Proc. Annual Symposium on Research & Industrial Training, 02(2015) 103-107
Department of Electronics – Wayamba University of Sri Lanka

COMPACT FLUORESCENT LAMP OPERATION AND ENDURANCE ANALYSIS

E.A.K.K Edirisinghe*, C.A.N Fernando

Department of Electronics, Wayamba University of Sri Lanka, Kuliyapitiya, Sri Lanka
*eakkedirisinghe@gmail.com**

ABSTRACT

Compact fluorescent lamps (CFLs) are gaining wide-spread acceptance due to energy conservation concerns. The key objective of the work presented in this paper is to gain improved and updated understanding of the operation and performance of the CFL. The work presented in this paper summarizes the detailed testing that has been performed to characterize the response of modern CFL to temperature and power abnormalities. Moreover, an effective criteria to detect defect components of CFLs is implemented. The tests are based on recent testing standards and utilized a modern industrial advanced power supply with newly designed chamber. Finally, the impacts of excessive voltage fluctuations on sensitive low voltage (LV) equipment were also investigated. Experimental results show that all CFLs are sensitive to voltage sags and vary in a wide range. It also proves that some brands of CFLs having similar power rating are sensitive to both voltage sag magnitudes and its duration. Finally a method to improve the sensitivity of CFLs to voltage sags is implemented. The information in this paper proves useful facts to decision makers in industry.

Keywords: Compact Fluorescent Lamp (CFL), Power abnormalities, temperature

1. INTRODUCTION

Compact fluorescent lamps (CFLs) have recently emerged as cost-competitive, energy efficient alternative to replace conventional incandescent lamps in their existing fittings. Recently, power companies have been encouraged the use of CFLs due to its energy efficiency[1]. The use of CFLs is expected to save up to 10% of a household's electricity usage and have longer life time when compare to other lighting alternatives. Beside from energy efficiency, CFLs are susceptible to power system abnormalities such as voltage dips, pops, outages and lack of temperature sensitivity. During dip, the voltage suffers a sudden reduction of voltage between

10-90% of the nominal voltage that lasts between 10 milliseconds and one minute. Voltage sag may cause lamps to extinguish or flicker that cause nuisance and reduction of light intensity or damage in some cases. However, there is a little available information related to the sensitivity of CFLs due to voltage sags or temporary outages and temperature tolerances. In most of research papers about CFL performances discussed effect of harmonics and their influences. Some literature have discussed flicker generation in CFLs mainly due to fluctuations in their supply voltage. Moreover, there are few works on the sensitivity of CFLs in the presence of power system disturbances such as inter harmonics and phase jumps which are not normally associated with flicker[6] and its operation performances. The extensive use of CFLs with electronic ballasts demands a comprehensive analysis, including not only their effects on harmonic emissions[2] and flicker sensitivity, but also their performance during the other power quality problems such as voltage sags, temperature sensitivity in electric distribution systems. In this study, after a thorough description about the operation of compact fluorescent lamps, variety of tests are performed on various CFLs. These tests are carried out to observe the variation of tube temperature with chamber temperature and light intensity variation of the CFLs during voltage fluctuations. Moreover, to evaluate the voltage, temperature tolerance levels of the tested CFLs are subjected to test repeatedly to gain threshold tests values. Typical circuit of a CFL is shown in the Figure1.

