INFO SHEET

Oxidation Reduction Potential (ORP):

A New Tool for Evaluating Water Sanitation

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Clean sanitized water is one of the most critical, but unfortunately often overlooked, elements in allowing a flock to perform to its full potential.

A standard guideline in the poultry industry for water sanitation was 2 to 3 ppm of free chlorine at the end drinker. With time, it was discovered that this did not always guarantee clean water because the pH of the water was not being taken into account. When a sanitizer such as liquid chlorine, is added to water, the pH of the water determines how much will dissociate into hypochlorous acid (which kills bacteria immediately) and hypochloriteion (which kills bacteria only after prolonged contact.) Consequently, 3 ppm of free chlorine at a pH of 6.8 will sanitize the water effectively but as pH increases the effectiveness of the chlorine decreases. (See the Hybrid Info Sheet: "Effective Chlorination").

So, to effectively sanitize water we need to find the correct proportion between the pH and the free chlorine. Measuring the oxidative reductive potential of the water will allow us to do this. Most importantly, it is a way for us to know immediately whether our flocks are receiving clean, sanitized water or not. Today, with improved yet inexpensive technology, evaluating the quality of water has advanced from pH and free chlorine measurements to include Oxidation Reduction Potential (ORP).

What is Oxidation Reduction Potential?

ORP is a measurement in millivolts (mV) of the oxidation level in the water. This value reflects the activity of the water sanitizer rather than its concentration level (ppm). Chemicals like chlorine, bromine, hydrogen peroxide, peroxyacetic acid and ozone are all oxidizers. It is their ability to oxidize or 'steal' electrons from other substances, that makes them good water sanitizers—because in altering the chemical makeup of unwanted bacteria, algae and organic material, they kill them.

The formation of rust is an example of a commonplace oxidation/reduction reaction. Oxygen combines with iron to form iron oxide (rust). In this process, the iron is oxidized while the oxygen is reduced. This illustrates the basic characteristics of oxidation/reduction processes; namely, that materials involved undergo chemical changes.

'Potential' is a word that refers to ability rather than action. Potential energy is energy that is stored and ready to be put to work. It's not actually working, but we know that the energy is there if and when we need it. When all of the oxidizing and reducing materials have reacted, equilibrium is reached and there is usually a surplus. It is this surplus that creates the oxidation or reduction 'potential' of a solution.

How do you measure ORP?

An ORP probe is really a millivolt meter measuring the voltage across a circuit formed by a reference electrode constructed of silver wire (in effect, the negative pole of the circuit), and a measuring electrode constructed of a platinum band (the positive pole), with the water in between.

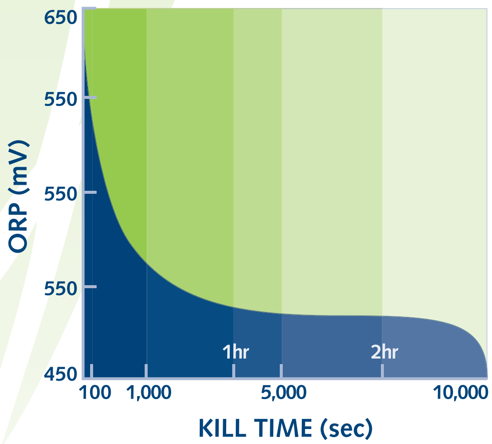
Modern ORP electrodes are almost always combination electrodes, that is, both electrodes are housed in one body—so it appears that it is just one probe. We are reading the very tiny voltage (millivolts or mV) generated when a metal is placed in water in the presence of oxidizing and reducing agents. These voltages give us an indication of the potential of the oxidizers in the water to keep it free from contaminants.

What should my water ORP be?

Once the instruments and methods for measuring ORP were developed in the 1960s, researchers began working toward setting standards under which ORP measurements could be used as an accurate gauge of water quality. In 1966 a study by Carlson, Hasselbarth and Mecke of the Water Hygiene Institute of the German Federal Health Office, demonstrated that the rate of killing *E. Coli* in swimming pool water was dependant on ORP and not on the free residual chlorine level.

Kill time of *E. Coli* in swimming pool water

(Carlston et al. 1966)



ORP (mV)	KILL TIME *E. Coli*
650	0 seconds
600	10 seconds
550	100 seconds
500	1 hour
450	No Kill

In 1972, the World Health Organization recognized in its Standards for Drinking Water that, at an ORP level of 650 mV, water is disinfected and viral inactivation is almost instantaneous.

Research has shown that at a level of 650 mV of ORP, bacteria such as *E. Coli* are killed on contact or within a few seconds. Tougher organisms such as *listeria*, *salmonella*, yeasts and molds may require 750 mV or higher in order to be killed.

The table below illustrates the relationship between ORP and bacterial levels measured from commercial spa water (Oregon, 1985).

Free Chlorine (ppm)	pH	ORP (mV)	Total Plate Count	Pseudo-monas (CFU)
4	5.8	805	0	0
4.4	7.4	730	0	0
4.9	7.9	668	0	0
2.3	7.8	653	0	0
1.2	7.1	618	170	12,400
1.2	7.8	296	640	1,600
0.8	7.8	590	310	2,400
0.7	8.3	480	15,000	2,400

ORP Uses

Measurement of ORP allows you to evaluate the effectiveness of the water sanitation, regardless of the type of oxidizer or combination of sanitizer, and regardless of other varying water conditions. It tells you if your sanitation process is really doing what you think it is.

