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LED LAMP: ECONOMICS OF ENERGY EFFICIENT USE

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ABSTRACT

Energy conservation refers to efforts made to reduce energy consumption. Energy conservation can be achieved through increased efficient energy use /in conjunction with decreased energy consumption and/ or reduced consumption from conventional energy sources.

Energy conservation can result in increased financial capital, environmental quality, national security, personal security and human comfort. Individual and organizations that are direct consumes of energy choose to conserve energy to reduce energy costs and promote economic security. Industrial and commercial users can increase energy use efficiency to maximize profit.Standard economic theory suggests that technological improvements increase energy efficiency, rather than reduce energy use. It is said to occur in two ways.

Firstly, increase energy efficiency makes the use of energy relatively cheaper, thus encouraging increased use.

Secondly, increased energy efficiency leads to increased economic growth, which pulls up energy use in the whole economy. This does not imply that increased fuel efficiency is worthless, increase fuel efficiency enables greater production and a higher quality of life.

Efficient energy use, sometimes simply called energy efficiency, is the goal of efforts to reduce the amount of energy required to provide product and service. For

example, insulating a home allows a building to use heating and cooling energy to achieve and maintain a comfortable temperature. Insulating fluorescent lights or natural skylights reduce the amount of energy required to attain the same level of illumination compared to using traditional incandescent light bulbs. Compact fluorescent lights use two-third less energy and may last 6 to 10 times longer than incandescent lights. Improvements in energy efficiency are most often achieved by adopting a more efficient technology or production process.

Keywords: Conventional Energy Sources, Incandescent light, Illumination etc.

I. INTRODUCTION

LED LAMP

A LED light-emitting-diode lamp is a solid-state lamp that uses light-emitting-diodes (LED's) is die source of light. The term "LED light bulb" is also colloquially used. "LED lamp" may in general refer to conventional semiconductor light- emitting diodes, to organic LED's (OLED), or polymer light-emitting diodes (PLED) devices.

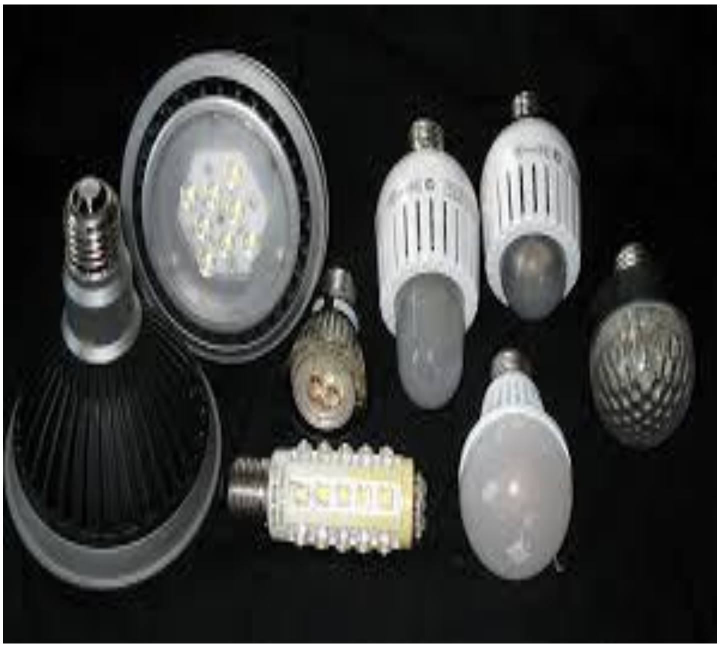

Fig.1: Varity of LED based Lamps

Since the light output of individual light-emitting diodes is small compared to incandescent and compact fluorescent lamps, multiple diodes are often used together. In recent years, as diode technology has improved, high power light-emitting diodes with higher lumen output are making it possible to replace other lamps with LED lamps. One high power LED chip used in some commercial LED lights can emit 7527 lumens while using only 100 watts. LED lamps can be made interchangeable with other types of lamps. Diodes use direct current (DC) electrical power, so LED lamps must also include internal circuits to operate from standard AC voltage. LEDs are damaged by being run at higher temperatures, so LED lamps typically include heat management elements such as heat sinks and cooling fins. LED lamps offer long service life and high energy efficiency, but initial costs are higher than those of fluorescent lamps.

An assortment of LED light bulbs that are commercially available as of 2010 as replacements for screw-in bulbs, including floodlight fixtures (left), reading light (center), household lamps (center right and bottom), and low-power accent light (right) applications.

II. LED LIGHT TECHNOLOGY

General purpose lighting needs white light. LEDs emit light in a very small band of wavelengths, emitting strongly colored light. The color is characteristic of the energy band gap of the semiconductor material used to make the LED. To emit white light from LEDs requires mixing light from red, green, and blue LED's, or using a phosphor to convert some of the light to other colors.

The first method (RGB-LED's) uses multiple LED chips each emitting a different wavelength in close proximity, to form the broad white light spectrum. The advantage of this method is that the intensity of each

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LED can be adjusted to "tune" the character of the light emitted. The major disadvantage is high production cost.

