PTI Technical Note

Technical Information on Lamps

Compact Arc Lamps

High pressure gas discharge lamps having an arc length which is small compared with the size of the electrodes are called short arc or compact arc lamps. Depending on rated wattage and intended application, the arc length of these lamps may vary from about a third of a millimeter to about a centimeter. These lamps have the highest luminance and radiance of any continuously operating light source and are the closest approach to a true "point" source.

The envelope is made from optically clear quartz material of various grades and has a spherical or ellipsoidal shape. The grade of the quartz will determine the amount of ozone generated. The most widely used material for the electrodes is tungsten.

Most compact arc lamps are designed for DC operation. This results in better arc stability and substantially longer life. DC systems consist of an igniter and a regulated power supply. High voltage pulses (up to 50,000 volts) break down the gap between the electrodes, ionize the gas and heat the cathode tip to thermionic emitting temperatures.

Note that higher wattage lamps do not necessarily yield more light intensity. When higher illumination intensity is needed, lamps must be selected with greater brightness, and this does not always increase with lamp wattage.

Xenon Lamps

Xenon compact arc lamps are filled with several atmospheres of xenon gas. They reach 80% of final output within 10 minutes or less of starting. The arc color is very close to daylight (6000 deg. K). The spectrum is continuous in the visible range and extends far into the ultraviolet. A Xenon lamp exhibits strong lines in the near infrared between 800 and 1000 nm and some weak lines in the blue portion of the spectrum.

Xenon compact arc lamps are made with rated wattages from 75 to 30,000 watts and are available for operation in either a vertical or horizontal position. The breakdown voltage between the electrodes will run from 10kv for a small lamp up to 60kv or more for lamps rated 30kw.

The luminous efficacy of Xenon compact arc lamps is approx. 30 lumens per watt at 1000 watts, 45 lumens per watt at 5000 watts, and over 150 lumens per watt at 20kw.

Mercury-Xenon Lamps

A Mercury-Xenon lamp contains a specific amount of mercury and a small amount of xenon added at a pressure exceeding one atmosphere. The xenon is necessary to facilitate starting and to sustain the arc until the mercury is fully vaporized; it also reduces the warm-up period. Normal warm-up time is 10-15 minutes.

Mercury lamps are sensitive to cooling because the bulb temperature determines the vapor pressure. The lamp can be over-cooled to the point that full output in the mercury spectrum is never achieved. The cooling water should be ordinary tap water. Chilled water may decrease the operating voltage and interfere with the proper evaporation of mercury. In some cases, the mercury may not evaporate at all, causing unsuitable performance and shortened lamp life.

Typical steady state voltage of a Mercury-Xenon lamp is higher than that of a xenon lamp. The output in the visible range consists mainly of four mercury lines and some continuum, due to the high operating pressure. A properly warmed lamp will show no significant trace of the xenon gas spectrum.
Mercury-Xenon lamps are available in wattages from 200 to 7000 watts. The luminous efficacy is approximately 50 lumens per watt at 1000 watts and about 55 lumens per watt at 5000 watts.

PTI Technical Note

Technical Information on Lamps

Tungsten Lamps

Technical lamps consist of a coiled tungsten filament mounted in a precision glass envelope. The envelope may have a vacuum or, more commonly, be filled with an inert gas such as argon or krypton. Typical technical lamp operating parameters are 2.5 to 12 volts and .02 to 1 amp. Color temperature ranges from 2,200 to 3,000 degrees Kelvin; lamp life may be as high as 30,000 hours.

Tungsten-Halogen lamps feature a tungsten coil filament mounted in a quartz glass envelope that has been filled with an inert gas plus a trace of halogen (normally bromine). This gas creates the "halogen cycle": tungsten that has evaporated from the filament combines with the halogen gas. Convection currents within the bulb carry this gas to the quartz wall where it is cooled and then returned to the proximity of the filament.

The heat of the filament causes the tungsten and bromine to separate, and the tungsten is then deposited on the cold portion of the filament. This regenerative process prolongs the life of the filament considerably, and also eliminates blackening of the bulb by preventing the evaporated tungsten from condensing on the envelope. The Halogen lamp color temperature runs from 2900 to 3400 deg. Kelvin and are available in wattages from 10 to 250 at operating voltages from 6 to 24; lamp life ranges from 10 to 2500 hours. Luminous efficiency is approximately 22 lumens per watt.

