October 2025 Newsletter – Exhaust Injection Angle

Photo Essay: Exhaust Injection Angle

Water-cooled, often referred to as “wet” exhaust systems, enable otherwise extremely hot gasses to be safely conveyed through a vessel, and expelled to the outside atmosphere. Dry exhaust gasses can be as hot as 1,000° Fahrenheit. Without a stack, and a metallic, insulated exhaust system, safely removing them from the vessel simply isn’t practical without cooling them first, and not all vessel designs lend themselves to the inclusion of a dry exhaust stack.

Enter the wet exhaust system; these inject seawater into the dry exhaust stream shortly after it leaves the engine, cooling those gasses considerably, often to under 150° Fahrenheit, which allows them to then travel through fiberglass pipe and hose, before being discharged from the vessel close to, or sometimes below, the waterline.

After these gasses leave the engine’s turbocharger or exhaust manifold flange, they enter an exhaust pipe, which is either an “elbow” or “riser”, which enables water to be injected into, and mix with, the exhaust gasses. The design of this elbow or riser can range from simple to complex and it may be off-the-shelf, or fully custom. In the latter case, it’s critical that the design closely conform to specifications provided by the engine manufacturer regarding support, and the angle at which the water is injected.

Many, but not all engine manufacturers provide an injection angle, with the primary goal being, to prevent water from backing up into the engine; and with a secondary goal of ensuring adequate mixing of water, and exhaust gasses, to prevent heat-induced failures in exhaust hose and fiberglass pipe.

In the accompanying image, the angle at which water is injected into the exhaust is less than 10°. This is below the threshold, which varies from manufacturer to manufacturer, established by most marine engine makers. Cummins, for instance, mandates a minimum of 15°, while John Deere calls for 25°. A failure to adhere to this requirement could lead to water back-flowing into an engine's cylinders, which nearly always results in costly damage, and in some cases requires complete engine replacement. Such water entry is almost never covered under warranty, with engine manufacturers' taking the position, 'if you build the system the way we tell you to, this should never occur'. More on exhaust system design here.

If you are purchasing a vessel, new or pre-owned, or if you are having an exhaust system replaced, ensure the design complies with the engine manufacturer's requirements, including and especially for the angle at the point of water injection.

Ask Steve

Hi Steve,

We just hauled our boat for a bottom job and have halos around the thru hulls that did not exist a year ago. Can you provide any advice as to the cause? For context, the sacrificial anodes are one year old and still very much intact; the black paint is Micron CSC, and the blue is an ablative indicator coat.

As additional background, the marina had a nearby lightning strike a few months ago. I had to replace a transducer and a couple resisters but nothing material. Could this be related given it didn't exist prior?

Thanks for any advice you can provide. It is very much appreciated.

Bob Lime

Bob:

Bottom paint halos are usually not as ominous as many would-be experts claim. In the vast majority of cases, they are not associated with corrosion or “electrolysis” (a term frowned upon in corrosion professionals’ circles). Instead, haloing is usually the result of cathodic over-protection, i.e., too much zinc. Over-protection results in the production of an alkaline solution at bonded, underwater metals, such as through hulls, and struts; which in turn causes the paint to lift and flake off in a circular pattern around these metallic components. While undesirable, on a fiberglass vessel, other than the damage it causes to the anti-fouling paint, cathodic over-protection is harmless. Over-protection can be harmful to timber vessels; the alkaline attacks the lignin, or pulpy material between wood grain, in a process called de-lignification”.

The fact that your anodes are a year old, and still intact, would be consistent with either over-protection, or the anodes are not making good, low resistance, contact with the bonding system. Generally, normally functioning anodes should not last this long. Additionally, zinc anodes used in fresh or brackish water will go dormant, and therefore seemingly last a very long time. However, they are in fact ineffective; in that scenario an aluminum anode should be used.

Ultimately, what I have described above is purely a theory, and where potential corrosion is concerned theories should be backed up with solid data. I would recommend two analyses be carried out, ideally by an ABYC Certified Corrosion Technician. The first, a reference cell test, which is performed while the vessel is afloat, will confirm the protection level of your underwater metals. The second, a bonding system continuity test, is carried out while the vessel is hauled. There should be no more than one ohm of resistance between any bonded underwater metal, and any sacrificial anode that is connected to the bonding system.

Further reading…

- Bottom paint halos: https://stevedmarineconsulting.com/feature-article-bottom-paint-halos-what-causes-them-and-how-to-prevent-them-from-occurring-editorial-do-you-need-wi-fi-or-texting-smoke-alarms/
- Reference cell testing: https://stevedmarineconsulting.com/reference-cell-testing-know-thy-corrosion-protection-level-editorial-old-vs-new/
- Busting the 'Hot Marina' myth: https://stevedmarineconsulting.com/feature-busting-the-hot-marina-myth-editorial-a-blue-collar-resurgence/
- Anode selection and galvanic isolators: https://stevedmarineconsulting.com/galvanic-isolators-and-zinc-anode-selection/

Steve,

I just bought a Sabre 36 hardtop and I want to install a Bimini and screens over the windshield.

