

10 Tips to Prevent Biofouling on Water Quality Instruments

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With advances in electronics, power management and battery life, *biofouling* is now the key factor in determining the length of time a water quality instrument can stay deployed, particularly in long-term, continuous monitoring applications.

Using various available anti-fouling technologies will extend your deployment intervals, resulting in fewer trips to the field for instrument service and improved accuracy of water quality data.

For most users, field servicing of water quality sensors is a significant part of their monitoring budgets. The Alliance for Coastal Technologies estimates that maintenance costs due to biofouling consume 50% of operational budgets. So a reduction in the number of field servicing trips can have a huge cost savings. Using anti-fouling components is one of the best investments you can make to save money for your program.

Reducing the growth of biological organisms on your instruments:

- maintains the sensitivity and accuracy of your water quality sensors by reducing drift
- reduces needed site visits to clean instruments
- prolongs the life of the sensors and your investment
- makes cleaning and maintaining equipment faster and easier

Recommended Anti-fouling Items:

- Anti-fouling wipers
- Anti-fouling port plugs
- 2" wide copper tape
- Plastic anti-fouling sleeves
- Copper-alloy sensor guard
- Copper-alloy screen
- C-Spray protective probe solution
- Clear packing tape
- High-visibility duct tape
- Plastic cling wrap
- Anti-fouling paint



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The following tips are based on YSI's many years of instrument research and testing, as well as YSI customer successes.

In productive, high-fouling waters (such as warm marine waters), a water quality instrument equipped with anti-fouling features will easily allow you to **double** your deployment times. Furthermore, at less fouling intense sites, an anti-fouling equipped sonde could allow you to **triple or even quadruple** your deployment times!

Typical deployment results

	YSI EXO sonde with anti-fouling	YSI 6-Series sonde with anti-fouling	Sondes without anti-fouling
Freshwater	60-90 days possible, site dependent	30 days possible, site dependent	<5 days
Marine	45-90 days possible, site dependent	14-30 days possible, site dependent	<5 days

Anti-fouling Components for Water Quality Sensors and Sondes

To provide optimal protection, copper-based materials with anti-fouling properties are often coupled with mechanical systems that physically wipe or guard the sensing element between sampling intervals.

1 Wipers

Many water quality instruments designed for long-term monitoring utilize one or more wipers to clean the top surface of the sensors. It's important that the wiper is large enough to clean the entire top surface, not simply the optical sensing portion. A larger wiper prevents biofouling organisms from colonizing the edge of the probe and migrating towards the sensing element.

YSI EXO2 central wiper part number: 599090

YSI 6-Series copper-alloy wiper part numbers: 616625 (optical sensor wiper); 616630 (6600EDS wiper brush); 616445 (6600V2-4 wiper brush)

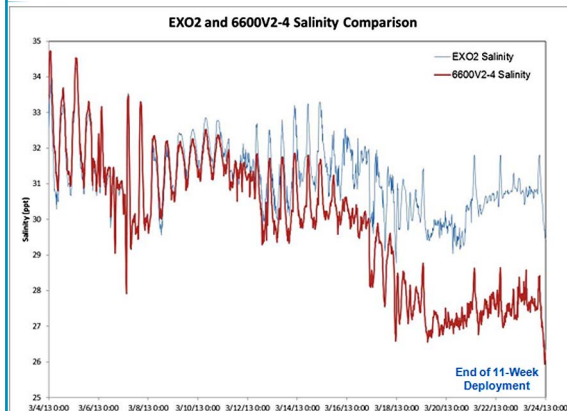


Case Study: South Carolina Estuary



At a long-term monitoring station in a productive South Carolina estuary, a YSI EXO2 sonde and YSI 6600 sonde with anti-fouling components were deployed. The sondes were connected to a data logger that transmitted real-time data back to our office.

At week 11 of the deployment, we observed that the EXO2 sonde was performing well, without any signs of biofouling accumulation. Around week 9, the salinity data from the 6600 began to experience fouling drift. *(Data from last 4 weeks shown below.)*



Without any anti-fouling precautions, either sonde would have likely begun to experience drift by as soon as week 2 or 3 in this environment.

