Water Analytics
makers of AquaMetrix instruments

White Paper

The Care and Feeding of the Aquametrix Differential Probe

Congratulations on your purchase of an Aquametrix differential probe. This probe has been proven in thousands of installations around the world as the probe that "works when everything else fails." If properly maintained the probe will give you years of accurate measurements. Just what "properly maintained" means we'd like to spell out here.

1. Why Good Probes Go Bad

Most probes on the market are "combination" probes, which means that the reference and process electrodes are "combined" in one glass envelope. The reference electrode is immersed in a neutral salt solution that is connected to the outside world via a porous junction. Over time the reference solution becomes contaminated with ions and molecules from the outside world and the efficiency of the probe drops. After approximately one year the reference solution is too contaminated for the probe to work and the entire sensor has to be replaced.

2. Why the Differential Probe has a Good, Long Life

The differential probe's uniqueness lies in its construction. It consists of two pH-measuring circuits that have in common a titanium ground rod. One circuit (the reference) is always bathed in pH 7 buffer and the other is immersed in the process. By subtracting the voltage of the reference circuit from that of process we get a very accurate pH measurement. The splitting of the electrode circuit allows the reference solution to be accessible. This means we can discard old reference solution and dispense new solution as often as we wish.

To do so could not possibly be easier. Simply unscrew the salt bridge, toss out the old pH 7 buffer and pour in new. Just make sure to fill the reference will with solution only to the bottom of the threads. If you overfill and then overtighten the salt bridge you can create enough hydrostatic pressure to crack the reference electrode.

3. How Often to Change the Reference Solution

We recommend calibrating a pH or ORP probe at least once per month. For pH probes, at the end of each calibration, the Shark readout will display an efficiency factor. No probe leaves the factory unless its efficiency is better than 90%. If calibration leads to an efficiency of 85% or less then it's time to change the buffer.

The important point to keep in mind is that a probe with an efficiency of 50% will still give an accurate pH reading if it is calibrated. However its precision will be half of that of a probe with 100% efficiency. Remember that accuracy is not the same as precision. A yardstick with only ¼" divisions is accurate but not precise. A micrometer with 0.001" resolution but not properly zeroed is precise but not accurate. Furthermore, a probe's accuracy will worsen as its efficiency drops. So, for accurate and precise pH measurements, change the pH 7 reference buffer when the calibration yields an efficiency of less than 85%. Or just play it safe and change it once a month. Fresh reference solution is cheap insurance.

4. How Often to Change the Salt Bridge

Many users mistakenly change the salt bridge when the efficiency of the probe drops. This rarely fixes the problem. The salt bridge is essentially a slug of saturated potassium chloride solution and provides an electrical pathway from the process to the reference. When it becomes clogged the response of the probe slows down but, unless the salt

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bridge is severely clogged, the efficiency of the probe will not improve significantly when it is changed.

So how often should you change the salt bridge? Certainly a response of the probe that is more than 30 seconds is a clear indicator that a change is needed. Otherwise we recommend once a year if the water is relatively clean and twice if the process is full of salts or organic contaminants.

5. The Other Reason Why Probes Get Sick

We've been talking about the reference solution becoming contaminated. But there is another fate that befalls probes—allowing one to dry out. A pH probe only works when its electrodes are kept wet. The electrode has a gel layer which responds to acidity. If the gel layer dries out, it can't work. Of course the reference electrode is always wet but it is common for someone who usually goes nameless to leave a probe out of the box without its wet cap. When the probe is put in to service it magically loses efficiency and may not even calibrate.

A probe with a dry electrode is a sick probe—maybe a dead probe. But here's the good news. If it has been left out for less than a week and you don't live in the desert then you can probably revive it. Just soak it in a weak acid (pH about 2) for a few hours. White vinegar works just fine. After it has soaked you might find that it is back to its former glory. We have even resuscitated probes that had been dry for several weeks.

6. Calibrate. It's fun, easy and absolutely essential

Like any analytical instrument a pH or ORP probe needs to be calibrated on a frequent basis. Just what is "frequent?" If we had to pick a number it would be once per month. If you have a process that alternates between acid baths and caustic ones then the large pH swings will dictate that you calibrate once per week. If your probe is on the effluent end of water treatment just before it is discharged into the environment then its swings in pH will be mild and you calibrate once a month.

Remember that pH calibration is a two point process involving two of the following calibration solutions: 4, 7 and 10. If your process is on the acid side then you will want pH 4 and 7. If you process is on the caustic side then pH 7 and 10 are the preferred solutions. If your process is on both sides of pH 7 then pH 4 and pH 10 calibration solutions are the right choices. ORP calibration is a one point calibration. We make 200 and 600 mV ORP calibration solutions but, for most applications, we recommend the 600 mV solution.

7. Real Men (and Women) Use Diagnostics

pH and ORP probes are Galvanic devices, aka "batteries" (albeit with very tiny currents). If you have a 9 V battery that reads 6 V you have a sick battery. The same is true for probes. If you want to know how "healthy" a probe is just look at the voltage it is sending to the built-in preamplifier. To do that with the Shark controller or Shark TX transmitter all you need to do is to select the menu "Diagnostics" and scroll down to the sub-menu "Sensor Input."

Remember that, for every pH unit change in the negative direction, there is a change in voltage (at 25^0 C) of 59 mV. A probe in pH 7 solution puts out zero voltage. If you put that same probe in pH 4 solution then you should read (7-4) x 59 mV = 177 mV. If *Sensor Input* reads 159 then your probe is 159/177 = 90% efficient. This is exactly how the Shark gives you an efficiency rating when you calibrate the probe. By reading the sensor input voltage directly you can see directly how efficiently your probe is working.

If your sensor input voltage is giving you low readings then you know it's time to either change the reference solution or rehydrate the probe. If you sensor input voltage reads ±20 mV (on either side of zero) no matter what buffer into which you put your probe then you have a dead probe. Remember a reading of pH 7 means zero output.

So get in the habit of looking at probe voltages and you will be an expert in probe technology.

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