



Disinfection Sensor Technical Notes

Measuring Principles

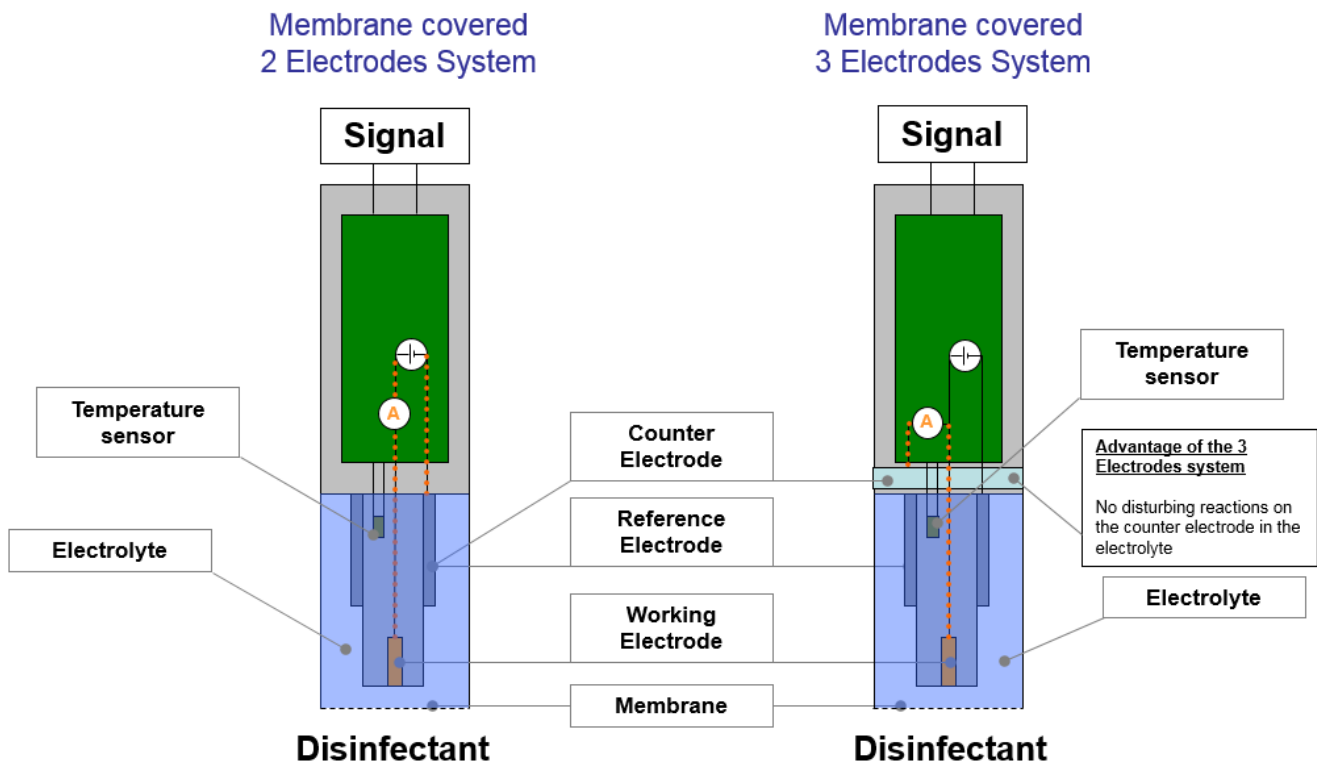
Our disinfection sensors utilize one of two measuring principles.

Two Electrode System

DC Voltage is applied between reference/counter electrode (Silver/Silver Chloride) and working electrode (Gold) and then current (in the range of pico to nano ampere) is measured between the reference/counter electrode and the working electrode; a two electrode system. The current is then converted to a temperature compensated output signal that is proportional to the disinfectant concentration.

Three Electrode System

DC Voltage is applied between the reference (Silver Chloride) and the working electrode (Gold), and then current (in the range of pico to nano ampere) is measured between a separate stainless steel counter electrode and the working electrode; a three electrode system. The current is then converted to a temperature compensated output signal that is proportional to the disinfectant concentration.





Membrane Types

Membranes can be hydrophobic or hydrophilic and can be porous or not. When porous, the holes are in the range of μm (so not at molecule level) and the thickness is only a few μm , making them very fragile. Non porous membranes are much thicker and more robust, allowing diffusion of disinfectants through the membrane. Hydrophilic, porous membranes need an electrolyte gel otherwise the electrolyte would be lost very quickly through the holes. They are also much more sensitive to flowrate changes as a higher flow rate will “force” more water through the holes. Hydrophilic membranes allow ions to pass through and can therefore be used to measure total chlorine (both HOCl and OCl^- will get through the membrane). Hydrophobic membranes will only allow non charged molecules to pass through, making them very pH dependent.

Types of Sensors

Our **standard free chlorine sensors** have membranes that are hydrophobic and porous. These types of sensor cannot tolerate surfactants because these will make the membrane hydrophilic, and this causes the sensor to lose electrolyte very quickly. Since OCl^- cannot penetrate the hydrophobic membrane, these sensors are pH dependent. These sensors are two electrode systems.

Our **free chlorine with extended pH range, Zero ppm chlorine, total chlorine sensors and stabilized bromine sensors** have membranes that are hydrophilic and porous, so these use gel electrolyte, and will tolerate surfactants. Fairly pH independent because both HOCl and OCl^- get through the membrane, the electrolyte has a pH buffer converting all free chlorine into HOCl which reacts at the working electrode. These sensors are three electrode systems.