Should I insist that the installer de-core every single intrusion, or could we use Sikaflex or something else for the little screw snaps?

Thank you,

Bruce Adornato

Bruce:

In an ideal world, de-coring or "reefing, and back filling", a process described here, would be standard for every penetration into a cored composite substrate. In reality, getting canvas makers to do this, correctly, is a long shot at best, and to be fair, this typically isn't part of their skill-set. If you wanted to do this for every snap, you certainly could do so.

As an alternative, for canvas snaps, I would settle for thoroughly de-waxing the surfaces, both the vessel and snap, and then bedding each penetration using a quality bedding compound, more on that process here.

Hi Steve,

Contemplating a small new-build diesel cruiser for extended passages in remote areas, I'm wondering how much reliability and repairability we've lost by computerizing engine controls in the quest for cleaner emissions.

All-mechanical diesels were (in my experience) highly reliable devices – failures were rare as long as they had cooling water plus clean fuel/air/lubrication. Key spares (impeller pump, injectors, alternator) were easy to keep on board and not too hard to install. You often had advance warning of a problem, and the owner or a local mechanic could get it back up and running again.

Although cars are produced and serviced on a vastly larger scale than marine diesels, new cars regularly experience computer glitches without warning or obvious cause. Most aren't disabling, but even the smallest seems to require a trip to the local dealer for diagnosis and at least a system reset. When the computer system has a significant failure, even the dealers struggle. The service network for marine diesels is orders of magnitude smaller than that for cars, and non-existent outside a few major boating centers. Marine chat sites tell sad tales of a fried component that can't be replaced, and of flying in a tech to replace the engine's computer.

Three questions:

1) In your experience, how much reliability and repairability have been lost with Tier III diesels compared to their mechanically-controlled brethren?

2) How are your clients dealing with this issue on boats that will spend extended time far from boating centers – is it mostly ‘bring more money’?

3) Would you happily take a small new-build cruiser on extended remote trips with a single Tier III engine?

Best regards,

Craig Stephens

Craig:

On the face of it, you have little choice when it comes to *new* diesel engines over 50HP, nearly all of which are electronically controlled, either via unit injection or high-pressure common rail. You can still obtain and install factory-rebuilt legacy mechanical diesels, with warranties, from some engine manufacturers (Cummins at least still offers this). Not long ago I read about an individual who had a custom cruising vessel built, one in which he installed a rebuilt, but otherwise “antique” mechanical diesel engine, a model that was renowned for its use in the UK’s double decker busses, because he was leery of modern, electronically-controlled diesel engines. Shortly after the vessel was completed, the engine had to be removed, repaired and reinstalled because of a rebuild error.

When the prospect of an electronically-controlled marine diesel engine first began to rear its head, in the early 90s, many boat buyers and builders scrambled to get the last of the mechanically injected engines, believing that adding an electronics package to the venerable diesel engine would affect its reliability. In fact, that premonition never came to pass, as electronically-controlled marine diesels have proven themselves to be very reliable. Before the first electronic diesel was ever installed on a recreational or commercial vessel, these engines were thoroughly “tested” in over the road trucks, where they ran for millions of miles, during which time they were continuously improved.

Since that time, tens of thousands of vessels have been built using these engines, and they have traveled millions of ocean miles, mostly without incident. Many of these engines have been installed in blue water, passage-making, and ocean-crossing vessels, including Fleming, Nordhavn, Grand Banks, Palm Beach, Selene, Kadey Krogen, and Marlows, to name a few. I’ve personally traversed thousands of offshore miles aboard vessels equipped with electronically-controlled diesels, to such remote locations as the Aleutian Islands, Greenland, Iceland, the Faroe Islands, and Svalbard, and never did I worry about their reliability. Not only are most electronically controlled diesels very reliable, they also offer features not found in mechanical diesels, including and especially the ability to self-diagnose, and quieter and cleaner operation.

Having said all that, it is undeniable that adding an electrical system to an engine that previously didn’t need one, does increase complexity and the potential for failure. Most of the electronic/electrical failures I encounter are related to harnesses support, chafe and plug/pin corrosion, as well as wiring-related errors committed by installers and boat builders. My advice is, for a new build or repower alike, to mandate that the engine installation fully comply with the manufacturer’s, and ABYC’s guidelines, and this should be verified by a third-party specialist.