Oxidation-reduction potential

Oxidation-reduction potential (ORP) is the potential of a disinfectant to inactivate micro-organisms in a swimming pool or spa pool. It is a direct measure of disinfection power.

Last updated: 14 November 2016

Oxidation-reduction potential (ORP, redox) measures the rate of oxidative disinfection caused by the addition of the effects of all oxidants in the pool water. ORP is determined by using a high quality ORP probe and meter. The unit of measurement of ORP is millivolts (mV).

Oxidisers (mainly disinfectants) consume electrons while reductants (mainly contaminants) donate electrons. As chlorine is continuously added to the swimming pool the disinfection action is mainly due to chlorine compounds, particularly hypochlorous acid (HOCl). The ORP is the potential of a disinfectant to do its work of inactivating micro-organisms and oxidising organic materials. The higher the millivolt reading, the more powerfully the swimming pool water is able to oxidise and disinfect.

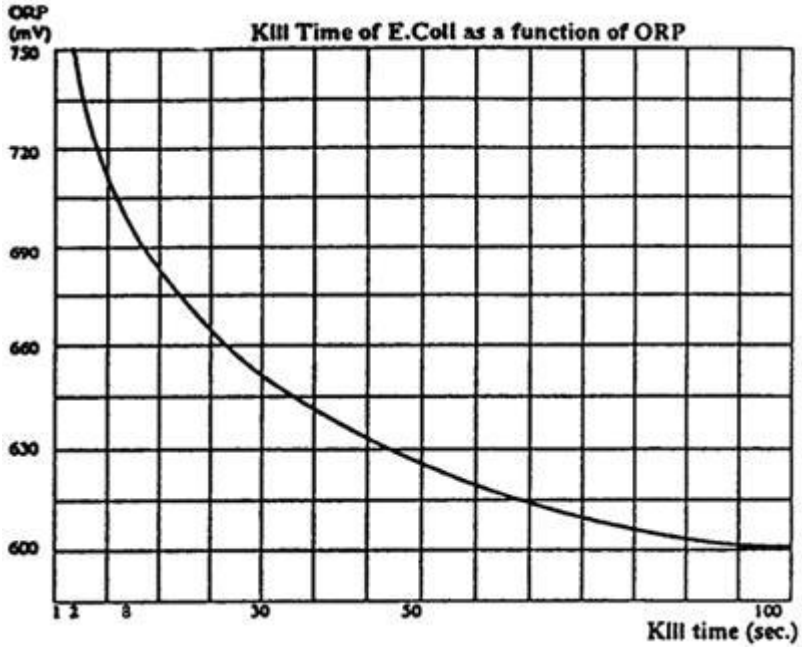
Oxidisers cause the millivolt value to increase and therefore increase disinfection. Typical oxidisers are hypochlorous acid (a component of free chlorine), ozone, hydrogen peroxide, and potassium monopersulphate.

Reductants cause the millivolt value to decrease and therefore decrease disinfection. Typical reductants are the hypochlorite ion (a component of free chlorine), chloramines, cyanuric acid, organic matter (dust and dirt), urine, perspiration, sputum, micro-organisms, cosmetics, and faecal material.

A drop in the ORP indicates an increase in chlorine demand caused by reducing agents or contaminants entering the water. A decrease in ORP indicates that chemical reactions are about to occur. Compared to amperometric control, ORP is considered to be a more accurate measure of disinfection rate. Also, ORP controllers can automatically add disinfectant according to demand. They therefore anticipate the disinfecting and oxidising chemical reactions that are about to occur.

ORP is an indicator of micro-organism inactivation. Studies on specific micro-organisms have found a direct correlation between increasing ORP and micro-organism inactivation as shown in Graph 6.1. Drinking water is adequately disinfected at an ORP of 650 mV. In swimming pools, an ORP of 700 to 720 mV allows for both a quick disinfection and for breakpoint chlorination (destruction of chloramines) where conditions permit.

Graph 6.1 Kill Time for a log 3 Reduction of E. coli as a Function of ORP



Source: Eutech Instruments Pty Ltd

The ORP value required in swimming pools is higher than that required for water supplies because contamination is constantly being added to swimming pools.

Section 4.4.1 (ii) of the Swimming Pool and Spa Pool Advisory document explains that pH affects the concentration of hypochlorous acid (HOCl) while the concentration of free chlorine remains the same. An increasing pH decreases the

concentration of HOCl and hence its disinfection power. Similarly a decreasing pH increases ORP because the oxidative power of free chlorine increases.
ORP measurement correlates weakly with free chlorine measurement because they measure two different entities. ORP measures oxidative disinfection power not the concentration of free residual chlorine. Free chlorine measures the concentrations of hypochlorous acid (HOCl) and the hypochlorite ion (OCl-) not the oxidation disinfection power. Free chlorine is a variable component of ORP. Oxidative disinfection does not correlate well to free chlorine for two reasons:

- when free chlorine exists as the hypochlorite ion (OCl-) the ORP will be low. This will occur when the pH is high. Therefore free chlorine could be high and the ORP low at a pH greater than 7.6.
- reductants lower ORP. Therefore free chlorine could be high, but the ORP will be low if combined chlorine is high, cyanurate is present, contamination is high, etc.eductants lower ORP. Therefore free chlorine could be high, but the ORP will be low if combined chlorine is high, cyanurate is present, contamination is high, etc.

A pool with satisfactory ORP could have low free chlorine if the reductants are low. That is, there is low combined chlorine (i.e. breakpoint chlorination), low pH, no cyanuric acid, and low organic contaminants. Such a pool will have satisfactory disinfection power.

It is often difficult to obtain a satisfactory ORP reading in an outdoor pool stabilised with cyanuric acid. It may be necessary to limit the cyanuric concentration to 25 mg/L or even 20 mg/L to obtain a satisfactory ORP reading.

It is often difficult to obtain a satisfactory ORP reading in an indoor pool with excessive combined chlorine. It may be necessary to control combined chlorine by the installation and use of medium pressure UV light lamps or low dose ozone to obtain a satisfactory ORP reading.

ORP will also vary according to the water source used to fill the swimming pool. ORP will vary according to the materials used to construct the swimming pool. However, the constant is that ORP is an accurate measure of killing power as it takes all of the variables into account due to the combined effect of their respective ORP values.

Careful calibration of the probe and controller is required. There are two methods or calibration:

- by the use of buffer solutions, and
- by using electronic calibratorsy using electronic calibrators.

It is essential that the ORP system is calibrated every six months by an independent person who might reasonably be expected to be competent to do so and a certificate of calibration should be obtained.

Where shock oxidation or superchlorination is practiced, the shock dose will temporarily raise the ORP. Shock oxidisers tend to raise the ORP short term whereas superchlorination raises ORP for a longer period.

To detect and prevent failures due to instrument errors, ORP should be checked against manual free and total chlorine measurement daily and the probes and other equipment must be regularly maintained in accordance with the manufacturer's specification.

Further information

The Public Swimming Pool and Spa Pool Advisory Document provides detailed explanations and information on disinfection, pool chemistry, risk assessment and other issues relevant to swimming pool operation.
Public swimming pool issues may be discussed with an environmental health officer at a local Public Health Unit: by calling 1300, 066 055 or at your local council.

Page Updated: Monday 14 November 2016
Contact page owner: Environmental Health