Energy Innovators Initiative

Technical Fact Sheet

Fluorescent Lamp and Ballast Options

Description

Fluorescent lamps require a high voltage surge at start-up. An electrical device called a ballast achieves this surge, then limits the flow of current during operation. This fact sheet provides a review of some of the current technologies for lamps and ballasts along with a brief review of their advantages and disadvantages. The focus is on the 122-cm (4 ft.) length × two-lamp ballast combination, as it is the most common configuration in Canada.

Technical Specifications

Lamps

The F32T8 lamp (Figure 1) has become the fluorescent lamp of choice for many reasons:

Figure 1 – T-8 Lamps

- It has a higher colour rendering index (CRI). A typical "cool white" F40T12/ES lamp has a CRI of approximately 62, whereas the CRI of a typical 800 series F32T8 lamp ranges from 82 and 86 (100 is considered optimal). This high index is achieved cost-effectively by using a smaller-diameter lamp with more expensive tri-phosphor coatings.
- The smaller-diameter lamp allows for greater optical control, thereby increasing luminary efficiency.
- It has a longer-rated lamp life – 24 000 hours versus 20 000 hours (based on three hours per start).
- Its lumen maintenance is better – 94 percent versus 86 percent for T-12 lamps.
- Lamp choices include CRI ratings of 70+, 80+, and 90+.
- Colours typically used include 3000°Kelvin (K) (similar to warm white), 4100°K (similar to cool white) and 3500°K, which is the most popular choice.
- Light output choices typically range from 2800 to 3100 lumens (F40T12/ES lamps are rated at 2650 lumens).

Figure 2 – Electronic Ballast

Ballasts

There are three main types of fluorescent lamp ballasts: electromagnetic, electronic and hybrid. Electromagnetic ballasts perform the essential functions required to start and operate a lamp, but are not as efficient as electronic (Figure 2) or hybrid ballasts.

Table 1 – Ballast Types

Electronic	Electromagnetic
No lamp flicker (20 000+ Hz)	Visible lamp flicker (60 Hz)
No tar	Can leak tar
25-year life expectancy	10-year life expectancy
1-, 2-, 3- or 4-lamp models	1- or 2-lamp models

Although hybrid ballasts can be almost as efficient as some electronic ballasts, they retain some of the disadvantages of electromagnetic ballasts, including lamp flicker, tar leakage and a shorter life expectancy. Electronic ballasts virtually eliminate lamp flicker, do not leak, and have a 25-year life expectancy (Table 1).

Electronic ballasts are available in three basic types: instant start (IS), rapid start (RS) and dimmable. Dimmable ballasts for fluorescent lamps are more expensive than non-dimmable systems, and are therefore typically used for special applications, such as boardrooms and perimeter areas. The primary difference between IS and RS ballasts is the way they start lamps. IS ballasts apply a high voltage across the

lamp without preheating the cathodes (filaments), whereas RS ballasts apply a low voltage to the cathodes to preheat them before starting the lamp.

As a result of this difference in starting, IS ballasts are more energy efficient than RS ballasts, typically using 1.5 to 2 watts less per lamp. However, on shorter duty cycles (e.g. three hours per start), IS ballasts reduce lamp life. As the duty cycle increases to eight hours and more, the effect on lamp life is similar. RS ballasts are therefore recommended where lights are cycled on and off frequently, such as in an office environment when its lights are operated by occupancy sensors.

Energy Information

Ballasts are available with various ballast factors. Ballast factor is defined as the relative light output compared to a reference ballast. For example, a ballast factor of 0.85 would yield 85 percent of a lamp's rated lumens or light output. Refer to Table 2 for energy usage for various types. Electronic ballasts are typically available in three groups of ballast factors:

- Low ballast factor (LBF) = 70 to 80 percent light output;
- Normal ballast factor (NBF) = 85 to 95 percent light output; and
- High ballast factor (HBF) = 100 to 115 percent light output.

Table 2 – Energy Use For a Two-Lamp System

System	Watts	Light Output (initial lumens)	Operating Cost/yr ($5/kW; $0.05/kWh @ 4000 hr/year)	kWh/m²	Operating Cost/m²
T-12ES and Std. ballast	81	4370	$25.11	66.17	$5.13
T-12ES and electro-magnetic ballast	74	4370	$22.94	60.45	$4.68
T-8 lamp and LBF ballast	51	4543	$15.81	40.07	$3.11
T-8 lamp and NBF ballast	59	5310	$18.29	39.66	$3.07
T-8 lamp and HBF ballast	78	7080	$24.18	39.33	$3.05

Table 2 further illustrates the differences in operating costs for the common two-lamp system. Further analysis will reveal that the T-8 lamp combined with an electronic ballast produces approximately 90 lumens of light per watt, whereas the T-12 system using standard magnetic ballasts produces only 53 lumens per watt.

Comparison

The combination of lamp and ballast determines the type of light produced. Selecting the right combination starts with knowing what the task is and where it will be performed. After determining the required lighting levels and selecting the appropriate luminaire, the proper lamp and ballast must be chosen. Refer to Table 2 for light output comparison. It should be noted that light outputs are based on initial levels. The lamp lumen depreciation (LLD), at 40 percent of rated lamp life, is 85 percent of initial lumens for a T-12 lamp, whereas a T-8 lamp is much better at 95 percent.

In areas with fixed ceiling grid patterns or for a retrofit project, the available options allow you to select the right combination of lamps and ballasts to meet the lighting requirements for the space in the most cost-effective and energy-efficient manner.

Figure 3 – Office Building

Case Study

As an example of an upgrade to an existing lighting system, consider the case of a 25-storey building with 6500 luminaires (Figure 3). The existing lighting used recessed lensed luminaires with three F40T12 ES lamps and standard electromagnetic ballasts. To optimize this type of lighting system, the existing three-lamp luminaires were converted to three F32T8/841 lamps with a low ballast factor (LBF) ballast. This combination allows the tenants to select three different lighting levels with one, two or three lamps operating. With the three-lamp arrangement, de-lamping could be achieved while maintaining an even illumination over the lens surface.

As Figure 4 illustrates, the energy savings for an office building project of this size would be $100,000 per year, at a rate of $5 per kilowatt and $0.05 per kilowatt hour, with a resulting five-year payback period.

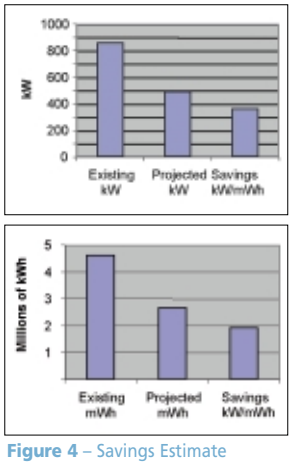

Figure 4 – Savings Estimate

For more information, contact

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