

ChemScan[®] Process Analyzer

Reprint

Project Summary

Side by Side Evaluation of
ChemScan UV-4100
and
Hach (Dr. Lange) Optiquant
at
Littleton-Englewood Colorado

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Introduction

ChemScan and Hach were invited to provide demonstration systems for analysis of nitrate in the influent to and effluent from an up flow denitrification filter pilot under evaluation by Littleton-Englewood CO.

Other instrument suppliers such as Endress & Hauser, WTW and ABB were also evaluated, but were found to be unacceptable due to high maintenance or poor reliability. These systems were removed or disabled prior to the Hach and ChemScan side by side evaluation.

At this location, one ChemScan UV-4100 was used to provide a separate analysis of nitrate and ammonia in process influent and a separate analysis of nitrate and nitrite in process effluent. One Hach Optiquant was used for nitrate analysis in the influent and a separate Optiquant was used in the effluent.

This evaluation is a good example of operational differences between these systems and also highlights some of the sales tactics that can be anticipated in future competitions between Hach and ChemScan.

Hach's claims at this location include the following major points:

1. Hach contends that Optiquant and ChemScan use "similar analysis techniques".
2. Hach contends that ChemScan requires "more fiddling around".
3. Hach contends that Optiquant is less expensive than ChemScan.

Each of these claims is addressed in the following analysis.

A ChemScan system was ultimately purchased for this application.

Nitrate Analyzer Comparison at Littleton-Englewood, CO

Analysis Techniques

Both the ChemScan and the Hach Optiquant use UV light absorbance for analysis. Hach uses one detection wavelength and a second wavelength to compensate for turbidity. ChemScan uses 256 wavelengths, with multiple wavelength analysis and multiple wavelength compensation for background chemistry. ChemScan does not use ion specific electrodes for any analysis and does not use reagents of any kind for analysis of nitrate and/or nitrite. (Some of the other on-line analyzers provided through Onedo/Biofor were ion specific analyzers. Is there some possible confusion here?)

ChemScan achieves accuracy and stability by performing a discrete full spectrum analysis of a specific sample within a flow cell in order to measure the desired chemical concentration. Because of the many wavelengths available, ChemScan can compensate for other chemicals and interferences that may be present in the sample. The discrete analysis performed by ChemScan means that a single system is capable of performing a successive independent analysis of incoming samples from several different process locations, regardless of concentration or background chemistry differences at each location. (It also means that multiple parameter analysis is possible.)

Hach can only measure at one wavelength, with a second wavelength for turbidity compensation. Thus, the Optiquant cannot compensate for chemical interferences such as organics, metals, or other nutrients that absorb light at the same wavelength used for nitrate analysis. For example, Hach cannot separate nitrate (NO₃) from nitrite (NO₂), so both are measured together and reported as "oxidized nitrogen", which can be an issue at the influent to a denitrification process since nitrite is an intermediate species that actually exerts on oxygen demand. Stability in the Hach system is apparently achieved by "smoothing" the data, essentially taking an average of responses over a long time period, which means that the instrument appears to have good stability but actually is less sensitive to instantaneous concentration changes that occur within a short period of time, such as rapid detection of a change in effluent nitrate resulting from a change in influent methanol. We have observed substantial on-line nitrate concentration change in 10 minutes or less following a change in methanol concentration, such as the period between midnight and 6:00 am on 5/15/02 when methanol feed was apparently lost at the demo site, the effect of which can be seen on the attached Excel spreadsheet, which was prepared using the internal data log in the ChemScan analyzer.

Rapid, dependable response is an essential feature for any chemical feed control application. ChemScan conducted an experiment at Littleton-Englewood by adding several ml of 1000 mg/l nitrate standard into a 5 gallon bucket that contained the Hach Optiquant analyzer sensor and the ChemScan sample line. The Hach system required more than 30 minutes to reach a peak response, while the ChemScan system detected the full increase on the first analysis following the change and held steady on each successive analysis. When the bucket contents were replaced with fresh (unaltered) process sample, the Hach system required more than 30 minutes to return to a stable low concentration, The ChemScan system detected the lower concentration on the first analysis following the change and held steady thereafter.

“More fiddling around”

Operator attention can be classified into four categories:

1. Startup and site specific calibration

ChemScan always performs an initial site-specific calibration, to assure a good correlation between the analysis performed by the analyzer and the corresponding laboratory result for each parameter and each sample point. This is a one-time task performed by ChemScan personnel and is included in the price of the instrument. The task does require a series of samples to be analyzed in the site laboratory for comparison. This analysis comparison does result in some initial effort by the plant laboratory, but the result is a site-specific calibration for each analyte that is in agreement with the laboratory. Due to our flexible configuration, our analog output connections and output range adjustments also require a little initial effort.

The Hach Optiquant is factory calibrated to standards that may not reflect site conditions and site specific water chemistry background. A site specific calibration can be performed (by the plant or by Hach for additional cost), but the limited number of wavelengths in their instrument only allows adjustment of the measurement higher or lower but does not allow for any adjustment to separate analyte concentration changes from background water chemistry changes. It is, however, a standardized product and is very easy to install.

