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REAL-TIME OPTICAL ABSORPTION ANALYZERS

APPLICATION NOTE

# Sulfuric Acid Concentration in Water Using a NIR-O™ Spectrometer or ClearView® db Photometer

Our GUIDED WAVE™ product line includes a near-infrared (NIR) spectromter, called the NIR-O™ process analyzer and the ClearView® db Dual-Beam photometer. This application note discusses the use of our hardware and software tools for the measurement of sulfuric acid using fiber optic-based NIR spectroscopy. NIR analysis can be applied directly in process monitoring or as a laboratory procedure. In either case NIR is a time and money saving alternative to traditional methods such as titrations. Additionally a spectrometer proves more reliable and accurate than other common devices for measuring acid concentration such as pH meters and densitometers.

## Measurement Background

The NIR region of the electromagnetic spectrum allows the use of the overtone and combination bands of the C-H, O-H, and N-H fundamentals. By measuring the NIR spectra of a series of samples having known sulfuric acid concentration, a quantitative model can be developed which will allow the measurement of future samples based only on their NIR spectrum. Our analyzer systems use fiber optics to allow the sample probe to be located in remote locations away from the spectrometer, greatly reducing the level of operator exposure and providing a real time assessment of the process stream.

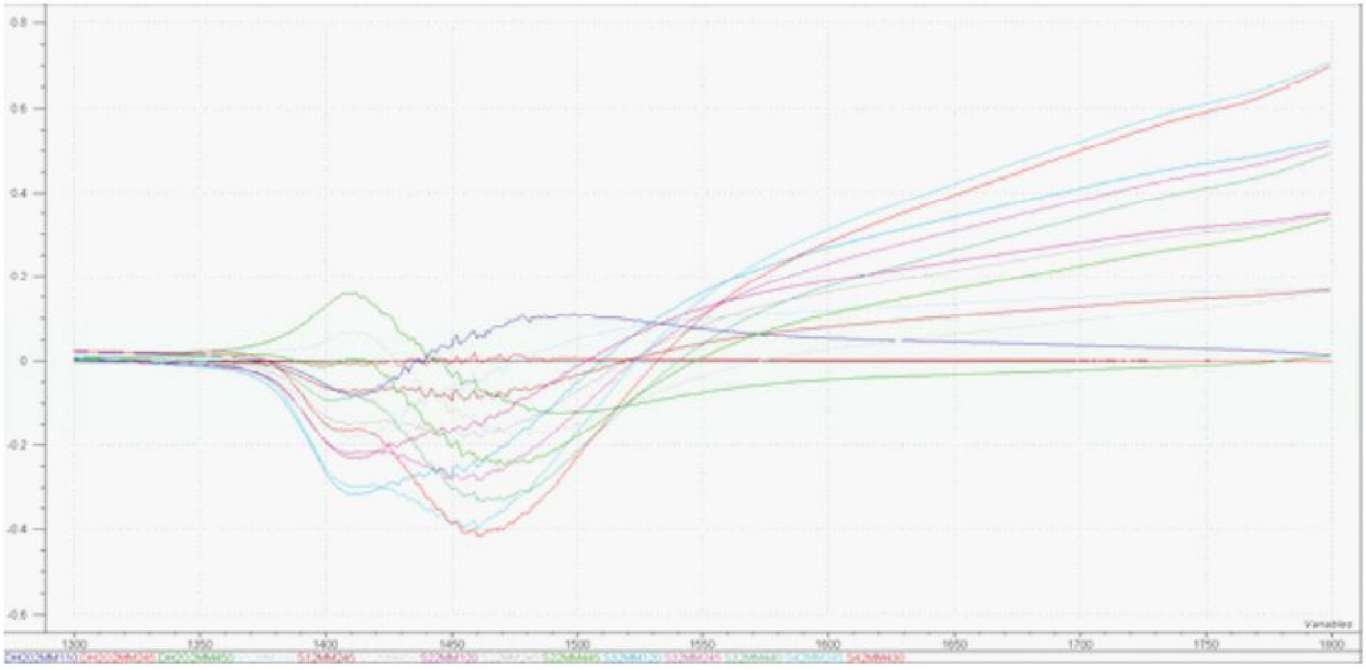

Figure 1: NIR Spectra of Sulfuric Acid Samples

## Experiment

The NIR spectra of a group of aqueous sulfuric acid dilutions of 0-20% were measured at a series of different temperatures between 11 and 45 °C using the NIR-O process spectrometer. The unit was zeroed using water, allowing the spectral features attributed to sulfuric acid to be more easily seen. Figure 1 shows the absorbance spectra collected using a 2 mm pathlength cuvette cell from 1300 - 1800 nm. The correlation is .999 and RMSEP is 0.281% $H_2SO_4$.

