

Metal Halide Lamps

A Pacific Energy Center Factsheet



Introduction

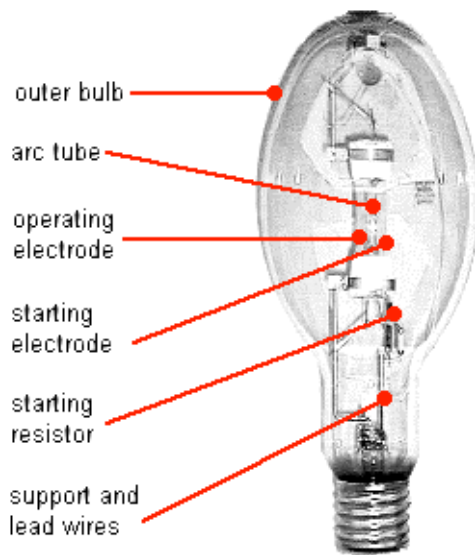
Metal halide lamps, a member of the high intensity discharge (HID) family, produce high light output relative to their size, making them a compact and powerful light source. Originally developed in 1965 for exterior and industrial lighting, metal halide technology today includes lamps suitable for nearly any lighting application. Wattages range from 32 to 1500 watts, and a large number of envelope and base configurations are available. Because metal halide lamps are very bright point source, they require luminaires with good optical control.

Basic Operation

Like fluorescent and high pressure sodium lamps, metal halide lamps produce light by passing an electric arc through a mixture of gases and require ballasts to provide proper starting and operating voltages. In a metal halide lamp, a compact arc tube contains a high-pressure mixture of argon, mercury, and a variety of metal halides. The argon 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 metal halides. These metal vapors produce light as the pressure and temperature within the arc tube rises, with the light's color properties depending on the specific mix of metal halides.

About 24% of the energy used by a metal halide lamp produces light, making them generally more efficacious than fluorescent lamps. Some metal halide products provide enhanced color rendering properties, but with some reduction in efficacy. Depending on the lamp wattage and color rendering properties, metal halide lamps can be less efficacious than some fluorescent lamp systems.

Components



- The arc tube contains a mixture of argon, mercury, and metal halides and provides the proper environment for producing light.
- The electrodes, with proper voltage applied, strike an arc and vaporize the elements in the arc tube.
- 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 outer bulb's inner surface to diffuse the light.

Ballasts and Starters

Metal halide lamps require ballasts to regulate the arc current flow and to deliver the proper voltage to the arc. Larger ("standard") metal halide lamps employ a starting electrode within the lamp to initiate the arc. Smaller metal halide lamps, on the other hand, do not contain starting electrodes. Instead, an electronic starting circuit in the ballast generates a high-voltage pulse to the operating electrodes. American National Standards Institute (ANSI) lamp-ballast system standards establish parameters for all metal halide components, except for newly introduced products.

A few electronic ballasts are now available for metal halide lamps. The primary benefit of these ballasts is more precise management of the lamp's wattage, which provides more consistent color and longer lamp life. With few exceptions, high-frequency operation does not increase lamp efficacy, as is the case with fluorescent lamps.

Operating Characteristics

Operating characteristics of metal halide lamps are presented below.

Efficacy	65 - 110 lpw
Color Temperature	3200 - 5000K
CRI	60 - 80
Depreciation	10 - 30%
Life (10 hrs/start)	5,000 - 20,000 hrs

Color

Some metal halide lamps have very good color characteristics, while some have less desirable color temperatures and lower CRIs. Perhaps the most significant point to keep in mind is that, due to tolerances in the manufacturing process, color temperature can vary from lamp to lamp, and the color properties of metal halide lamps cannot be predicted with 100% accuracy. Moreover, both the color temperature and color rendering index will vary over the life of the lamp due to changes in operating conditions provided by the ballasts.

Striking and Warm-Up

A cold metal halide lamp cannot immediately produce full light output, because as power is applied, temperature and pressure build gradually, causing the metal vapors to enter the arc and begin producing light. Starting the arc sometimes takes a few seconds, and the warm-up period is about five minutes, depending on the lamp type. During this time, the lamp exhibits different colors as the various metals vaporize.

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

A few metal halide products are made with "instant restrike" capability, requiring special outboard electronics to generate extremely high voltages that overcome the elevated lamp temperature and pressure and regenerate the arc. (See Instant Restrike Metal Halide Lamps, below.) Alternatively, metal halide 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 metal halide lamp can restrike. The relative infrequency of power interruptions, as well as increased cost, make the use of instant restrike products relatively uncommon.

Burning Orientation

Most metal halide lamps are designed to operate in a specific burning position, such as horizontal, vertical with base up, or vertical with base down. Operating metal halide lamps in burning positions other than those recommended by the manufacturer will adversely affect lamp life and lumen output. Many manufacturers also produce "universal position" lamps (see below), which are relatively insensitive to burning position.

Dimming

Dimming metal halide lamps requires specialized ballasts and dimming electronics. Operating metal halide lamps at less than full output, however, produces color shift and reduced lamp efficacy. For example, a metal halide lamp can be dimmed to about 40% power, but at this level it generates only about 25% of its rated lumens, and changes color in an undesirable manner.

Temperature Sensitivity

Metal halide lamps are sensitive to low starting temperatures, and lamp life will be reduced if they are frequently started below -12°C (10°F).

