FUSION UV SYSTEMS, INC.®

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# Why ALL the Data?

## Radiometers as Diagnostic Tools

Dick Stowe

We are often asked to troubleshoot a UV process that has changed in some way. Could the cause be in the chemistry or in the UV exposure? Or in something else?

Radiometry is the tool of communication when it comes to assessing UV exposure. Radiometers can tell us peak irradiance (some can give the complete irradiance profile), and energy in specific wavelength bands. That's usually not enough. We seem to want ALL the data. Why?

The information usually desired for process troubleshooting is:

Type of lamp and type of bulb
Style of reflector and reflector material
Distance from the lamp to the work
Type of power supply
Model number and manufacturer of radiometer used
Peak irradiance in UVC, UVB, and UVA bands
Energy in UVC, UVB, and UVA bands
Speed of conveyance

With this we can compare to 'standard' measurements of properly working lamps. Then, we can assess the difference, change, or error.

**Some very rough rules of thumb:**

1. If the peak AND the energy decrease, this may be the result of a change (intentional or not) in lamp power;
2. If the peak remains, and the energy decreases, the cause may be belt speed error;
3. If the peak drops but the energy remains, the cause may be focus;
4. If the peak reading is erratic, but energy remains, the cause may be sample-rate error;
5. If the ratio of UVC to UVA decreases, dirt or age may be affecting the reflector or bulb.
6. A change in the spectral distribution ratios can indicate a change (intentional or not) in the selection of the bulb or reflector type.

**Here are some observations on "sample rate" error:**

Why does my peak measurement vary all over the place? **Irradiance does not change with speed, and energy is strictly inversely proportional to speed.** So, if you see that the peak irradiance (Ip) appears lower at higher speeds, something must be wrong. This demonstrates the error caused by sampling rate.

Example: The PowerPuck® takes samples at 25 samples per second – and at a speed of 200 fpm, its samples are 1.6 inches apart! At this sample distance, there is a random probability

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that the radiometer will not be under the focus of the lamp when it takes its measurement. This is the cause of the difference in Ip of measurements. Sometimes it will be correct. (For this reason, all of our standard radiometry is done at 20 fpm.) If you use the only 50-200 fpm range of your conveyor, then your reference measurements should be at 50 fpm. At 50 fpm, the sample distance will be a little less than ½ inch. You should take several readings of peak – don't average them – the highest will be the correct one. This is the best number to be used for any speed.

Some radiometers measure at faster rates (some, *much* faster). Knowing the model of radiometer tells us the sampling rate. Some can sample *so* fast, that they can actually track the pulsing of the UV-emitting plasma in the bulb! This can result in a different kind of error, and usually in an erroneously high peak reading. Different types of power supplies drive the bulbs with different amounts of *ripple* in the electric current. That's when knowing the type of radiometer, we need to know the waveform of the lamp power supply.

**Energy (Exposure)**

Sampling errors have less effect on integrated energy. Even so, rather than send a radiometer under a lamp at lightning speed, it's easier and more accurate to calculate the energy at different speeds (based on a reference speed) than it is to measure it. Saves work, not to mention the problem of "catching" a radiometer traveling at high speeds.

Relationship to adjustable power levels: The measurements of Peak and Energy at various power levels are what they are. The reason for checking the ratio of E/I is a "sanity check"

**Dynamic Range**

Many lamps can produce peak irradiance levels up to 20 watt/cm². If the radiometer does not have the range to record the peak produced by the lamp, then not only will the peak reading be in error, but the energy reading will incorporate that error. We can determine the instrument dynamic range from knowing the model.

**Wavelength Band**

Various manufacturers of radiometers give them different *responsivity*. Most of these instruments are detector-filter types, and the combination of components in them determines the wavelength band to which they respond. Just reporting "UVA" or "UVC" is not sufficient. Knowing the manufacturer and the model of the radiometer will instantly tell us what the wavelength band is.

So bear with us when we seem to ask for more data than you may have.

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