Ocean Optics

Application Note

Keywords

- Process environment
- Thermal stability
- Miniature spectrometer

Techniques

- Transmission spectroscopy

Applications

- Quality control
- Process monitoring

On-line Quality Control Measurements in Varying Conditions

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Modern miniature spectroscopy is well suited for process environments, where real-time monitoring of raw stock, routine processes and finished goods is critical. Modularity of spectrometers, light sources and sampling optics allows for deeper implementation of instrumentation into the process flow, and makes it much simpler to optimize setups.

With the use of a new generation of robust, repeatable and stable instrumentation like the Flame spectrometer, manufacturers can more easily assess sample quality under rigorous conditions. In this application note, we investigate the thermal stability of a Flame spectrometer system for process line transmission measurements at different temperatures.

Background

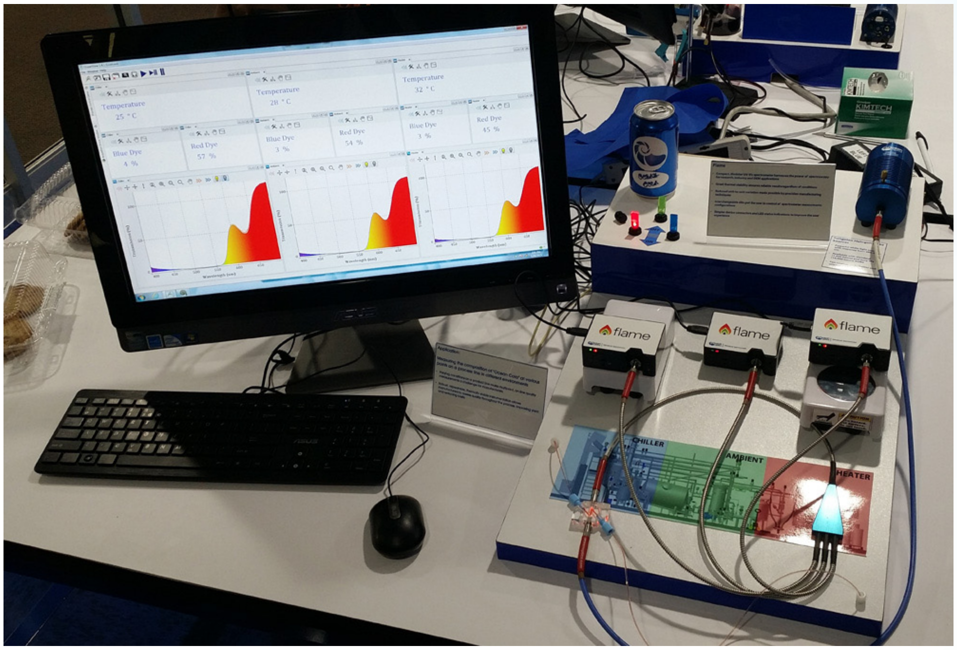

Figure 1: Several food dye mixtures were measured using Flame spectrometers in a simulated process line setup.

Even as advances in engineering technologies and manufacturing processes have lowered the cost to make and distribute products, the demand for continued improvement is as strong as ever. In an environment where small improvements in characterization of raw materials or subtle changes in process parameters can result in significant production savings, the ability to design faster, smarter and more robust instrumentation is paramount.

When the emergence of miniature spectrometers coincided with development of modular fiber optics, spectroscopy was no longer limited to the lab. Now you can bring the instrument to the sample, which allows industrial users to integrate the measurement into the process. Small-footprint modular systems can be rapidly configured for a variety of absorbance, reflectance and emission measurements, with a number of potential applications.

The Flame spectrometer addresses some of the limitations associated with miniature spectroscopy systems in dynamic process environments. For example, improvements in the optical design of the spectrometer and in how the spectrometer is assembled have resulted in low unit-to-unit variability, a critical element for high-volume OEM customers; and high thermal stability, which is essential for maintaining measurement consistency in a changing environment.

Measurement Conditions

To evaluate the effectiveness of the Flame spectrometer at different temperatures, we measured transmission of several concentration levels of food dye mixtures on a simulated process line. The instrument setup (Figure 1) comprised three FLAME-S-VIS-NIR spectrometers (350-1000 nm); a high-power tungsten halogen light source (HL-2000-HP-FHSA); a 10 mm pathlength flow cell (FIA-Z-SMA-PLEX); a trifurcated 600 micron Vis-NIR fiber, with each leg connecting to one of the spectrometers and the common end connecting to the flow cell; and a single 600 micron Vis-NIR fiber, for connecting the light source to the flow cell. OceanView spectroscopy software completed the system.

To simulate conditions encountered in a process environment, we isolated each Flame spectrometer in a different temperature environment – cool (using a chiller), ambient and hot (using a lab heater). Several sample mixtures were prepared for testing, using the Z-type flow cell to move each sample through the system. Water moving through the flow cell was measured as a reference (Figure 2).

