“Banning of Incandescent Bulbs” and Its Influence to Electromagnetic Compatibility

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Abstract—**This paper presents worldwide “Banning of incandescent bulbs” campaign, which aims to replace traditional incandescent bulbs that have long been known as inefficient sources of electrical lighting, with compact fluorescent lamps (CFLs). Controversy, operations and comparisons between these two alternatives are introduced in succession. Electromagnetic compatibility (EMC) issues, such as light flicker, which emerge more apparently because of the coming popularization of CFLs, will be discussed. Additionally, precautionary senses and steps to limit adverse interferences are mentioned when installing lighting systems.**

Index Terms—**incandescent light bulbs, compact fluorescent lamps, flicker, electromagnetic compatibility**

I. Background

The worldwide “Banning of incandescent bulbs” campaign has been supported by most governments, according to pass measures to phase out incandescent light bulbs. In some jurisdictions this has been done through legislation (Cuba, Brazil and Venezuela phased out incandescent light bulbs in 2005); while others, like United Kingdom, through voluntary measures. The aim is to encourage use of more energy efficient lighting alternatives, such as compact fluorescent lamp (CFLs) and LED lamps.

For European Union, the Irish government was the first member state to ban the sale of incandescent light bulbs. It was later announced that the member states of the EU agreed to a phasing out of incandescent light bulbs by 2012, which will save the European economy up to 10 billion euros. Nevertheless, it is up to the government of each member state on how to accomplish the eventual phase out. For example Italy will accomplish this through a ban on their sale, while the UK has enlisted the help of retailers with a voluntary, staged phase out.[1][2][6]

II. Controversy Of The Campaign

A. Environmental concerns

As the recommended alternative, CFLs, like all fluorescent lamps, contain small amounts of mercury as vapour inside the glass tubing, averaging 4.0 mg per bulb. A broken compact fluorescent lamp will release its mercury content. Safe cleanup of broken compact fluorescent lamps differs from cleanup of conventional broken glass or incandescent bulbs. Because household users in most regions have the option of disposing of these products in the same way they dispose of other solid waste, most CFLs are going to municipal solid waste instead of being properly recycled.

B. Cost and existing fixtures

The cost of CFLs is higher than incandescent light bulbs. Typically this extra cost may be repaid in the long-term as CFLs use less energy and have longer operating lives than incandescent bulbs. However, there are some areas where the extra cost of a CFL may never be repaid, typically where bulbs are used relatively infrequently such as in little-used closets and attics. Use in situations such as stairways where the lamp is turned on for less than five minutes at a time will cause a significantly shorter lifespan for a CFL. In the case of a 5-minute on/off cycle the lifespan of a CFL can be up to 85% shorter, reducing its lifespan to the level of an incandescent lamp.

Typical CFLs may have issues when being used in older dimmer light fixtures and with some electric timers, meaning many people would need to replace fixtures to retain that functionality. However some specialized CFLs can be purchased which may fit into the fixture without the need for replacement.[6]

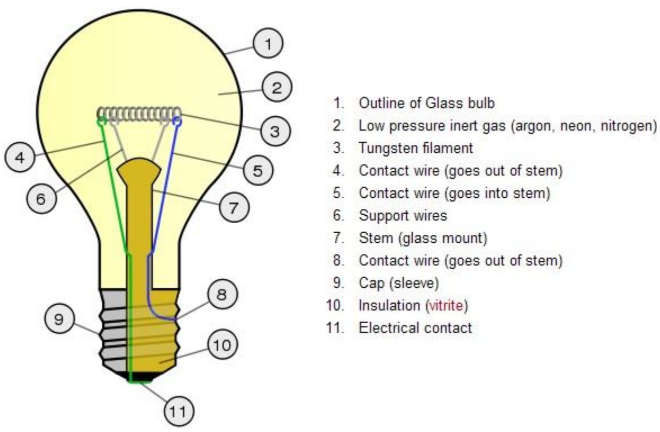

Figure 1. Interior configuration of an incandescent bulb

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III. Operations And Comparisons Of Incandescent Bulbs And CFLs

Incandescent lamps, with the interior configuration shown in Fig. 1, consist of a tightly coiled tungsten filament supported in an inert gas typically argon encapsulated in a glass bulb.[6] Electrical current passes through the filament heating it to 2000-3000°K where it emits photons in the visible range as well as considerable amount in the Infra-Red range.

