OPTIONS FOR GYMNASIUM LIGHTING: METAL HALIDE VS. T-5 HIGH OUTPUT

Metal halide high-bay fixtures have long been the method of choice for illuminating gymnasiums. However, high-bay fixtures utilizing fluorescent lamps, specifically T-5 high-output (HO)[1], are quickly gaining popularity. These fixtures offer another option to consider when illuminating gymnasiums and similar spaces.

Warm-up vs. Instant-on

Energy savings can be realized from turning off gymnasium lighting when not in use.

Fluorescent lamps provide virtually instant illumination, while metal halide (MH) sources do not. Due to their inherent properties, MH lamps have a warm-up period before producing adequate light. At initial startup this delay is about four minutes; however, it increases to around 15 minutes if the lamps have been turned off and then are restarted. Whether due to switching or a power interruption, this re-strike period after extinguishment cannot be avoided. Newer pulse-start lamps[2] have reduced, but not eliminated, warm-up times. The inability of MH lamps to produce light instantly makes them unsuitable for frequent switching applications. On the other hand, fluorescent lamps are essentially instant-on light sources; therefore, they can be switched on and off as needed. Additionally, the fluorescent fixtures contain multiple lamps, which can be controlled through switching to provide various light levels.

Our observations when conducting energy assessments show that lighting in gymnasiums is frequently left on continuously throughout the day, sometimes even nights and weekends. The most common reason given is to avoid the inescapable warm up period. As previously mentioned, fluorescent lighting can be turned off and on as needed for an instant source of illumination. Energy savings can be realized from turning off gymnasium lighting when not in use.

Controls

Dimming fluorescent lamps has been possible for quite a few years. Newer technologies now also make it practical to dim metal halide lamps with the use of electronic ballasts. However, the equipment for dimming metal halide lamps is still relatively expensive. While fluorescents can be dimmed as low as one percent of full light output, metal halides are limited to about 30 percent. At 30 percent light output MH systems still consume about 50 percent of the energy they do at maximum brightness. Fluorescent dimming is more linear, that is, at 30 percent output, for example, they use about 30 percent of maximum power.

Motion sensors can also be used with fluorescent lighting systems. These sensors turn the lights on when they detect the presence of occupants and off when there is no activity for a given period of time. Switching off lighting when no one is present, i.e. illumination is not needed, saves energy (this will be discussed further later) and thus dollars. Also, installation of motion sensors serves to meet the requirements of the International Energy Conservation Code, which requires a means to automatically turn off lighting.

[1] For more information on T-5 HO lamps, refer to "The Skinny on T-5 Lamps" by Estes, McClure & Associates, Inc.

[2] Metal halide lamp with redesigned arc tube and starter circuit

Light Characteristics

Fluorescent lighting provides better quality light than metal halide in some respects. Aging affects a lamp's output characteristics. Both metal halide and fluorescent lamps experience lumen depreciation. That is, their light output decreases as they age. MH light output commonly declines about 40 percent during the lamp's life, compared with only about five percent for T-5 lamps. (For comparison, T-8 lamp output falls up to 15 percent.) Another consequence of aging is color shift. As MH lamps age, the color of light they produce changes. Depending on the specific type of lamp, the shift may be toward warmer or cooler hues. All lamps of the same age should be approximately the same color, making the change less noticeable. However, if a single burned out lamp in a group is replaced, the difference will become apparent. The color rendering index (CRI)[3] for T-5 lamps ranges from 82 - 95, compared with 65 - 70 for most MH lamps.

The Influence of Temperature

The light output of fluorescent lamps is influenced by the ambient air temperature. Lamp outputs are published for a certain temperature. If the actual temperature varies significantly, the light output may decrease significantly. Standard T-8 lamps have their light output maximum at about 70ºF. For T-5 HO lamps this peak occurs at approximately 95ºF. Output diminishes either side of these points. Therefore, fluorescent lamps should not be considered in unconditioned spaces where light levels are important. The life of metal halide ballasts is also influenced by ambient temperatures. These ballasts are typically rated at 40ºC, 55ºC, and 65ºC (104ºF, 131ºF, and 149ºF). Environments warmer than the rated temperature will shorten ballast life, while cooler temperatures may extend it.