The second method, phosphor converted LEDs (pc LED's) uses one short wavelength LED (usually blue or ultraviolet) in combination with a phosphor, which absorbs a portion of the blue light and emits a broader spectrum of white light. (The mechanism is similar to the way a fluorescent lamp emits white light from a UV-illuminated phosphor.) The major advantage here is the low production cost, and high CRI (color rendering index), while the disadvantage is the inability to dynamically change the character of the light and the fact that phosphor conversion reduces the efficiency of the device. The low cost and adequate performance makes it the mostwidely used technology for general lighting today.

A single LED is a low-voltage solid state device and cannot be directly operated on standard AC current without some circuitry to control the voltage applied and the current flow through the lamp. A series diode and resistor could be used to control the voltage polarity and to limit the current, but this is inefficient since most of the applied voltage would be dropped as wasted heat in the resistor. A single series string of LEDs would minimize dropped-voltage losses, but one LED failure could extinguish the whole string. Paralleled strings increase reliability by providing redundancy. In practice, three strings or more are usually used. To be useful foillumination for home or work spaces, a number of LEDs must be placed close together in a lamp to combine their illuminating effects. This is because individual LEDs emit only a fraction of the light of traditional light sources. When using the color-mixing method, a uniform color distribution can be difficult to achieve, while the arrangement of white LEDs is not critical for color balance. Further, degradation of different LEDs at various times in a color-mixed lamp can lead to an uneven color output. LED lamps usually consist of clusters of LEDs in a housing with both, driver electronics, a heat sink and optics.

II. APPLICATIONS OF LED LAMPS

LED lamps are used for both general and special-purpose lighting. Where colored light is needed, LEDs come in multiple colors, which are emitted with no need for filters. This improves the energy efficiency over a white light source that generates all colors of light then discards some of the visible energy in a filter.

Compared to fluorescent bulbs, advantages claimed for LED light bulbs are that they contain no mercury (unlike compact fluorescent light bulbs), that they turn on instantly, and that lifetime is unaffected by cycling on and off, so that they are well suited for light fixtures where bulbs are often turned on and off. LED light bulbs are also less apt to break.

White-light light-emitting diode lamps have the traits of long life expectancy and relatively low energy use. The LED sources are compact, which gives flexibility in designing lighting fixtures and good control over the distribution of light with small reflectors or lenses. Due to the small size of LEDs, control of the spatial distribution of illumination is extremely flexible, and the light output and spatial distribution of a LED array can be controlled with no efficiency loss.

LED lamps have no glass tubes to break, and their internal parts are rigidly supported, making them resistant to vibration and impact. With proper driver electronics design, an LED lamp can be made dimmable over a wide range; there is no minimum current needed to sustain lamp operation. LEDs using the color-mixing principle can emit a wide range of colors by changing the proportions of light generated in each primary color. This allows full color mixing in lamps with LEDs of different colors. In contrast to other lighting technologies, LED emission tends to be directional (or at least lambertian). This can be either an advantage or a disadvantage, depending on the requirements of the application. For applications where non-directional light is required, either a diffuser is used, or multiple individual LED emitters are used to cover different directions.

III. LAMP SIZES AND BASES

LED lamps intended to be interchangeable with incandescent lamps are made in standard light bulb shapes, such as an Edison screw base, an MR16 shape with a bi-pin base, or a GU5.3 (Bipin cap) or GU10 (bayonet socket). LED lamps are made in low voltage (typically 12 V halogen-like) varieties, and as replacements for regular AC (e.g. 120 or 240 V AC) lighting. These lamps typically include circuitry to rectify the AC power and to convert the voltage to a level usable by the internal LED elements. LED Light Bulbs Many LED lamps have become available as replacements for screw-in incandescent or compact fluorescent light bulbs, ranging from low-power 5-40 watt incandescent bulbs, through conventional replacement bulbs for 60 watt incandescent bulbs (typically requiring about 7 watts of power), and as of 2010 a few lamps were available to replace higher wattage bulbs, e.g., a 13-watt LED bulb which is about as bright as a 100W incandescent. The technology is improving rapidly, and new energy-efficient consumer LED lamps have been announced by big companies in lighting industry such as Oshram Sylvania, Philips, and General Electric etc.

White LED lamps have achieved market dominance in applications where high efficiency is important at low power levels. Some of these applications include flashlights, solar-powered garden or walkway lights, and bicycle lights. Monochromatic (colored) LED lamps are now commercially used for traffic signal lamps, where the ability to emit bright monochromatic light is a desired feature, and in strings of holiday lights.