★ Soft fouling organisms typically characterize freshwater systems and are often more easily controlled by mechanical wipers. Marine biofouling may present a greater challenge than freshwater biofouling due to presence of hard fouling organisms such as barnacles and mussels, so additional biofouling measures are recommended in marine monitoring environments.

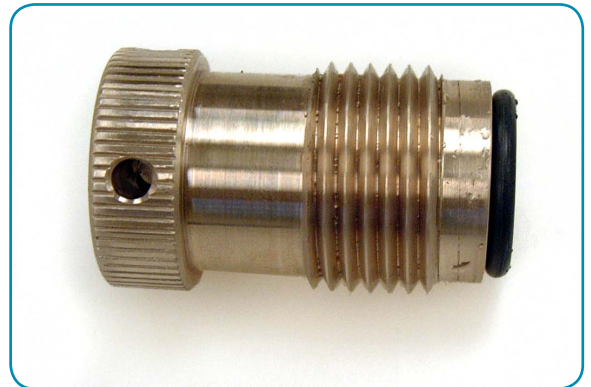


Copper tape, copper-alloy sensor guard and mesh screen would provide additional anti-fouling protection to the equipment above and at left.

2 Sensor Port Plugs

Biofouling will adhere to just about any rough surface where it can get a foothold. If all the ports in your 6-Series water quality sonde are not occupied by probes, then replace the plastic port plug with a copper-alloy port plug. Not only does the port plug seal and protect the electronics inside the port, but the copper material in the plug will deter the settlement of organisms. Fouling will form on any unprotected surface of the instrument, so using anti-fouling port plugs reduces the risk of instrument damage from trying to remove a badly fouled plastic plug.

YSI 6-Series copper-alloy port plugs part number: 616151 (optical sensor port); 616161 (pH or DO sensor port); 616171 (ISE sensor port)



Case Study: St. Petersburg Harbor

Sondes deployed by the University of South Florida in St. Petersburg Harbor tested a variety of anti-fouling methods.

Sondes equipped anti-fouling components performed well over a **40-day deployment**, while the control sondes diverged from the norm 11 days after deployment.

Anti-fouling sondes utilized copper-

alloy sensor guards with copper wire mesh, copper-alloy sensor housings and copper tape. The control sondes used only the standard wiper design.

By using a combination of anti-fouling components, the monitoring program in St. Petersburg Harbor **decreased its yearly maintenance visits by 66% and saved \$10,000.**



3 Copper Tape

Many water quality probes have either plastic or metal housings. While copper-alloy housings offer some measure of biofouling protection, plastic and metal (non-copper) housings do not. You can apply excellent anti-fouling protection to these probes by wrapping the housings in copper tape in a two-step treatment.

YSI copper AF tape has excellent anti-fouling properties and uses a very strong water resistant adhesive. However, if you apply copper tape directly to the probe, you could end up with a sticky mess later when the spent copper has to be removed. To prevent this from happening, first apply clear packing tape to the water quality sensors. The clear tape acts as a barrier and makes removal of the old copper tape much easier after deployment.

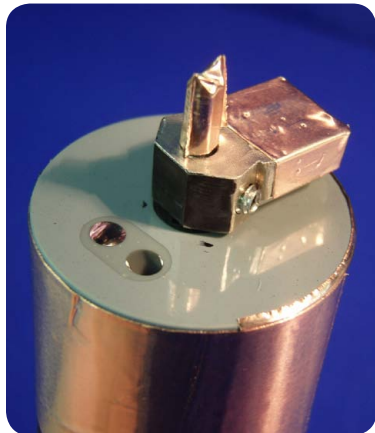
Cut a 3-inch piece of packing tape and press it onto the sensor so it is as tight and bubble free as possible. Press out any air bubbles or wrinkles by rubbing the surface with the body of a permanent marker.

Next cover the sensors with the copper tape. Press on the tape so it is as tight and bubble-free as possible. Press out any air bubbles or wrinkles by rubbing the surface with the body of a permanent marker. For the conductivity/temperature sensor, use a sharp Xacto knife to remove the tape from the round vent holes on the side of the probe.

