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The Study of Flickering Effect Present in Commercial LED Lights, Studies of their Optical Power and Driver Circuitry. Awareness Towards the Danger

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Abstract:

We have examined the flickering effect and optical power fluctuation of commercially available different LED bulbs and bare LED strips. Comparison of optical power changes at 75% of maximum power supply voltage is done after using area under spectrum of these bulbs. Role of driver circuitry and their difference are also been discussed. The paper represents the ongoing problems in commercially available LEDs and drawing attention towards the importance of using safe light sources.

Keywords — **Flickering, spectroscopy, LED (light emitting diode), driver circuitry**

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I. INTRODUCTION

A hazardous phenomenon which has been observed in LEDs is periodic modulation also known as flickering. The flickers below the frequency range of 100 Hz are called visible flickers whereas the flickers observed above 500 Hz frequency range are called invisible flickers. According to Solid-State Illumination System and Technologies (AISSIT); Flicker percentage above 20% is unacceptable for 100 Hz whereas more than 30% for flicker percentage is unacceptable for 120 Hz [1, 2]. Headaches, migraines, eyestrain, and even epileptic seizures etc. are some of the main diseases which are perceived from the flickering effect. It may also cause the increase in blinking rate of eye which causes concentration problems in human. [3, 4, 5]

Some filters have been developed and for solving the problem of flickering, good quality SMPS's are employed to provide continuous current to LED's but a lot of improvement is necessarily required [6,7,8]. The requirement for standard norms and regulation is necessary specifically for the market flooded with low-cost LED bulbs. The present study aims at finding out the present status on flickering, optical power variation with power supply fluctuation and role of driver circuitry for the LED bulbs commonly available in the market.

II. EXPERIMENTAL DETAILS

After investigating the local market we have taken 7 Watt, 6500K bulb of a popular brand (Bulb-A), a 7 Watt, 6500K unbranded bulb (Bulb-B) and an 12 Volt, 7 Watt LED strip, popularly used by street vendors (Bulb-C).

Flickering Measurement studies has been done using a photo detector (Instec, PD02) and a 2-channel digital storage oscilloscope (Tektronix TDS 2024c). Optical power of different LED bulb has been measured using spectrum of each bulb in direction normal to LED plane using spectrometer (Avantes, Avaspec2048).

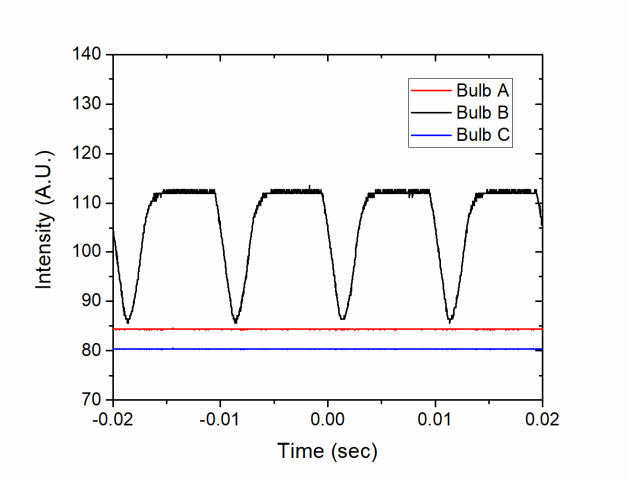

Fig. 1. Flickering Waveform of Studied LED bulb at maximum supply voltage.

III. RESULT

The time domain waveform of optical signals on digital storage oscilloscope corresponding to bulbs A, B & C respectively is shown in Fig (1). It can be observed that flickering is visible only for Bulb B, while no fluctuation in intensity is observed for Bulb A and C. The flicker values for bulb B are estimated as percentage flicker using the formula given below [9]

$$Percentage\ flicker = 100\% \times \frac{(A-B)}{(A+B)}$$

Where A is the maximum intensity and B is minimum value of intensity of the spectrum.

To find out the variation in optical power with supply voltage, we have measured intensity of each bulb using spectrometer as shown in Fig 2. We measured the intensity at full recommended supply voltage and 75% of full supply voltage. The optical power has been calculated using the area under the spectrum.

In case of bulb A, when we reduced the voltage supply by 25% there is no significant change in the spectrum as both the spectrum lines are over lapping each other as shown in Fig 2 (a). In case of bulb B and C, we see a significant amount of drop in the intensity as given in Fig 2 (b, c). It is evident that luminous power of bulb A remains approximately unaffected by supply voltage variations whereas it changes substantially for bulbs B and C.

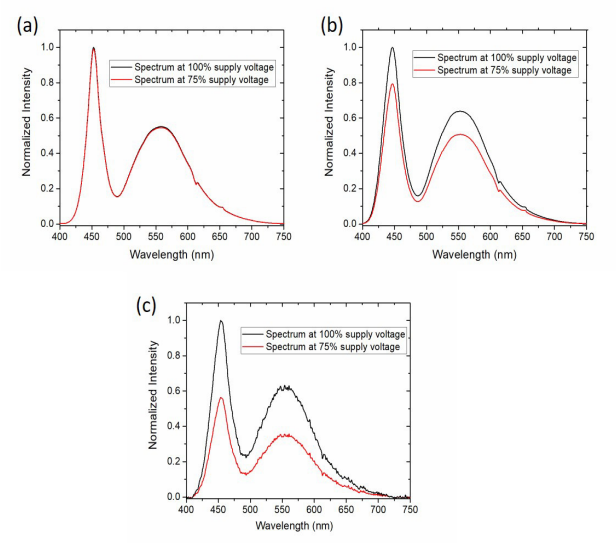

Fig. 2 Spectrum of a) Bulb A, b) Bulb B, c) Bulb C at maximum supply voltage and 75% of maximum supply voltage

The amount of flicker at full supply voltage and the variation in output optical power at 75% supply voltage is tabulated in Table 1. It can be observed that bulb B has high amount of flicker (22% at 100 Hz) which is not good for human eye (3). Whereas bulb A & C are showing approximately negligible flickers. However, bulb A does not show much variation in optical power with change in supply voltage. Bulb B and C show significant fluctuation in optical power with variation of 21.6% and 44.6% respectively.

