

Fluorescent Tubes and Compact Fluorescent Bulbs

Description

Fluorescent lamp is a gas-discharge lamp that uses electricity to excite mercury vapor in argon or neon gas, resulting in plasma that produces short-wave ultraviolet light. This light then causes a phosphor to fluoresce, producing visible light.

Unlike incandescent lamps, fluorescent lamps always require a ballast to regulate the flow of power through the lamp. In common tube fixtures (typically 4 ft (120 cm) or 8 ft (240 cm) in length), the ballast is enclosed in the fixture.

Compact fluorescent light (CFL) have ballasts integrated in the bulbs, allowing them to be used in lampholders normally used for incandescent lamps. The general principle of working remains the same as in fluorescent tubes, and the surface area of phosphor is increased by creating coils or u bends, thus increasing the amount of visible light produced by these comparatively smaller sized bulbs. CFLs that flicker when they start have magnetic ballasts; CFLs with electronic ballasts are now much more common.

PERFORMANCE

Appearance

Fluorescent tubes are found in various sizes and types, typically four and eight-foot long lamps with varying diameters. They require separate ballasts independent of the bulb. Most times they are bulky which seems to be cause of concern for most designers. They have different ends, on the pins, at either end of the long tube, so they cannot be used in the wrong fixtures.

As the name suggests Compact Fluorescent bulbs are generally smaller in size than the regular fluorescent lamps, they are made in special shapes to fit in standard household light sockets, like table lamps and ceiling fixtures. In addition, most compact fluorescent lamps have an “integral” ballast that is built into the light bulb.

Both types offer energy-efficient light.

Efficiency

For a given light output, CFLs use between one-fifth and one-quarter of the power of an equivalent incandescent lamp, thereby saving significant amounts of energy in use. They last about 10,000 hours—almost 9,000 hours longer than a standard incandescent.

Although a direct and exact comparison cannot be made between the lumens produced to the number of watts of electricity consumed of incandescent bulbs and CFL's. It is clearly seen that CFL's outperform their counterparts.

e.g. A 15W CFL producing 900 lumens, can be used as a replacement for a 60W incandescent bulb producing about 700 lumens or a 75W bulb producing 930 lumens.

In a similar way a 23W CFL producing about 1500 lumens can be used to replace a 100W incandescent bulb that produces only 1330 lumens. Compact fluorescent lamps may provide as little as 50-80% of their rated light output at initial switch on and can take up to three minutes to warm up, and

color cast may be slightly different immediately after being turned on. This compares to around 0.1 seconds for incandescent lamps and around 0.01 seconds for LED lamps. Studies are on to quantify the loss of lumens produced by the fluorescent lamps over its lifetime, although its figures may not be alarmingly high, efforts are on to increase their efficiency.

Illuminance

Colour Rendition Index

A phosphor emits light in a narrow frequency range, unlike an incandescent filament, which emits the full spectrum, though not all colors equally, of visible light. Mono-phosphor lamps emit poor quality light; colors look bad and inaccurate. The solution is to mix different phosphors, each emitting a different range of light. Properly mixed, a good approximation of daylight or incandescent light can be reached. However, every extra phosphor added to the coating mix causes a loss of efficiency and increased cost. Good-quality consumer CFLs use three or four phosphors—typically emitting light in the red, green and blue spectra—to achieve a "white" light with color rendering indexes (CRI) of around 80 although CFLs with a CRI as great as 96 have been developed.

Luminous efficiency or Luminous efficacy

- Fluorescent lamps have about 7%-15% efficiency
- 5W-24W compact fluorescent bulbs have a luminous efficacy between 45-60 that relates to about 6.6%-8.8% luminous efficiency.
- A 34W fluorescent tube (T12) bulb has a luminous efficacy of 50 that relates to 7% luminous efficiency.
- A 32W fluorescent tube (T8) bulb has a luminous efficacy of 60 that relates to 9% luminous efficiency.
- A 36W fluorescent tube (T8) bulb has a luminous efficacy of up to 93 that relates to up to 14% luminous efficiency.
- A 28W fluorescent tube (T5) bulb has a luminous efficacy of 104 that relates to 15.2% luminous efficiency.

