Portable Parallel Analysis: Streamlining Distribution System Water Testing

By Derek Walker, Application Development Manager

Problem
Myriad tools for sampling, long test cycles, and manual data logging create various water quality issues for water distribution utilities

Solution
The Hach SL1000 consolidates tools and offers rapid, real-time results as well as tools for data logging

Benefits
Streamlining the sampling process saves communities water, and quicker, more accurate results produce higher water quality

Background

New advancements in Portable Parallel Analysis (PPA) handheld instrumentation allow for more efficient, accurate, and simultaneous multi-parameter water quality analysis, representing a radical shift in the future of field testing. PPA also provides an effective means for earlier detection of precursors to monochloramine decay that can lead to nitrification. For a large utility leveraging Hach's SL1000 PPA, the analyzer significantly reduced analysis time for field personnel while reducing the potential for testing errors.

One Hach customer operates a water treatment facility responsible for delivering water to households and businesses. Instead of treating their own raw water from a river or well, they purchase treated water from a large wholesaler. The utility treats and maintains the water, as they are ultimately responsible for water quality. Its water system sits at the far end of the distribution network served by a large wholesaler, and much of the water is two to eight days old—or sometimes older—by the time it reaches the customer's tap. The utility purchases a unique and complex water supply—a blend of river water, desalinated seawater, and groundwater. Its surface water treatment plant covers more than 200 acres and can produce up to 120 million gallons per day. The average distribution system demand is 52 MGD. The system is lengthy, containing approximately 2,000 miles of piping and more than 3,000 "dead ends." The area's humid subtropical climate results in warm water in the distribution system year round, and parts of the system are relatively old.

The utility conducts vigilant field sampling to regularly measure free ammonia levels at numerous points within the distribution system to guard against nitrification. As part of its sampling program, the distribution system is divided into seven geographic sections, with each section containing 10 to 12 screening areas, or sampling stations.

Nitrification

Proper testing is critical for identifying potential problems before they affect water quality. Utilities need to consider numerous variables when testing water quality. These include variables such as:

- Length of the pipeline

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- “Dead ends” within the pipeline
- Age of the pipeline
- Age of water before it reaches customers’ taps.

Like many large utilities, the utility and supplying wholesaler practice chloramination, which produces monochloramine residual for disinfection. Ammonia is added to chlorine to form chloramines. Because ammonia is an energy source for nitrifying bacteria that may be present in the distribution system, unreacted (or “free”) ammonia is kept to a minimum. Nitrification occurs under optimal conditions for growth of nitrifying bacteria in the distribution system. The chloramine residual is consumed, and any free ammonia is converted into nitrite and nitrate.

To guard against nitrification, it’s vital to conduct field sampling regularly to measure free ammonia levels at numerous points within the distribution system. Historically, distribution system sampling is time consuming and labor intensive for utilities. Also, sampling quality is affected by the analytical procedures used, the diligence of the water quality specialist conducting the analysis, and of course the quality of each sample taken.

Assessing PPA

Field personnel typically carry multiple instruments on their daily routes, including a Hach DR900 Portable Colorimeter to run tests for sulfate, monochloramine, total chlorine and nitrite, as well as an electrochemical water quality meter and probes for measuring pH, temperature, and conductivity. Using the colorimeter, field personnel typically run total chlorine or free chlorine tests, a nitrite test, pH, and water temperature at the screening sites. Because only one sample can be run at one time using the DR900, and individual tests can take up to 20 minutes to complete using the handheld unit, testing at many of the system’s screening sites can be a particularly lengthy process.

Solution and Improvements

Recently, the utility participated in a field trial for the newly introduced Hach SL1000 PPA. The introduction of simultaneous multi-parameter measurement with the SL1000 allows field specialists to run six key measurements at the same time using the same water sample without any special preparation. The SL1000 PPA is a handheld water quality meter that performs up to four colorimetric and two probe-based measurements in parallel. It uses disposable planar cuvettes (Chemkeys™) for meso-fluidic channel colorimetric analysis for free and total chlorine, monochloramine, free and total ammonia, nitrite, and copper. Copper is a valuable parameter to monitor for corrosion control as well as averting potential negative impacts on the wastewater treatment plant processes.

The small cuvettes include all necessary reagents and also act as the sample cell. In addition, the meter has two ports for plugging in pH, conductivity, and dissolved oxygen (DO) probes. The handheld meter records and stores all data, including site location, operator ID, date, and time. Field technicians can download data into an Excel spreadsheet, eliminating manual data entry—another potential source for errors.

How PPA Works

To begin field analysis at a site, the user inserts up to four of the applicable Chemkeys into the unit’s slots or ports—similar to inserting a USB flash drive or thumb drive into a computer. The meter automatically identifies the type of Chemkeys installed, as well as the type of probes connected.

