High-Bay Lighting: New Fluorescent Options on the Rise

High-intensity discharge (HID) light sources, such as metal halide and high-pressure sodium lamps, have long dominated the market for lighting indoor spaces with high ceilings. These high-bay spaces are typically found in warehouses, factories, large retail stores, and athletic facilities. In recent years, however, improvements in fluorescent lamps and the emergence of new high-intensity fluorescent fixtures have made fluorescent lighting the most cost-effective choice for lighting high indoor spaces. These high-intensity fluorescent systems are more energy efficient than HID solutions and feature lower lumen depreciation rates, better dimming options, virtually instant start-up and re-strike, better color rendition, and reduced glare.

The Lamp Choices

HID lamps produce intense light in such a small area that they are considered "point sources." As a result, they are often installed in fixtures that direct their light using parabolic reflectors. Compared with other installations (of the older T12 fluorescent lamps, for example), an HID installation may require fewer individual fixtures, which sometimes allows for lower capital and installation costs. HID lamps are popular in applications that feature large expanses lit by distant fixtures, such as indoor and outdoor sports facilities, factories and warehouses with high ceilings, and street lighting. Although there are several different kinds of HID lamps, the most popular types for indoor applications are metal halide and high-pressure sodium lamps. A key difference between these two is the type of vaporized metal that constitutes the gas within the inner glass vessel of the lamp, through which the electric arc is struck. Of these two types, metal halides—with their high-quality light, high efficacy, and wide range of sizes—are more versatile.

Fluorescent lamps emit diffuse light from long glass tubes. This characteristic of diffusivity has enabled fluorescent fixtures to dominate the market for lighting commercial, institutional, and industrial spaces with ceilings less than 15 feet high. In recent years, however, the emergence of more intense and efficient fluorescent lamps (such as T5s) coupled with specially designed reflecting fixtures has enabled fluorescent systems to break through the ceiling-height barrier and compete directly with HID lamps in indoor applications.

Case Study: New Lighting at Timken Aerospace

In 1999, Timken Aerospace implemented a lighting upgrade project for its 142,000 square foot (ft^2) manufacturing facility in Lebanon, New Hampshire. This facility produces precision ball bearings and requires high-quality lighting in the manufacturing areas, which operate continuously (8,760 hours a year). Timken chose to replace all 543 of the facility's 400-watt metal halide low-bay light fixtures with 2-ft x 4-ft T5 fixtures supplied by MetalOptics. The new fixture draws only 232 watts, compared to 455 watts each for the metal halide fixtures. The project was executed using Timken personnel, cost a total of $268,000, and qualified for a rebate of $91,500 from Timken's utility, Granite State Electric. As a result of this upgrade, Timken Aerospace has reduced its demand by 120 kilowatts, and is saving more than a million kilowatt-hours per year and cutting its annual energy costs by $70,200, resulting in a payback period of 2.5 years. The facility also benefits from improved lighting quality and better color.

New Developments: Occupancy Sensors and Ballasts

New developments give fluorescent fixtures even more advantages over their HID rivals. One involves occupancy sensors. With HID lamps, there is a delay of several minutes between when the light is turned off and when it can be turned on again. In contrast, the instant re-strike capabilities of fluorescents make the combination of fluorescents and occupancy sensors a practical idea for spaces such as warehouses that are notoriously over-lit and under-occupied. New line-voltage occupancy sensors have reduced the installed costs for occupancy sensors from approximately $150 to $50 per sensor, making it cost-effective to consider installing one sensor for each fixture in low-occupancy areas, resulting in potentially huge energy and cost savings.

The other new development is in the area of ballasts. Until recently, if an existing HID lamp was wired with 480 volts (V), replacing the lamp with a fluorescent fixture would require a rewiring job. Now 480-V fluorescent ballasts are available, making these replacements much more feasible. In addition, four-lamp ballasts are now available, reducing the installation costs for fluorescents compared to the conventional two- or three-lamp ballasts.