## Analyzer Selection

For well established process measurements, a ClearView db multi-wavelength photometer can be used to achieve similar results. The photometer systems offer robust measurement capability for a more focused set of applications. Visit the Process Insights website for guidance on the choice between measurement systems.

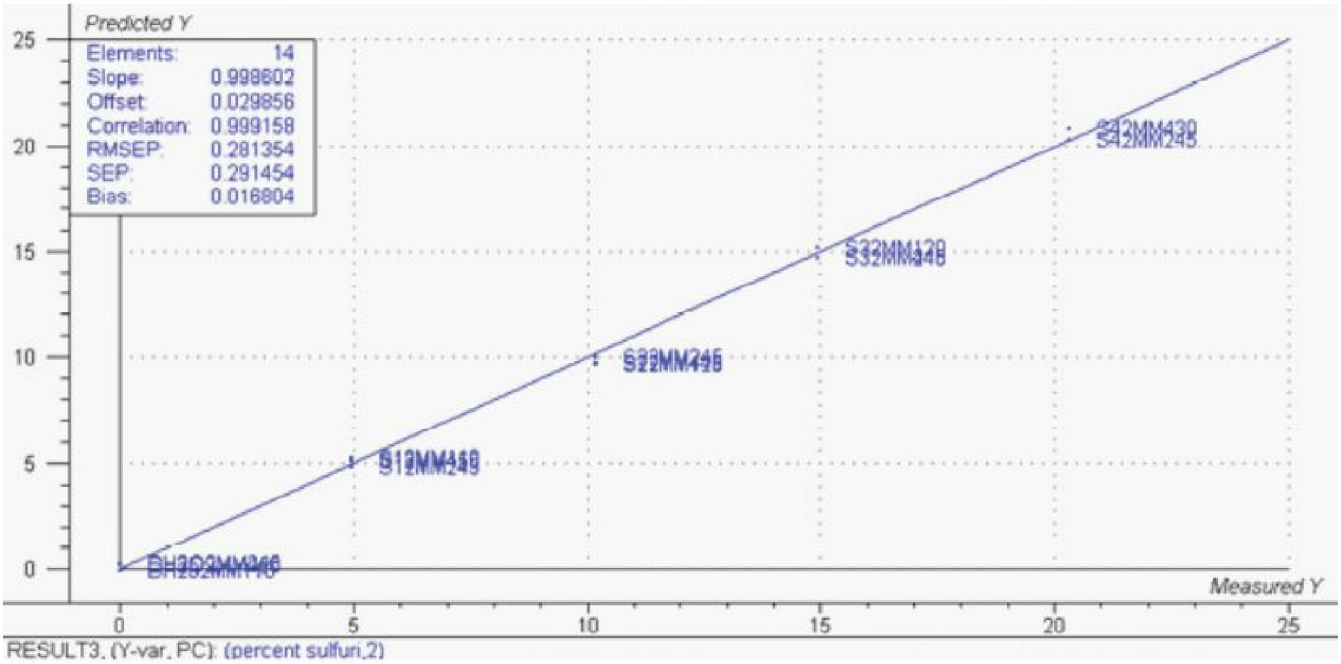


Figure 2: PLS1 Plot

## Analysis

Savitsky Golay first derivative pre-processing was applied. A Partial least squares (PLS1) regression analysis was performed using the spectral data from 1300-1425 and 1550-1700. Results are shown in Figure 2.