Once all the Chemkeys and probes required for the site testing are inserted, the field technician rinses the unit's meter sample cup with the sample and then fills the cup to the fill-line with the sample. The inserted Chemkeys are dipped into the meter sample cup. Following an on-screen and audible alert (within one to two seconds), the field technician immediately removes the Chemkeys from the sample cup.

The parameters have different reaction times and the meter displays a progress bar for each parameter, indicating the time remaining until measurement is completed. Once completed, all measurement values appear on the display and is accompanied by an audible alert. Method reaction and measurement times and internal temperature control are fully automated. The used Chemkeys are disposable or recyclable.

Testing Time Reduced

The evaluation of the SL1000 analyzer by the utility was coordinated with treatment plant laboratory in June and July of 2014. During the evaluation period, the new handheld instrument operated side-by-side with the utility's existing colorimeters and pH/temperature/conductivity probes.

Testing time for total chlorine, monochloramine, free ammonia and nitrite using the utility's existing colorimeters averaged 24.8 minutes, compared to 11.1 minutes using the SL1000. Analysis time via on-site parallel analysis was reduced by 1.5 hours on a typical screening route that takes four hours.

The utility flushes these points when nitrite reaches an action level of 0.025 ppm. During the flushing, the utility performs nitrite and chlorine tests with a colorimeter. The nitrite tests last approximately 20 minutes, and that doesn't factor time for testing other parameters. "With the SL1000, we ran all these parameters simultaneously–total chlorine, pH, temp, nitrite, monochloramine and conductivity—all within eight to 10 minutes," said a Water Quality Management Technician for the utility.

This is significant. Utility staff determined that the faster sampling time, especially for nitrite, and the addition of free ammonia analysis saved both time and water in the utility's system maintenance flushing to reduce nitrification. The flushing program includes flushing and monitoring the dead ends within the distribution system. It is estimated that approximately 20,000 gallons of flushed water would be saved per site if testing time during flushing operations were cut to eight minutes.

"We're flushing water and running samples at hydrants flowing at 1,540 gallons per minute," said the field technician. "And [we're] doing this at anywhere from six to 10 sites a day. That eight minutes versus 20 minutes can save a community a lot of water and a lot of time for a utility's staff."

Catching Nitrification Early

Earlier detection of certain conditions preceding nitrification is advantageous. Free ammonia, for example, is a key indicator for distribution system nitrification. Free ammonia is a precursor to nitrification. The utility still needs to collect free ammonia samples to test for this. There are two major problems when collecting these samples: the samples can change when transferring them from the test site to the lab, and it takes about a week to receive finalized results from the lab. "Using the SL1000, we can know a site's free ammonia level almost instantaneously," said a veteran Water Quality Management Specialist.

Reduced Variability

In addition to reduced testing time, sample results experience reduced variability because the SL1000 PPA performs the same tests with less than half the manual steps compared to other methods. Automation and internal pH and temperature control makes the process more consistent and repeatable than the standard handheld colorimeters, while applying the same processes and reagents as current Hach methods. “The efficiency gained from less sample-to-sample and operator-to-operator variability provides a tremendous advantage,” said another veteran Water Quality Management Specialist. “Out in the field it’s a good thing to know that you’re going to get consistent numbers over and over again.”

The new portable parallel analyzer also takes the manual steps out of datalogging, further reducing the potential for human error. “We’re currently using field data record sheets that are manually entered,” he explains. “The ability to set up individual sample sites on the meter takes out the possibility of entering something wrong into a spreadsheet. The data is saved directly into the meter, then it can all be imported onto a spreadsheet. Every day we take all the data that we receive from the water technicians and input it manually into a spreadsheet. That data then has to be QA/QCed every single day. By not having to manually input that data into any type of spreadsheet, the QA/QC on that data can go away, basically, because it’s input directly into the spreadsheet by the meter, taking away any potential for human error.”

Conclusion

Expanding Capabilities / Reducing Discrepancies

The advancement of colorimetry on the mesoscopic scale (which has helped to bring about the development of the SL1000 PPA) is poised to greatly expand the capabilities of all personnel involved with water quality monitoring and sampling. Further, these advancements aim to eliminate many of the factors that have long contributed to discrepancies in analysis results.

“The major advantages of using this new portable technology is not just the speed of it,” said a senior Water Quality Management Specialist for the utility. “It removes many of the variables—the unknown factors—we have to deal with, such as exacting sample cell measurements, cell cleanliness, and many other issues. It takes all those unknown factors out of the equation. Everything is done in the same way because this new technology is doing all that for us.

Good testing forms the basis for regulatory compliance and ensures the best possible quality drinking water. However, any variation in testing processes has the potential to impair the quality of the data that water quality specialists work so hard to obtain. Differences in field personnel, equipment, materials, calibration procedures, environmental conditions, and other factors all have the potential to contribute to discrepancies in testing results. “Whoever is doing the test is going to be doing it exactly the same as the next person,” said the senior specialist. “This provides much more reliable information [so] utilities like ours can make the best decisions regarding water quality.”

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