Better Quality Assurance Through ORP

By Heather Rekalske

There are many forces driving water treatment and quality assurance practices: efficacy, reliability, health and safety, cost, practicability, aesthetics and government regulations from government agencies such as the U.S. Environmental Protection Agency. Though effective, there are alternatives to the traditional testing methods prescribed for characterizing and monitoring water quality, saving time and money.

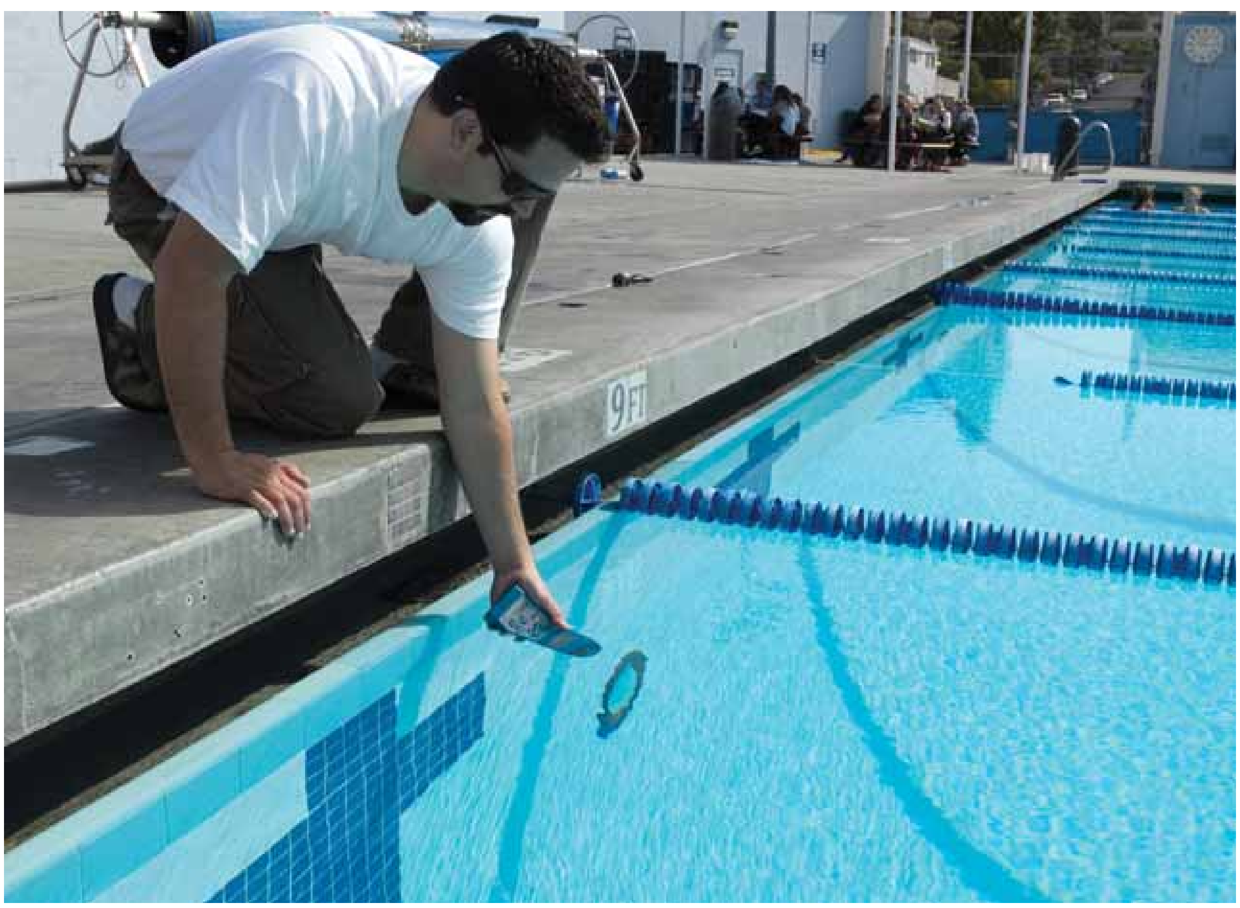
Using ORP to accurately measure disinfectant efficacy

One example is the use of oxidation-reduction potential (ORP) as a reportable monitor and control parameter in disinfection. This article seeks to explain how and why ORP is the preferred measurement for determining disinfection efficacy in most situations, particularly those involving residential drinking water.

What is ORP?

ORP is also known as redox potential. ORP as a parameter is a differential measurement of the millivoltage (mV) potential of an electrode at which the oxidation or reduction takes place versus a reference electrode and a sample solution. ORP describes the net magnitude and direction of the flow of electrons between pairs of chemical species, called redox pairs. In a redox pair, one chemical loses electrons while the other chemical gains electrons. The chemical that loses electrons becomes oxidized and more positive in charge. Any chemical that gains electrons becomes reduced and more negative. As a result, ORP directly quantifies the chemical activity of the solution.

ORP can be used to measure the efficacy of disinfectants, such as chlorine in swimming pools.



Measurement Capabilities

ORP can determine the efficacy of chemical disinfectants that work via the oxidation or reduction of the physiological structures of microbial contaminants. For example, chlorine is cheap, easy to manufacture and can strip electrons from the negatively charged cell walls of some bacteria. Because ORP measures the total chemical activity of a solution, it also measures the total efficacy of any oxidizing or reducing disinfectants in solution: hypochlorous acid, monochloramine, dichloramine, hypobromous acid, sodium hypochlorite, UV, ozone, peracetic acid, bromochlorodimethylhydantoin and more.