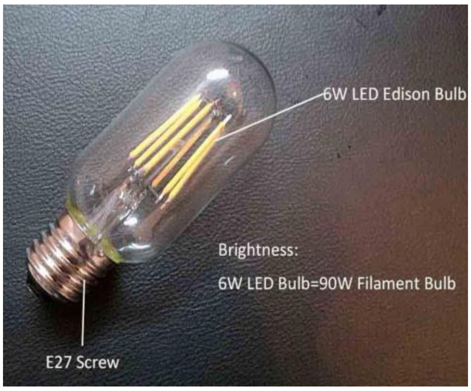

Fig.2: Household LED Lamp with Edison Screw

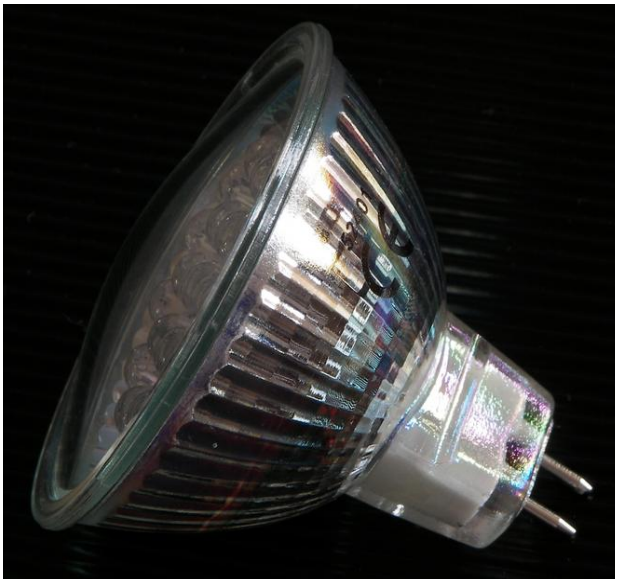

Fig.3: High Power LED Lamp with Gu5.3 Fitting

IV. COMPARISON OF LED LAMP WITH OTHER LIGHTING TECHNOLOGIES:

- Incandescent lamps (light bulbs) generate light by passing electric current through a resistive filament, thereby heating the filament to a very high temperature so that it glows and emits visible light. A broad range of visible frequencies are naturally produced, yielding a "warm" yellow or white color quality. Incandescent light is highly inefficient, as about 98% of the energy input is emitted as heat. A 100 W light bulb emits about 1,700 lumens, about 17 lumens/W. Incandescent lamps are relatively inexpensive to make. The typical lifespan of an AC incandescent lamp is around 1,000 hours. They work well with dimmers.Most olderlight fixtures are designed for the size and shape of these traditional bulbs.
- Fluorescent lamps (light bulbs) work by passing electricity through mercury vapor, which in turn emits ultraviolet light. The ultraviolet light is then absorbed by a phosphor coating inside the lamp, causing it to glow, or fluoresce. While the heat generated by a fluorescent lamp is much less than its incandescent counterpart, energy is still lost in generating the ultraviolet light and converting this light into visible light. If the lamp breaks, exposure to mercury can occur. Linear fluorescent lamps are typically five to six times the cost of equivalent incandescent lamps but have life spans around 10,000 and 20,000 hours. Lifetime varies from 1,200 hours to 20,000 hours for compact fluorescent lamps. Most fluorescent lamps are not compatible with dimmers. Those with "iron" ballasts flicker at 100 or 120 Hz, and are less efficient. The latest T8-sized tri-phosphate fluorescent lamps made by Oshram, Philips ,Crompton and others have a life expectancy greater than 50,000 hours, if coupled with a warm-start electronic ballast. The life expectancy depends on the number of on/off cycles, and is lower if the light is cycled often. The efficiency of these new lamps approaches 100 lumens /W. The efficiency of fluorescent tubes with modern electronic ballasts and compact fluorescents commonly ranges from 50 to 67 lumens/W.Most compact fluorescents rated at 13 W or more with integral electronic ballasts achieve about 60 lumens/W, comparable to the LED bulb.

V. ROLE OF VOLTAGE ON THE EFFICIENTLY OF LIGHTING SYSTEM

In electrical system, Voltage variations has direct impact on the efficiency of the system. In lighting too, variation in voltage affects the performance of lighting. Variation of voltage include overvoltage and undervoltage from the desired value. In lighting system, undervoltage is sometimes deliberately used to control the light output to achieve the energy saving. This technique is better known as voltage optimization.

Voltage Optimization is a term given to the systematic controlled reduction in the voltages received by an energy consumer to reduce energy use, power demand and reactive power demand. While some voltage 'optimization' devices merely reduce the voltage using a transformer, others give the end-user the ability to control and optimize their electricity supply locally, correcting voltage and power quality problems from the grid and are designed to do so very efficiently. Voltage optimization systems are typically installed in series with the mains electrical supply to a building, allowing all its electrical equipment to benefit from an optimized supply. Voltage optimization as an energy efficiency measure is growing rapidly in popularity. A common misconception as far as voltage optimization is concerned is to assume that a reduction in voltage will result in an increase in current and therefore constant power. Whilst this is true for certain fixed-power loads, most sites have a diversity of loads that will benefit to a greater or lesser extent with energy savings aggregating across a site as a whole. The effect of voltage optimization in lighting system is as follows:

When lighting loads are in use for a high proportion of the time, energy savings on lighting equipment are extremely valuable.When voltage is reduced, incandescent lighting will a large decrease in power drawn, a large decrease in light output and an increase in lifetime.

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