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White Paper:

Fluorescent Ballast Start Type and Lamp Life

Each time a linear fluorescent lamp is powered on, a very small amount of emission coating from the lamp's two cathodes (electrodes) is lost. The emission coating on the cathodes is needed to pass the electrons into the lamp's gases and start the lamp. This ultimately means that a linear fluorescent lamp is one step closer to its end-of-life each time it is turned on. The two main methods of minimizing cathode emission coating depletion and consequently prolonging the operating life of linear fluorescent lamps are outlined below.

Ballast Starting Method

T8 and T12 linear fluorescent lamps have traditionally been operated by rapid start and instant start ballast systems. For many years, electromagnetic ballasts using rapid start technology were the primary method of operating T12 lamps. Although many electronic ballasts used to operate T12 lamps are rapid start, most ballasts that operate T8 lamps use instant start or programmed start technologies.

Rapid start ballasts maintain a constant low voltage (3.6V) through the lamp's cathodes and apply the starting voltage as the cathodes are heating. The primary advantage of rapid start ballasts is that they are relatively gentle on the cathodes. However, rapid start ballasts occasionally provide the starting voltage before the cathodes are sufficiently heated, which can cause additional emissive coating to sputter from the cathodes. Since rapid start ballasts are constantly heating the electrodes during lamp operation, the system consumes approximately two watts of additional power per lamp. Another disadvantage of rapid start ballasts is that the lamps take a little longer to warm up to full brightness.

When lamps are operated by an instant start system, there is no preheating of the cathodes. Instant start ballasts simply apply a high voltage (around 600V) pulse to the cathodes to start the lamps. It is a method of lamp starting commonly referred to as a "cold start." Lamps operated by instant start ballasts achieve full brightness immediately, eliminating the delay experienced with rapid start systems. Since instant start ballasts do not provide constant current to the cathodes before or during lamp operation, it is considered the most energy efficient option available. Each lamp consumes about two less watts than lamps in rapid start systems. In a school or office building with hundreds of fixtures, power savings realized by instant start systems become rather significant. Other benefits of instant start ballasts include:

1) With fewer wires, instant start ballasts are less complicated and easier to install.
2) Can start lamps at colder temperatures than rapid start ballasts.
3) Wire in parallel – when one lamp fails, the remaining lamps operated by the ballast will continue to work.

Although instant start ballasts offer several advantages, the primary downside of an instant start system is shorter lamp life. The high voltage start provided to the cathodes depletes more emission coating than the gentle starts provided by rapid start and programmed start models. When operating cycles (described below) are equal, about 20% shorter lamp life can be expected from instant start systems compared to systems utilizing a programmed start ballast.

A relatively recent ballast technology – programmed start ballasts – decreases the depletion of cathode emission coating more effectively than both rapid start and instant start systems. Programmed start ballasts preheat the cathodes with about 3 to 6V of power before providing starting voltage to the lamp. When the cathodes are sufficiently heated (700 degrees C), voltage supplied to the lamp is minimized, reducing damaging glow current on the cathodes. Glow current causes early lamp end darkening and shortens lamp life. While cathodes are being preheated, glow current leaves the cathodes.

The pre-programmed period of time required to preheat the lamp cathodes is the "programmed" aspect of the ballast. Once the cathodes reach their optimal temperature, voltage is applied across the lamps. The voltage required to start the lamps is much lower for a programmed start system than an instant start system because programmed start ballasts apply voltage to the preheated cathodes rather than a cold start. This gentler start minimizes the depletion of cathode emission coating and subsequently prolongs lamp life.

While programmed start and rapid start ballasts are quite similar, programmed start ballasts apply the starting voltage once the cathodes are known to be heated. In comparison, rapid start ballasts may apply the starting voltage before the cathodes are sufficiently heated. Additionally, many programmed start ballasts provide less heat to the cathodes while the lamps are operating while rapid start ballasts apply continuous heat. While not quite as efficient as instant start systems, programmed start systems are generally more efficient than rapid start systems. Furthermore, programmed start systems are optimal for applications with occupancy sensors, which are becoming more commonplace as municipalities and businesses look for ways to save money and become more environmentally friendly.

Operating Cycle

The average duration linear that linear fluorescent lamps are "on" – known as the operating cycle – has a significant influence on the life one can expect from a lamp. Regardless of lamp starting method, when lamps are started frequently, cathode emitter coating is depleted more frequently, and the lamp's life is shorter. When determining the average rated life of a lamp,

IESNA defines the standard lamp operating cycle as three hours on, followed by 20 minutes off. Longer operating cycles are commonplace in many applications that utilize linear fluorescent systems such as schools, office buildings, retail environments, and healthcare facilities where 12, 18, even 24 hour starts are oftentimes the norm.

Most linear fluorescent lamp manufacturers base their average rated life specification on the standard 3-hour start. Since instant start ballasts are the most common system used to start F32T8 lamps, the average rated life is usually calculated based on an instant start system. The average rated life of T5 lamps, on the other hand, is based on programmed start systems since this is the operating system prevalently used with T5 lamps. Because so many applications have longer operating cycles than the 3-hour start, many manufacturers publish what's known as a "commercial life" specification in addition to the 3-hour start average rated life spec. Commercial life is based on commercial standards of 12 hours per start. This means that for every 12 hours of operation, the lamp is only turned on once. By comparison, lamps that are operating on a 3-hour cycle are powered on four times during a 12 hour period. Commercial life is typically 15-25% greater than the rated average life following a standard 3-hour operating cycle. For example, our F32T8 800 series lamps have an average rated life of 24,000 based on a 3-hour start. The commercial life (12-hour starts) of this lamp is 30,000 hours. All things being equal, fewer on-off cycles translate to longer lamp life.

Which Ballast is Right for Me?

Programmed start ballasts make the most sense if your application includes one or more of the following:

- Frequent on/off cycles
- Occupancy sensors
- T5 lamps
- Customer wants the longest possible operating life

Instant start ballasts make the most sense if your application includes one or more of the following characteristics or requirements:

- Longer operating cycles
- Customer wants the lowest possible power usage
- Customer wants the lowest upfront cost

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