Tungsten-Halogen lamps must be operated at voltages that maintain an envelope temperature between 250 and 350 deg. C. Cooler temperatures will not allow the halogen cycle to take place, thus causing bulb blackening and shorter life; higher temperatures will cause oxidation of the conductors and lead to premature lamp failure.

Lamp Handling

WARNING: Compact arc lamps contain highly pressurized gas, and present an explosion hazard even when cold. Wear face protection, such as a welder's helmet, whenever handling lamps.

Special storage cases are provided to eliminate possible hazards during shipping and handling. Safety goggles and soft cotton gloves should be worn when removing and installing lamps. Never touch the quartz envelope with bare hands; such handling may lead to deterioration and premature failure. If accidentally handled, clean the lamp surface with an alcohol swab to remove any residue.

WARNING: Never look directly at an operating arc lamp; severe eye injury will result. Wear U.V. protective lenses, such as a welder's helmet, when working around operating arc lamps.

Polarization

Some lamps can only be mounted one way in the PowerArc housing since the anode (+) and cathode (-) have different diameters, thus making accidental polarization reversal nearly impossible. However, some lamps have the same diameter anode and cathode, allowing room for error. Refer to the lamp manufacturer's data sheet for proper identification of the anode and cathode.

Note that reversed polarization will result in immediate and permanent damage to the lamp electrodes. A lamp that has been fired with reversed polarization will have obvious physical damage to the electrodes. A damaged lamp will fire, but it will exhibit unstable performance and a severely shortened operating life.

PTI Technical Note

Technical Information on Lamps

Lamp Stability

Short term stability is measured over seconds, while long term stability is measured over minutes, hours, or even days.

Short term stability is affected by arc "wander," "flare" and "flutter." Arc wander is the movement of the attachment point of the arc on the cathode surface. Typically the arc moves around the conical cathode tip in a circular fashion, taking several seconds to move a full circle. Arc flare refers to the momentary change in brightness as the arc moves to an area on the cathode having a preferential emissive quality over the previous attachment point. Arc flutter is the rapid side-to-side displacement of the arc column as it is buffetted by convection currents in the xenon gas which are caused as the gas is heated by the arc and cooled by the envelope walls.

Arc wander and flare can be reduced by a slight decrease in the operating current. For example, a 75 watt xenon lamp rated at 5.4 amps may be operated at 4.5 amps for the first one or two minutes of operation, after which the current should be brought up to the specified normal operating level.

Lamp Life

The useful life of compact arc lamps is determined primarily by the decrease of luminous flux caused by the deposit of evaporated electrode material on the inner wall of the envelope. Frequent ignition accelerates electrode wear and hastens the blackening of the envelope. Average lamp life is based on approximately 20 minutes of operation for each ignition. The end of the lamp life is the point at which the UV output has decreased by approximately 25%, the arc instability has increased beyond 10%, or the lamp has ceased to operate under specified conditions. Lamps should be replaced when the average lamp life has been exceeded by 25%.

As the lamp ages, the operating voltage will increase. Lamp current should be decreased to maintain output until the minimum operating current is reached. At this time the lamp should be replaced.

Lamp life varies with different types. Check the manufacturer's specifications for the rated lamp life.

Photon Technology International

USA: Photon Technology International, Inc., 300 Birmingham Road, PO Box 272 Birmingham, NJ 08011
Tel: 609-894-4420, Fax: 609-894-1579, E-mail: marketing@pti-nj.com, www.pti-nj.com

Canada: Photon Technology International, Inc., 347 Consortium Court, London, Ontario, N6E 2S8
Tel: 519-668-6920, Fax: 519-668-8437, E-mail: sales@pti-can.com

UK: Photon Technology International, Inc., Unit M1 Rudford Industrial Estate, Ford Road, Ford, West Sussex BN180BF
Tel: +44 (0) 1903 719555, Fax: +44 (0) 1903 725722. E-mail: sales@pti-uk.co.uk

Germany: PhotoMed GmbH, Inninger Str. 1, 82229 Seefeld, Germany,
Tel: +49 (0) 81 5299 3090, Fax: +49 (0) 81 5299 3098, E-mail: sales@photomed.com