SHOOTING TROUBLE

STRAY CURRENT CORROSION—HOT HARBORS

Especially timely for winter layup–stealthy ghosts can eat underwater metals while topside the quiet, snowy docks tell nothing.

Picking Up Strays—what it is, how to tell, what to do

Electrolysis gets a bum rap. Sure, it has something to do with the boat's metal disintegrating below the water line. A lot, even. But not everything. The real problem you're seeing could be Corrosion, or Erosion, or Cavitation. It's a big topic. In the next several issues we'll try to help you identify the real culprit eating your metals. Sort of like electrolysis, we'll eat away at it; let's hope your zincs are in good shape.

Electrolysis is only one of several processes disintegrating boat metals *(see pg. 2)*. Here, the *Cliffs Notes*: Electrolysis is used in chemistry and manufacturing to separate bonded elements, metals, and compounds by passing an electric current through them–also the namesake for hair removal using direct current. (Electrolysis of water, for instance, produces Hydrogen and Oxygen.) On a boat, stray current can come from almost anywhere–inside or outside the boat. Some degree of "Strays" lurk in all harbors–and of all corrosion caused by electrolysis, strays do the most damage, the fastest.

Now, it takes a village: The destructive electric source could come from the boat next door or the one 2 floats over. Current runs only about 45 feet in a straight line in saltwater (more in fresh) but could daisy-chain so the whole harbor feels the charge from one problem boat. Can you vouch for the bonding and electrical integrity of the whole village?

Current is fueled by dissimilar metals–each with its own potential to react *(see Galvanic Scale pg. 2)*. By the laws of chemical reaction the dissimilarity creates electricity. It's what all metals do, to some degree, relative to any other metal. Usually a slow process involving a few volts, protected by the boat's bonding system which connects all metals susceptible to corrosion to the zincs. The sacrificial zincs we rely on to take care of it all, no worries.

But stray current–now you can worry. Maybe from faulty insulation & short circuits, improper grounding of electrical devices, defective shore power supplies–strays involve voltage potentials 100s or even 1000s of times the dissimilar metal potential! Think of the dangers–the rate of metal corrosion.

The protective bonding & wiring system can be sabotaged by poor wiring, lack of maintenance, or a defect in any component conducting current along the way. Stray current–in extreme cases–can wipe out hardware in just hours. Hours! Hardware that keeps your boat afloat. Now how do you feel about the village.

Electricity's unpredictable and confounds us mere mortals–currents running roughshod, ignoring zincs, showing up wherever, eating whatever looks good. The variables are endless; the premise common to all: Electricity does not like imbalance. We want it to find balance with your zincs.

Any voltage differences between a boat and the dock or another boat will lead to stray currents. Corrosion from strays typically occurs at whichever element along the electric path provides the best ground. Zinc-armor the boat? No, too much of a good thing can overpower the boat's bonding system, ends up *attracting* strays. The boat with the most zinc usually sacrifices herself for the greater good: she will lose zinc to the dock or that other boat.

Your boat's also susceptible to stray current corrosion when underway–all electrical systems are on and engines create their own electrical field.

Just when you thought it was safe to go back in the water.

Good Places to Pick Up Strays:

inside the boat:

- Leaks from frayed or fractured wire (yours, theirs, the marina's)
- Badly insulated connections
- Connections actually made in bilge water *(don't do it!)*
- Reversed polarity
- Voltage drops (bad wiring, external radio ground plate)
- Ground faults
- Battery chargers *(for cars!)* without isolation transformers *(very bad)*
- 3-way plug with ground prong cut (ground or reverse polarity issues)
- Reverse polarity lamps (surprise ... so isolate it with a switch)

outside the boat:

- Defective shore power: fluctuating voltage, power spikes, poor grounding
- Marine welding or electrical work above water
- Electric power plants sending power offshore through conduits
- That other boat's bad wiring or polarity, connected to dockside power
- Tying neutral side of AC system into boat's ground system
- Defective shore-power wiring–mismatched voltage levels in ground circuits

Symptoms of Strays Running Rampant:

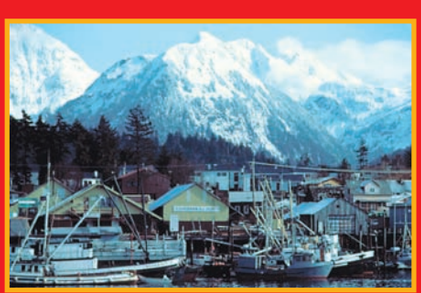
- Premature deterioration of zincs (usually should last a year)
- Broken wire connections between through-hulls or underwater elements & bonding strap
- Corroded fasteners (submerged)
- Pinholes in center of prop blade or pitting in shafts & rudders (don't confuse with normal-wear "notching" on leading edges)
- Getting zapped on the boat when touching metal

Many thanks to Jerry Kirschenbaum for his comprehensive 3-part series "Electrolysis & Corrosion," Wooden Boat, 1978; "The Shocking Truth" by Jerry Sitser & Clark Fritze, Waterfront News Northwest, January 1996; & "Break the Circuit" by Mike Smith, Power & Motoryacht, Sept. 2006.

