Grounding Probes Debunked

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Conventional wisdom found in magazine articles and in the bowers of World Wide Web chat rooms indicated that “voltage” in aquaria is one of the factors that can cause Hole in the Head and Lateral Line Erosion. We read quotes like, “Stray voltage is something that exists in every tank. Stray voltage can be eliminated with a simple ground probe available at most pet shops in the twenty dollar range. Elimination of stray voltage is a simple step in reducing the stress on your fish. Every marine tank should be grounded for your protection and that of your fish.”

Is it true? Well not exactly, and as I will discuss below, the addition of a ground probe may even make matters worse!

Clearly electrical items submerged within your aquarium (power heads, heaters, etc.) can provide a direct interface between the prime power source (120 volts alternating (60 Hz) current (VAC) in the United States and 220 VAC, 50 Hz in most of the rest of the world) and the water, but some claim that the stray voltages can be indirectly induced by the lighting systems. This is possible because the skin depth of salt water (a conductor) at 60 Hz is not zero. “Skin depth” is the distance that electromagnetic energy can penetrate a conductor. Salt water is a conductor, but not a perfect conductor, so there is penetration by 60 Hz emissions. These induced voltages are small in magnitude. On the other hand, shorted pumps can develop large currents through the water, but typically between the “short” and some “ground” like your ground probe. This means that the inclusion of a ground probe could make things worse. If a pump were shorting within itself, the currents flowing through the water would remain local to the pump and should not be a problem. You would have to have two shorting pumps, or a pump and a ground probe, or some other current path to get electrical current to flow through your tank.

Direct shorts would have other ramifications. Copper or iron could be introduced into the aquarium water as plating occurred. Other compounds would plate out as well since salt water contains many ions in suspension. Electrolysis would occur, heating the water while it liberated oxygen and hydrogen. There is of course a shock hazard.

Most people do not understand the problem however. Lots of web space has been devoted to the measurement of voltage in aquariums... most of which is of no value. Voltage is *not* the problem, *current* is. Voltages can exist without there being any current. For example, birds sitting on a power line may be in direct contact with 10,000 volts, but they are not electrocuted. Why? Because no current is flowing through their bodies. Voltage is the “potential” or force that drives electrons through a conductor. The actual flow of electrons is the “current”. It is current that kills. Were one of the birds sitting on the power line to simultaneously touch one of the other wires on the transmission pole, a current path would be created (through the bird) and it would be electrocuted (and probably incinerated as well). So what are you doing when you add a grounding probe to your aquarium? You are providing a current path that might not already exist. Any fish between the source and the grounding probe will experience a current flowing through their bodies... not good!

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Taking a volt meter and measuring a voltage in your aquarium relative to some arbitrary ground point does not indicate that there is a current flowing through the salt water (conductive medium) in your aquarium! It just means that the aquarium water is at a different potential than the ground reference point that you chose.

Measuring a voltage between submerged points in your aquarium may be misleading if not done correctly. The use of metallic probes can create a “battery effect” if dissimilar metals are involved (think your volt meter probes are the same metal? What if they are chrome plated (most are) and what if you’ve worn the chrome off one to expose brass or copper beneath?).

Also, some currents in salt water are perfectly natural as described below.

You can measure electrical currents everywhere-- the fact that salt water ions flow, actually generates an electrical current. It’s unavoidable. The open ocean has lots of electrical currents flowing. Some of these are caused by currents flowing through the Earth while others are actually perturbations to local fields caused by the motion of objects (fish, turtles, etc.) in the water. When I was tracking the Florida Manatee (*Trichechus manatus*) in the Banana and Indian Rivers around the Kennedy Space center, we actually considered sensing the extremely low frequency (ELF) emissions generated by the manatee’s tails as they accelerated the brackish or salt water ions in the presence of the Earth magnetic field during vigorous swimming (alas, manatees are not very energetic most of the time and other means were chosen (Sirenian Tracking Project)). For example, the ampullae of Lorenzini in a shark’s nose detect minute current flow disturbances in the water as an aid in locating prey.

I don't use any power heads and all of my pumps are totally external and physically isolated (motor and pump head are separate). With the exception of an emergency heater in the sump, no electrical appliances come in contact with the water.

There are all sorts of anecdotes about how much better the fish in a given tank will act and look after adding one of these “grounding probes”. My belief is that if there are any stray currents in the tank coming from an electrical appliance, the solution is not to try to draw the current away with a grounding probe (symptom), rather, the appliance must be damaged and should be replaced (cure).

Fish don’t like electrical current to flow through their bodies. When higher electrical current levels flow through the water, fish will orient their bodies to minimize the potential (voltage) across their bodies, thereby minimizing the electrical current flowing through their bodies. At very low levels, the fish may only act strangely or seek areas of the aquarium where electrical current is not flowing. It is doubtful that continuous current flow through a fish’s body is beneficial, and may in fact be the source of anecdotal reports of Hole in the Head disease and Lateral Line Erosion. If your tank is at a different potential from the “ground” in your house, no electrical current may exist in your tank based on this static voltage. However as soon as you ground your tank by inserting a “grounding probe”, you will be guaranteed to have electrical current flowing even if the voltage drops.

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For a technical discussion of stray voltage in aquaria and the use of Ground Fault Interrupters, click here. (http://angel-strike.com/aquarium/GFI&TechnicalDetails.html)

In conclusion, the addition of a “grounding probe” will guarantee an electrical current flow in your aquarium and may induce erratic behavior or disease in your fish. If you have defective aquarium appliances that are creating a current path in your aquarium by using the salt water as a conductive medium, then the solution is to repair the appliances or replace them... not divert a portion of the current into a “grounding probe”.