Why Poultry Growers Have Issues Dimming LED Lamps

MISSISSIPPI STATE UNIVERSITY EXTENSION

Lighting programs are a common practice in today's poultry industry to improve bird performance and meet welfare criteria. Lighting is an important concern in most poultry facilities because it represents a large part of monthly energy consumption and expenses.

Traditionally, incandescent or fluorescent lamps (or perhaps high-pressure sodium lamps in broiler breeder houses) were used to provide required light levels in poultry houses. However, in recent years, light-emitting diode (LED) technology has become quite popular because of the associated energy efficiency properties and the energy savings they offer growers.

Energy savings of LEDs are quite remarkable (they are roughly 80–85 percent more energy efficient than incandescent lamps). However, there have been some issues along the way.

Fortunately, by working with growers in the field and manufacturers in the laboratory, we now better understand many of the technical and operational problems with LEDs. These problems can be addressed by properly installing bulbs and properly matching bulbs with other control equipment, particularly when it comes to light dimming.

Lighting Terms

Before we get into the dimming issues, there are a few terms to be familiar with. When purchasing LED lamps, it is important to understand the information on the label (**Figure 1**) and the lamp (**Figure 2**) in order to make the right decision. Information that may be found on the label or the lamp can include:

- **Lumens** – The amount of light output from a lamp (brightness)
- **Watts** – The amount of energy required to create the light output (power draw)
- **Dimmable** versus **non-dimmable**
- **Average Rated Life** – The average rated life for a non-LED lamp is the time it takes for 50 percent of the lamps to fail. For LEDs, usable life (L70; see **Figure 1**) is the point in time when LEDs produce 70 percent of their initial light.
- **Color Rendering Index (CRI)** – The CRI is a measure of the accuracy of the color perceived under the light of the lamp as compared to color perceived under natural light (i.e., sunlight). A lower CRI value indicates that some colors may appear unnatural when illuminated by the lamp.

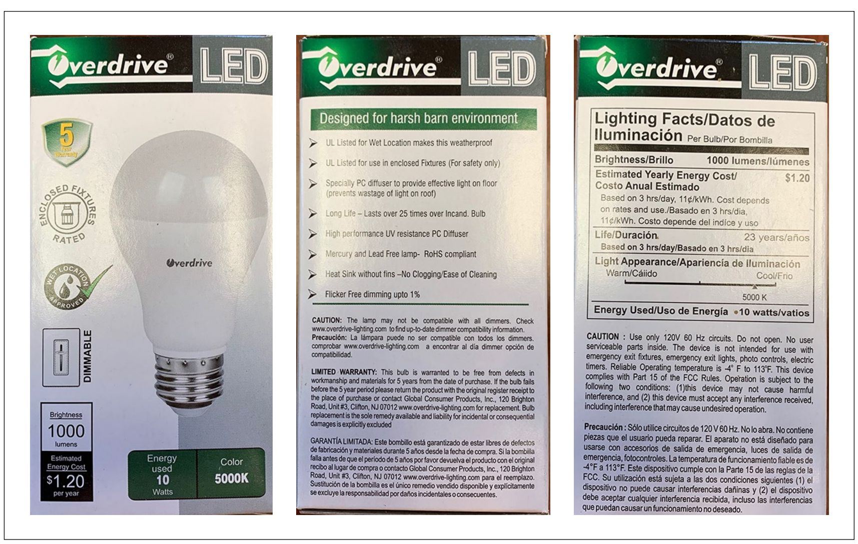


Figure 1. Information provided on an LED lamp label.

Figure 2. Information provided on an LED lamp.

A CRI of 100 represents the maximum value. For poultry applications, look for LEDs that have a CRI of 80 or greater.

- **Kelvin (K) –** The color or appearance of the light that the lamp emits. Warm/soft white light (similar to incandescent light) has a range of 2,700–3,000 K. Natural white light has a range of 3,000–4,500 K. Cool white light has a range of 4,500–6,500 K. Broilers today are often grown under 5,000 K, while layers and broiler breeders are more likely grown under 2,700–3,000 K.

Dimming Issues

The majority of poultry houses are equipped with some version of a triode alternating current (TRIAC) switch light dimmer to adjust lighting levels during the flock. A TRIAC is a small semiconductor device, similar to a diode or transistor. Without getting too deep into electrical engineering, light dimming works something like this: Resistors rapidly shut the light circuit off and on to reduce the total amount of energy flowing through the circuit. The lamp circuit is actually switched off many times per second. The switching cycle is built around typical alternating current (AC). Alternating current has varying voltage polarity in an undulating sine wave that fluctuates from positive to negative voltage. In other words, the moving charge that makes up AC is constantly changing direction.

