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Capabilities and benefit of Light Emitting Diodes (LEDs)

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ABSTRACT

Light Emitting Diodes (LEDs) have benefited from growthly performance improvements such as Light efficiency and low operating costs compared to traditional light source .Because LED lamps are made of a monolithic semiconductor material, they are inherently more concreted than traditional lamps, which have endeared LED lamps to industrial markets

The aim of this paper is to compare the possible hazards from LEDs and other light sources including; heat, hazardous material, carbon dioxide and blue light hazard, and compare the measured number with the standard limit.

KEY WORDS

Light source, hazard, carbon dioxide, blue light, LED, CCT

NOMENCLATURE

UV: Ultraviolet radiation.
IR: Infrared
BLH: Blue - light hazard. .

1. INTRODUNTION

LED lights have been described as a super - efficient alternative to traditional lights because they use more than 85% less energy and each lamp can last up to 25000 hours.'

LED lighting advantages are

- saving of consumed electric energy , while maintains same illuminance level
- saving of air condition thermal load (no IR radiation from LED)
- Saving of annual maintenance cost (lamp and ballasts periodic replacement)
- lumen output and color rendering level stability during life time
- high color rendering index up to 80%

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- eco-friendly (it doesn't contain any mercury or other Toxic Gases)
- Directional light, allowing users to easy focus the light beam on desired area

Most white LED lights manufactured today start as a blue LED with additional phosphor coating to create a broad - band white light source .This has led to the development of brighter and brighter blue LEDs

2. Electromagnetic Radiation

Visible spectrum (Light)

Electromagnetic radiation with a wavelength between 380 nm and 760 nm is detected by the human eye and perceived as visible light. The wavelengths near IR (longer than 760 nm) and UV (shorter than 380 nm) are also sometimes matched to as light. White light is a combination of lights have different wavelengths in the visible spectrum.

Ultraviolet radiation (UV)

LED based light sources do not emit any UV radiation (unless specifically designed for the particular use). LEDs are not harmful to people with a specific sensitivity for certain UV radiation and can bring relief to certain crews of patients. Therefore, LED light sources provide advantages over traditional light sources.

Infrared (IR) light

IR is a region of the electromagnetic spectrum, has longer wavelengths and lower frequencies than visible light, but is not visible to the human eye. IR can be detected as the heat emitted from light sources.

3. Possible hazards from light sources

Visible light (range: 380 nm to 760 nm) can in principle only damage the eye by thermal or photochemical effects. LED- based light sources are not lead to damage the eye due to UV or IR radiation or with damage to the skin. The possible hazard according to wavelength range are:

- The Retina thermal injures , the range :380 - 1400 nm
- Blue light hazard (BLH) , the range 300 - 700 nm

The range of white tones achievable is:

- From color white (daylight white) , CCT >5000K
  (Which containing a greater proportion of blue)
- to neutral white , 5000k >CCT >3300K
- to warm white , CCT <3300K
  (which containing a greater proportion of red)

The larger Correlated Color temperature (CCT) value of the white tone, the higher proportion of blue light will be the radiation emitted.

4. Led compared to other light sources:

With regard to photo biological safely, LED is not basically vary to light sources using traditional technologies; such as incandescent or fluorescent lamps. The portion of blue light in LED is not higher than the portion of the blue light in other light sources at the same color temperature (CT).Compared to other sources of optical radiation , lamp used for lighting have the advantage that the level of visible radiation that is fall in the area where humans are present , there are minimum required levels , its depend on the required task , that means, the upper range of lighting level is limited to prevent glare and also to limit cost .The level of 500 lx is used as reference level in several international and national product safety standard .[7]

5. Blue - light hazard (BLH)

BLH is defined as the potential for retinal injury due to high-energy short - wavelength light (400-500 nm) **.**The main factors affecting the BLH damage potential of a light source are [10] **:**

- the quantity E_B and spectrum of radiation incident on given area of the retina
- the size of the source
- duration of exposure

Given these factors, the standard documents [2] establish exposure limit risk groups (RGs). Four risk groups are used to categorize exposure based on human characteristics:

