

SunPulse Technical Bulletin – February 2012 – Total Harmonic Distortion

The introduction of the electronic ballast has created significant changes for the commercial food production industry. Solid-state electronics don't behave anything like the traditional magnetic core and coil ballasts. Voltage requirements, starting sequences and high frequency have all changed as well. Advancements in HID electronic ballast power supplies have caused new distortions in these lighting systems that weren't present before. These distortions, while invisible to human eyes, contribute to mechanical problems such as premature lamp failure and excessive stress on electronic components.

What is Total Harmonic Distortion? (THD)

When you put different waveform distortions together in a power supply, you get a new reference called Total Harmonic Distortion (THD). Total Harmonic distortion in the power system can distort voltages and overload equipment. It's important to not only understand harmonics, but also how the electrical and power system reacts to the harmonics.

The **total harmonic distortion**, or **THD**, of a digital lighting system signal is a measurement of the total harmonic distortion present, bulb, ballast, etc., and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency. The lamps waveforms, power current and the operating frequency are influenced by lamp, ballast type, power conditions, lighting controls and temperature.

Lesser THD allows the components in digital lighting system to produce a higher quality digital signal by reducing harmonic distortions that are added by the ballast. A THD rating of < 1% is considered to be the high end of the scale. This reference applies to high frequency electronic ballasts which generate the THD that the lamp broadcasts. The lamp is literally broadcasting the frequency and any signal noise generated by the ballast.

All electronic ballasts have a different level of THD. Some popular e-ballasts are running from 250% to 400% THD! That level of THD is a very large, unacceptable number. These THD's are causing massive problems for the lamp and ballast and are producing huge amounts of signal hash, which translates into poorer light quality.

How is it created?

THD will be created by using particular digital or electronic high frequency ballasts, a particular cord set and a particular lamp and fixture. When each of these particular components are combined together it creates the total harmonic distortion. A high THD can not only distort light, but can also shorten the life of electronic ballasts and HID lamps. Harmonics in these distorted waveforms can also cause interferences and put burdens on electrical components.

Does an electronic ballast have more THD than a magnetic ballast?

Traditional 50/60 hertz lamps are designed for a slow, simple sinusoidal wave form put out by 50/60 hertz magnetic ballasts; they were made for each other. These magnetic, core and coil, ballasts have a total harmonic distortion of approximately 16%, which is considered to be a low number that's acceptable for the mechanical tolerances of the system. In contrast, poorly manufactured high frequency electronic ballasts can create a total harmonic distortion that can exceed **400%**.

I don't get it.....

If you spent thousands of dollars on a new stereo system, for example, you don't want to hear static and distortion. The same is true with an electronically ballasted HID lighting system, except human eyes don't see distortions of light. The rods and cones of human eyes are not equipped to register the distortions in waveforms. If the light is distorted, you are not getting the quality of light for the cost of energy being paid.

Lighting System Performance

The entire lighting system must be considered when talking about "performance" and "reliability". The lamp and the ballast must work properly together, like a speaker and an amplifier. If there is a mis-match in lamp and ballast systems, then distortions are created and amplified. Adding a complex, high frequency wave form to a lamp that was made for a simple one causes mechanical stresses on that lamp causing premature arc tube blackening, as well as cause fissures and cracks in the arc tube due to erratic arc stream performance.

There's a THD rating on my electronic ballast and the number is very low...

THD in lesser quality electronic ballasts will continue to be an important factor. Electronic ballast manufacturers do list a level of THD on their products. What these listed ratings are measuring is the total harmonic distortion that travels from the ballast to wall; what they aren't measuring is the distortion level from the ballast to the lamp which can actually be much higher. This was a rather large oversight by the makers of electronic ballasts.

References of THD

IEEE Std. 519 is an electrical safety standard for "Recommended practices and requirements for harmonic control in electrical power systems." The IEEE allows no more than 5% THD, with the largest single harmonic being no more than 3% of the fundamental voltage. Quoting the IEEE standard, "Higher levels of harmonics result in erratic, sometimes subtle, malfunctions of the equipment that can, in some cases, have serious consequences." The IEEE makes its recommendations for what's considered to be technically acceptable for consumers.

Summary

There are a wide variety of considerations to take into account when converting to the new HID digital electronics. Proper lamp and ballast combinations are essential for successful integration of these technologies. A lack of understanding these THD considerations will cost time, money and energy at the expense of the crops. Failing systems are frustrating, costly and inefficient. Take all the necessary time and precautions to buy compatible digital lamps and ballasts, with a low THD, to gain the maximum benefits.