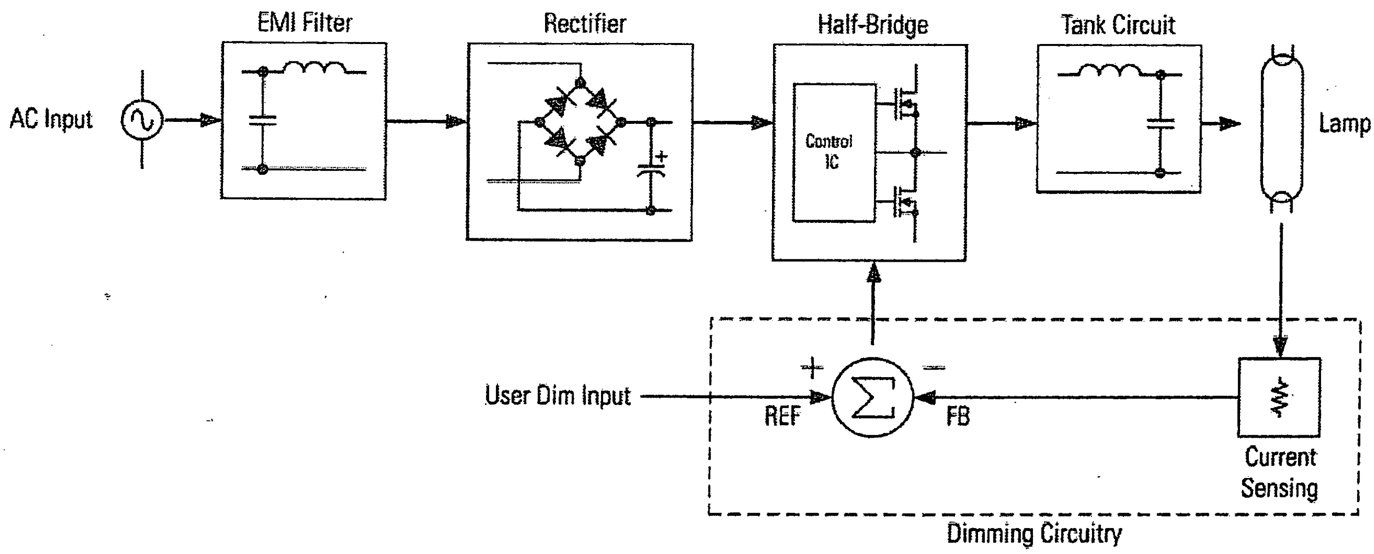
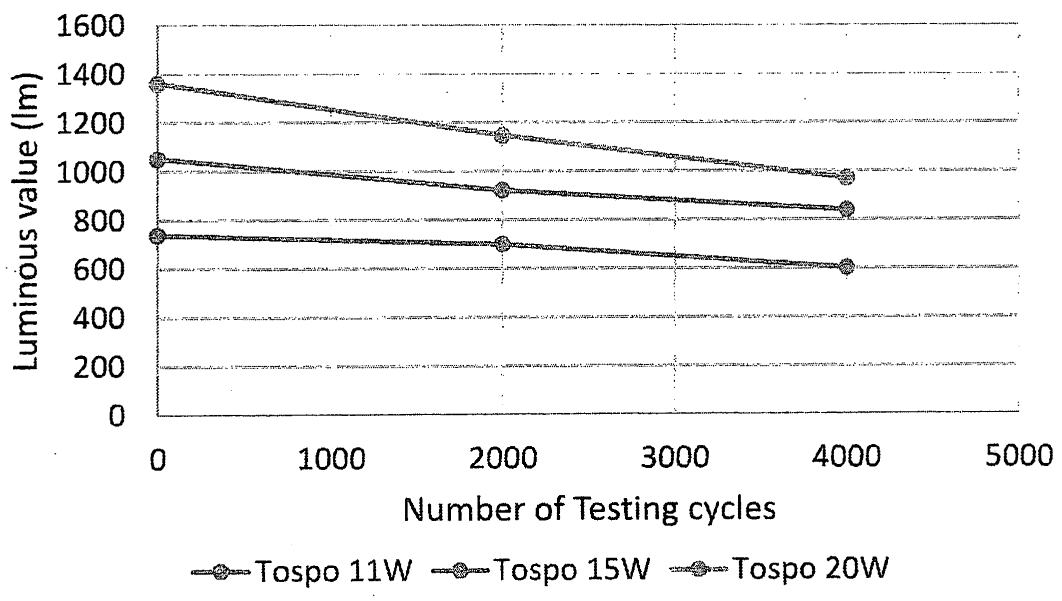