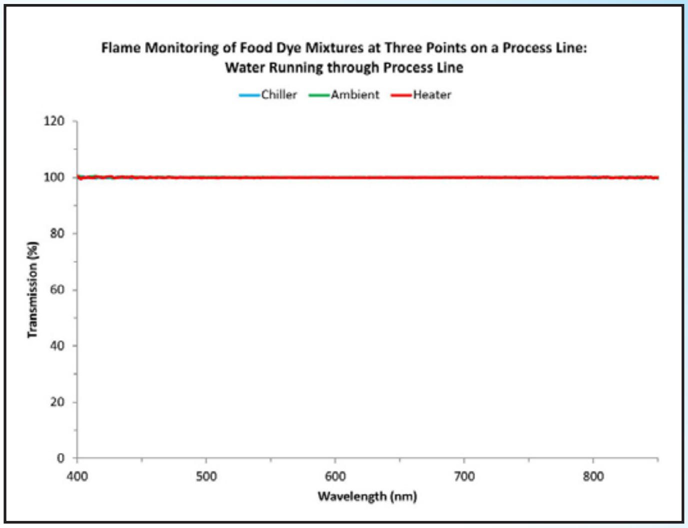

Figure 2: To establish a reference measurement for the experiment, water was measured in each of three temperature environments (chilled, ambient and heated).

Results

Although the Flame spectrometers measured the transmission of the mixtures flowing through the system at different temperature conditions, the resulting spectra – and sample composition information derived from the spectra – were nearly identical (Figures 3, 4). This result is significant for process line applications, where temperatures can vary from zone to zone within the stream. For quality control professionals, getting the correct answers under all sorts of conditions -- including temperature extremes -- is critical.

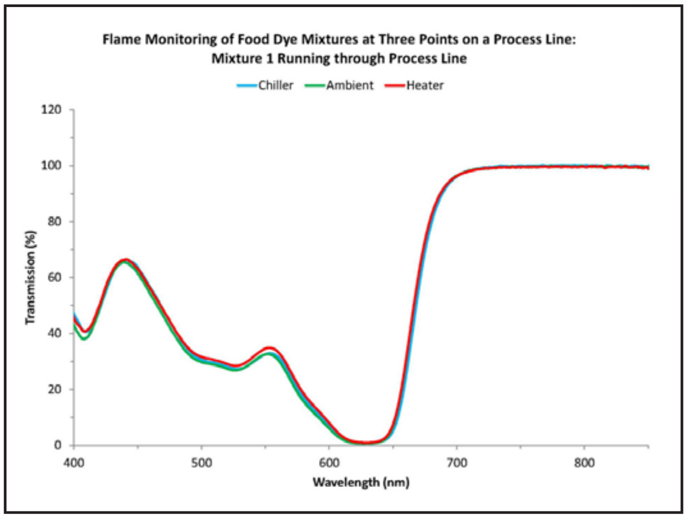

Figure 3: Spectra measured for the Mixture 1 solution were remarkably consistent across each temperature condition – chilled (24 °C), ambient (27 °C) and heated (30 °C).

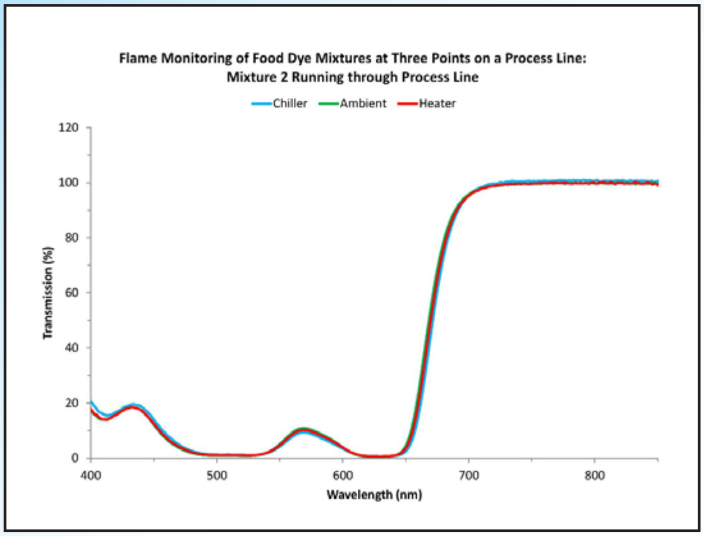

Figure 4: The Flame spectrometer produced consistent results across different temperature conditions, as these transmission spectra reveal.

Conclusion

Process environments can be harsh, with extremes in temperature and humidity, and the harmful effects of dust and vibration. That's why process-ready spectroscopic instrumentation such as Flame has been designed with few moving parts, has a high degree of thermal stability, and is easily adapted for different setups. The availability of such robust, repeatable, thermally stable instrumentation allows manufacturers to assess sample quality online at multiple points in processes, helping to improve yields, eliminate waste and reduce costs.

Contact us today for more information on setting up your spectroscopy system from Ocean Optics.

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