



Energy Efficiency - HID Lighting

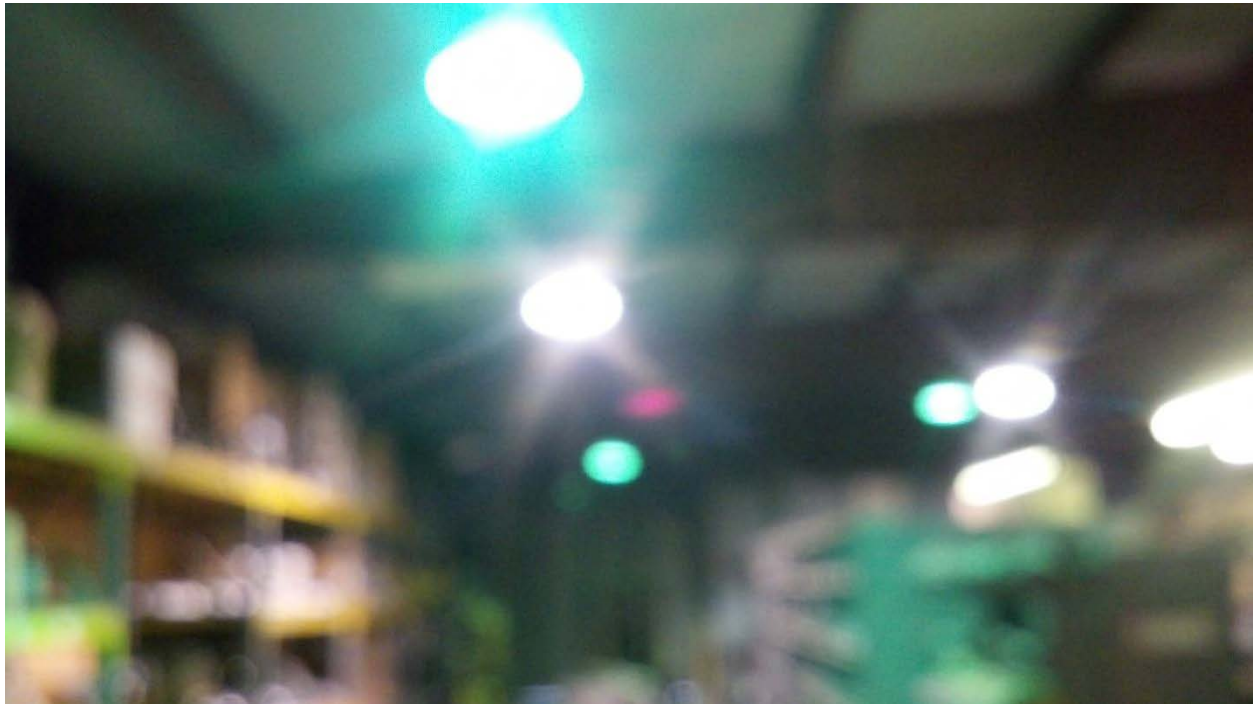
An Online Continuing Education Course for Engineers

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Energy Efficiency – HID Lighting

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Introduction

Gas-discharge lamps are light sources that generate light by sending an electrical discharge through an ionized gas. The character of the gas discharge depends on the pressure of the gas as well as the frequency of the current. High-intensity discharge (HID) lighting provides the highest efficacy and longest service life of any lighting type. It can save 75%-90% of lighting energy when it replaces incandescent lighting.

Figure 1 shows a typical high-intensity discharge lamp. In a high-intensity discharge lamp, electricity arcs between two electrodes, creating an intensely bright light. Usually as gas of mercury, sodium, or metal halide acts as the conductor.

HID lamps use an electric arc to produce intense light. Like fluorescent lamps, they require ballasts. They also take up to 10 minutes to produce light when first turned on because the ballast needs time to establish the electric arc. Because of the intense light they produce at a high efficacy, HID lamps are commonly used for outdoor lighting and in large indoor arenas and they are most suitable for applications in which they stay on for hours at a time.