- RG 0 Exempt
- RG 1 Low
- RG 2 Moderate
- RG 3 High

Fig .1. shows the comparison of the E_B of a number of light source on blue light hazard irradiance at 500 lx. This shows that the quantity of Blue light is low to very low. Fig .2. shows the relation between CCT (k) and illuminance (lux) for white light source classification, and the boundary for RGs [9]
This shows the reference distance of 500 lux level , the BLH exposure limit, for lamps emitting 'white' light with color temperature below 12000 Kelvin ,which cannot be exceeded , i.e. always in the exempt group of IEC 62471 (RG0) .
The Most LED product that emit white light include a blue LED lamp , the proportion of blue light in the spectrum is not significantly higher for LEDs that it is for any other light source at the same CCT [9]

IEC 62471 standard

The photochemical blue light hazard (BLH) can be evaluated on the basis of the standard IEC 62471. It classifies light sources into risk groups (RG) : 0,1,2 and 3 (0=no risk & 3=high risk) , for each group : the higher is the risk group , the shorter is the time basis to applied. BLH is define as the potential for retinal injury due to high-energy short - wavelength light. IEC 62471, specifically it define exposure limits , references measurements techniques and the classification scheme for the evaluation and control of

photo biological hazard from all electrically powered incoherent broadband sources of optical radiation, including LEDs, in the wavelength range from 200 nm through 3000 nm.

6. Glare

Glare is caused by excessive difference in luminance or unfavorable luminance distribution at the eye [8] .
Glare does not itself cause direct damage to the eye , but can go to harm indirectly by impairing vision and the capable to specific objects .
There is generally no fundamental difference in terms of glare between LED lamp and other light sources

7. Recycling

One big problem with incandescent lamp is that it not recyclable, so they just end up in a landfill. LED lamps are made with recyclable materials such as aluminum heat sink , plastic casting, printed circuit and lamp base, and the production process is highly automated with low energy used to produces each component .
Once the LED has come to the end of its life cycle they can actually be recycled and used to make LEDs again to manufacture new LEDs, Even if the LED lamps are not properly recycled, they do not lead to land and water contamination.

8. Hazardous materials

Burning coal is a far larger source of mercury (Hg) in environment and a far bigger risk to human health. Using more efficient bulbs leads to:

- conserving electricity
- avoid some of the mercury emissions from power plants that burn coal, as shown in table **1**.

The amount of Hg contained in a CFL is about 3-5 mg. About 99% of Hg is typically contained in phosphor, especially on bulbs that are near to the end of their ages. No mercury is used in manufacturing of incandescent, halogen and LEDs bulbs. Therefore LED lights are free of toxic chemicals like mercury and harmful gases.

9. Carbon dioxide

LED lamps a very less energy compared to equivalent incandescent and halogen lamps, therefore mainly burn fossil fuels to produce electricity is directly link between the amount of electricity used and the levels of carbon dioxide that is entered into atmosphere . So because LEDs lighting takes much less energy the end result is that

less carbon dioxide is produced. Tables (2) and (3) represent examples for energy use, manufacture and CO2 for some type of lamps

10. Bulbs produce heat

IR radiation heats the enclosures and surrounding of bulbs, making them hot to the touch. The temperature to the touch depends on the produce heat in the form of infrared (IR) radiation.
Incandescent, halogen and CFL bulbs get so hot because part of their energy is being released as IR-radiation, making them much more inefficient.
Table **4**. shows measured temperatures, by using infra-red 'temperature gun', to the touch for some type of bulbs. From this table, proprietary tests show 100w incandescent, equivalent 24w CFL, and 13w LED produce 260 c°, 84 c° and 43 c° respectively. In fact, LEDs are cool to the touch because they generally don't produce heat in the form of IR radiation. Heat should be conducted away from the LED in an efficient manner, and then removed from the area by convection.