2. Replenish zero standard and cleaning solution

Any optical analyzer needs to contend with the effects of fouling on optical surfaces in contact with the sample. ChemScan does require zero standard (DI water) and cleaning solution (dilute bleach) to be replenished at periodic intervals (once or twice per month). This is necessary in order to eliminate the effects of fouling within the flow cell. The effects of fouling can be eliminated by measuring full spectrum light absorbance while a zero standard is in the cell, then subtracting the response from any subsequent on-line measurement. The fouling itself can be removed or reduced by flushing the cell with a cleaning solution. Both tasks are performed automatically by the analyzer at periodic (operator selected) intervals, which results in long term stability with a minimum amount of maintenance.

Hach uses a mechanical wiper to remove deposits from the window, which is located on the sensor head immersed in the process liquid. We know from experience that mechanical wipers will not effectively remove mineral deposits and can smear slimes across the window as the wiper wears. This will eventually impact the accuracy of the analysis unless the deposits are physically removed. If the wiper, window, lamp or detectors need to be serviced, the entire assembly must be removed from the process for service. A site does generally not

experience these issues during a short term demonstration for this type of analyzer, since they are longer term wear issues.

3. Reagent replenishment

The ChemScan analyzer provided during the demonstration performed both nitrate and ammonia analysis on the Biofor influent and a separate nitrate and nitrite analysis on the Biofor effluent. ChemScan uses no reagents for analysis of nitrate or nitrite. Non-proprietary reagents, consisting of dilute bleach and hydroxide, are used for ammonia analysis. These reagents need to be replenished once per month. (Ammonia reagents may not have been replenished during the demonstration period, resulting in the exhaustion of reagent during the last few weeks.) ChemScan was prepared, at the request of the plant, to add phosphate analysis capability to the demonstration system for a special study, but this request was dropped prior to the end of the demonstration. An additional reagent (vanado-molybdate) would have been used for phosphate analysis.

The Hach Optiquant analyzer can only perform oxidized nitrogen analysis at one sample point. Optiquant cannot perform ammonia analysis or phosphate analysis or a separate analysis of nitrate and nitrite.

4. Comparison Samples

Most demonstration projects verify analyzer performance based on comparison of analyzer results with a series of extracted grab samples. ChemScan suggested this type of data comparison, but instead, the plant apparently used comparison of time proportioned composites for Biofor influent and effluent with the results of flow proportioned physical composites for the secondary clarifier effluent and the final effluent sample points.

We were told that both analyzers had acceptable results and were reading “about right”, based on the composite comparisons. This method, however, does not demonstrate the ability of the analyzers to rapidly and accurately detect and track concentration changes that occur within short time intervals.

Cost Comparison

The list price for a ChemScan nitrate analyzer is about double the list price for a Hach Optiquant analyzer (excluding freight and service). Thus for nitrate only, at two sample points, the system cost will be close to the same for one ChemScan with two incoming sample lines compared with two Optiquants. The ChemScan UV-3150 nitrate analyzer can monitor up to eight sample points, with a cost of under \$2,500 for each additional sample point, much less than the marginal cost of an additional Optiquant analyzer.

The ChemScan system is fully programmable and can communicate directly with the Tetra Pace system. ChemScan can receive instructions directly from the Pace controller if desired. This capability can be used, for example, to perform repeat analysis on a high

priority sample point or to perform a rapid and reliable analysis of any sample point, on demand, if needed for an operational decision.

The Optiquant system may not be able to rapidly and reliably track the changes in nitrate concentration that result from a change in methanol feed rate. This may require a fundamental change in the Pace software to accommodate a "continuous" analyzer that can only output an "average" change over a long time interval. The cost of this additional software should be considered.

One time startup and field calibration by ChemScan, although an additional cost, avoids the need for numerous manual field adjustments to keep the analyzer in agreement with the laboratory. Occasional adjustment of slope and offset is recommended for ChemScan based on a set of 4 to 6 samples. Each Optiquant system may eventually require periodic adjustment by the plant, with or without initial adjustment by Hach, to compensate for drift and fouling and to correct for changes in background water chemistry.

Long term maintenance is very low for the ChemScan UV-3150 system due to the initial site specific calibration and automatic zero/clean. Many ChemScan instruments have been in continuous operation on this application for more than five years (a few systems for more than ten years), without the need for recalibration or rebuild. Our customers report average maintenance for ChemScan nitrate analysis systems at less than 2 hours per month, mainly for zero/clean solution replenishment and optional grab sample comparison. Lamp life has been demonstrated to be in excess of five years. There are no wipers to adjust or replace. Internal pump maintenance is infrequent (quarterly) if sample flow from pressurized sample lines is available. Sample manifold valves are high quality and interchangeable. Any and all maintenance is at the analyzer, not at tank side.

If multiple parameter analysis capability is desired the UV-3150 is not the appropriate product, as it is limited to analysis of a single parameter without reagents. The UV-3150 is not able to be field modified for additional parameters, but can be field modified to add additional sample lines, up to a maximum of eight, if originally ordered with fewer lines.

The ChemScan UV-4100 is capable of detecting up to four parameters, including ammonia, phosphate, nitrite, uv transmittance and/or COD in addition to nitrate, but is only capable of analyzing a maximum of two incoming sample lines for these multiple parameters. The UV-4100 is more expensive than the UV-3150, depending on the exact configuration desired, but the additional cost is less than the cost of one additional single parameter analyzer for ammonia or phosphate. The UV-6101 is capable of detecting up to eight parameters and monitoring up to eight sample lines. If ammonia and or phosphate analysis at a few sample points were desired in addition to nitrate (or nitrate and nitrite) at several sample points, the additional charge for the UV-6101 would also be less than one additional analyzer. Total maintenance on either of these analyzers will be under four hours per month.