Watt, Me Worry? What to Do About Harbor Strays

Hanging a zinc over the side only works if connected to your bonding system–sometimes overlooked. Use a minimum of 8-gauge insulated wire from the zinc.

To protect your boat from dockside AC–the fluctuating voltage, power spikes, poor grounding, and virtual connection to all other boats on the power source–make sure you have Ground Fault Interrupters (GFI) on all AC circuits aboard. They stop current flow should the green-wire ground become energized.



Sitka Channel, Southeast Alaska

When plugged into shore power the boat's electrically connected to the dock as well as to that other plugged-in boat, through both the common dockside ground and its own vessel's ground, using seawater as a conductor. If that other boat has weird electrical stuff going on, your zincs can be toast. Add in every other boat plugged to shore power, and you've got a corrosion disaster just waiting to happen.

You need to isolate your boat from her neighbors. Adding a Galvanic Isolator in the ground circuit is fairly inexpensive and easy to install.

Your best bet: Isolation Transformer. Runs $500–$1000 but it's the electrical equivalent of being at anchor–connects the boat to shore power magnetically, not electrically. No connection, no corrosion.

No worries.

ARCHIVE PHOTO © JANA M. SUCHY

Testing for Stray Current, page 2

Always exercise extreme caution when working on or testing any electrical circuit, or get a licensed marine electrician.

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Shooting Trouble

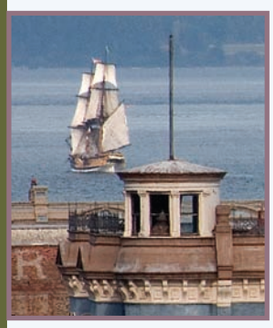
ELECTROLYSIS—Galvanic Corrosion

Electrolysis alone does not bear the burden of all your corroded metal. Electrochemical corrosion, through Galvanic Action, is all about Givers and Takers and Relativity–metals relative to each other–and that is the driving force behind it. Add additional current "Strays" and you speed up the process dramatically.

Each metal has its own "potential" to decay–to corrode. Arranged according to their potential the metals list out from most to least *(right)*.

Galvanic action is an electrical driving force of a few volts created by a difference in potential between 2 metals. Difference in metals (potentials) creates electrical current (anode to cathode direction), which immersed in seawater (electrolyte) causes the less noble metal of any given pair to decompose. Electrons move from the less noble metal toward the more noble; one gives, one takes. Everything in nature seeks balance.

All *You* need to know: Galvanic action makes its own current and the corrosion process is accelerated by "stray" electric current.



Electrolysis has corroded boat metals since ... boats had metals.

PHOTOS © JANA M. SUCHY 2006; Port Townsend, Wash., Wooden Boat Festival

We all know about sacrificial zincs–a less noble metal very likely to corrode–bonded to the hull to protect every metal below it on the list. No Zinc on your boat, what's next on the list to go–Aluminum, Iron, Alloys?

Consequences? Slight roughing up of a corroding prop can cause a costly drop in efficiency, requiring up to 11% more power (fuel) to produce the same thrust as a smooth prop.

If you put a penny on the bottom of an Aluminum boat, it'll eventually eat a hole in the hull.

Looking at the Galvanic Series–how many dissimilar metals are on your boat? All hooked up to your zincs, are they? Givers & Takers–electricity must have balance ... and it finds it, in your metals.

Galvanic corrosion eats not only the boat's hardware in the water–props, rudders, propeller shafts, outdrives, metal hulls–but the machinery and piping carrying water inside the boat as well–manifolds, pumps, plumbing. Wherever water flows, corrosion can follow.

Zincs and coolant additives in engine water jackets, heat exchangers, and keel coolers are not as readily evident as those chunks of zinc on the hull, but dangerous to lose nonetheless. And it happens quickly in the fast moving, high-temperature streams.

Like we said: Big Topic. And we'll keep eating away at it, just like electrolysis.