Table 1. Estimation of Flicker and variation in optical power with change in supply voltage.

S.No.	Parameter	Specified Value	Estimated Value		
		Bulb A, B &C	Bulb A	Bulb B	Bulb C
1	Flicker	NA	0	22% , 100Hz	0
2	Variations in Optical power at 75% of maximum Supply voltage	NA	0.01%	21.6%	44.6%

IV. DISCUSSION

In the flickering measurements we found that bulb B is showing 22% flickering at 100 Hz, while there isn't any amount of flicker present in bulb A and bulb C in fig(1). To investigate the cause of flicker the driver circuits for bulbs A and B are investigated. Figures 3(a) and 3(b) represents the driver circuit and inside housings of bulb A and Figures 4(a) and 4(b) represent the circuit and housing for bulb B. It is evident that LEDs in bulb A are driven by AT 9933 PWM controller IC which is operating in low noise boost and buck operation providing smooth constant current supply to LEDs, whereas bulb B is driven by simple basic rectifier and resistor network for driving LEDs causing ripples in the power supply in output and thus producing flickers. By upgrading the driver circuit with a circuit having constant smooth current supply we can rectify the problem for flickering.

During the optical power measurements we found that after reducing 25% of total voltage supply, there is no change in the spectrum in case of Bulb A. The overlapping of spectrum in Fig 2(a) shows that variation was not observed in the optical power even at 75% of maximum voltage supply where as there is a significant amount of variation i.e. 21.6% was observed in bulb B and 44.6% was observed in bulb C. Observation of the driver circuit shows that Zener breakdown isn't steep in the case of bulb B due to this voltage stabilization is not good and which causes reduction output voltage and thus reduces the optical power of LED. As Bulb C is a led strip for which we have used common DC adaptor to switch on the bulb. It can be observed that ~45% drop in optical power is observed when we reduced optical power to 75% of maximum rated voltage. It indicates the similar stabilization issues in driver circuit as in bulb B.

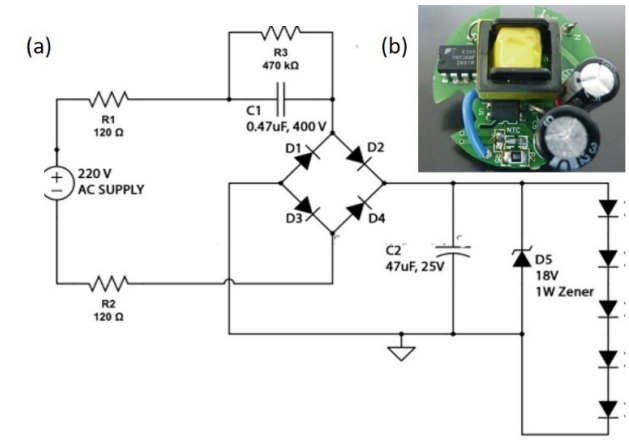

Fig: 3 (a) Driver circuit and (b) housing of Branded Bulb A

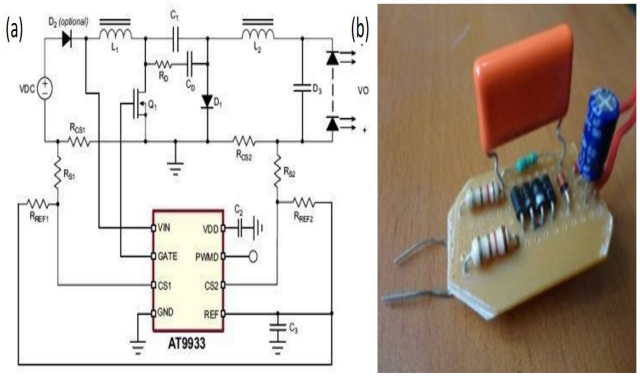

Figure: 4 (a) Driver circuit and (b) housing of Branded Bulb B

V. CONCLUSIONS

In conclusion we have studied the effect of driver circuit and input power supply on flickering and optical power respectively. We have observed 22% of flickering for non rectified driver circuit & cost reduction by putting basic driver circuits will produce large amount of flicker. Low cost LED strips used by street vendors are also cause of concern if it is not been powered by well rectified and stabilized DC supply. Low cost LEDs manufacturer does not use proper rectification system which is the main cause of flickering. Large decrease in optical power has been observed with reduction in input power by 25% when stabilization is not good. Thus stabilization unit in the driver circuit is also important and requires proper biasing and specified Zener diode.

VI. GUIDELINES FOR USERS

Though LED lights are durable and energy efficient but excess use of this light may cause different problems especially to eyes. So it is suggested that use only good quality LED lights only when required, "cheap can be dangerous"

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