Setting Standards for Excellence

Alternatives to Mercury-containing Light Sources

January 2008

Mercury is an essential ingredient for most energy-efficient lamps. Fluorescent lamps and high intensity discharge (HID) lamps are the two most common types of lamps that utilize mercury. Fluorescent lamps provide lighting for most schools, office buildings, and stores. HID lamps, which include mercury-vapor, metal halide, and high-pressure sodium lamps, are used for streetlights, floodlights, and entertainment, sports and industrial lighting. Mercury-containing lamps also are used for medical treatment, semiconductor, integrated circuit board and other industrial production, and water and air purification.

With a few exceptions, mercury-free electric lamps are not direct substitutes for mercury containing lamps due to incompatibilities in light output, shape, color, life, physical fit, and electrical characteristics, or because their increased energy consumption may violate building energy codes.

Fluorescent Lamps

Despite continued efforts by the private sector, government research laboratories, and academia, researchers have yet to develop a viable replacement for mercury used in general purpose fluorescent lamps. Mercury-free, xenon-based fluorescent discharge sources are available in flat panel and tubular formats, suitable for specialty applications; however, since xenon discharge is only 30% as efficient as mercury-based fluorescent technology, it is environmentally impractical for general lighting applications.

High Intensity Discharge (HID) Lamps [1]

Mercury-free metal halide lamps have been under development for several years and are of particular interest to automotive manufacturers. These lamps will not likely become available as “screw-in” replacements for existing types. Maintaining a stable discharge is challenging and widely available, mercury-free metal halide products for general use are still a number of years away.

The high-pressure sulfur lamp is fundamentally mercury-free, but is unstable and requires forced cooling. Lamps that have reached the market to date are high wattage ($\geq$1 kilowatt), and require coupling to a lighting distribution system such as a light pipe. Overall system efficacy is lower than an equivalent fluorescent or HID system, especially if filters are used to correct the greenish color.

Low Pressure Sodium Lamps

This mercury-free light source is characterized by its orange appearance and very poor color properties. Although very efficient in photometric terms, its visual efficiency in typical outdoor (street lighting)

1. High Intensity Discharge (HID) Lamps are used in street lighting, floodlighting, industrial and some commercial applications

applications is below that of other lamps. All colors are rendered in shades of brown or gray, making recognition of people and vehicles very difficult. These lamps contain sodium in quantities sufficient to fail tests for reactivity and ignitability.

Light Emitting Diodes (LEDs)

LEDs are the newest generation of mercury-free light sources. They are digitally compatible, which allows the light to be easily controlled. Because of their long life, LED lighting systems are practical for use in applications where maintenance is costly and downtime is critical such as signage, airfield illumination, and safety lighting. They are also popular in display and refrigeration lighting, due to their automatic control capability.

At the present time, the overall light output of LEDs, despite their brightness, is less than fluorescent and HID systems. LEDs are steadily improving, however, and are now an appropriate source for specialty lighting applications such as under-cabinet illumination, decorative, accent, and architectural lighting, where design and color mixing are desirable. As the technology evolves over the next decade, LEDs are expected to become suitable for most general illumination purposes.

.

Incandescent Lamps

Incandescent and tungsten halogen lamps contain no added mercury. High efficiency incandescent lamp technology is under development. Tungsten halogen lamps, while not as efficient as fluorescent, possess infrared coating technology that greatly improves the efficiency of standard incandescent. They are still less efficient than mercury-containing lamps, however, and typically use approximately 4 times the power of a fluorescent lamp for comparable light output. Higher energy usage leads to greater emissions from power generation facilities. Whenever possible, consumers should use dimming controls to manage light output and energy usage of incandescent and halogen lamps.

CONCLUSION

As long as we continue to rely upon fossil fuels for power generation, light sources containing small amounts of mercury for efficient operation will continue to be important in reducing overall mercury emissions. Mercury-free light source alternatives, particularly LEDs, show promise in the future, but their efficiency must be dramatically improved to offset the total mercury burden.

Approved by NEMA Lamp Section, January 2008. Members include Advanced Lighting Technologies, Inc./Venture Lighting, EYE Lighting International of N.A., Inc., Feit Electric Company, Inc., GE Consumer & Industrial Lighting, Halco Lighting Corporation, Light Sources Inc., Litetronics International, Inc., OSRAM SYLVANIA, Panasonic, Philips Lighting, Ruud Lighting Inc, SLi Lighting, Technical Consumer Products, Inc., Ushio America, Inc., Welch Allyn, Inc., and Westinghouse Lighting Corporation