The Galvanic Series—A Relative Scale of Nobility

RELATIVE DIFFERENCE IN METAL POTENTIALS*

Memory Aid: Think Royalty, the More Noble CATHODE *sits* Passively *and* Takes–*a* positive *thing; the little people–a much* Less Noble ANODE–*must sacrifice itself &* Actively Gives *... electrons, just like taxes. A* negative *thing.*

Givers Anodic End Negative Least Noble Active

Potential (volts)	Metal
	Active Zone
1.73	Magnesium (Mn)
1.58	Magnesium–9% Aluminum (Al), 1% Mn, 1.5% Zinc
–	Aluminum Anode Alloy
1.14	Galvanized Iron (Fe), (hot dipped)
1.13	Zinc Plating (electro-plated)
1.12	Cadmium (Cd) Zinc solder
1.09	Zinc-Based Alloy
1.05	Zinc (Zn)
–	Aluminum Rivet Alloy
–	Beryllium (Be)
1.02	Aluminum–4% Zinc
0.96	Aluminum–1% Zinc
0.91	Aluminum Alloy–12.5% Zn, 2.5% Copper (Cu), 0.8% Iron, 0.7% Silicon (Si)
0.86	Cadmium-Plated Steel (0.001 in)
0.85	Aluminum (Al)
0.79	Steel, non-stainless–0.5% Mn, 0.20% Si, 0.12% C
0.78	Grey Cast Iron
0.74	Tinned Steel, (hot-dipped)
0.73	Forged Aluminum Alloys
0.61	Mild Steel
0.61	Chromium plate on Nickel on Steel (Ni 0.0005 in)
0.56	Tinman's Solder
0.55	Tin, electro-plated on Steel
–	Some "Active" Stainless Steels (Passive stainless steels can go "Active" under certain conditions & can then be Anodic; hence, they'd fall here on the series.)
	Metal (Electron) Flow
	Passive Zone
0.55	Lead (Pb)
0.53	Chromium Plate on Nickel on Steel (Cr 0.005 in)
0.50	Silver Lead Solder
0.50	Tin
–	Wrought Iron
0.47	Cast Iron Allioy
0.45	Steel, Stainless (12% Chromium)
–	Manganese Bronze
–	Naval Brass (60% Copper–39% Zn)
–	Yellow Brass
0.36	Admiralty Brass
0.35	Steel, Stainless, high Chrome
0.33	Brass (60/40)
0.31	Gun Metal
0.29	Copper/Nickel/Iron (Cu/Ni/Fe)
0.26	Silicon (Si)
0.26	Cupro-Nickel
–	Silicon Bronze (containing Ni, Zn, Cu, & Si)
0.25	Brass (70/30)
0.22	Copper (Cu)
0.14	Nickel (Ni)
–	Nickel, Passive (with Fe, Chrome, Stainless Steel)
0.11	Monel Alloy
0.10	Titanium
0.08	Tin Bronze (5% Tin)
0.08	Silver (Ag)
+0.25	Graphite
+0.26	Platinum
–	Gold (Au)

Takers Cathodic End Positive Most Noble Passive

* All potentials negative unless noted, & shown only to illustrate relative position of materials in the series. Potential values only valid considering solution's full environmental aspects–i.e., temperature, velocity, oxygen content–& may vary in both value and order under different conditions.

Source: Wooden Boat *No. 23, July/Aug. 1978*

Coming issues: other Metal Destroyers–Erosion, *more* Corrosion, Cavitation; *plus* You're Grounded! *both AC, DC Bonding Systems.*

Keep Galvanic Series for future articles and reference!

Electrolysis and Stray Current in the Cooling System

Electrolysis occurs when stray current takes the path of least resistance and travels through the engine coolant, seeking a ground. The coolant becomes electrically charged–the liquid electrolyte needed for electrolysis. The softer "Less Noble" metals–i.e., unprotected aluminum cooling system components–give up metal in the electrochemical reaction, sometimes seen as a white, black, or green crusty deposit forming around the solder joints, eventually leaking coolant.

Pinholes may also occur in any part of the cooling system–i.e., oil cooler, cylinder liners, expansion tank, or thermostat housing. Although a poor engine component ground such as a starter motor or alternator may result in a defective oil cooler in a matter of a few weeks, an improperly grounded electrical accessory may take months to destroy the same components.

Adding a ground to the heat exchanger isn't the best solution, & could actually complicate it. You may eventually need to add a ground, but finding the component with the problem is the key to the solution. Electric water pumps or any electrical accessory grounded in close proximity to the cooling system are likely candidates, but the problem could be anywhere in the electrical system.

