E-Notes

Energy Efficiency Notes

Improved Efficiency Fluorescent Lamps and Ballasts

Background

Fluorescent fixtures are the most common type of light source in offices, schools, and many other non-residential buildings. First introduced in 1939, fluorescent lamps have an efficiency that is considerably greater than that of incandescent lamps.

Figure 1 Typical Construction of a Fluorescent Lamp

In recent years, the efficiency of fluorescent lamps has further increased because of two new technologies--T-8 lamps and high frequency ballasts.

T-8 Fluorescent Lamps

T-8 lamps (1.0 inch diameter) are generally more efficient than the T-12 (1.5 inch diameter) lamps. For instance, the light output for a 32 watt 4 foot T-8 lamp is 69 lumens/watt. For a 40 watt T-12 lamp, the light output is about 50 lumens/watt, or about 28% less. In other words, the T-8 lamp is about 28% more energy efficient than a T-12 lamp.

Electronic Ballasts

A ballast is a device used with fluorescent lamps and other gas discharge lamps to provide the necessary starting and operating electric conditions. Standard ballasts consist of a core and coil assembly. On a typical fixture with two 4 foot 40 watt T-12 fluorescent lamps, the ballast consumes about 13 to 16 watts of electricity. Thus the total consumption of the two lamps plus the ballast is about 93 to 96 watts.

The most efficient ballasts are electronic, or high-frequency ballasts. These typically boost the frequency of the electricity from 60 cycles per second (hertz) to between 25,000 to 40,000 hz. At the higher frequency, the fluorescent lamps are more efficiently excited. Coupled with the T-8 lamps, the electronic ballasts are very efficient. On a fixture with two 4 foot 32 watt T-8 cool white fluorescent lamps and an electronic ballast, the total consumption of the fixture can be as low as 60 watts. (In other words, the total consumption of the fixture is less than the nominal consumption of the two lamps. This unusual effect occurs because of the very high efficiency of the electronic ballast in exciting the lamps.)

In comparison with standard ballasts, electronic ballasts weigh less, operate at lower temperatures and

at a lower audio noise level, are more energy efficient, but cost approximately two to three times as much as standard ballasts.

Points to watch

1. Electronic ballasts tend to have greater electrical noise than conventional ballasts. Choose ballasts with low harmonic distortion for electronically sensitive areas. (For instance, a TV set with a rabbit ear antenna will pick up the electrical noise from some electronic ballasts.)
2. Some T-8 lamps have an improved design which maintains a higher lumen output from the lamp over the total life.
3. Dimming electronic ballasts are available where adjustable light levels are desired.
4. T-8 lamps are available in a range of colour rendering index values.
5. When retrofitting fluorescent fixtures, always measure the light levels and provide only the appropriate amount of lighting. Overlighting is expensive.
6. When retrofitting fluorescent fixtures, the use of reflectors should always be considered as a means of reducing the number of lamps and ballasts.

Savings from T-8 lamps and electronic ballasts

The more operating hours per year that a fixture is energized, the shorter will be the payback period on the extra costs for T-8 lamps and electronic ballasts. Silver or anodized aluminum reflectors are also frequently used with the T-8 lamps and electronic ballasts to provide extra savings.

T-8 lamps are more expensive than the T-12 lamps. The cost of T-8 lamps has been declining, however, as their use increases. In 1997, the cost of 4 foot T-8 32 watt lamps was about $3.25 each including taxes.

Electronic ballasts are available for one-lamp, two-lamp, three-lamp, and four-lamp fixtures. The most cost-effective electronic ballast is generally the four-lamp type. In 1997, the cost of a four lamp electronic ballast to excite 4 foot T-8 lamps was about $40; and the cost of a two-lamp or a one-lamp electronic ballast was about $31.

One of the side benefits of higher efficiency lights is reduced cooling loads in the summer period. Lighting usually accounts for about 40% of the electrical energy usage in a typical office building. If the office building is air-conditioned, less heat will have to be removed from the building with high efficiency lighting, and the cooling apparatus can be reduced in size.

In a new building, the more efficient light systems can result in smaller electrical transformers, wiring, and smaller air conditioning and air handling systems. Often the higher initial cost of the more efficient lighting systems can be recovered immediately in the lower cost of the electrical distribution system and the air conditioning and air handling systems.

References

Lighting Reference Guide, Canadian Electrical Association, 1991, Suite 1600, 1 Westmount Square, Montreal, Quebec, H3Z 2P9 Fax: 514-937-6498 Phone: 514-937-6181

Lighting Research Center Publications, Rensselaer Polytechnic Institute, Troy, New York, U.S.A. 12180-3590 T8 Fluorescent Lamps, Order Code NLP-SA, 6 pages; Electronic Ballasts, Order Code NLP-CA, 12 Pages Phone 518-276-8716