Types of Metal Halide Lamps

Current metal halide product offerings include a wide range of sizes (32-1500 watts), base types, and specialty lamps. A few of the more significant lamps types are described below.

Vertical Position Screw Base Metal Halide Lamps

The vertical burning metal halide lamp is optimized for base-up, base-down, or base-up/base-down operation, primarily for use in downlights. In addition to standard clear (4000-4500 K) and coated (3700-4000 K) lamps, warm color (2700-3200 K) clear and coated lamps are available in various wattages. The newest products tend to be lower wattages with medium bases and smaller envelopes. One product, the 32-watt lamp, is designed specifically for operation on an electronic ballast. A principal advantage of vertical burning lamps is their high efficacy -- about 70-110 lumens per watt. However, operation in any other position will reduce both lamp life and lumen output.

Horizontal Position Screw Base Metal Halide Lamps

Horizontal high output or "super" lamps often have bowed arc tubes, and use a position-fixing pin in the base, called a prefocus or position-orienting mogul (POM) base. This base and matching socket assure correct positioning of the lamp. Since these lamps are primarily used in outdoor lighting, the smallest wattage product available is 175 watts. Special versions have been developed for signs and sports lighting. The most popular metal halide lamp colors are offered (3200 K coated, 3700 K coated, and 4100 K clear). As for vertical lamps, output is 70-110 lumens per watt.

Universal Position Screw Base Metal Halide Lamps

In addition to vertical and horizontal position products, metal halide lamps are also available that can be used in any operating position. These "universal" position lamps are the most easily used; however, they produce about 10% less light output than the position-specific lamps, and fewer color options are available. Moreover, they perform best when the arc tube is in a vertical position, with longer life and higher lumen output than when the arc tube is off vertical by more than 15 degrees.

Lamp color choice with universal metal halide lamps is generally limited to standard clear (4000-4500 K, 65 CRI) or coated (3700-4000 K, 70 CRI). Recent improvements include the addition of more wattages, as well as the development of medium-based compact lamps. These lamps operate on ANSI standard ballasts and generate 65-100 lumens per watt.

A few of these lamps are available with silver bowl arc-tube shields. These bowls act similarly to the familiar incandescent silver bowl lamps, by blocking unreflected arc tube radiation from the front hemisphere of the lamp.

Horizontal Position Double-Ended Metal Halide Lamps

Double-ended metal halide lamps in compact packages, were originally introduced in Europe and have been very successful there. Some manufacturers produce these lamps with rare earth metals, resulting in lamps with very high CRIs of 80 or more, while others make the lamps with the more conventional 65-70 CRI associated with metal halide technology. The lamps with lower CRIs may be less sensitive to American power supply variations than the higher CRI lamps. Double-ended lamps must be operated with the arc tube within 45 degrees of horizontal, end-to-end. These lamps operate in the range of 65-95 lumens per watt, and the 70-watt lamp with electronic ballast achieves about 75 lumens per watt - over 10% more than with magnetically-ballasted operation. In addition, the 70-watt lamp operated on the electronic ballast virtually assures consistent light color and lamp life. Moreover, the reduced ballast package lends itself to smaller luminaires, especially track lighting equipment.

Open Fixture Rated Metal Halide Lamps

Most metal halide lamps require enclosed luminaires to protect people and property from lamp rupture. Although rare, there are documented cases of metal halide lamps exploding. In most instances, this has occurred with near end-of-life lamps that have been continuously operated without having been switched off.

A few metal halide lamps are listed for non-enclosed use. These lamps typically employ an inner glass shield that can contain a violent failure within the combination of the inner shield and the normal bulb envelope. This technology is especially important where many

downlights in high ceilings are relamped using extension poles, and the cover glass required for most metal halide lamps hampers this operation.

Most open fixture lamps are designed for universal or vertical burning. There is a slight reduction in lumen output as compared to standard vertical burning lamps.

Instant Restrike Metal Halide Lamps

Even a momentary fluctuation of input power can cause a 10-15 minute interruption in metal halide lamp light output. For applications where such a possibility is intolerable (such as lighting for televised professional sports), instant restrike metal halide lamps are an appropriate choice.

By building the lamp, ballast, and socket to withstand extremely high voltages (up to 30,000 volts), metal halide lamps can be reignited "hot," returning to full light output in seconds. Designed for the larger envelopes and wattages, instant restrike lamps utilize a separate anode wire that can carry the 30,000 volt re-ignition pulse without failing.

Universal Position Directional Metal Halide Lamps

These familiar R- and PAR-shaped lamps provide metal halide efficiency in a compact enclosure with its own reflector. Only in the last few years have these lamps become available in lower wattages. Now, metal halide directional lamps can be used in many applications previously limited to low-efficacy incandescent or mercury vapor lamps.

Metal halide PAR-38 lamps are especially important because they can be operated without a protective cover glass. This permits their use in track lights, landscape lights, and other similar applications. The lack of a cover glass also makes relamping and maintenance easier.

The metal halide R- lamps require a cover glass, but provide a reasonable-cost alternative for situations such as landscape lighting. The larger metal halide PAR-56 and PAR-64 lamps also require a cover glass, but offer relatively compact sources of high-intensity, energy-efficient light. These could be particularly effective when used in recessed, track, and surface-mounted general and highlighting applications.

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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