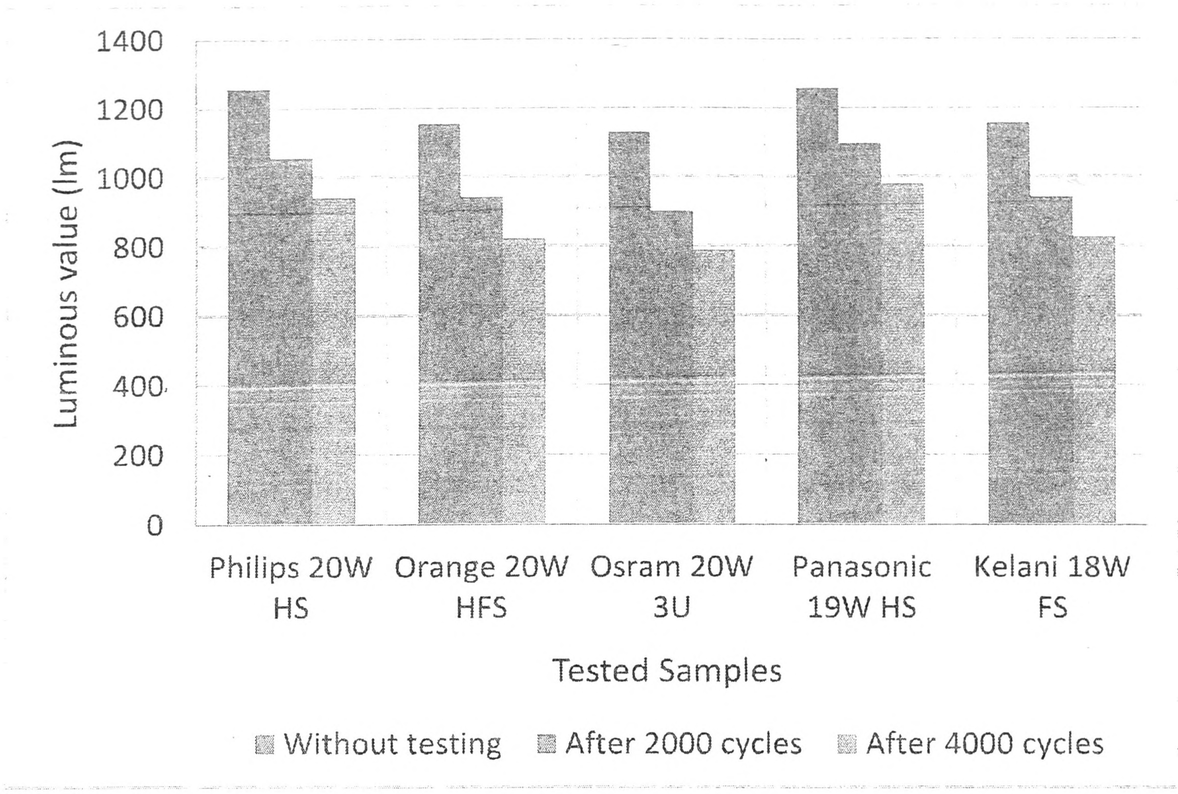
Figure 1: Schematic diagram of typical CFL

2. EXPERIMENTAL

Before starting tests, the researcher searched on available sources for different types of power abnormality tests that applied to test compact fluorescent lamp. Newly designed torture chamber and advanced power supply is utilized for experimental apparatus. The methodology that is used in the testing is generally based on the guidelines published in the IEC Standard 61000-4-11. Selected samples from production line and competitor brands from different manufacturers in various power ratings were tested to study the effect of temperature, voltage sags[5] on the performance of the lamps. Initially temperature[3] endurance tests are performed. Torture chamber has in built facility to adjust temperature inside using its digital PID controllers. Temperature readings of corresponding lamps are measured by IR thermometer. Then, the specifications for power abnormality simulations of the tested CFLs are studied using the standards (IEC 61000-4-11). Advanced power supply can be used as voltage fluctuations generator which also consists programming advanced power simulations. After that, simulating power disturbances[4] from the mentioned power supply and their functionality were studied. Finally observed results were evaluated. Variation in Luminous values by the affect from power abnormality cycles are shown in Graph1 and Graph2.