SHOOT THAT TROUBLE!

Testing for Strays in the Cooling System

Measurable voltage may be detected in any cooling system, as the different metals in the system react through the coolant.

This voltage should not exceed 0.1 volts.
The electrolysis test is simple to perform.

With a digital voltmeter set on the 12-volt DC scale, attach the negative lead directly to the negative post of the battery. The positive lead should be placed into the coolant. Don't let the test probe make contact with anything but the coolant. Two readings are preferred, one with the engine off and the other with the engine running at approximately 1,800 rpm, with all electrical accessories on. Take precautions, the cooling system may be hot and under pressure.

A voltage reading in excess of 0.3 volts confirms electrical leakage into the cooling system. If the condition is present, flush the system, install new coolant and retest. If the condition is still present, a thorough ground inspection is next. It's a process of elimination. Turn on all electrical accessories, turn them back off one at a time while observing the voltmeter. When the voltage drops below 0.1 volts, you have identified the problem circuit. Check and if necessary add a ground to that circuit and retest.

If the excessive voltage continues after turning off all electrical accessories pull the fuses or open the breakers individually while observing the voltmeter. This will isolate the problem circuit. Now you must isolate the component feeding off that circuit–your vessel wiring diagram may be helpful if it's up to date. To check the starter circuit, crank the engine while observing the voltmeter. A poor starter ground can consume the oil cooler in a very short time.

Intermittent problems can be elusive; for example, some components, such as an electric bilge pump, may not function until an automatic switch turns it on. Always go for the add-on electrical accessories first–this is usually where we identify poor ground returns. Don't just treat the symptoms–sacrificial anodes and Selective Coolant Additives (SCAs) can only do so much to protect the internal components. Go after the cause of the problem and fix it.

Basic checks & observations will save you time and money.

Meet the MER Crew–Herb Knight, Service Manager

MER is growing, and this spring we hired a new Service Manager to tend to the fleet. More likely than not Herb Knight will be the MER guy who comes down to the boat to service or swap out your engine. He's the best there is: has engine experience you wouldn't believe–pretty much worked on everything that floats–and provides valuable OJT (on-the-job training) to our shop crew. But overall Herb just loves working with people–people like you.

Herb's storied career in mechanics began as a young kid, working in an air conditioning shop sweeping floors at 8, installing his first unit at 12. Must've had a knack. Built his own race cars–'57 Chevy, '64 Super Sport–drag racing up and down streets in the Deep South where he grew up.

"As far south as you can go in the continental U.S.," he says–McAllen, Texas–then Mississippi. Very Deep South. Says he worked long and hard "learning how to talk like somebody who's not from the South," but, truth be told, it can sneak back in when he's not looking.

"Figured the only way I was gonna get out of Mississippi was join the military," Herb says, volunteering for the Navy in 1970–The War Years–serving the next 7.

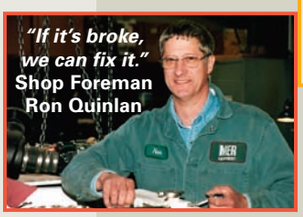
"Best thing I ever did," he says.

Herb mechanicked tugboats in Adak (YTMs–Yard Tug Mediums), where, he says, "I got Alaska in my blood," then served a tour in Viet Nam before eventually discharging as an E-4 in Alameda, Cal., working the next 16 years there in the marine business.

With his Naval engineer training Herb got to work on some pretty impressive rigs in the service. Aircraft Carriers, with over 1100 ft. on the waterline, where Herb worked on lifeboat engines and the CVA (Carrier Vessel Aircraft) auxiliaries: 3 of them, Cleveland 16278-A's.

"I like the big engines," he says. EMDs–electromotive diesels–so named because, well, they put them in locomotives; and ALCO–up to 3500 hp of engine that "wouldn't fit in this room."

After OJT working the Clevelands Herb got a sweetheart deal as private engineer to the captain's gig assigned to the CVA *USS Ranger* in the Pacific theater. Out here it was all "Dee-troits," he says, servicing the 671-Detroit aboard the 45-ft. yacht given the captain as his personal ship-to-shore and R&R cruiser. Some gig.



MER's engine experience at your service: Our new service manager Herb Knight takes service calls; longtime shop foreman Ron Quinlan keeps things moving in the shop.

In his civilian mechanics duty Herb went on to work the CATs, Deeres, Detroits, Yanmars, ZF, Twin Disc–pretty much everything that's out there.

