Gearhead

Fluid Analysis Saves Time and Money

By Steve D'Antonio

My first encounter with fluid analysis was as a young sea cadet. One summer I was fortunate enough to spend a few weeks aboard a U.S. Navy destroyer. It was a sign of the times I suppose. As a 14-year-old, I was given virtual free reign of the nearly 600-foot fighting vessel, from the "nixie" torpedo decoy gear aft to the anti-submarine rocket launchers forward. The ship was new and undergoing sea trials, which included speed runs, hard-over turns, and even firing of the 5-inch guns. It was great fun and educational, too.

One day, while walking down a passageway I poked my head into a small cubby of a compartment. Inside, neatly stacked on shelf after shelf, were scores of clear glass vials that contained liquids of different hues, from brown and black to red and purple. As I was scanning this strange scene I was startled by a voice from behind me. "Those are samples of all the fluids from the ship's gear," said a young petty officer.

The value of fluid analysis cannot be overestimated. Proper sampling technique is, however, equally as important. Those drawing them must follow established guidelines in order to ensure accurate results.

Over the course of the next half hour or so he explained the science of fluid analysis, called tribology, and how it helped the ship remain ready to fight and ply the oceans, and how it saved the Navy money by identifying when machinery needed to be serviced or repaired before it actually failed. Despite my being a budding gearhead even then, I'm sure much of what he said went over my head. Many years later my interest in tribology would be rekindled.

FLUID ANALYSIS HISTORY

As it turns out, my introduction to the world of fluid analysis aboard a Navy vessel was fitting. Fluid analysis has been effectively used for more than a half century, ushered in with the jet age, and specifically, with carrier-born aircraft whose first-generation turbines' lubrication systems were especially sensitive to water, salt, and metallic debris.

Today, the science of tribology, or the analysis of friction of machinery components and their fluids, which include crankcase oil, transmission fluid, and coolant and hydraulic fluid, is well established in the mechanical world.

During my tenure as a boatyard manager I instituted a comprehensive fluid analysis program. Instead of relying on a mechanic's or my own intuition or anecdotal experience, I wanted something that was more scientific. I wanted something my customers and I could use to evaluate the condition of equipment when it malfunctioned, and just as importantly, when it appeared to be working well. I wanted to be able to carry out condition-based maintenance, and I wanted to predict failures and prevent them rather than react to them after they occurred. Tribology is the means by which this goal is achieved, providing hard data that could be used to make important maintenance, repair, and replacement decisions.

RETURN ON INVESTMENT

The return on investment where fluid analysis is concerned can be substantial indeed. Analyzing a few ounces of crankcase oil, for instance, can yield reams of information about the current health of an engine and how it's been maintained throughout its life. For instance, sodium, when found in an engine's lubricating oil, may be indicative of ingestion of salt-laden mist (this can happen if spray is ingested into an engine room air intake) while glycol contamination often spells trouble in the area of the cylinder head gasket. Wear metals such as iron, chrome, nickel, copper, lead, tin, and aluminum each tell a different story about a component within the engine, from pistons and rings to bearings and valves.

Contaminant metals such as silicon, sodium, and potassium tell a different story as they are introduced from outside sources such as dust, seawater, and coolant. The quantity of metal in a sample, measured in parts per

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million, when compared to the number of hours accrued by the sample oil, determine whether there is cause for concern. Still other contaminants, such as fuel and soot, and imbalances such as acidity and viscosity, can indicate malfunctioning fuel injection systems, use of the incorrect stock oil, or simply oil that is old and worn out.

Fluid detective work doesn't end with crankcase oil. Transmission fluid and coolant are also fertile ground for this sort of testing. Transmission fluid analysis can often detect issues with bearings, clutches, shift mechanism adjustment, damaged gears, or overheating. Many transmissions include some type of cooler; however, if it's not working properly, oil can overheat and lose some of its lubricating properties. An improperly adjusted shift cable can cause the same problem. Coolant includes additives that inhibit rust and corrosion as well as control pH; however, over time these become depleted. Common wisdom dictates that cooling systems be flushed and coolant replaced every two years, however, that's likely very conservative. An analysis of the coolant can stave off this service if it's unnecessary, often paying for itself.

