

High Pressure Sodium Lamps

A Pacific Energy Center Factsheet

Introduction

High pressure sodium (HPS) lamps, a member of the high intensity discharge (HID) lamp family, are the most efficient white light source commercially available today. HPS lamps were developed and introduced in 1968 as energy-efficient sources for exterior, security, and industrial lighting applications, and are particularly prevalent in street lighting applications. Due to their high efficiency and long life, today's HPS lamps are also suitable for many interior applications, particularly where color rendering is not a crucial concern.

Basic Operation

In a high pressure sodium lamp, a compact arc tube contains a mixture of xenon, sodium and mercury. The xenon gas which is easily ionized, facilitates striking the arc when voltage is applied across the electrodes. The heat generated by the arc then vaporizes the mercury and sodium. The mercury vapor raises the gas pressure and operating voltage, and the sodium vapor produces light when the pressure within the arc tube is sufficient. High pressure sodium lamps are the most efficient artificial white light source with about 29% of the energy used by the lamp producing light.

Components

- ?? The arc tube contains the xenon and sodium-mercury amalgam mixture and provides the proper environment for producing light.
- ?? The electrodes, which are made of tungsten, carry a high-voltage, high-frequency pulse to strike the arc and vaporize the mercury and sodium.
- ?? The base of the lamp provides a means of electrical connection.
- ?? The outer bulb shields the arc tube from drafts and changes in temperature, prevents oxidation of the internal parts, and acts as a filter for most of the UV radiation generated by the mercury vapor.
- ?? Some lamps have a phosphor coating on the inner surface of the outer bulb to diffuse the light.

Ballasts

HPS lamps require ballasts to regulate the arc current flow and deliver the proper voltage to the arc. HPS lamps do not contain starting electrodes. Instead, an electronic starting circuit within the ballast generates a high-voltage pulse to the operating electrodes. American National Standards Institute (ANSI) lamp-ballast system standards establish parameters for all HPS components, except for newly introduced products.

Operating Characteristics

The operating characteristics of fluorescent lamps are summarized below.

Efficacy	40-140 lpw
Color Temperature	1900-2800 K
CRI	20-80
Depreciation	10-15%
Life (10 hrs/start)	10,000 - 24,000 hrs

Striking, Warm-Up, and Re-Strike

It is not possible to instantly ignite a cold HPS lamp to full brilliance. As power is applied, temperature and pressure build gradually, causing metal vapors to enter into the arc and release light energy. Starting the arc sometimes takes a few seconds, and the warm-up period is generally about four minutes. During this time, the lamp exhibits different colors as more sodium vapor, enters the arc stream.

If power is interrupted, even briefly, an HPS lamp's arc will extinguish. The lamp must cool down before the arc can restrike with restrike periods lasting from one to two minutes, depending on lamp type. This is a major concern in applications where prolonged lighting interruption could create hazardous conditions or a manufacturing shutdown.

For situations where continuous lighting is required, HPS lamps can be obtained with two arc tubes. These so-called "standby" lamps provide rapid restrike cycles while offering extended lamp life. It should be noted that lamp warm-up time will still be in effect in the event of a power interruption; however, the lamp will not have to cool down before the second arc can be struck. These lamps are especially applicable for roadway and parking lot applications. In normal operation, standby lamps alternate operation between the arc tubes. This may, in effect, double lamp life, although lamp life of these products has not been fully tested, and manufacturers' published lamp life values do not, as yet, reflect an increase for double arc tube lamps.

Alternatively, HPS luminaires are available that contain supplementary high-output quartz backup lamps. In the event of a brief power interruption, the backup lamps ignite until the HPS lamp can restrike. The relative infrequency of power interruptions, as well as increased cost, make the use of instant restrike products relatively uncommon.

Note that, due to the HPS ballast's electronic starting circuit, warm-up and restrike periods are much shorter than those of metal halide lamps.

Dimming

Some HPS lamps are dimmable using specialized ballasts and dimming electronics. Operating HPS lamps at less than full output, however, produces color shift, changes in CRI, and reduced lamp efficacy. Dimming is limited to about 50% of full light output.

High Pressure Sodium Applications

HPS lamps, unlike most metal halides, do not require enclosure except to prevent moisture from accumulating on the lamp. This makes HPS lamps especially easy to use in many fixture types. Moreover, the virtual insensitivity of HPS lamps to burning position means that fewer lamp types are needed as compared to metal halide.

Lamp color temperature in HPS lamps does not vary much. While the "deluxe" HPS lamp has a relatively high CRI (65) for HPS technology, its color temperature of 2100-2200 K is not much different from standard HPS, which varies between 1900 K and 2100 K. All HPS lamps except "white" sodium appear a golden-pink color, and are not recommended for non-industrial interior lighting.

HPS lamps are offered in sizes ranging from 35 to 1000 watts. Efficacies are between 70 to 120 lumens/watt (including ballast), increasing with wattage. Electronic ballasts, said to be under development, could provide a small increase in system efficacy.

PAR and R-configured HPS lamps

PAR and R-configured HPS lamps are useful for compact directional light sources, such as track lighting and outdoor lighting luminaires. The poor color rendition of these lamps, however, limits the usefulness to specific industrial and security floodlighting and general lighting

Double-ended HPS lamps

The double-ended HPS lamp was designed to take advantage of luminaires and lighting installations originally designed for the double-ended metal halide lamp. The double-ended HPS lamp offers comparable lumen output, as well as HPS' longer lamp life and excellent lumen maintenance characteristics. These lamps, however, are relatively uncommon at this time.

White sodium lamps

White HPS lamps use ballast designs with electronic circuits that increase system color temperature and CRI, making them suitable for many interior spaces. The color temperature of white sodium lamps, at 2600 K to 2800 K, closely resembles incandescent lighting. During the lamp's stable color-life, the color performance is more consistent and appealing than most metal halide lamps (including 3000 K lamps). Although efficacy is a relatively low 35-45 lumens per watt, the white sodium lamp is in many ways the best (if not the only) high-efficacy substitute for incandescent lamps. Note that white sodium lamps are incompatible from manufacturer to manufacturer.

For More Information

Contact your PG&E representative or call 1-800-468-4743 for more information about PG&E's energy efficiency programs and other services.

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