Durability

Modern CFL's typically have a life span of between 6,000 and 15,000 hours, whereas incandescent lamps are usually manufactured to have a life span of 750 hours or 1000 hours. The lifetime of any lamp depends on many factors including manufacturing defects, exposure to voltage spikes, mechanical shock, frequency of cycling on and off and ambient operating temperature, among other factors. The life of a CFL lamp is significantly shorter if it is only turned on for a few minutes at a time: 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. CFL lamps give less light later in their life than they did at the start. The light output depreciation is exponential; with the fastest losses being soon after the lamp was new. By the middle to end of their lives, CFL's can be expected to produce 70% to 80% of their original light output. A 20% to 30% reduction over many thousands of hours represents a change, which is barely noticeable in everyday life.

Sustainability (environmental impacts)

The actual environmental effect of CFLs is the subject of much debate. Apart from the gross electrical power saved during operation, it is questioned whether the amount of power and raw materials used in their manufacture compares well with incandescent lamps, and also whether the mercury used in CFLs is a significant environmental hazard. CFLs, like all fluorescent lamps (e.g., long tubular lamps common in offices and kitchens), contain small amounts of mercury and it is a concern for landfills and waste incinerators where the mercury from lamps may be released and contribute to air and water pollution.

But, it's been since seen that, while CFL's require more energy in manufacturing than incandescent lamps, this is offset by the fact that they last longer and use less power to supply the same amount of light as an incandescent lamp of the same lumen rating, they can be used to decrease energy consumption at the location they are used in. In countries where electricity is largely produced from burning fossil fuels, the savings reduces emissions of greenhouse gases and other pollutants; in other countries the reduction may help reduce negative impacts from radioactive waste, hydroelectric plants, or other sources. Studies by the US Environmental Protection Agency (EPA) show that mercury emissions by an incandescent bulb, that uses electricity generated by a coal power plant is significantly higher than in a fluorescent bulb, combining the use of mercury in the manufacture and during the running of the bulbs using electricity generated by a coal power plant, when evaluated over a five-year life.

US Environmental Protection Agency (EPA) has done studies on the mercury emissions by light sources evaluated over a five-year life. It shows that Incandescent bulbs generate up to 10.0 mg of mercury when it uses electricity generated from a coal power plant. While a fluorescent lamp generates only about 6.4 mg of mercury while using the same power source, that includes about 4.0 – 5.0 mg of mercury that goes into the manufacturing process.

Mercury is an essential, irreplaceable element in CFL's and is what allows the bulb to be an efficient light source with no current substitute. However, manufacturers have taken significant steps to reduce mercury used in their fluorescent lighting products over the past decade.

Availability and Cost

With the recent awareness of the efficiency an increasing number of companies are producing fluorescent tubes and CFL's that could be easily adaptable to the fixtures already in use. Although the purchase price of a CFL is typically 3 to 10 times greater than that of an equivalent incandescent lamp, the extended lifetime and lower energy use will compensate for the higher initial cost in many applications. In addition to the savings on energy costs, CFL's average life is between 8 and 15 times that of incandescent bulbs.

Applicability

Fluorescent light in particular has replaced many applications of the incandescent lamp with its superior life and energy efficiency. The concerns of some people who find the colour spectrum produced by some fluorescent lamps to be harsh and displeasing has been negated by manufacturing CFL's that have a high Colour rendering index and so the use of CFL's has been accepted even in places where high quality light is required, example in showrooms etc. The use of CFL's is wide spread in office buildings and in air-conditioned spaces because it reduces the cooling loads drastically, unlike incandescent lights that generate unnecessary heat.

CFLs that are not designed for outdoor use may perform poorly in cold weather; CFLs are available with cold-weather ballasts, which may be rated to as low as -23 degrees Celsius (-10 F). Standard compact fluorescents may fail to operate at low temperatures.

Manufacturers

Philips, Osram, Bajaj