PROCEED WITH CAUTION

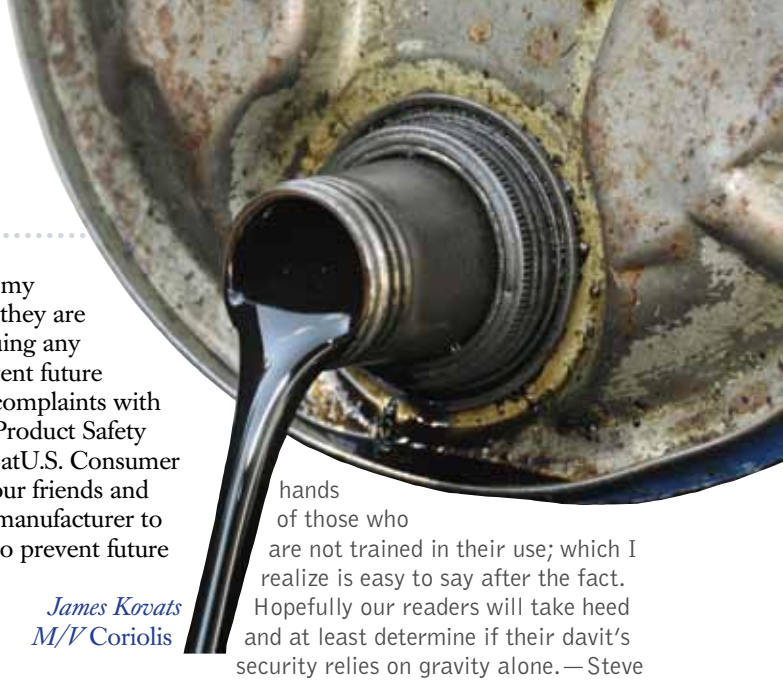
As valuable as fluid analysis is, it isn't perfect, and in the hands of an inexperienced or tribologist wannabe, misinterpretation is all too easy. For example, a client recently contacted me, distraught over the results of a transmission-fluid analysis. The report showed very high levels of copper—so high that the analysis lab had flagged them in red. After exchanging a few emails with the transmission manufacturer, however, I determined that the clutches are sintered copper alloy and therefore these high copper readings were not abnormal. The lesson here is the value of the amount of data a lab has accumulated on an engine, transmission, or other type of equipment is important when it comes to alerting the user to potential trouble.

Yet another area where analysis often goes awry involves a sample-taking technique. If, for example, a vacuum pump and hose are used to draw a sample and the latter's intake is dragged across the bottom of an oil pan in the process, it is likely to show elevated wear metal, material that has accumulated over the course of hundreds or thousands of hours. It is for this reason that many commercial users rely on valves rather than vacuum pumps and tubes when drawing crankcase oil samples. The valve delivers oil as it's circulating through the engine, offering the most accurate representation of its condition.

Practicing fluid analysis isn't a cure all for your machinery's ailments; it doesn't take the place of proper maintenance. One thing, however, is certain: You can't benefit from its attributes if you don't take samples and have them analyzed. The average cost of analysis is approximately $25 per sample, a small price to pay for having yet another preventive maintenance arrow in your quiver.

Steve owns and operates Steve D'Antonio Marine Consulting (www.stevedmarine.com), providing consulting services to boat buyers, owners, and the marine industry.

Ask Steve



DANGEROUS DAVITS

Please alert your readers their davit can fall overboard! I realized this inconceivable fact when my 270-lb. davit fell 10 feet from my boat deck and crashed onto the swim step where I was standing moments before. Luckily, I heard it coming and jumped out of the way—or else it surely would have crushed and likely killed me. The accident occurred because my friend accidently pushed the wrong control button and boomed down onto the railing. The railing acted as a fulcrum and the weight of the dinghy pulled the davit (minus the pedestal) over the edge.