Fluorescent lighting excites gaseous mercury atoms in a plasma arc. These atoms release photons in the UV range which then excite a phosphor coating to produce visible light. The plasma arc exhibits negative resistance and therefore requires an electrical ballast to limit the current.

Traditional incandescent lamps have remained relatively unchanged since the invention in the 19th century and have long been known as inefficient sources of electrical lighting. With current global pressures towards energy efficiency, CFLs offer 4-5 times the efficiency using fluorescent technology. From the statistical result of Fig. 2, we can get the straightforward understanding of efficiency discrepancies.[6] By compacting the discharge tube and developing low cost electronic ballasts, domestic use is increasing.

However, a number of concerns have been raised when replacing incandescent lamps with CFLs. Some lamps: 1) produce a 'cool white' colour not matching the 'warm white' colour of incandescent bulbs, 2) have delayed start-up and/or take considerable time reach full brightness, 3) fail to produce the equivalent rated light output, 4) produce audible sound, and 5) are usually non-dimmable. Aside from these consumer aspects, CFLs like incandescent lamps are susceptible to power system disturbances resulting in light flicker.[3]

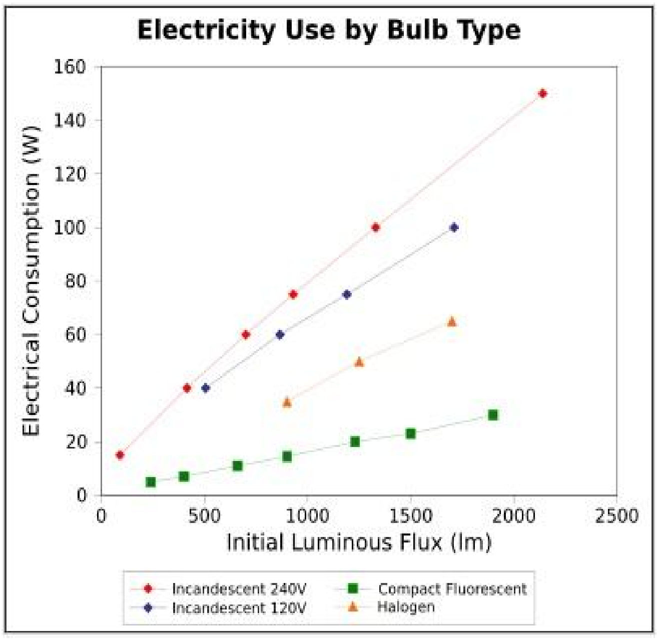

Figure 2. Energy usage for different types of light bulbs

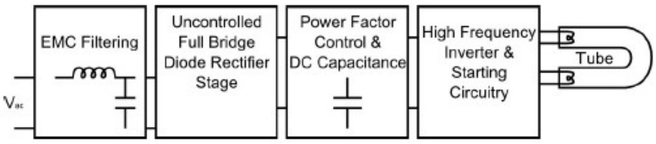

Figure 3. Typical CFL ballast design

IV. Influence To The Electromagnetic Compatibility

Light flicker (Flicker) is the variation of luminous flux (or visible light) within the frequencies perceptible by people. It generally has a adverse physiological effect on persons causing eye strain and/or even annoying emotion. In rare cases it can have serious health risks such as being stranded in distraught situation, loss of concentration, headaches or the triggering of epileptic seizures.[3][6]

However, because CFLs use electronic ballasts, their subsequent non-linear behaviour has made modelling of their operation difficult. Equally their susceptivity to voltage disturbances resulting in visible light flicker is widely unknown and difficult to predict. This has given rise to discrepancies between the measured flicker levels by relevant international flicker standards and the actual flicker produced.

