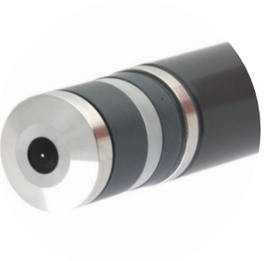
Technical Note 25

Comparison of ORP (Redox) sensors and ppm (amperometric parts per million) sensors for Swimming Pool Control

Introduction

Some people use ORP (Redox) sensors and some people use ppm (parts per million) amperometric sensors to control their disinfectant dose in lots of different control situations including swimming pools. Which one should we use and why?

ppm Sensors



ppm Sensor

These sensors use electrochemistry to measure the free chlorine in the water and there are two types. The first measures some of the free chlorine (HOCl only) and these are to be avoided as they are very pH dependent[1]. This means that when the pH changes for any reason, the chlorine reading changes which leads to poor control.

The second sort (as supplied by Pi) measures all of the free chlorine at the pH's found in swimming pools (both HOCl and OCl^-) and are therefore pH independent.

The rest of this technical note assumes that only **pH independent** ppm sensors are used. A ppm sensor measures the amount of chlorine that is available in the water to do the disinfection.

ORP Sensors

ORP Sensor

These sensors also use electrochemistry, but they don't just measure the chlorine. ORP sensors measure the electron activity (electrons are involved in disinfection)[2]. This means that ORP sensors measure everything including temperature and pH. If the electron activity largely comes from the addition of chlorine then it measures the electron activity of the chlorine that has been added.

Comparing ORP and ppm Sensors

In order to understand what the two different sensors are doing, an analogy might be helpful.

Imagine that you want to fill a tank with water. If you go to a tap to fill your tank, the ORP tells you how much pressure there is behind the tap. This gives you an idea of how fast the water will come out, but doesn't tell you how much water there is available. You might get a lot very quickly and then it could dribble to nothing, way before the tank is full. So ORP is a measure of how strong the disinfection is at any one time in the pool but it doesn't tell you how much disinfection there is available[3].

A ppm sensor is the equivalent of knowing how much water is available at the tap. You don't know exactly how fast it will come out, but you know it will fill up your tank.

Some customers are happier knowing that they have enough water available to fill their tank (i.e. enough chlorine available to kill the bugs) and so use ppm sensors.

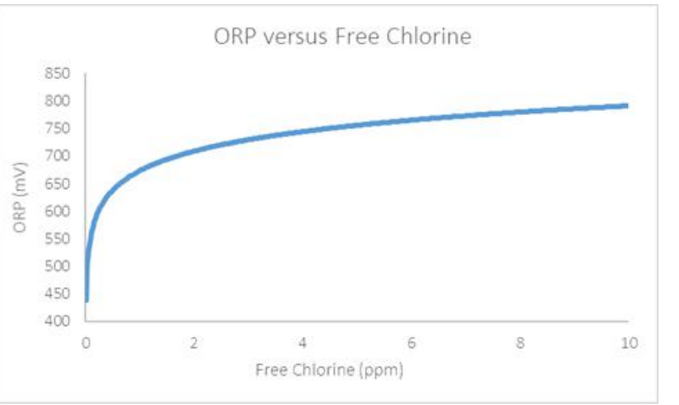
Other customers are happy that as long as there is enough pressure behind the tap at any time then when they turn on the tap, some water will go into the tank and so they use ORP sensors.

Some customers want both.

So which is best?

Over the last 20 years, the authorities in Europe have decided that ppm sensors give the best overall disinfection protection to bathers so the control of chlorine in pools has become more and more based on ppm sensors.

In the US and in other parts of the world, the majority of pool control is still done on ORP measurement although it is changing (slowly) as more and more pools discover that they can achieve better control and therefore can run at lower residuals using ppm sensors which makes for nicer bathing water, lower corrosion, lower chloramines (chlorine smell) and lower chemical costs.



Other differences

1. **A ppm sensor is linear - so the more chlorine you put in, the bigger the signal. An ORP sensor is not linear so over about 3ppm chlorine, it is very difficult to control as adding more chlorine increases the ORP signal less and less. This is particularly problematic for spas that often run above 3ppm[4].**
2. **An ORP sensor is about a fifth of the cost of a ppm sensor.**
3. **A ppm sensor will last more than ten years (with proper maintenance). An ORP sensor will generally last about a year.**
4. **Water with no disinfectant always reads 0 on a ppm sensor. Whereas on an ORP sensor, the reading can be different from pool to pool which makes standardization difficult[5].**
5. **In Europe they use ppm sensors or both. In the US they generally use ORP sensors (although the use of ppm sensors is getting more popular as their advantages become more widely known).**
6. **Using ppm sensors allows tighter control of the disinfectant leading to pools with lower chlorine levels leading to less 'red eye', less corrosion, less chemicals etc[6,7,8].**

	Advantages	Disadvantages
ORP	• *Cheaper* • *Little to no maintenance* • *Indicates rate of disinfection, not amount of disinfection*	• *Responds to pH* • *Responds to everything in the pool water* • *Usually leads to higher chlorine levels in the pool* • *Not good at >3ppm control* • *Not reproducible*
pH independent ppm sensors	• *Precise and reproducible* • *Indicates amount of disinfection available* • *Does not respond to pH* • *>3ppm control possible* • *Generally leads to less chemical dosing*	• *Bigger initial investment* • *Some maintenance (calibration) required*

Conclusion

Pi supplies pool controllers with ORP sensors, with ppm sensors, and with both. It is for the pool management to select the appropriate technology to control the pool bathing water disinfection.

It is Pi's advice that the choice of chlorine control should be made knowing all of the options and should be evidence based. If you would like to talk to our experts about pool control, please don't hesitate to contact us.

References

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