Economic Benefits

High-intensity fluorescent fixtures are more efficient than most HID fixtures, so they tend to deliver significant cost savings (**Table 1**). In addition, fluorescent fixtures have much better dimming options than HID lamps, which can translate into significant additional energy savings. A set of fluorescent lamps can be dimmed in two ways. First, because most fluorescent fixtures have multiple lamps, they can be wired with multiple circuits that can be switched to vary the light levels. Second, light levels can be dimmed with a dimming ballast. HID fixtures contain individual lamps, so they don't offer the first option. They can be

Table 1: Evaluating fluorescent fixture lighting retrofits

To determine whether the cost of retrofitting high-intensity discharge (HID) fixtures with fluorescent fixtures could be recovered in a reasonable amount of time, we compared a typical HID fixture with two fluorescent retrofit options. Both of the retrofits produced greater net design pupil lumens than the HID system. Both also yielded simple payback periods of less than three years, based on energy savings alone.

	Standard 400-watt high-intensity discharge	Four 55-watt biaxial fluorescents	Four 54-watt T5 high-output linear fluorescents
Initial lamp output (lumens)	36,000	19,200	20,000
Design (40% of life) lamp output (lumens)	24,000	16,781	19,500
Lamp life (hours)	20,000	15,000	20,000
Fixture input power (watts)	465	234	234
Design lamp efficacy (lumens/watt)	52	72	83
Fixture efficiency (percent)	70	98	95
Design lumens from fixture (lumens)	16,800	16,445	18,525
Conversion factor, standard lumens to pupil lumens	1.49	1.62	1.62
Net design pupil lumens from fixture (lumens)	25,032	26,641	30,011
Color rendering index	65	85	85
Annual electricity consumption @ 5,000 hours per year (kilowatt-hours per year)	2,325	1,170	1,170
Annual electricity cost @ $0.08/kWh ($)	186	94	94
Annual savings ($)	N/A	92	92
Cost of retrofit ($)	N/A	250	270
Simple payback period (years)	N/A	2.7	2.9

N/A = not applicable

Source: Platts

dimmed, but only to about 50 percent of their full output—and even then the dimming is not linear with the energy consumed so that in some cases very little energy is actually saved. In many applications where dimming is required, the HID lamps are dimmed by the use of shutters rather than dimming ballasts, which results in no energy savings at all. For example, school gymnasiums host several types of activities that require less light than sporting events. A system of fluorescent fixtures, each with multiple lamps, could be installed and wired to allow several different lighting levels, which would result in huge energy savings at the lower levels compared to an HID lamp lighting system with little or no dimming capabilities.

The cost-effectiveness of fluorescent lighting compared with HID depends on several factors, including lamp life, lumen depreciation, hours of operation, and electricity prices. When evaluating costs of different lighting technologies/fixtures, make sure to compare alternatives that provide approximately equal amounts of light.

Other Benefits

In addition to lower energy consumption and better dimming options, the new fluorescent fixtures designed for high-bay applications have several additional advantages over similar HID fixtures: lower lumen depreciation rates, faster start-up and re-strike, better color rendition, and reduced glare. Not only do these advantages make fluorescent fixtures more cost-effective in many applications, they also enable them to provide superior lighting to the spaces they illuminate. The lamp life for fluorescents is about the same as for HID lamps, but fluorescents may have a slight advantage when you factor in their lower lumen depreciation rates. There may be a slight convenience advantage for fluorescent fixtures when it comes to changing lamps: HID lamps need to be replaced immediately when they fail, but when a fluorescent lamp fails, several other lamps in the fixture will still be working.

Suppliers

Several manufacturers of fixtures, ballasts, and occupancy sensors are listed below. (This list is not meant to be comprehensive, and does not represent an endorsement by Platts Research & Consulting for any of the companies listed.) Most fluorescent fixture designs for high-bay applications are square or rectangular and are derived from either recessed troffers or surface-mounted fixtures. To facilitate one-for-one replacement of existing HID fixtures, the new fluorescent fixtures are usually hung from chains or pendant-mounted from a single point. Design variations address aesthetics and some specific customer needs.

Lighting Fixtures

1st Source Lighting
1730 Industrial Drive
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GE
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