How to interpret LED lamp data

To make the best lighting product choice, consumers must understand how to interpret lamp performance data. Jeanine Chrobak-Kando explains what kind of data is available, and how to use that data to make the best LED lighting choice.

LED lamps are now rapidly replacing conventional incandescent lamps and compact fluorescent lamps (CFLs) in domestic and commercial lighting. Understanding the data that is presented with respect to lamp performance and operating life is the key to making informed product choices.

Data on LED lamps is to be found on their packaging, or in data sheets. Some of the information is based on verifiable facts but some marketing claims may not be based on sound engineering principles. A number of major global brands are now competing for a share of the general LED lighting market. Prices are falling as the technology matures, manufacturing process become more refined and the economics of high volume manufacturing and supply chain management come into play. For a given product, prices from these reputable suppliers will be found to be within a range of perhaps ±20%. Products from lesser-known brands, or even those of unbranded LED lamps, may at first appear to be significantly lower. However, to be able to sell at these lower prices, compromises will have been made in the quality of materials and components employed - it is unlikely that significant cost advantages in manufacturing can be realized. The quality of components in the electronic circuits inside LED lamps are critical in determining product life, so you can expect early failures in cheap lamps and a poor return on capital outlay. The reputation of the whole LED lamp industry is dependent upon consumers understanding this argument.

A typical LED lamp specification will include mandatory information, as demanded by EU or FTC legislation, including its power rating, the equivalent incandescent lamp rating, the operating voltage and frequency, the light colour emitted, its colour rendering index (CRI), luminous flux, operating life time, fitting type and whether the lamp is dimmable. In the case of directional lamps, the luminous intensity and beam angle may also be quoted, although this is not a legal requirement.

Classic A E27 10W warm white: A typical data table for an LED lamp

Product Features	• LED retrofit bulb as replacement for 40W standard incandescent lamps • dimmable • energy savings up to 75%
Wattage	10W
Voltage	220-240V
Operating Frequency	50-60Hz
Light Color	Warm white - 3000K
CRI	>80
Luminous Flux	480 lumens
Luminous Efficiency	48 lumens/Watt
Lifetime	35,000 hrs = 16 years*

*at 6 hours per day

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With respect to power savings, today's best LED lamps offer energy savings of up to 75% compared with incandescent lamps. The precise figure depends upon operating conditions, including the ambient temperate and whether or not a dimmer is used. Where the lamps are not used at full rated output, the efficiency of the driver circuit is reduced.

The light colour defines the colour temperature of light emitted by the lamp and is expressed in degrees Kelvin. For the technically minded, the definition of colour temperature of visible light is "the temperature of a black body radiator that radiates light of comparable hue to that of the light source." LED lamps are generally classified as providing "warm white" or "cool white" light. What are consumers are looking for is replication of the light produced by an incandescent bulb, because they are accustomed to this. Bright sunlight, perhaps at midday, equates to a colour temperature of around 5500-K.

A very important characteristic to take into account when selecting an LED lamp is its colour rendering index (CRI). This describes how accurately the light from a lamp reproduces colours of various objects compared with an ideal or natural light source. In practice, a tungsten halogen lamp is considered to have a CRI of 100. LED lamps based on blue chips plus phosphors are now achieving CRI of approximately 80. A higher CRI is possible but only at the expense of lower efficiency. Anything lower than a CRI of 80 is likely to give a distorted view of the world with respect to colour and within the next year or two, LED lamps with CRI of up to 98 will be available. The colour rendering performance of these lamps will be virtually indistinguishable from that of natural light and will be achieved through the use of violet chip technology developed companies such as Mitsubishi Chemical Corporation (see Fig. 1). The company sells LED lamps under the Verbatim brand.

Luminous flux, measured in lumens, is the level of light emitted by the lamp. Dividing this by the power consumed gives you an indication of the lamp's efficiency and the result is expressed as lumens per Watt. Few in the lighting supply chain, including the end consumers, will have the facility to measure luminous flux. Once again, the better-known, reputable brands will tend to quote conservative figures. If you see lamps advertised that seem to exceed the norm by a large margin, you should question the validity of such claims.

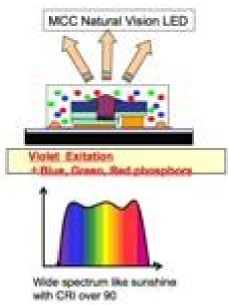

Fig. 1. MCC natural vision LED

The situation is similar regarding operating life. Unlike conventional lamps, which fail suddenly and totally, potential failure modes of LED lamps may involve a reduction in output, rather than the lamp failing totally. For this reason, the operating life of LED lamps is sometimes stated with respect to the time until the light output has dropped below a certain level, perhaps 70% or 50% of its original output. This is designated by L70 or L50 in the data sheet.

The operating life of an LED chip itself is dependant upon temperature, which is directly related to the current passing through the diode. Of course, you can get higher light output by driving more current through the diode, but the resulting increase in temperature is at the expense of operating life. Operating life is normally quoted on the assumption that the temperature at the junction inside the LED is 25°C, but this situation may not be maintained in real-world conditions. An LED chip may have a life of 100,000 hours at this temperature but in a poorly designed lamp the temperature could reach 150°C causing the lamp to fail much earlier. The final location of the lamp, particularly with respect to available ventilation, will therefore affect its operating life. The life of drive circuits is similarly dependent upon temperature. Thermal efficiency is therefore a vitally important factor in the design of LED housings, to ensure that heat is effectively dissipated away from the drive circuit and LED itself. This is one of the reasons why lamps of different types, but that utilize the same LED and driver technology, may have widely differing life expectancy. For example, it may not be as easy to cool a GU10 lamp as it is to cool an E27 replacement for a conventional incandescent bulb simply because the latter has a larger surface area from which heat can be dissipated.

Claims of operating life can be exaggerated. As with luminous efficacy, companies with brand reputations to protect will usually quote conservative figures. Those companies trying to grab an early market share, but with less to lose in terms of brand reputation, have already shown themselves to be somewhat optimistic in their predictions of operating life, and rather less than forthcoming with the relevant component data, or accelerated life test data, to support such claims.

Specifications for directional lamps may contain two additional pieces of data. The first is beam angle, which usually ranges from about 25° to 50°. The second is light (or luminous) intensity. This is a measure of the wavelength-weighted power emitted by a light source in a particular direction per unit angle. It is specified in candelas. There is a mathematical definition of a candela but it approximately equates to the light output of a typical candle. Put simply, the light intensity figure takes into account both the luminous flux of a lamp and its beam angle. Creating a direction lighting solution is always a challenge, particularly with respect to avoiding leakage of light. The goal is to ensure that maximum light is emitted within the desired cone.

Summary

A few major players have dominated the traditional lighting market in recent years. The transition to solid-state lighting in the form of LED lamps is creating business opportunities for other materials and electronics companies to enter the sector, particularly some of the major Japanese corporations. It is also creating a frenzy of activity from smaller, low cost producers, some of which are prone to exaggerated claims of efficacy and reliability of their products. Buyers of LED lamps need to understand the underlying factors that affect the efficacy and reliability of these products in order to select the most appropriate products for their applications. Reputable suppliers will make available data that supports their product specifications. Furthermore, companies with reputable brands at stake are far less likely to make performance claims that are not sustainable. With so many smaller, anonymous companies entering this high growth market, the advice “caveat emptor” has rarely been more appropriate. However, high quality LED lighting has the potential to add real value to people’s lives whilst contributing to the world’s urgent need to reduce our energy consumption.

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