The ORP of the water can be measured at any point within the system—you can determine the cleanliness of the well source, the lines leading to the barn and the lines within the barn. Measuring the ORP of the water within the lines at the front and the back of the barn can help you determine whether the water line cleaning and disinfection process was effective. The ORP level at both points in the system should be greater than 650 mV. If the ORP mV at the end of the water line is less than at the front it indicates that the lines have not been completely cleaned and the organic biofilm present in the line is using up the free chlorine.

If this is occurring while the flock is in the barn, the ORP at the front of the line can be increased. Although birds will tolerate high levels of chlorine (i.e. 10 ppm), this increase must be gradual. Sudden increases in chlorine can cause birds to back off drinking. Research has not yet been completed to indicate how pH affects water consumption of turkeys, but it is generally felt that a pH lower than 6 will decrease water intake. Inconsistencies in water quality from the front of a barn to the back of the barn will contribute to lack of uniformity in a flock.

Utilizing ORP allows you to find the optimal balance between pH and free chlorine for your operation. It gives an accurate measurement so that chlorine levels can be minimized to prevent corrosion. (i.e. If ORP is 850 mV then free chlorine could be decreased. On the other hand, if ORP is 600 mV, then pH and free chlorine must be tested and adjusted by decreasing pH or increasing free chlorine.)

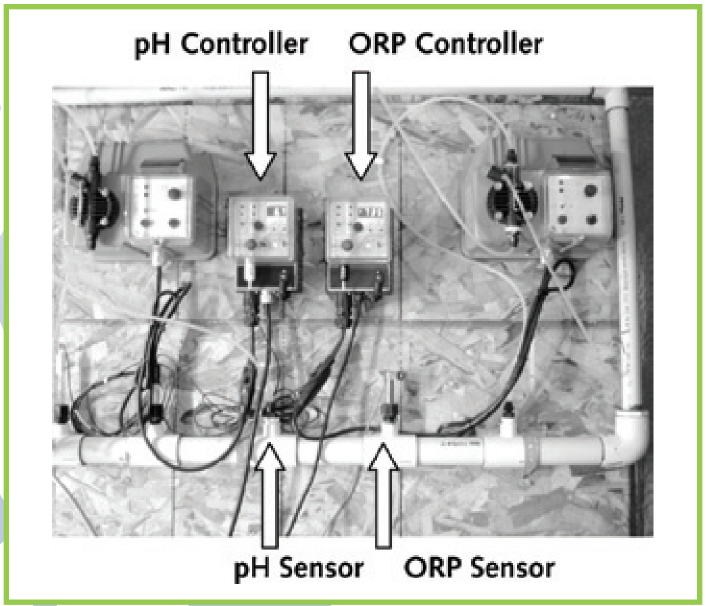
ORP technology is used in the following industries: pre- and post-waste water treatment, metal finishing, fresh fruit and vegetable sanitation, ozone treatment (commercial aquariums, water disinfection), wine making, bleach production, poultry processing, paper industry (pulp bleaching), swimming pools and spas.

ORP is not affected by the temperature of the water.

Equipment for Measuring ORP

There are several types of ORP measurement meters that vary depending on the process requirements and design. Measurement is made by simply dipping the electrode in water and observing the display. A stable reading is normally reached within a couple of minutes.

Process Meters/Controllers: These are useful on large farm complexes where the water is sanitized at a central location. They measure, control and regulate the pH, free chlorine and ultimately the ORP. They are demand-based units that automatically inject sanitizer or acidifier into the line according to preset values. Very close control can be maintained. They provide a reliable method of process control as well as recording for automated record keeping and HACCP programs.



As water flows through the line, the pH sensor measures the pH of the water and relays this information to the pH controller which is set at 6.5. If the pH is higher than this, acidifier is automatically injected into the system until the set point is reached. The acidified water flows past the chlorination injection port where the ORP is measured. The ORP in this case is set at 730 mV. If the ORP sensor detects a value less than this, additional chlorine is automatically added until the set point is reached.

Hand-Held Meters: Typically low cost, fit in the pocket and are very portable. Both meter and electrode are integrated together into a compact design. Useful life of the electrode is 1 to 2 years. Calibration testing and cleaning is recommended at least once a week to ensure ongoing reliability. This type of meter can also come with a pH electrode as well.

Maintenance: All ORP and pH electrodes need periodic maintenance and cleaning. A simple cleaning procedure consists of dipping the electrode tip in a dilute (1:100) acidic solution for two minutes and rinsing with clean water. Then dip in electrode checking solution to verify accurate readings.

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Conclusion

ORP has proven to be a reliable method of evaluating water sanitation. It allows you to take the step forward from merely thinking that the water is acceptable for the flock to knowing that it is. Turkeys consume twice as much water as they do feed. Considering this, it is absolutely critical that the flock consistently receives sanitized water in order to reach their full potential. Making use of oxidative reductive potential meters will help you achieve this.

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