In the United States, this alternating cycle (moving from positive to negative voltage) happens 60 times per second. This frequency is referred to as hertz. Common electrical supply in the U.S. is 60 hertz (meaning the current changes direction or "alternates" 120 times, or 60 cycles per second). A light dimmer actually "chops" or interrupts the sine wave based on the dimmer setting. It automatically shuts the light circuit off every time the current changes direction. This happens twice per cycle (120 times per second). It will turn the light circuit back on when the voltage reaches a certain point.

This "turn-on point" is based on where the dimmer switch is set. If the dimmer switch is turned to a brighter setting, the cut-on point is very soon after the cut-off point. Therefore, the circuit is on for most of the cycle and the light remains fairly bright. However, if the dimmer is set for a low light level, the cut-on point is much later in the cycle and the circuit is off for much of the cycle, keeping the light level fairly dim. This is ideal for incandescent lighting because the tungsten filament in incandescent lamps is slow to heat up and cool down, and the human eye sees the light output as a constant level of decreased brightness without any flicker. The longer the interruptions in the sine wave, the dimmer the light.

That's a quick and very elementary description of how a TRIAC light dimmer works in a chicken house. TRIAC dimming was first introduced in 1960 and, since that time, has been used primarily with incandescent and fluorescent lighting circuits. It has worked well because incandescent lighting is a simple resistive load and the relationship between current, voltage, and brightness is linear, direct, and straightforward. A change in the voltage affects the current proportionally.

Unfortunately, this is not the case with LED technology. LEDs do not like interruptions in power; they require constant current. LED lamps do not have a resistive filament and, by design, are complex loads. Because they are low voltage, direct current sources, all LEDs require drive electronics to convert the alternating current that flows through power lines into a usable and regulated direct current source.

A good LED dimmer will have resistance built into the dimmer to control the output of electricity to ensure consistent performance when dimmed. If you take an LED lamp apart, you will find a small circuit board with little diodes and other things attached on the inside. Because these diodes rely on drive circuitry to ensure constant current and to adapt power and voltage for their use, LEDs often do not function properly when paired with a non-LED TRIAC dimmer. For example, at very low dimming levels, an LED driver that is designed to supply constant current or voltage may try to compensate for the TRIAC dimmer's interruptions in the AC sine wave by pulling in additional current, causing the LED to remain too bright or to flicker. Problems that have been observed when trying to operate LED lamps with TRIAC dimmers include:

- Ghosting – Cannot completely cut off the current, so lights cannot be totally turned off.
- Linearity issues and "dead travel"– Lights turn on fully bright as dimmer level is raised or turn off completely as dimmer level is lowered without a linear increase or decrease in light level.
- Difficulty in dimming lights to very low levels.
- Excessive lumen depreciation much too soon in the life of the lamp.

Light dimmers should be compatible with the specific LED lights installed. Never mix brands or wattages of lamps in the same poultry house. Different LEDs have different electronics, different dimming capabilities, different in-rush currents, different starting thresholds, etc. No dimmer can handle all these different scenarios. There is simply too much electrical non-compatibility.

Improvements over TRIAC diming include the metal-oxide semiconductor field effect transistor (MOSFET) or the insulated-gate bipolar transistor (IGBT) dimmers. There is no universal standard to determine which device offers better performance in a specific type of circuit. It varies depending on applications and a wide range of factors such as speed, size, and price. However, historically speaking, low-voltage, low-current, and high-switching frequencies favor MOSFET circuitry, while high-voltage, high-current, and low-switching frequencies favor IGBT circuitry. MOSFET circuitry was specifically designed for operations of 20 amps or less. Many poultry house controllers communicate with light dimmers using 10 amps.

Light Sockets

Another serious issue is putting new LED lamps in old, damaged light sockets. Older, cracked, broken, corroded keyless sockets are causing multiple problems on poultry farms today. Corrosion in keyless sockets results in added resistance in the circuit and can quickly cause premature bulb failures. Other problems include poor dimming capability at low levels, excessive light depreciation, and intermittent flickering. Growers often assume that if the lamp is not performing properly, it is defective, and they will replace it under warranty. However, thousands of LED lamps that have been replaced under warranty have turned out to be fine when sent back to manufacturers. In many cases, the problem was not the lamp but the conditions the lamp was exposed to.

LEDs have outstanding energy saving capabilities, but they must be taken care of to achieve the maximum benefits. Anyone considering switching from incandescent or fluorescent lamps to LEDs should consider upgrading to nickel-brass screw-shell sockets and replacing their old TRIAC light dimmer with a dimmer specifically designed to handle LEDs. Also, make sure that the light dimmer has its own dedicated neutral running to it. The neutral should be directly from the power panel box and should not be a common neutral associated with any other equipment.

LED lamps are a high-tech tool with much to offer the poultry industry. However, we now know that they need a strong supporting cast around them that includes proper wiring, good light sockets, and a light dimmer capable of handling sophisticated LED technology. We know much more today than we did 5 years ago about LED lighting, and the most important lesson is that it's not as simple as just changing out the lamps like we once did.