It is important to remember that ORP indicates the effectiveness of disinfectants that work only through oxidation or reduction. ORP cannot be used to detect the presence of a particular chemical or chemical species. This means although ORP is the best way to know whether or not your sanitizer is working, it cannot tell you what kind of sanitizer is working.

ORP Applications

For the purpose of microbial control, ORP values should be correlated to plate counts to determine true efficacy, just as free chlorine parts-per-million levels must be tried and tested. For this correlation to be valid, the water undergoing treatment must be characterized so all chemical constituents are known. Temperature and pH values should be reported and held constant. In short, although ORP will report how active the sanitizer is, you must make certain that microbial contamination is responding to treatment and the system is stabilized. Once a stable correlation is established, ORP is an effective way to

A textile manufacturing facility uses ORP to determine proper sodium hydrosulfite dosing and maintenance.

ORP is also a useful parameter when screening effluent. Here, a staff member tests effluent at a power plant.

At the same power plant, the staff member measures ORP in water from a cooling tower control panel.

monitor microbial control.

Some organizations, such as the World Health Organization, prescribe an ORP standard of 650 to 750 mV to monitor safe disinfection in bathing waters with the sanitizer type and concentration, as well as other influential parameter values, are under the purview of regulatory agencies. In other words, they are able to do this because all of the factors that affect sanitizer efficacy are prescribed and controlled prior to monitoring. ORP has long been used in bathing waters as the only means for automatic chemical dosing, so it is a proven measurement parameter in that industry.

For the purpose of pretreatment screening, influent must first be characterized to determine which chemicals, if any, will contribute to ORP value. With pH and temperature constant, ORP can safely correlate to specific sanitizer concentrations, such as chlorine, in their known forms. The same holds true of effluent screening. Some manufacturers of RO membranes and other water quality treatment equipment also specify an ORP tolerance value for prescreening and influent control.

Measurement Methods

ORP is sampled by either placing solution in a discreet compartment of an electrochemical ORP analyzer, or dipping a sensor that is connected to an online analyzer in solution for continuous monitoring. The instrument measures the millivolt potential difference between the measurement electrode and a reference. The instrument reports this potential. A positive reading indicates an oxidizing reaction, or that electrons will be stripped from constituents, and a negative reading indicates a reducing reaction, or that electrons will be donated to constituents.

Maintaining Accuracy

The most common ORP sensors are constructed of platinum or gold measurement electrodes. The reference electrode is made with silver or silver chloride. Platinum is best for oxidizing solutions that contain chloride and natural waters, and gold is best in strongly oxidizing solutions that could destroy platinum.

The physical parameters determining the best electrode for a given situation require consideration of specific constituents that can poison, attack or react violently with any of the metals in the electrodes.

Platinum is the most widely used metal for measurement; however, platinum is readily passivated by dissolved oxygen, which forms a layer of oxygen one molecule thick on its surface. This oxygen layer acts as an electron repository, which makes the sensor fast and accurate in oxidizing solutions. If the same sensor is then placed in a solution that is oxidizing less or is reducing, the sensor takes a long time to equilibrate to the new sample, making response slow or sluggish. ORP conditioning solutions, such as Myron L ORP Sensor Conditioner, are available for chemical removal of this passivated layer. The electrodes should be cleaned of other contaminates prior to treatment. Care must be taken not to abrade or roughen the surface of the platinum, as any surface irregularities can further exacerbate oxygen adsorption.

ORP electrodes seldom require recalibration. Any deviation from expected readings is most likely due to surface contamination of the electrodes, which can easily be remedied by cleaning with a light abrasive, such as Softscrub. Another source of error usually comes from the reference electrode, which can be calibrated.

ORP & Free Chlorine

If parts-per-million free chlorine readings are indicated for reporting and control, some instrumentation, such as the Myron L Ultrameter II 6Pfc, can correlate the ORP value to an analytical reference hypochlorite solution with respect to pH and temperature. This type of measurement gives an accurate picture of the sanitizing activity of the solution as it is without forcing the pH into specified limits that make titration practicable. This means the converted free chlorine readings may vary from the DPD measurements, but the measurement will more accurately describe what is happening in the solution.

What is most important when establishing disinfection control parameters, is correlating measurements to plate counts. For ongoing monitoring or prescreening, a simple measurement gives a good indication of whether or not water is suitable for drinking, processing and discharge.

Saving Time & Money

ORP is simpler than titration with DPD or other methods, and in many cases it gives the most

A staff member tests influent ORP at an RO desalination plant. Some manufacturers of disinfectant-sensitive equipment provide ORP tolerance values for prescreening and influent control.

accurate picture of the effect of all sanitizers in solution. No in-depth knowledge or training is required to obtain accurate repeatable results. User error is virtually eliminated because ORP readings require no subjective interpretation, nor do they require temperature compensation or calibration.

ORP control can be automated because its measurement produces an electrical signal that can trigger switches when outside established control parameters. ORP sensors are relatively low maintenance as simple rinsing with distilled water is often enough to remove contaminants. *wqp*

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