This thesis written in five chapter. Where chapter one covers the background of study for this project and the problem statement. The objectives and the focus of this project were stated in this chapter. The significant of this project also highlighted in chapter one. And lastly the structure of this thesis have been explained.

In chapter two, the review of past research are being discussed. The various type of disturbance in power system are briefly explained. The discussion will bring into the recent research work related to harmonic emission and voltage fluctuation that related to LED lamps. A comparison of the past research work is presented. This chapter, generally provide an overview of disturbances in power system and the development of LED lamps is discussed.

In chapter three, the equipment, methodology as well as experiment set up that conducted are being explained. The focus of this chapter will be the explanation of methodology have been executed in this project. The flowchart of methodology also presented and explained.

Furthermore in chapter four, the harmonic emission from LED lamps during normal operating condition and during voltage fluctuation are recorded in this chapter. The data including total harmonic current emission and price of LED lamps are analyzed and discussed.

Lastly, in the last chapter the relationship of LED lamps related to active power, price of LED lamps, and the harmonic emission are presented. The recommendation to improve this project work also highlighted in this chapter as well.

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