Efficiency

T-5 HO lamps produce more light output per unit of electric input than MH sources. The measure of lamp "efficiency", known as efficacy, is defined as lumens of light output per watt of power consumed. For 400-watt metal halide lamps (commonly used in gymnasium lighting), this value ranges from 40 – 80 (standard) to 60 – 100 (pulse start). The efficacy of T-5 HO lamps varies by manufacturer, but is typically about 90 lumens per watt (based on mean lamp lumens[4]). When the entire system (i.e. lamp and ballast) is taken into account, MH systems with electronic ballasts and high-output pulse start lamps are slightly more efficient than T-5 HO systems. However, MH fixtures with magnetic ballasts still lag far behind those with T-5 HO lamps. System efficacies (again based on mean lumens) for T-5 HO fixtures, 400-watt metal halide with standard ballast, and 400-watt metal halide pulse-start with electronic ballast, have system efficacies of about 80, 54, and 88 respectively.

Example Savings

The table on page 3 is based on lighting an area 100' x 150' with 28' ceiling and 24' fixture mounting height (a high school gym, for example) to 75 fc (maintained). The

[3] The color rendering index (CRI) describes how well a given light source depicts colors and is measured on scale ranging from zero to 100, with 100 indicating that a source depicts all colors perfectly.
[4] Mean lamp lumens is defined as lumen output at 40% of lamp life.

fixtures and pricing are representative of one manufacturer and may vary from other manufacturers; however, the data should be adequate for a relative comparison of options. Markups have been added to more accurately reflect the customer's cost.

From the table below, operating the 66 6-lamp T-5 HO fixtures costs approximately $2 per hour. Turning them off just one hour daily during the school year would yield a savings of $360. However, typically, there are opportunities to turn gym lighting off for three hours a day or more during a school day, saving $1080 annually. Potential savings for smaller gymnasiums and multipurpose areas in middle and elementary schools would be less, but proportional to the sizes of the spaces. In a large district, for example, with three high schools, 12 middle schools, and 30 elementary schools, each with a gym or multipurpose room, the annual energy savings could total over $5000.

	400-watt MH (standard ballast) w/ prismatic glass reflector	400-watt pulse start MH (electronic ballast) w/ prismatic glass reflector	6-lamp T-5 HO high-bay fluorescent
Quantity of MH fixtures Additional fluorescent fixtures for emergency lighting	66 30	48 30	66 0[&]
Fixture Costs* MH Fluorescent (emerg.) Total	 $19,000 1,900 $20,900	 $18,900 1,900 $20,800	$16,800
Watts per Fixture (including ballast)	460	422	363
Annual Energy Cost (at $0.085 per kwh)[#]	$4645	$3099	$3332
Energy savings for turning off: 1 hour Overnight Weekend	 $2.58[@] $31 $124	 $1.72[@] $21 $83	 $2.04 $24 $98

* Including lamps. Installation costs were considered to be equal.
[&]Emergency ballasts included in 20 fixtures.
[#]Fixtures operating 10 hours per day, 180 day school year
[@]Not typical due to warmup time required when turning back on

Turning them off just one hour…savings of $360.

Again referring to the table above, the standard metal halide and fluorescent high-bay fixtures with T-5 HO lamps both require 66 fixtures, while only 48 fixtures with electronic ballasts and pulse start MH lamps are needed. First costs for both types of metal halide fixtures are less than for the high-bay fluorescents. Energy costs are highest for standard MH lamps with magnetic ballasts and lowest for electronic ballasts with pulse start lamps, with fluorescent high-bays in between. However, the ability to turn off some or all lamps in the fluorescent fixtures as needed potentially lowers their annual energy cost.

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Both metal halide and T-5 HO fluorescent fixtures are viable choices for lighting gymnasiums and other large spaces with high ceilings. While metal halide systems are an established technology, new enhancements such as pulse-start lamps and electronic ballasts are improving energy efficiency and provide better dimming capabilities. Metal halide lamps are also virtually unaffected by ambient room temperatures and can be more efficacious depending on the lamp and ballast combinations selected. T-5 HO systems are a relatively new product, but seem to be increasingly used. Systems with fluorescent lamps offer excellent lumen maintenance, instant-on capability, switchability, and improved color rendering. However, on the other hand, they do use more lamps, making relamping costs higher. Although lighting systems utilizing T-5 HO lamps offer some advantages over those with metal halide, their suitability should be evaluated for any given application.