

Instrument Selection Criteria for Near-Infrared Process Monitoring – Guidelines and Applications

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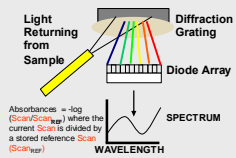


Introduction

Near-Infrared (NIR) spectroscopy has proven to be a valuable tool in monitoring many different process applications ranging from refinery measurements to pharmaceuticals to chemical production to sterilization. One key consideration when developing a NIR process measurement application is the wavelength range of the spectrophotometric analyzer. A full scanning spectrometer will provide the most flexibility when making measurements, but often times a measurement can be made with one or a handful of wavelength points. This paper will present some guidelines to making this choice accompanied by related application data.

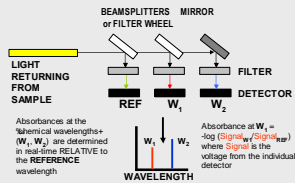
How They Work

Spectrophotometers



Entire spectrum of absorbances

Photometers



Several discrete absorbances

Process NIR Hardware Considerations

Full Scanning Spectrophotometer

- Multiple products of different chemistry or different grades
- A single very complex product
- Applications such as CIE Color that inherently require more than 18 wavelengths
- As an Instrument used to develop calibrations for other photometers

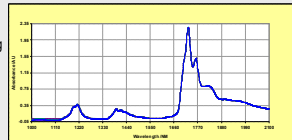
Photometer

- Products with simple chemistries
- Simple mixtures
- Small number of wavelengths required for calibration
- Photometer is tuned to an individual measurement

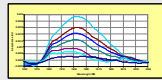
Application : Water in Hydraulic Fluid

Process Measurement Required:

Measure water content in hydraulic fluid during the bottling process. Target concentration: 50ppm

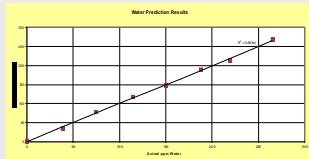


NIR spectral data reveals one single peak related to the concentration of water in the hydraulic fluid. This peak measurement along with a reference wavelength make this application well suited for a photometer.



Water in Hydraulic Fluid - Results

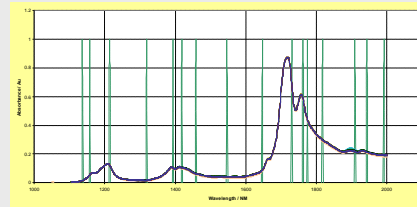
A simple least squares calculation produces calibration results accurate to +/- 5 ppm water. This can provide detection of water down to 15 ppm water in the hydraulic fluid during bottling. This improves control and reduces the variation in product quality.



A Guided Wave ClearView™ photometer coupled with a fiber optic probe assembly allows for easy continuous, real time results with no user interaction during the measurement process.

Application : Biodiesel

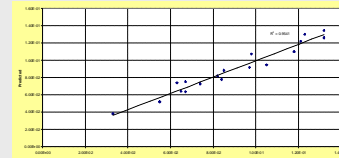
Process Measurement Required: Monitor both incoming raw material as well as finished biodiesel product for contaminants. Parameters of interest include methanol, total glycerin, water and free fatty acids. Spectral data from a series of biodiesel samples indicate several spectral regions that will provide sufficient information for making the required measurements. The regions marked in green indicate the wavelength positions of the filters selected for this application measurement.



The Guided Wave MultiView™ photometer can be configured and pre-calibrated for individual applications. The unit allows for 18 discrete filter measurements across the NIR spectral region. All of Guided Wave's standard probes work with the MultiView™ unit making it an easy fit into a process scheme.

Biodiesel - continued

Calibration results for total glycerin using 10 wavelengths are shown in the figure below.

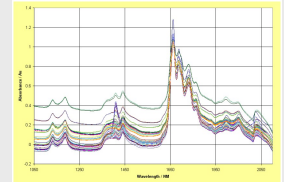


Multiple parameter predictions in biodiesel are possible using a series of bands across the NIR spectral region, making this an ideal application environment for a multi-filter photometer such as the Guided Wave MultiView™ photometer. In addition, making outlier detection possible enhances the reliability of the results.

Application : Polymer Processing

Process Measurement Required: Measurement of hydroxyl number and acid number in polyester resin in a batch production.

Faster measurement times can result in a decrease in the lag in production. Also, improved control over the resin quality is possible.

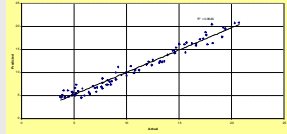


In the process, temperature fluctuations can have an impact on the spectral data. A full scanning spectrometer can account for these types of interferences as well as easily identifying situations where a product may be out of specification.

Polymer Processing - continued

Calibration results for hydroxyl number over a range of temperatures and products is achieved using the full scanning spectrophotometer. Accuracy shown below for this measurement is 0.92 hydroxyl units.

A full scanning instrument such as the Guided Wave Model 412 Process Spectrophotometer allows for calibration selection amongst batches, easy outlier detection, multiple stream analyses, an easier path to transition to new applications, and even use as a development tool for other measurements.



Summary

NIR is a proven technique for process monitoring applications. The application requirements dictate what level of sophistication is needed in the hardware to accomplish the measurement. Guided Wave is in the unique position to address all of these hardware needs from a 2 wavelength measurement with a ClearView™ analyzer to a multiple wavelength photometer measurement with a MultiView™ analyzer to a full scanning multiplexed system with either the Guided Wave Model 412 NIR Process Spectrophotometer or the Model 508 UV/Vis Process Analyzer.

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