★ You can expect the copper tape treatment to last 2-6 months before needing to remove and reapply the tape. It is a good idea to write the date applied on the taped sensor with the Sharpie marker.

Note: Do *NOT* apply copper tape to any EXO probes that will be submerged in Quinine Sulfate standard during an fDOM calibration. Quinine Sulfate will react negatively with the copper and degrade the standard. We recommend wrapping the sensors with copper tape *after* you have performed the Quinine Sulfate calibration.

YSI copper tape part number: 616189



4 Protective Plastic Sleeves

In deployments where fouling is minimal you can use specially sized plastic sleeves for the probes and sonde body of the YSI EXO1 or EXO2 sondes. The plastic sleeves slip easily over the parts and require an application of heat to shrink the sleeves to a tight fit on the parts.

Throughout a deployment, biofouling will collect on the sleeves rather than directly on the instrument. After deployment, the perforated sleeves can be easily removed and the biofouling comes right off, significantly reducing cleaning and maintenance.

If you do not have an EXO sonde, then see tip 3 about using copper tape and tip 8 about using duct tape and plastic wrap for similar anti-fouling effect.

EXO anti-fouling sleeves kit part number: 599663



5 Sensor Guards

For optimal biofouling deterrence, you can use a metal (copper alloy) anti-fouling sensor guard that fits on the end of the sonde and protects the water quality probes. This guard is used in place of the plastic guard usually supplied with the instrument. A copper-alloy guard very effectively prevents fouling organisms from attaching to it; these organisms could seriously affect optical sensor measurements and in severe cases make the sensor guard difficult to remove.

In lieu of a copper-alloy guard, you can also apply copper-based anti-fouling paint to a plastic guard (see tip 10).

EXO1 copper-alloy guard part number: 599563

EXO2 copper-alloy guard part number: 599564

6600 copper-alloy guard part number: 616145

6920/6820 copper-alloy guard part number: 616176

600OMS copper-alloy guard part number: 616175



Copper-alloy sensor guards effectively deter biofouling settlement on sensitive water quality sensors. As the guard ages, it naturally gains a patina.



6 Screens

Sensors: Pre-formed copper-alloy screens for conductivity-temperature probes and non-wiped pH probes are easy to apply and offer excellent biofouling deterrence benefits. The screens allow water to flow through the cells in conductivity-temperature and YSI 6-Series pH sensors for accurate measurements.

EXO sensor copper-alloy screen part number: 599867

6-Series sensor copper-alloy screen part number: 616270



Sensor Guards: You can also prevent debris and small animals from entering the sensor guard by using 0.25-inch plastic mesh around guard. Wrap the mesh around the outside of the guard 1.25 times and secure with a cable tie or rubber band. The mesh can also be sprayed with copper-based anti-fouling paint (see tip 10 below).

In marine applications with moderate to severe fouling, you can use copper mesh of the same size around the sonde guard. It is more expensive, but it's very effective and requires little maintenance.

Plastic mesh screen is available from Aquatic Ecosystems part #1170. Copper screen is available from McMaster Carr, an industrial supply company.



7 C-Spray Solution

C-Spray is an environmentally safe, nanopolymer spray that keeps non-wiped surfaces slick and challenging for biofouling settlement. C-Spray is based on a solution used in many marine and boat applications to keep the growth of microorganisms and barnacles to a minimum.

Once the prepared sensors are installed on the sonde, apply a light coating of C-Spray Protective Solution on the sensor bulkhead, the sides of the probes and the probe nuts to make cleaning after deployment much easier.

- Try **NOT** to spray the solution on the sensor optics (the top face of the sensors). If C-Spray is applied to the optics, then the optics will have to be buffed with a microfiber cloth to ensure optical clarity.
- Do **NOT** apply C-Spray on the pH or DO probe faces and allow to dry. If applied, rinse with tap water within a few minutes of application.



In testing in marine environments, *C-Spray plus the copper-mesh screen* around the conductivity-temperature sensor resulted in **90+ days of maintenance-free, accurate data.**

Conversely, an *untreated* conductivity-temperature sensor in the same waters was impacted by biofouling in as little as 18 days.