Figs. 3, 4 and 5 show the results of measured temperatures, by using temperature gun for incandescent and LED bulbs.
The measured temperatures for fixture (three x 60cm fluorescent tube lamps) at different distance presented in Table 5 and Fig. 6

Table 6 and fig. 7 show the measured temperature for LED fixtures (2 tube x 120cm) at different distance

11. Conclusion

LED lights have several advantages like energy saving , saving of annual maintenance, high efficiency, high color rendering index, and eco-friendly lights.
With regard to photo biological safely , LED is not basically vary to light sources using traditional technologies ; such as incandescent or fluorescent lamps . The portion of blue light in LED is not higher than the portion of the blue light in other light sources at the same color temperature (CT). The Most LED product that emit white light include a blue LED lamp , the proportion of blue light in the spectrum is not significantly higher for LEDs that it is for any other light source at the same CCT [4].
There is generally no fundamental difference in terms of glare between LED lamp and other light sources. Once the LED has come to the end of its life cycle they can actually be recycled and used to make LEDs again to manufacture new LEDs , Even if the LED lamps are not properly recycled, they do not lead to land and water contamination. LED lights are free from toxic chemicals like mercury and harmful gases, also it is less carbon dioxide is produced. In addition LEDs are cool to the touch due to they generally don't emit heat in the form IR radiation. Heat should be conducted far from the LED in very efficient manner, and removed from the area by convection.
LEDs are safety and eco-friendly lamps.

Table 1. OVERALL MERCURY (Hg) IMPACTS OF DIFFERENT EQUIVALENT BULB OVER THE LIFE TIME OF CFL

Type Of Bulbs	***Rating (w)***	***Total Emission/bulb (mg of Hg)***
Incandescent	100	12.8
Halogen Incandescent	72	9.2
CFL	27	3.5
LED	15	0.9

Table 2. ENERGY USED AND MANUFACTURE FOR LED AND INCANDESCENT LAMPS

	Incandescent	***LED***
Rating (w)	40	5
Rnergy use (kwh)	3290	658
Energy Manufacture (kwh)	15.3	9.9

Table 3. CO2 EMISSION FOR LAMPS

	Incandescent	***CFL***	***LED***
Rating (w)	75	15	6-8
η(lm/w)	12	60	150
Life (h)	1200	8000	25000
Co2 Emission (kg)	1000	200	90

Table 4. MEASURED TEMPERATURE TO THE TOUCH FOR SOME TYPE OF BULBS

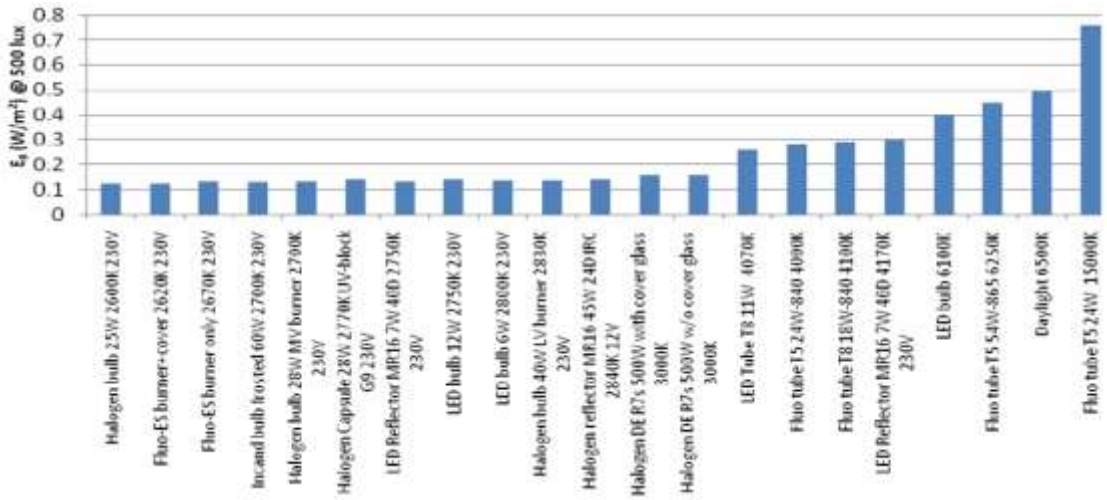
Type Of Bulb	***Rating (w)***	***Lumen***	***Temperature to the touch***	***Fact***
LED	9 w	600 lm	40 c°	***Cool to the touch***
	9.5 w	600 lm	44 c°	
	13 w	1055 lm	43 c°	
Halogen	53 w	850 lm	137 c°	***High hot to the touch***
	70 w	1200 lm	154 c°	
Incandescent	60 w	750 lm	181 c°	
	100 w	1690 lm	260 c°	
CFL	24 w	1500 lm	84 c°	***Moderate hot to the touch***
	18 w	840 lm	89 c°	