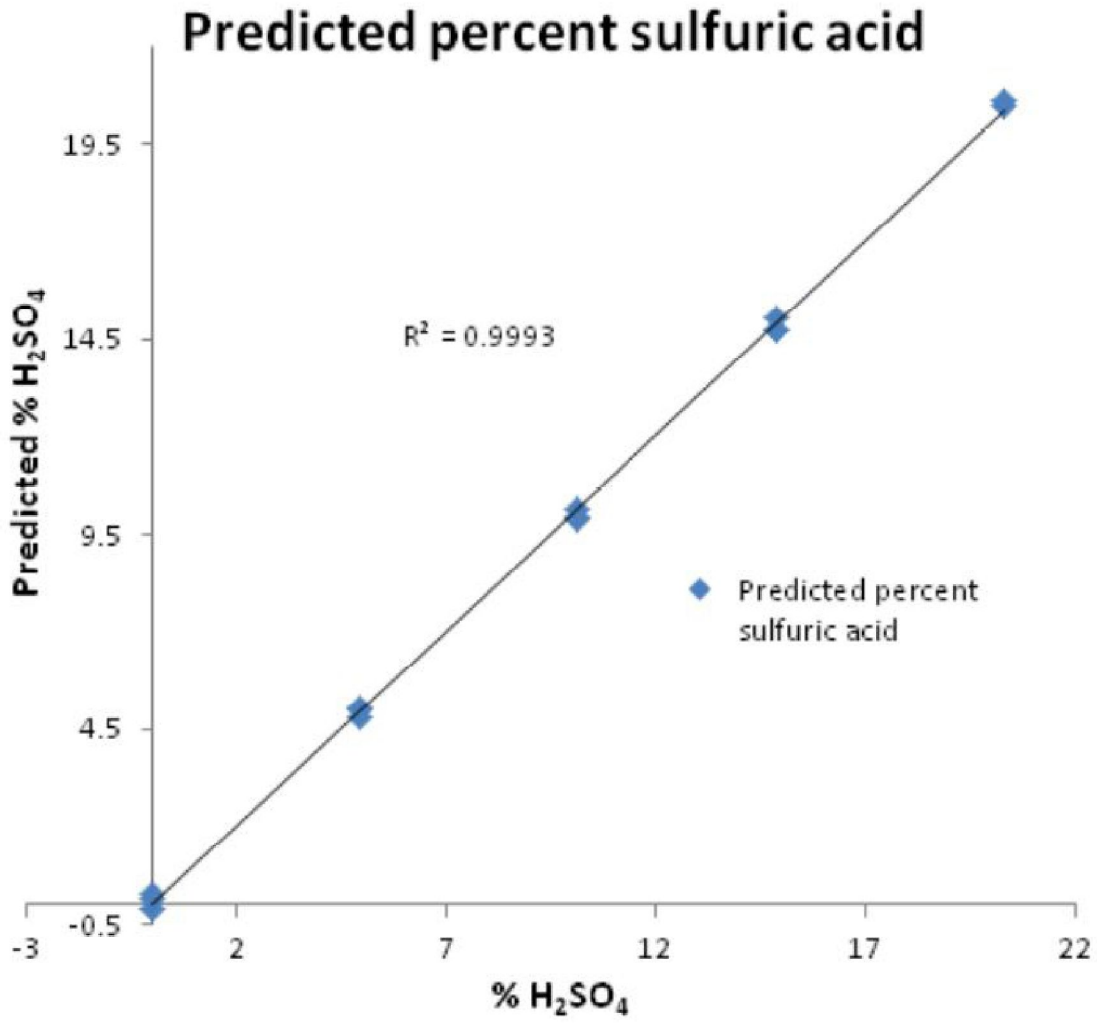


Figure 3: Predicted Percent Sulfuric Acid

## Experiment (continued)

The original spectra were also baseline corrected at 1300 nm. The 1390 and 1500 wavelengths were selected, along with the temperature, for a multiple linear regression model. The prediction results from the MLR model are shown in Figure 3.

Using the temperature and baseline corrected absorbances at 1390 and 1500 nm a correlation of .999 and a standard error of 0.210% $H_2SO_4$ was achieved. This demonstrates that a our ClearView db photometer with 3 filters and temperature input would also be suitable for sulfuric acid monitoring applications at these concentration levels.

## Discusion

The measurement of sulfuric acid concentration in water using NIR spectroscopy is both fast and reliable utilizing the hardware and software tools described. This method minimizes the need for laboratory sample collection. Results are available in real-time (seconds) for acid concentration in aqueous streams. For more detailed information regarding system specifications please contact a Process Insights technical sales specialist.

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