YSI C-Spray Protective Probe Solution part number: 616290

8 Duct Tape & Packing Tape

9 Plastic Wrap

Common household items—such as duct tape and plastic cling wrap—appear to have some fouling-resistant properties when used with C-Spray.

To create these anti-fouling layers around your instrument:

- Wrap the body of the sonde in plastic wrap and secure it with 2-inch clear packing tape.
- Apply two bands of clear packing tape on the lower section of the instrument. For example, over the 6600 sonde's depth sensor module and on the lower label section of the EXO2 sonde (this will allow you to see the magnet symbol and LEDs).
- Wrap the rest of the sonde body in high-visibility duct tape. Overlap slightly and press all seams firmly together. The layer of plastic wrap underneath makes removal of the tape much easier and prevents a sticky glue build-up on the sonde.
- Spray the top of the sonde, the duct tape and the base of the sensors with C-Spray, which will make these surfaces easier to clean especially when deploying in areas with hard fouling.



To illustrate this effect, a YSI 6600 sonde was deployed without any kind of anti-fouling protection. Alongside it, an EXO2 sonde wrapped in plastic wrap and covered in high-visibility Duck® brand duct tape was deployed.

After 2 weeks in the water, you can see that the 6600 sonde body was heavily encrusted in barnacles and sea squirts (top) whereas the EXO2 sonde only accumulated small barnacles and some slime (bottom). The EXO2 was easily scrubbed clean, while the 6600 had to be scraped, causing serious cosmetic damage to the labels.



Note: When wrapping sondes that are equipped with depth sensors on the side, make sure that you cut small holes in the plastic wrap/tape layers over the depth ports so that water can flow freely into the ports for correct pressure measurements.



10 Anti-fouling Marine Paint

Copper-containing paints can also be used as a biofouling countermeasure, but there are limitations. Be aware that the paint cannot cover the sensing technologies, may pollute the environment, and must be re-applied on a regular basis.

Because copper tape is so effective on water quality instruments, it is best to use anti-fouling paint instead on peripheral equipment—plastic screens, plastic deployment tube or other mooring hardware—to keep them free of biofouling.

If you use anti-fouling paint on your instrument, follow these guidelines:

- We recommend *waterbase* anti-fouling paint; it's easier to clean up and contains no solvents which may damage plastic parts
- Mix the paint well, as the copper in the paint will settle to the bottom
- Two thin coats applied with a small brush are better than one thick coat.
- Do not get paint on the optical sensing components of the water quality sensors, the CT electrode, or on any moving parts
- Paint ABS or PVC deployment tubes *at least once per year*, inside and out. Pipes that are not protected can have their flow-through holes sealed with growth in a short period of time, which will affect your data.

Petit Paint and Interlux anti-fouling paints are available from West Marine and Boat U.S., marine supply companies.



Next Steps

YSI's comprehensive monitoring sondes and anti-fouling components allow you to collect water quality data over long intervals and with high accuracy.

★ [Visit EXO Sonde web site](#)

★ [Request a Quote](#)

★ [Ask a Question](#) to Mike Lizotte, YSI Senior Applications Specialist and anti-fouling expert

About the Authors

Mike Lizotte has more than 35 years of experience with water quality instrumentation, field monitoring, and deployment. He spent his childhood summers on the beach and exploring marshes and estuaries. Now he works closely with YSI customers including the USGS,



NERRS, and many state and federal EPA and DEP offices to help improve their monitoring and data collection programs.

Danielle Dumont is a marketing communications manager for environmental monitoring systems at YSI Inc., a Xylem brand. She spent her childhood summers firmly planted on Midwest soil, usually with her nose buried in a book. She has more than 13 years of experience writing about water quality instrumentation and applications.



All photos courtesy of YSI Inc.

xylem
Let's Solve Water

YSI Inc.
1725 Brannum Ln
Yellow Springs, OH 45387
Tel +1.937.767.7241
800.897.4151
environmental@ysi.com

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