Table 5. MEASURED TEMPERATURE FOR DIFFERENT FLUORESCENT FIXTURES

Sample	***Distance (meter)***	***Max.Temperatures (c°)***	***Min.Temperature (c°)***
1	1.71	67.6	20.8
2	1.41	48.8	15.1
3	1.46	54.6	17.8
4	1.46	56.2	16.2

Table 6. MEASURED TEMPERATURE FOR DIFFERENT LED FIXTURES

Sample	***Distance (meter)***	***Max.Temperatures (c°)***	***Min.Temperature (c°)***
1	0.95	36.7	20.2
2	1.1	40.7	20.0



Fig(1) Comparison of various light sources on blue light hazard irradiance at 500 lux

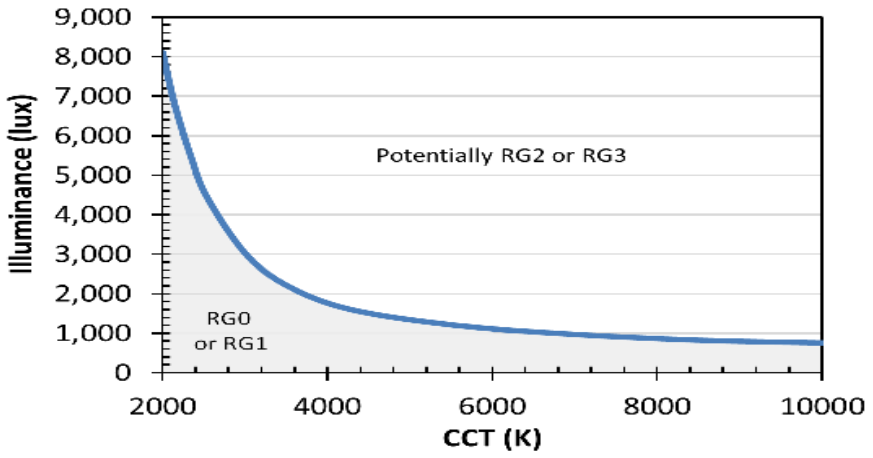


Fig.2. The relation between CCT and illuminance (Lux)