Please warn your readers to inspect their davit installation and check if it is positively attached. It is my understanding that many davits (especially the manually rotating type) are held onto their pedestals with gravity only. I have contacted the manufacturer of my davit and found out they are not interested in issuing any modification to prevent future accidents. I've filed complaints with the U.S. Consumer Product Safety Commission and BoatU.S. Consumer Affairs. Please tell your friends and pressure your davit manufacturer to issue modifications to prevent future accidents.

James Kovats
M/V Coriolis

James, thank you for sharing this important information with *PMM* readers and me. Davits and all gear should be routinely inspected for wear, damage, and compliance and initially with manufacturer's installation and maintenance guidelines, but if this was not a defect per se, there's not much you could have done to prevent it, other than keeping the controls out of the hands of those who are not trained in their use; which I realize is easy to say after the fact. Hopefully our readers will take heed and at least determine if their davit's security relies on gravity alone. — Steve D'Antonio

BYPASS FILTERING

Steve, after reading your article on bypass filters, I have a question or two. I have read many similar articles in diesel-related magazines and recall reading something about very small micron filters removing some of the good stuff, and actually removing some

Ask Steve

of the oil additives. Have you heard of anything like that?

I want to install a bypass filter on my Cummins marine engine. I'm looking into one that uses a centrifuge. Any opinions—pros or cons—on the centrifuge? Thanks, and keep up the good work.

David McBain
Stirling, Ontario, Canada

David, to my knowledge, and based on the research I've carried out, filters, full-flow or bypass (or centrifugal), have no deleterious effect on an oil's chemical makeup or additive package.

Centrifuge bypass filters use oil pressure to create centrifugal force, which in turn, and in theory, slings contaminants from the oil. Centrifugal fuel filtration systems use a similar approach that has been proven effective, however, they rely on a dedicated motor to create extremely high-speed rotation (I wrote an article on this subject, published in *PMM,* March '08).

One of the advantages of centrifugal filtration is the elimination of the need for filter elements. The contaminants are simply deposited on the inside of the housing, where they can be cleaned off. However, some debate how effective such filtration can be, when it relies on oil pressure jets alone to establish centrifugal force. Before making your decision as to which unit to select, ask the manufacturer for test results regarding the efficiency and size of particle removal.—Steve D'Antonio

SANITATION SYSTEM

Steve, I know you are a busy guy and if you have already addressed this question, tell me where I can go for the info. If not it might be an interesting topic to discuss.

I am going to have to take our aft head apart to discover why it isn't getting flushing water. Part of re-installing it would be to check out the hose and replace most of them as we own a 1985 43-foot Albin Sundeck, which we purchased two years ago, and I'm not sure how old they are.

I recently read of someone using plastic pipe in his septic system (obviously there would be a need for some hose to make certain connections).

We have a Raritan Electra Scan and a holding tank. Is there, and here is my question, any ABYC guidelines for or against doing this? It seems like it would be a good idea and would probably last longer than hose. Thanks.

Charles Williamson
Media, Pennsylvania

Charles, you've posed a very good question indeed.

With a few caveats, using schedule 40 or 80 PVC pipe for sanitation systems makes very good sense indeed. Above all else, the primary woe of sanitation systems is odor, which is frequently the result of hose permeation. Hose can permeate for several reasons, chief among these are low-quality material or hose runs that allow effluent to stand within them. The former is easy to avoid by purchasing only high-quality hose that includes a minimum five-year permeation warranty. The latter can be more challenging to deal with—it's often a function of the vessel's overall design. However, when PVC pipe is used, the permeation issue, as well as the need for hose replacement for any other reason, is eliminated.

