A NON TECHNICAL EDUCATION ON BOAT ELECTROLYSIS

Whenever different metals are placed in a conductive liquid you create a battery. If you connect these pieces of metal together, current will flow. The current will be removing metal from one of the metal pieces = "electrolysis". If this piece is the zinc in your flashlight battery, that is good, but if one of the pieces is your propeller it is bad.

The zincs you use on a boat are called "Sacrificial Anodes". Zinc is used because it has a higher voltage in the water so the current will be more inclined to flow from it than from your propeller. To complete the electrical circuit, the zincs must be connected to the items they are intended to protect. Usually this is no problem because the zinc is bolted right to the shaft or underwater housing. Non metal boats will usually have a copper bonding wire inside that connects all the underwater metal items together so they all share the protection from zinc anodes. Since engines use the metal frame as the negative battery connection and the engine is connected to the prop shaft, the engine and the negative side of your 12 volt system are also part of this bonding connection. This bonding wire is usually connected somewhere to the rigging. This is not for electrolysis protection but for some protection from lightning strikes to conduct it into the water through the items connected together.

If other currents are allowed to get into this bonding circuit they can easily overpower the small voltage available from your zincs and defeat the protection you need. This is usually the most destructive form of electrolysis and you notice it because your zincs get eaten up very quickly trying to keep up. Under normal circumstances, zincs should last at least a year if they are working normally, and much longer if you don't have any problems. If they are being "sacrificed" in a shorter period you need to find where the external current is getting in.

The most common source of this external current is the shore power connection, especially the ground lead. Docks are notorious for bad wiring and often the ground lead is not connected to ground, is connected to the neutral, is being used for carrying current to a mis-wired boat, and all other sorts of problems. So the ground lead should never be directly connected to the ground bonding system we talked about earlier. The purpose of the shore power ground lead is to provide a return path for current if there is a short circuit or power leakage from an appliance or the wiring on the boat. You don't want it to connect all the underwater items on your boat to the underwater items on all the other boats and the dock because now your zinc is trying to protect everyone else too.

Unfortunately it is not always possible to keep the circuits separate due to interconnections such as **shore power chargers**. There are a number of ways to separate the shore power ground from the boat's underwater bonding system. The preferable and safest way is to use a galvanic isolator to introduce a 1.2 volt insulator in the circuit. This is enough to isolate most galvanic voltages but it will still conduct electrical faults and keep the boat safe in the event of a ground fault in the wiring or in an appliance. The galvanic isolator must be rated for the size of your shore power circuit.

TESTING FOR CONNECTIONS BETWEEN THE SHORE POWER GROUND AND BOAT GROUND

Disconnect (unplug) the shore power. Plug in and switch all shore power items on. (Make sure your inverter is off if you have one.) Use an ohmmeter to measure the resistance from each of the pins in your shore power inlet to the negative bonding system. All should be greater than 1 million ohms although readings as low as 100,000 ohms are not uncommon due to salt and moisture.

If the reading is low you need to find where the connection is and correct it. Unplug items one at a time until you find the culprit. MAKE SURE THAT THE SHORE POWER GROUND HAS NOT BEEN CONNECTED TO THE BOAT GROUNDING SYSTEM ANYWHERE. Unplug your battery charger and measure resistance from each of its power cord pins to the 12 volt outputs. All should be greater than 10 megohms. Check any other items that connect between the 120 volt system and the 12 volt system or engine frame, or anything grounded to the battery. Check amplified antennas which might be grounded to the rigging and be grounded by the coaxial cable to the TV or VCR.

If you have any other connections to shore (telephone, cable TV), do the same test on them - disconnect from the dock and measure from incoming connections to your boat ground system.

When you have removed all connections from your underwater metal items to the shore connections you are well on the way.

FURTHER TESTS

You can also temporarily disconnect the ground lead in the shore power connection of the boat you are checking. Measure the AC voltage, the DC voltage and the DC current between the ends of the ground circuit after disconnecting.

If the AC voltage is above 1/4 volt while the shore power breaker is on but disappears when the breaker is off, then there is AC leakage on the boat. You can usually track it down by turning off shore power items on the boat one at a time to find the culprit. Once isolated it should be repaired or replaced. If all appliances are off but it still comes and goes with the shore power breaker, then it is leakage in the AC wiring. Check the shore power connectors, all junction boxes, outlet boxes, light fittings, breaker panels etc., to look for dampness or corrosion.