All told, Herb's worked on a lot of engines in those 35 years, 6 of them as a fleet manager out of Alameda–managing 7 mechanics, 235 route trucks and 17 tractor-trailer rigs on a multi-million-dollar annual budget. Then he ran his own business–Knight's Mobile Repair Service–servicing yachts for another Alameda decade.

At that time Herb tried to make his home in Washington state, a place he'd first seen back in the Navy as a buddy's best man. But just when he and his wife, Yvonne, bought their dream 5 acres in Graham he got the call and an offer he couldn't refuse: back to Alaska servicing the Dutch Harbor fishing fleet for Pacific Rim Diesel and Makushion Service Center, working 8 years on everything–Detroits, EMDs, you name it.

Since leaving Alaska, Herb's worked for various diesel engine outfits in the Seattle area, notably: service manager at Stewart & Stevenson; branch manager at Precision Power; started the generator division at RTB Contracting; and service manager working with all power generation at EC Power.

Then a tip from a friend put Herb in touch with MER, and we're glad to have him.

"I'm really enjoying it," says Herb–out of management from behind a desk and back in the field.

"I like being around people, so it's a good business for me.

"What I think is great about this company," he says of MER, "they've been around a long time. They're not going anywhere." Not like others, he says, the Big-Company others, that all dried up and blew away.

"Mechanics today, we've lost 2 generations of them–to computers. Who's going to work that hard anymore when they can sit at a computer terminal?"

Mostly the guys who grew up with it–don't mind getting their hands dirty.

It's hard to find a guy out there with Herb's marine experience and skills. He's been fixing engines his entire life, loves his work and it shows.

Clearly loving the interaction with people, you'll generally find Herb with that big Southern grin on his face.

But don't tell him it looks like it's from the South.

You can reach Herb by calling MER at 1.800.777.0714 or emailing herb@merequipment.com. He'd love to work with you.

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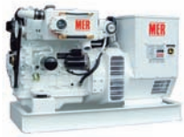

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ELECTROLYSIS ISSUE

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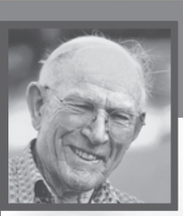
news you can use:

**Electrolysis–New Crew–NEW Website–
Product Lines ... *& Ivan Fox Remembers***



From the Founder–
Ivan Fox Remembers ... THOSE WHO BUILT AN INDUSTRY

Today, I, as well as many in the fishing industry, feel saddened at the passing of Bill HIngston on September 1st. Bill was a stalwart in the industry. I am sure that many fishermen still fishing today have had some assistance from Bill in getting their start.

I met Bill in the late 1940s, after WWII. Bill had been an Air Force pilot and served in the South Pacific; we had something in common as I was a merchant seaman serving on tankers and transporting aviation gas to the various South Pacific bases. After the war, having graduated from the UW, Bill went to work for Washington Fish & Oyster Co. at Port Williams, Alaska, as a pilot, flying a Grumman Widgeon. His plane was referred to as the Easter Egg, due to its bright paint job. This plane was later acquired by Kodiak Airways and became one of their fleet of planes. Bill eventually worked at Port Williams as an office manager and within a year or two became the plant manger, he was eventually promoted to vice president in charge of Washington Fish & Oyster Co.'s Alaska operations based at Kodiak King Crab in Kodiak.

Bill and I worked together on a good number of joint ventures, tender pools, and custom canning arrangements. I think it might be well to mention the processing plants and their managers of plants on Kodiak Island when Bill and I got our start:

Fred Gepner, Parks Canning Co., Uyak Bay;
George King, San Juan Fishing & Packing Co., Uganik Bay;
Chuck Turner, Kadiak Fisheries, Port Bailey;
Tom Johnson, PAF (Pacific American Fisheries), Alitak;
Otto Olsen, Kadiak Fisheries, Shearwater;
Gordon Jones, Alaska Packers, Larsen Bay;
Herb Domenici, Village Islands, Uganik Bay.

There have been many changes of the guard since Bill and I started. There has been a vast improvement in methods of handling and processing salmon as well as the effort put in by the fishermen to improve quality. Bill was a great person. We will all miss his wisdom.

Bill Hingston, 1921-2006. Bill flew B-24 Flying Boxcars in WWII over the Pacific; met Alice, his wife of 53 years, on a blind date in college; & got his first start in the fish business as a pilot for Washington Fish & Oyster in Kodiak.

WWII B-24

Writer/Photographer/Design: JANA M. SUCHY