ABYC is mute on the subject of sanitation system plumbing. However, in my opinion, PVC pipe should not be used in areas where its failure would result in seawater flooding.

I covered this and other sanitation system details in a *Channels* e-newsletter (Jan. '12). It's available via this link: http://www.passagemaker.com/subscriptions/channels-e-newsletter/item/1530-avoiding-sanitation-system-woes.—Steve D'Antonio

MARINE GAS DETECTION

Steve, maybe you have an opinion on monitoring of sleeping quarters that have 8D batteries stored under the bunk? Thank you, and my best to you and your family for a wonderful new year.

Bud Orr
Longboat Key, Florida

Bud, battery installations and their ventilation are covered by American Boat and Yacht Council (ABYC) Guidelines. Without going into too much detail, all battery installations require, among other things ventilation to prevent a buildup of explosive hydrogen gas. Under-berth battery installations can represent a variety of challenges. Chief among these is the difficulty involved with ventilating them from the highest section of the compartment, a necessity in order to remove lighter-than-air hydrogen, and an ABYC tennet.

Ask Steve

Mattresses often make for an effective airtight seal over hatches. Additionally, while the risk is low, depending on the alloy composition of the battery plates, another byproduct of lead-acid battery charging may be arsine and stabine gas, both of which are toxic.

While anecdotal evidence shows that CO detectors will sound in the presence of hydrogen, they are not designed to do so. If you have a concern about your under-berth battery installation, and I believe such a concern is warranted, you should begin by making certain it is fully compliant with all applicable ABYC guidelines, detailed in chapter E-10 'Storage Batteries'. Then, you can install a hydrogen gas detector. While not common in recreational applications, units designed for marine applications are available.—Steve D'Antonio

PIPE THREAD SEALANT

Steve, I am in the process of replacing/upgrading the sanitation plumbing on my Selene 53 and due to the location of the tank and associated inlets/outlets there is no way to prevent effluent from standing in significant lengths of the hose. This requires using PVC or PP pipe in these areas and associated threaded fitting to allow connection to the new Trident 102 hose I am installing.

In your recent "Avoiding Sanitation System Woes" you mentioned "Manufacturers of heads, holding tanks, and other sanitation system components are typically very specific about sealant use." I have not been able to find any references to a specific thread sealant recommended by either SeaLand or Raritan Engineering on their websites or installation manuals.

I have found numerous references on various PVC, polyethylene, polypropylene pipe vendor sites for various pipe thread sealants such as RectorSeal Tru-Blu. Can you provide a link to their recommended thread sealant or your recommended sealant? I have a VacuFlush SeaLand system. Thanks.

Robert Chancellor
Port Aransas, Texas

Ask Steve

Bob, a great deal of satisfaction can be derived from designing and installing a sanitation system that works well and is odor free. I commend you for taking on this task and using PVC pipe in areas where effluent stands is an excellent approach, one I've used successfully on many occasions.

When it comes to sealing pipe threads (i.e., NPT tapered threads between pipe-to-hose adapters and valves or other fittings), I've had good success with a product called Leak Lock, from Highside Chemical (it's available online and at many plumbing and refrigeration supply houses). It's ideally suited to a variety of pipe sealing tasks, including VacuFlush systems, and is appropriate for everything from potable water to fuel. You might find this Dometic installation guideline useful: http://www.dometic.com/0e7b237d-d33b-4f6d-a640-a5eba809b3a2.fodoc.

The interface between hoses and pipe-to-hose adapters, on the other hand, should be made dry, using no liquid or paste sealant. Many boatbuilders install sanitation system

and other hoses using sealant. In my experience this practice actually leads to leaks as the sealant breaks down, making hose removal extremely difficult. Hoses should fit snugly over barbed fittings, and diluted liquid dishwashing detergent can be used to aid the process, and then double clamped using high-quality, solid-band, all-stainless steel hose clamps like those available from AWAB. With that approach your sanitation system should remain leak and odor free. — Steve D'Antonio