

A current look at UV

Electronic ballasts eliminate impact of frequency variation.

By Myron Lupal

From the April 2001 edition of Water Technology magazine. For a free introductory subscription, [click here](#).

All ultraviolet (UV) disinfection systems have basic core components, including the UV lamp, reactor vessel, power source and peripheral components, such as UV monitors, temperature probes and solenoid valves.

A UV manufacturer can design most of these components to work as a stand-alone design. However, the key is for the manufacturer to incorporate the individual components into a total system. The challenge is to provide a system that will function in a country with a somewhat unstable power network equally as well as in a country with a very stable power network, such as in the United States or Canada.

Traditionally, manufacturers have used simple electromagnetic devices or ballasts, which incorporate electrical wires wound around a ferrite core. The number of windings determines the output current delivered to the lamp. The ballast also incorporates a starter to physically generate enough starting voltage to vaporize the mercury enclosed inside the low-pressure UV lamps. This all sounds relatively simple and in fact it is, as long as both the input voltage and input frequency remain constant.

The problem is that many regions around the world have extremely unstable power grids with both fluctuating voltage and frequency. To deliver the optimum UV output, a typical, low-pressure UV lamp operates at an output current of 425 (mA) (other lamp types may operate at 185mA or 800mA). If the lamp operates at less than 425mA, then the system produces less UV output and, consequently, less UV dose.

In simple terms, the UV system operates at less capacity on lower voltages. Conversely, if the lamp is overdriven at an output above 425mA, critical ballast and lamp failure will occur.

Beware of magnetic pitfalls

Magnetic ballasts suffer from a multitude of pitfalls. Although the cost of a magnetic ballast is relatively low, its use in the design of UV systems offers many obstacles.

Ultraviolet lamps give their optimum output at a temperature of 40 degrees Celsius (104 degrees Fahrenheit). If the temperature rises above this optimum, the resistance of the lamp changes, altering the voltage and current supplied by the ballast. The result is lower UV output and ultimately a lower UV dose.

In low-temperature situations, the lamp may experience difficulty in starting. In order for manufacturers to offer a variety of models with different flow rates, it is necessary to use UV lamps of varying lengths. As you vary the length of the lamp, you vary the voltage that the lamp requires to operate.

In order to provide a system incorporating a magnetic ballast, the windings contained within that ballast must be matched exactly to provide the proper voltage and current to the lamp. This translates into the need for a single ballast for each lamp at a specific voltage and a specific frequency.

As voltage and frequency vary tremendously (voltages do vary even in North America), many different ballasts would be required to provide the optimum output under each unique circumstance. When the incoming voltage is high, the lamp is overdriven and runs hot. The more it is overdriven, the hotter it gets, resulting in premature ballast and/or lamp failure.

What happens when a system using a lamp designed to operate on an input voltage of 115 volts suddenly receives 105 volts during a "brown out" condition? The results of this would be lower lamp current, resulting in a system that never reaches the prescribed UV dose. In an ideal situation, for a magnetic ballast to function as designed, you would need to vary the output flow based upon the input voltage and frequency.

Frequency, or the electrical "cycles" can cause even more disastrous results with magnetic ballasts. Input frequency variations as little as ± 3 hertz can cause ballast and/or lamp failures. Even though many countries claim to have "clean" power, vast variations do exist and the continued use of magnetic devices is not always flexible enough to adequately perform consistently in the field.

Electronics comes into play

In an effort to provide customers with the best possible components for their UV systems, the exploration of electronic solid-state ballasts began in the early 1990s.

An electronic ballast incorporates a series of transistors, filter capacitors and transformers. The ballast takes the AC input and converts it to DC, thereby eliminating the effects of frequency variations. The capacitors store this energy and modulate the

electrical output. The ballast then converts this DC back to AC and delivers this current back to the lamp.

If properly designed, the results of this device are a ballast that operates at extremely cool temperatures and operates over a wide voltage and frequency range.

These electronic ballasts proved to be a vast improvement over traditional magnetic ballasts. However, most of the electronic ballasts in use today are simply modified versions of ballasts used in the lighting industry.

Some designs do not address the issue of regulating the output current. And, even in new electronic ballasts, the lower the voltage delivered to the lamp, the lower the output current and the lower the UV dose delivered to the water.

Also, the useful life of a UV lamp is largely determined by the crest factor performance of the ballast driving the lamp. In some electronic ballasts, the crest factor is degraded by the amount of AC ripple voltage on the DC voltage supplied to the inverter circuit.

As the filter capacitors age, this ripple voltage of the DC supply will increase, therefore degrading the crest factor performance of the ballast.

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