A typical CFL ballast[5], as shown in Fig. 3, consists of a single phase rectifier stage creating a DC bus from which a high frequency inverter resonates to control the fluorescent tube current. Due to the diode rectifier, some require EMC filtering to comply with national harmonic standards, some however omit this. During starting two filaments at either ends of the tube are heated to create enough free ions for the plasma to be formed. Depending on the designed heating time, a delayed start-up can occur, on the other hand, insufficient heating reduces the lamps life.

For an uncontrolled full bridge rectifier the AC side voltage relates to the DC bus voltage through the switching function (modulation) by the diodes. Fig. 4, shows a generalised case of a rectifier switching function on a voltage waveform with a small distortion. Given that an AC side disturbance results in a modulated DC disturbance, the light output is likely to experience a similar fluctuation and result in visible flicker.[3]

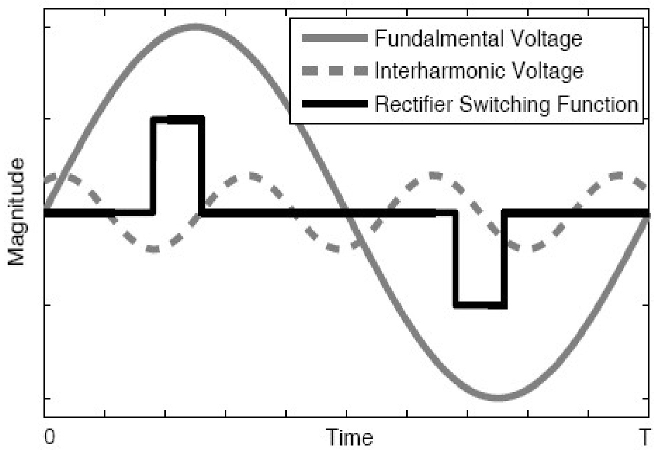

Figure 4. Switching operation of uncontrolled single phase rectifier

V. INSTALLING PRECAUTIONS RELATED TO EMC ISSUES

The lighting system is one of the most pervasive of the electrical loads. Lighting can create localized electrical field problems and affect susceptible electronic equipment.[4]

Especially for the coming popularization of CFLs, problems related to electromagnetic compatibility emerge apparently. Electric fields develop around fluorescent lighting fixtures, and today's electronic ballasts create high-frequency fields. The impact of these fields depends upon the sensitivity of equipment within those fields and the distance from the fixtures to the equipment.

Obviously, installation engineers should consider adverse interference effects when making selection of lighting fixtures. Our advice is to control the end results in the beginning rather than spend countless dollars and hours combating problems after the fact.

To minimize interference effects, take the following steps:

1. Install all wiring for lighting in separate conduits and power lighting circuits from dedicated-use isolation transformers.
2. Never combine lighting circuit wiring with computer system or other susceptible electronic system wiring in the same raceway.
3. In areas with susceptible equipment, use lighting systems without high-frequency electric fields (e.g., DC) or lighting fixtures with electromagnetic interference screens to control the electric fields.

Also, there are a few simple precautions should be taken for installing lighting systems near computers and data cables. They aren't new, and can be found in numerous site preparation manuals. Nevertheless, they warrant repeating here:[4][6]

1. Keep lighting circuits out of computer power panels.
2. Do not install data cables so that they run on top of fluorescent lighting fixtures because the magnetic fields from electronic ballasts may inductively couple into the data cable.
3. Make sure that you do not install poorly shielded data cables in the electric fields below lighting fixtures.

VI. CONCLUSION

"Banning of incandescent bulbs" is the governmental campaign to phase out the inefficient incandescent bulbs with compact fluorescent lamps (or LED lamps), which are not only taken into account of improving efficiency, but also should be considered of its following influence to electromagnetic compatibility issue, such as light flicker.

Because of CFL ballast, the induced flicker is much more complex, which may cause serious healthy problems to customers and subsequential detriment to the whole system's power quality. To minimize those potential interferences, installing precautions should be noticed and checked as the indispensable condition.

VII. REFERENCES

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VIII. BIOGRAPHIES

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