Graph 1: Variation in Luminous vs Tested cycles



Graph 2: Luminous variation in tested samples

RESULTS AND DISCUSSION

After test performed the complete analysis, evaluation of the measured data is implemented in two parts. Initially the temperature analysis and then endurance analysis to voltage fluctuations. According to temperature readings tube temperature is increased with chamber temperature. Above 150°C some lamps are showed startup delay. Most of the lamps turned off above 170°C.Due to rapid ageing in high temperatures lamp performances, lumens value is reduced. According to power abnormality reading of lamp performances, lumens value was greatly affected. Graph 1 illustrates the reduction in luminous value after affected by 0, 2000 and 4000 power abnormality cycles. When the immunity level of the tested lamps is compared in terms of voltage fluctuations, it can be noted that low power rating (11W) lamp was least sensitive while the high power rating (20W) lamp was most sensitive to voltage fluctuations. Further Graph 2 illustrates the reduction in luminous value in competitor brands after affected power abnormality cycles. It can be clearly noted that Osram lamp is more sensitive to voltage fluctuations. For instance Panasonic lamp is least sensitive to voltage fluctuations. Therefore, as a result of voltage fluctuations light output reduced badly.

3. CONCLUSION

An extensive experimental study has been performed to determine the effect of temperature, voltage fluctuations and to gain overall knowledge in operation of the CFL. From the results of the tested data, voltage tolerance curves and temperature variation curves were constructed to describe the sensitivity of various CFLs to temperature and power abnormalities. Furthermore, Temperature tests have been performed in extreme low temperatures and behavior of CFL in cold environment should have been discussed to make the research more success. Moreover, effect of humidity on CFL could have been discussed as well.

ACKNOWLEDGEMENTS

The author wishes to extend gratitude for the assistance given by the supervisor, quality assurance staff of Orel Corporation and thank all who have supported to make this research a success.

REFERENCES

[1]. M. Brandston, H. (2010). *RESEARCH INTO THE EFFECTS AND IMPLICATIONS OF INCREASED CFL USE*. 1st ed. United Kigndom,4-7

[2]. Mohamed, K., Shareef, H. and Mohamed, A. (2009). *An Analysis of Harmonic Emission from Compact Fluorescent Lamps*. 1st ed. Kebangsaan Malaysia,3-7

[3]. Performance of Compact Fluorescent Lamps at Different Ambient Temperature. (1993). 1st ed. Canada: Journal of the Illuminating Engineering Society,1-4

[4]. Sasaki, R. (1994). *THE IMPACT OF ELECTRONIC BALLAST COMPACT FLUORESCENT LIGHTING ON POWER DISTRIBUTION SYSTEMS*. 1st ed. West Lafayette,Indiana: Purdue e-Pubs, 40-43

[5]. SHAREEF, H., MOHAMED, A. and MOHAMED, K. (2010). *Sensitivity of Compact Fluorescent Lamps during Voltage Sags: An Experimental Investigation*. 1st ed. Selangor, Malayasia: WSEAS TRANSACTIONS on POWER SYSTEMS,1-3

[6]. Sharma, H., Sharp, F. and Mcgranghan, M. (2013). *Flicker/Voltage Fluctuation Response on Modern Lamps Including Those with Dimmable Capability of other Low Voltage Equipments*. 1st ed. EPRI-USA: Stockholm, 1-2