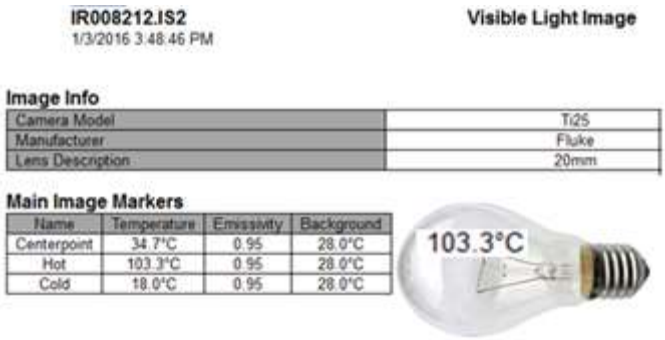


Fig.3. Measured temperature for 40w incandescent lamp

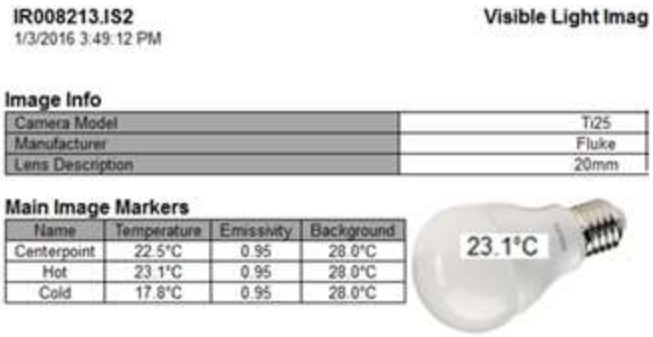


Fig.4. Measured temperature for 5.5w LED lamp

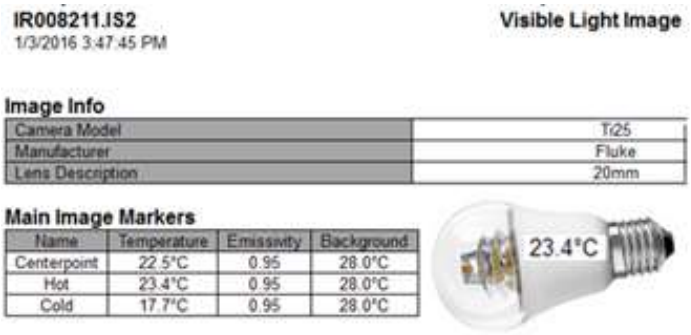
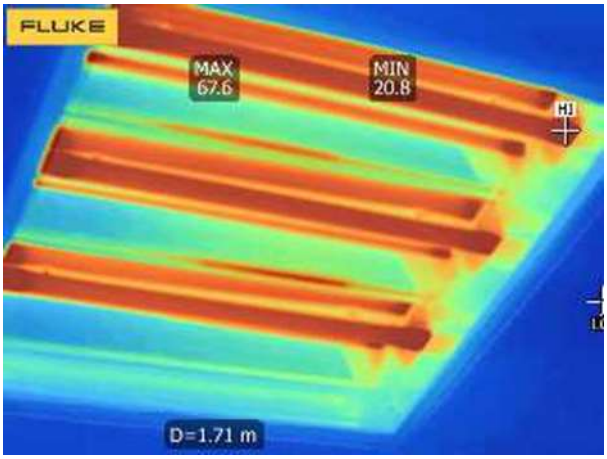


Fig.5. Measured temperature for 10w LED lamp

(a)



(b)

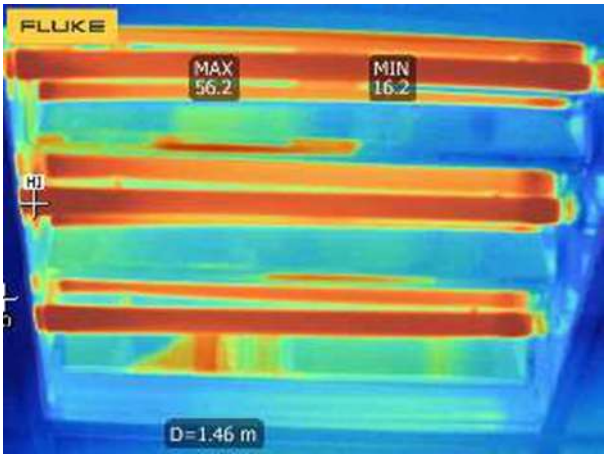


Fig.6. Measured temperature for fixture (3 x 60cm) fluorescent lamps

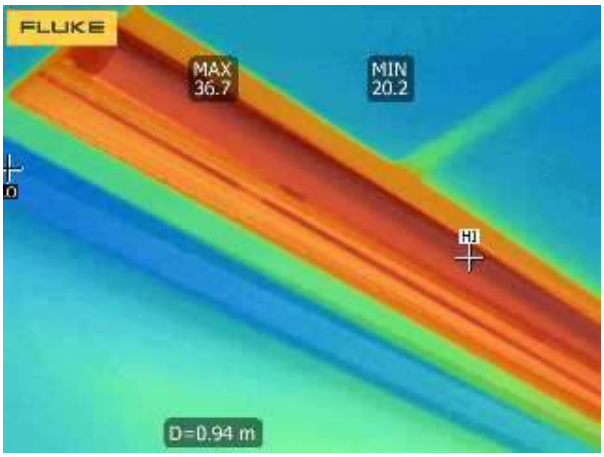


Fig.7. Measured temperature for LED fixture (2x 120cm)

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