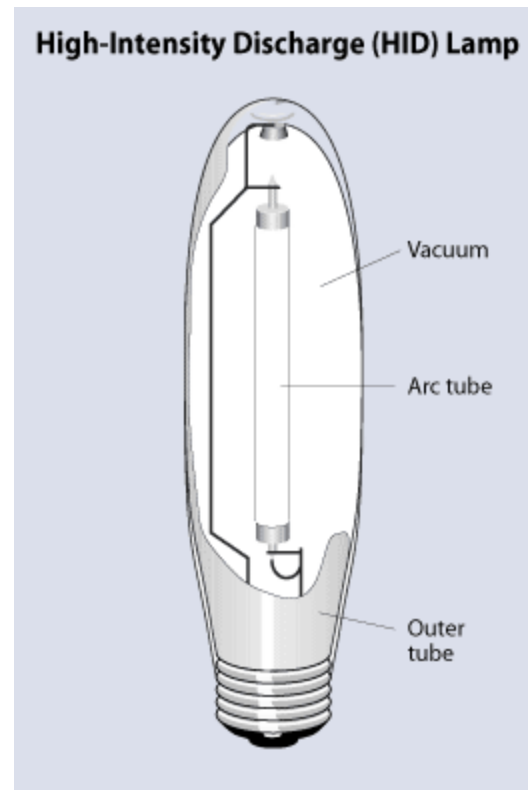


Figure 1

The three most common types of high-intensity discharge lamps are:

- Mercury vapor lamps
- Metal halide lamps
- High-pressure sodium lamps

Mercury vapor lamps are the oldest types of high-intensity discharge lighting and have been used primarily for street lighting. Mercury vapor lamps provide about 65 lumens per watt. They cast a very cool blue/green white light. Mercury vapor lamps have lifetimes of up to 24,000 hours.

Metal halide lamps produce a bright, white light with the best color rendition among high-intensity lighting types. They are used to light large indoor areas, such as gymnasiums and sports

arenas, and outdoor areas, such as car lots. Metal halide lamps are similar in construction and appearance to mercury vapor lamps. The addition of metal halide gases to mercury gas within the lamp results in higher light output, more lumens per watt, and better color rendition than from mercury gas alone. Metal halide lamps have shorter lifetimes than mercury vapor and high-pressure sodium lamps.

High-pressure sodium lighting is the most common type of outdoor lighting. High-pressure sodium lamps have an efficacy of up to 140 lumens per watt—an efficiency exceeded only by low-pressure sodium lamps. They produce a warm white light. Like mercury vapor lamps, high-pressure sodium lamps have poorer color rendition than metal halide lamps but longer lifetimes.

The first mercury vapor lamp was invented in 1901 by American engineer Peter Cooper Hewitt. In 1903, Hewitt created an improved version that possessed higher color qualities which eventually found widespread industrial use. The Hewitt lamps used a large amount of mercury. In the 1930s, improved lamps developed by the General Electric Company and others led to widespread use of mercury vapor lamps for general lighting.

The introduction of the metal vapor lamp, including various metals within the discharge tube, was a later advance. The heat of the gas discharge vaporized some of the metal and the discharge is then produced almost exclusively by the metal vapor. The usual metals are sodium and mercury owing to their visible spectrum emission.

In this course, starting with Chapter One, we will review the overall lighting market to get a sense of how HID lighting is participating in the marketplace. Chapter Two reviews the fundamentals of lighting and Chapter Three covers the basic characteristics of all HID lighting. In addition to the three major types of HID lighting just mentioned, there are variations and these will be discussed in more detail in Chapter Four.

Chapter 1

The Lighting Market



This chapter discusses the size of the U.S. lighting market, recent changes in the market and describes lighting intensities by sector (residential, commercial, industrial, and outdoor lighting).

In 2010, the total energy consumption in the United States was 97.8 quadrillion BTUs (quads) of primary energy. Roughly 40 quads (or 41 percent) of this energy was consumed for electricity use.

For the purposes of this course, the lighting industry is divided into four sections:

1. Residential
2. Commercial
3. Industrial
4. Outdoor Lighting

The total amount of electricity consumed by lighting technologies is estimated to be 700,000 GWh of site energy, or 7.5 quads of primary energy. Thus, lighting accounts for 7 percent of the total energy and 18 percent of the total electricity consumed in the U.S.

The residential sector accounts for the overwhelming majority of installed lamps, at 71 percent of installed base of lighting. However, in terms of electricity consumption, the sector only consumes 175,000 GWh, or 25 percent of the total. Due to the relatively low efficacy of residential light sources (primarily incandescent), the residential sector only accounts for 8 percent of the lumens produced.

The commercial sector is the greatest energy consumer, accounting for half of the total lighting electricity consumption. In addition, the commercial sector represents the sector in which the greatest number of lumens is produced. This is largely due to the longer operating hours found in the commercial sector as compared to the residential sector. Both the industrial and outdoor sectors make up a relatively small portion of the total installed stock of lamps, each approximately two percent. However, the use of high lumen output lamps and high operating