What Now?

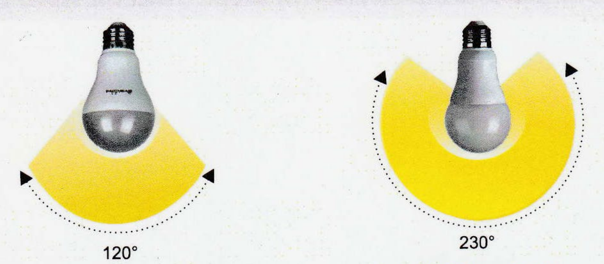
The relationship between LED lamps and TRIAC dimmers is problematic at best. No one wants to spend additional money unless absolutely necessary, but every grower must stay competitive. It is clear that a successful lighting program is more than just the lamps, photoperiod, and foot-candle level. All aspects of the system must work together to be successful—the wiring, the dimmer, the controller, the lamps, and the sockets.

Monitor light levels inside the chicken house. Lumen depreciation is a fact of life. LEDs that are 5 years old are not as bright as they were when new. Proper light levels are critical to flock performance and welfare practices that are a huge consumer concern today.

LEDs outlast everything else on the market today in terms of longevity. However, they will not last forever. They may not burn out, but, at some point, lumen depreciation will require their replacement. That point may be 6 or 8 years down the road, but they will need to be replaced.

Fortunately, LEDs pay for themselves in energy savings alone in just a few flocks, not years. If necessary, replace the sockets and the dimmer to get the most out of LED lamps. Check out possible rebate and incentive packages offered by local utilities to upgrade to LEDs. Ask distributors about any specials available from them or lighting manufacturers.

Another important aspect to consider today, at a time when many integrators are asking for additional floor light early in the flock, is the difference between omnidirectional and directional LED lamps (**Figure 3**). Omnidirectional lamps work great in a residential or commercial setting because the lamp spreads light from



6W A19 Overdrive	Equal to =	10W Household OMNI
6W	Lamp Wattage	9.5W
545	Lamp Rated Lumen	800
100%	%age Light on floor est.	65%
545	Effective Lumen on Floor	520
$16	Energy Cost over 25,000 hr	$26
$10	Saving in Energy Cost over Life	-
5 Year	**Warranty**	**3 Year**

Figure 3. Differences between directional and omni-directional LEDs. Image courtesy of Forrest Tabor and Tabor Group Inc.

all sides. Therefore, the ceiling, walls, and floor all receive light. Omnidirectional lamps send roughly 35–40 percent of their light either out or up. This is not ideal for a chicken house because all the light needs to go down to the floor where the birds are, not to the walls or the ceiling.

Most LED lamps sold at do-it-yourself/hardware stores are omnidirectional lamps. They are often relatively inexpensive, have a short warranty, and are not designed for a harsh poultry house environment. Omnidirectional lamps are designed for household use; they are made with consumer-grade electronics and are not properly sealed for corrosive or damp/wet locations. Directional beam angled LEDs are wet-location rated to protect the LED diodes against washdown and are designed with commercial-grade electronic parts, which allow for better low-end light control ability. When selecting LED lamps for a poultry house, choose a manufacturer with a strong track record in agricultural lighting, select lamps with at least a 5-year warranty, and purchase from a distributor that understands poultry house lighting and can help you make the right decisions.

There are multiple companies today that manufacture quality LED lamps rated for poultry house applications. Choose these over discount or bargain brands, even though they may cost more up front. Long-term energy savings and flock performance will be better with an agriculture-rated directional LED lamp than with a residential omnidirectional LED not designed for poultry house environments.

Summary

Lighting programs are common practice in the poultry industry today. These programs can have a significant effect on the production efficiency and welfare of the flock. LED lamps have become quite popular in recent years. However, their popularity has brought to light other issues that were unrecognized before and that should be addressed. Many older poultry houses have TRIAC light dimmers that are often not compatible with modern LED lamp technology. In addition, many older houses have old, corroded, cracked, or broken light sockets that do not work well with LED lamps.

The energy savings associated with LED technology are remarkable, and many growers have wisely switched to LED lamps to take advantage of this. However, with their increasing popularity, we have learned that adopting LED technology is more than just switching out lamps. To achieve the most from LED technology, it is critical that growers use proper light sockets and have the dimmer properly grounded with its own dedicated neutral coming directly from the panel box (not associated with a common neutral tied to other equipment).

In addition, to prevent issues such as ghosting, dead travel, excessive lumen depreciation, and difficulty dimming to very low levels, LED lamps should be controlled by a light dimmer designed to handle advanced LED technology. LED technology is an excellent tool for poultry growers and offers outstanding energy savings, but it must be properly managed to provide the most return on investment.

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