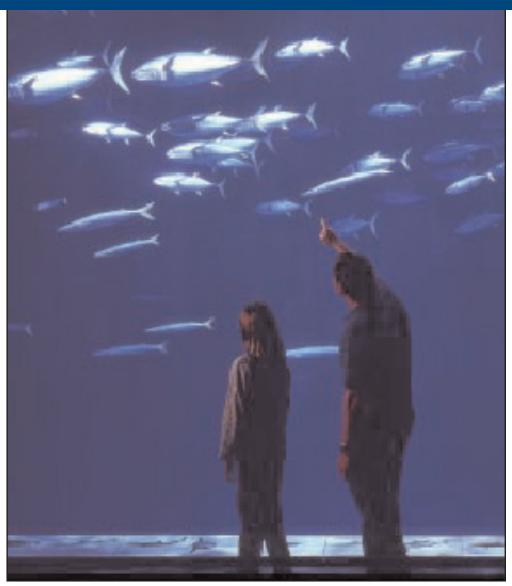
Aquarium Gets a Handle on Handhelds for Spot DO and pH Measurements



Although continuous, online monitoring and control of water quality parameters is essential at Monterey Bay Aquarium, scheduled spot measurements with handheld instruments also play a vital role in protecting the multitude of marine life exhibited there. New portable instrumentation is providing accurate, repeatable measurements, preprogrammed methods for multiple analysis as well as expanded data storage capabilities.

The Monterey Bay Aquarium is home to more than 35,000 animals and plants representing over 620 species of fish, invertebrates, mammals, reptiles, birds and plants found in the diverse habitats of Monterey Bay and other marine habitats worldwide. About 1.8 million people visit the aquarium each year to view its nearly 200 galleries and exhibits.

Approximately 1,500 gallons of seawater per minute are continuously pumped from the bay through the exhibit tanks. From an intake approximately 1,000 ft. offshore and at a depth of 55 ft., raw seawater is pumped through the exhibits at night, bringing with it plankton for filter feeders and spores of seaweed and tiny larvae of invertebrates such as anemones and cup corals. During the day, the raw seawater is filtered to allow for clearer displays.

When the aquarium opened in 1984, most life-support systems and filtration were handled manually, requiring a relatively large around-the-clock staff. But after nearly doubling its exhibit space in the mid 1990s, the aquarium decided to adopt advanced automation technologies as part of its ongoing water quality program.

Incoming seawater is monitored continuously on a five-minute interval using in-situ sensor technology. An online control system provides automation, monitoring, and alarming for all principal parameters of the aquarium's life support system, including temperature, flow, pressure, dissolved oxygen, pH, ozone injection, and ORP. It also controls repetitive tasks such as backwashing sand filters for filtration, boiler and chiller loop control for temperature control, ozone generator control, and oxygen injection control to maintain oxygen levels in the water.

Scheduled Spot Measurements Essential

Even with the addition of extensive on-line instrumentation providing continuous measurements at numerous points for automated process control, the use of portable handheld instruments and laboratory testing continue to play a critical role in water quality operations at the aquarium. The aquarium spot measures more than a dozen parameters on a scheduled basis, including total ammonia, nitrite, nitrate, phosphate, dissolved oxygen, temperature, pH, total alkalinity, calcium, magnesium, total gases, as well as certain microbiology measurements such as total coliform and fecal coliform.

Dissolved oxygen concentration (DO) and pH are two important water quality variables for which the aquarium uses handheld instrumentation to monitor on a scheduled basis.

"We're concerned about DO for the respiration of all our aquatic animals," says Eric Kingsley, water quality specialist at the aquarium. Fish absorb oxygen dissolved in the water directly through the one or two cell-thick blood vessels of the gills and skin.

"We have displayed certain species in the past that prefer low DO, but almost all our species here need dissolved oxygen levels close to saturation at least," he says.

"Spot pH measurements are very important when looking at the potential for ammonia toxicity. Ammonia and ammonium exist in equilibrium in water. This equilibrium is controlled mainly by pH and temperature, and high pH and high temperature have a tendency to favor ammonia, which is much more toxic to fish than ammonium."