Our free chlorine with extended pH range sensor is designed for free chlorine + isocyanuric acid so it may be used in swimming pool applications. This also means that it will detect some amount of total chlorine in addition to free chlorine. In most cases this small error is not significant.

The Zero ppm chlorine sensor was developed to measure the absence of chlorine, for RO systems and other dechlorination applications. The electrolyte includes a biocide, which delays the formation of biofilm on the membrane in the absence of disinfectant for about 4 weeks.

The stabilized bromine sensors are unique to the industry, and accurately measure the concentration of bromine that is stabilized with sulfamate, a product that is commonly used in cooling tower applications.

Our **Chlorine Dioxide, Ozone, and Peracetic Acid sensors** have membranes that are hydrophobic and non-porous. These thicker membranes can be cleaned with a soft brush. They are tolerant of weak surfactants. These sensors are two electrode systems.

Our **Hydrogen Peroxide sensors** have membranes that are hydrophobic and non-porous. These thicker membranes can be cleaned with a soft brush. They are tolerant of strong surfactants. These sensors are two electrode systems. These sensors have an internal pressure balancing system that eliminates the need for a vent hole and rubber band, which is more reliable, especially with high H_2O_2 concentrations. The membrane cap includes a “G Holder” which is a small cap that ensures plenty of electrolyte surrounds the working electrode.

Effect of Biofilm

The reason why the sensors always need flow and presence of disinfectant to work correctly, is solely to prevent the formation of biofilm on the membrane. In static water without disinfectant, a biofilm can form in a matter of hours, blocking the membrane completely. When the flow starts again, the fresh disinfectant will



gradually remove the biofilm, but this can take a while depending on the concentration and the thickness of the film. Meanwhile the measured concentration will be much lower and overshoots can occur. Carefully removing the biofilm with a wet paper towel will bring the signal back immediately. Always use extreme caution when cleaning membranes as they are very fragile. There is no need to recondition or recalibrate the sensor.

Selecting the Sensor ppm Range

The minimum concentration that can be accurately measured is about 0.25-0.5% of the max range (so for a 0-20 ppm sensor this is 0.05 ppm) but it mainly depends on the stability of the zero. At these low concentrations, the risk of biofilm formation is also high.

Every sensor is different and the slope of a new sensor can be anywhere between 60% and 150% of the nominal slope. To select the correct sensor range, you should multiply the set point by 1.5 to make sure the sensor will be able to measure as high if it happens to have a 150% slope. For example, for a set point of 1.5 ppm, take $1.5 \text{ ppm} \times 1.50 \text{ slope} = 2.25 \text{ ppm}$, so don't select a 0-2 ppm sensor! It is possible a 0-2 ppm sensor will do the job, but it cannot be guaranteed. Even if it does work and it gets replaced by a new one, there is a chance this new one won't work.

Temporary high concentrations of disinfectant will not damage or permanently "blind" the sensors. After a while the disinfectant that got into the sensor will be consumed and the sensor will come back to normal. If it takes too long, you can just replace the electrolyte.

Membrane Caps

Some membrane caps get delivered in a bottle to keep them wet. This is because the interior of the membrane is covered by a spacer to keep a set distance between the membrane and the electrode tip. When dry, it is very difficult to get rid of air bubbles that get trapped in the spacer.

When replacing membrane caps with rubber bands, you should only remove the rubber band when unscrewing the cap to prevent under pressure. When screwing the cap on, you must put the rubber band in place first so no air bubbles can get in. The overpressure when screwing the cap on is easily released by the electrolyte getting out of the small hole under the rubber band. For membrane caps with 2 rubber bands, you should only put one band back to cover the hole before screwing the cap on.

For standard free chlorine sensors





For extended pH range free chlorine, total chlorine and zero chlorine sensors

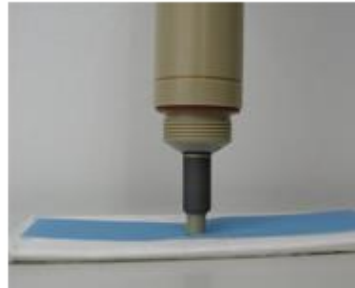
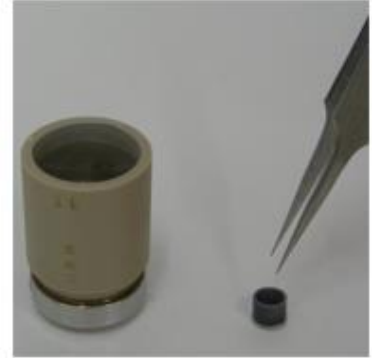


For ozone, PAA and ClO2 sensors





For hydrogen peroxide sensors



Air bubbles in the electrolyte can create pressure differences and generate a pumping effect that will dramatically increase the electrolyte use. It will also reduce the life time of the membrane as it will move with every pressure fluctuation.

To check if the membrane has been damaged, you can carefully dry the surface of the membrane by dabbing with a paper tissue and then screw the cap, filled with electrolyte, back on. The membrane should stay dry.

Sensor Troubleshooting

Sensor dry test:

The signal of a dry sensor without membrane cap should be 0 mV +/- 10 mV. Dry the gold working electrode tip and reference electrode shaft carefully by dabbing with a paper tissue. Never scrub or otherwise damage the grey Ag/AgCl reference electrode shaft! If this test fails then the sensor needs to be replaced or refurbished.

When the slope of the sensor is lower than 30%:

First clean the gold working electrode tip and replace the electrolyte

If that doesn't work, replace the membrane cap

If that doesn't work, the sensor needs to be replaced or refurbished