AC leakage can reduce the DC isolation provided by a Galvanic Isolator. If the AC voltage is above about 0.25 volts and you can't repair the appliance causing it, then you may need to install a Galvanic Capacitor. Some Galvanic Isolators come with a capacitor already installed but they don't specify the size so if you see this AC voltage it is inadequate. If the DC voltage is below 1 volt, a galvanic isolator will provide the protection you need.

If the DC voltage is above 1 volt you have a serious problem that may not be solved with a galvanic isolator. First check that the DC source is not coming from the boat by disconnecting all 12 volt DC sources on the boat either at the battery positive terminals, or with a main switch, but check that the main switch is actually disconnecting everything. Sometimes there are circuits like bilge pumps and alarms that are intended to remain on even when the main switch is off. If removing all sources eliminates the DC voltage, then reconnect and subsequently remove DC loads one at a time until you find the culprit. Once isolated it should be repaired or replaced.

If the DC voltage is still above 1 volt after disconnecting all on board DC batteries and chargers, then the DC must be coming from the dock ground. This is probably being introduced by faulty wiring in another boat connected to the common dock ground that is feeding down the ground line to all the other boats. The best way to isolate this problem is to wait until the other owners are away, or live-aboards have gone to work, and disconnect their shore power cords (after first turning off the dock breaker) one at a time until the voltage goes away. Please remember to replace them and restore power as you go. Having isolated the culprit, you have a public relations problem to convince the owner that he is not only risking damage to his own boat, but to all the other boats on the dock. Showing how disconnecting their shore power cord makes the DC voltage reading go away should convince them.

The DC current should be below 20 milliamps, +/- depending on the size and type of boat. Significantly higher readings indicate active galvanic action. Compare this reading to the current flowing with a galvanic isolator in the ground circuit to verify that it is providing protection.

There are other sources of electrolysis that you can't correct. The boats each side of you in the marina may be connected together through the dock ground lead and one may be eating up the zincs rapidly on the other. If your boat sits between them, this current may take a short cut by going in an item near one boat, and exiting via your zinc near the other. This will eat up your zinc too even though you are not connected to them. The best solution here is to use zinc fish while you are at the dock. They are large lumps of zinc, often cast in the shape of a fish, that are cheaper and easier to replace than the zincs on you shaft.

The "fish" come with a copper wire already attached which is also used to hang them in the water. They have an alligator clip on the end of the wire and this should be connected to the negative bonding circuit on your boat. If it is not conveniently available in the cockpit in the vicinity of the prop, you might consider installing a stainless bolt for clipping it to, with the head of the bolt inside the deck connected to the negative bonding system. Clipping it to the shrouds or railing will only work if somewhere on the boat the shrouds are connected to this boat negative bonding system.

How to Test for Electrolysis

Any boat owner can quickly check the electrolysis on his watercraft.

When a boat sits in the water the exterior metal parts interact with each other to create a current similar to that of a very weak battery. These currents flow from one metal part to another; the current strength depends on what types of metals interact, along with the mineral content of the water itself. Boat metals consist of steel, copper, zinc and brass metal. Sacrificial anodes of zinc strategically placed on the boat help dissipate electrolysis to keep metal corrosion at bay. If the anodes have been placed and maintained properly, they prevent metal corrosion. Checking the electrolysis of your boat can prevent severe corrosion.

Instructions

Moor your boat to a dock that has little boat activity or traffic around it. This will isolate your craft from electrical disturbances in the environment.

Place a thin steel braided wire (tie a weight on the end of it) in the water next to the side hull of your craft. The water depth should be about five or six feet.

Connect one end of the wire to a bonding ground source on your boat, like a rail or motor-mount bolt. Turn off every electrical device on the boat. Start with the master battery switches, if you have them.

Turn the ignition key off and double-check any component or appliance that runs directly off the battery. Turn all electrical switches to the "Off" position. Unhook any shore cable power feed.

Set a multimeter gauge to the low volt setting, one that will measure a scale from zero to one volts. Connect the negative lead of the multimeter to the negative side of your battery, or to a ground source on the engine.

Place the positive lead of the multimeter on the thin steel braided wire in the water. The reading on the gauge should indicate 0.7 or 0.8 volts.

Write down your initial reading. Now turn on your master battery switch and take another reading. Write it down. Your master battery switch reading should not differ from the initial reading by more than 0.05 volts. if it does, a problem lies with the master battery switch wiring. Turn on your bilge pump and look for a voltage change of no more than 0.05 volt change from your initial reading. A greater change will indicate a problem with the bilge pump through-hull fitting.

Start the engine and systematically turn on each appliance and component and record the individual readings. Any appliance or component that produces a reading greater than 0.05 volts from your initial reading indicates a problem with that specific component.