Handhelds Measure DO and pH

Temperature and pH in spot samples have been measured at the aquarium using handheld units including a Hach HQ20® electrochemical meter equipped with a Platinum Series pH Electrode. Dissolved oxygen levels in spot samples have been determined by using either a portable polarographic oxygen probe or the Hach HQ20 meter equipped with a Luminescent Dissolved Oxygen (LDO®) probe.

Not only must portable instrumentation used at he aquarium provide accurate, repeatable measurement, it must also be easy to use and calibrate, and be sufficiently durable to hold up to the harsh effects of seawater. In addition, users of portable instrumentation in general are increasingly demanding that new instruments provide pre-programmed methods for multiple analyses and include a wider array of data storage features.

In an effort to bring further accuracies and efficiencies to these spot measurement duties, the Monterey Bay Aquarium recently participated in beta testing of the Hach HQ40d portable electrochemical meter, the first instrument for field and laboratory use that does not require the user to predetermine parameters.

Multi-Parameter Instrumentation

Using Hach's new IntelliCAL™ probes, a single HQ40d meter can take up to two simultaneous measurements of pH, conductivity, LDO, or ORP. The meter has an intuitive user interface with guided self-calibration, reducing the chance for calibration errors. With the new IntelliCAL plug-and-pay probes, the last known calibration as well as calibration history is stored in the probe, reducing the need to recalibrate when moving from one meter to another. The system provides reporting data, including time and date, sample ID, and user ID, so that users can store and monitor previous readings.

"We tested the new meter primarily for DO measurement," says Kingsley. "We will most likely be switching to the HQ40d because of the faster response time for DO measurement we saw during the beta testing."

The first things the staff noticed about the new unit were its quick response and its robustness.

"DO readings locked in a lot faster than with our former LDO unit," says Kingsley. "Plus, the connection where the probe attaches to the meter is waterproof, which is important because that's one of the biggest things we look for when we shop for a workable meter – finding one that will survive in a seawater environment. Seawater is extremely corrosive."

Although the meter is self-calibrating, during the test period the beta unit's LDO probe was air-calibrated so as to agree with the facility's handheld galvanic probes. Because the aquarium's stationary DO probes are also the galvanic

type, this allowed the test unit to track very well to the stationary probes – within 1-2 percent, according to Kingsley. He says the test unit also demonstrated high repeatability.

The aquarium staff deployed the beta unit on its regular rounds. Because the Monterey Bay Aquarium is on a clean water body, the staff does not have to spot test quite as often as does a closed-system aquarium. Those tanks that have a fairly heavy bio-load as well as the ones specifically designed to not receive a lot of flow-through (fresh make-up water) are the ones typically tested.

"It varies from tank to tank," says Kingsley, "but we typically schedule testing some of our exhibit tanks one to two times a week, unless there's a major problem or a new tank is coming on line, in which case we test more often. Spot measuring DO is usually a good way to look at long term trends and identifying when there's a problem."

In addition to high accuracy and repeatability, Kingsley said they liked the multi-parameter functionality of the handheld beta unit and that the last known calibration as well as calibration history is stored in each probe. The meter automatically recognizes a probe as well as verifies the calibration of multiple probes.

"Once we get our production unit, we will probably have occasions when we will pull off one of the pH or LDO probes and put on a conductivity probe. Because calibrations are stored in the probes, this will make the switch very easy. We have some pH electrodes in our lab that if we pull one out of our meter and put another one on, we have to recalibrate, which takes time."

Eliminating Data Transcription Errors

Comprehensive data storage capabilities demonstrated during the beta test were also a major advantage that the aquarium found with the new handheld unit and IntelliCAL probes.

"With our previous pH meter and our galvanic-type DO meter, we did not have the capability to electronically store data," says Kingsley. "Because we'll now be able to store data and download it straight to our computer, we won't have to write numbers down by hand and key them in later. This will eliminate the potential for transcription errors."

The aquarium may also deploy the new handheld unit to automatically measure and log water quality data over pre-set intervals to determine trends in individual exhibit tanks.

"A good place for interval logging, for example, would be our anchovy exhibit, where DO often swings significantly," says Kingsley. "We may want to log data there and see what happens over the course of a day. This new meter will now allow us to efficiently do that."

About the Author

Chad C. Bertram is Program Manager & Product-Line Manager for Hach Company, Loveland, Colorado.
Phone: 970-663-1377 x2644. cbertram@hach.com