Biodiesel

This alternative fuel is much in the news these days. But most of what you're getting is noise, not information. Here, the author presents everything you need to know about biodiesel in practical terms: its formulation and diversity, its advantages and disadvantages, and its qualified acceptance by marine-engine manufacturers.

Text and photographs by Steve D'Antonio

Above—*Soy oil, derived from soybeans, is a common feedstock for biodiesel production, but its use for that application fluctuates with its market value. Recently there's been a shift to a variety of other raw materials, including waste vegetable oil and poultry processing by-products.*

"The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become, in the course of time, as important as petroleum…products of the present time."

Those could easily be the words of a former, recent U.S. vice-president. Or the head of a contemporary environmental advocacy group. In fact, they were spoken by the inventor of the diesel engine, Rudolph Diesel, during a speech he delivered in 1912. It's been a long time coming, but perhaps his century-old prophecy of widespread reliance on vegetable-based fuels is nearing reality.

With today's prevailing high cost and sometimes limited availability of conventional fuel, biodiesel is getting a closer look from consumers, commercial end-users, and government agencies alike. The dominance of diesel engines in the marine sector in particular makes biodiesel especially relevant to anyone who owns, builds, or maintains boats.

Let's begin by formally defining *biodiesel.* It's the name given to a liquid fuel derived from vegetable or plant oils, animal fats, waste cooking oils, and greases. These can be virgin

Left—*VA BioDiesel's Denny Sulick displays a sample of feedstock for making biodiesel.* ***Right***—*Glycerin, a by-product of biodiesel production and a versatile material in its own right, is seen here separating from the oil feedstock.*

oils, or re-refined from fast-food and restaurant deep-fryers. That's right: the same oil that your French fries or onion rings were cooked in today could power a marine diesel engine tomorrow.

In more scientific terms, biodiesel is methyl/ethyl ester–based oxygenate. It can be derived from soy methyl ester, or SME, popular in the United States; or rapeseed (canola) methyl ester, or RME, popular in Europe. Both oils are known as fatty acid methyl esters, or FAMEs. Other crops, among them mustard, cotton, sunflower, sesame, coconut, palm, hemp, and even algae, have been enlisted to produce biodiesel.

These oils cannot go straight from the press to the fuel tank. Accounts are legion of operators running diesel-engine-powered vessels and vehicles on allegedly "filtered" raw fast-food, deep-fryer, or other waste vegetable oils. The fact is, though, that it's simply not practical for the average recreational or commercial vessel, nor is the practice approved by any major marine diesel engine manufacturer.

Raw greases solidify to the consistency of lard or butter at the relatively high temperature of 50°F to 60°F (10°C to 15.5°C). To prevent this, a vessel trying to burn such fuel must remain in warm climes, or have fuel system heaters—tank, fuel lines, filters, everything must be kept warm—installed to keep the oil from congealing.

By contrast, biodiesel goes through a sophisticated refining process: *transesterification*. In this molecular "cracking" procedure, oils and fats are filtered to remove water and other contaminants, including food residue. The fats and oils are exposed to alcohol, most often methanol, in the presence of a catalyst, usually sodium or potassium hydroxide. The ensuing chemical reaction creates fatty acid methyl esters. If they're to become motor fuel, then we call the resulting liquid *biodiesel*.

(A useful by-product of the process is glycerol, or glycerin; it finds its way into various applications such as cosmetics, dust mitigation, and pharmaceuticals.)

Some biodiesel producers can incorporate almost any fat or vegetable oil—including recycled cooking grease—as "crude." U.S. restaurants produce about 300 million gallons (1.1 billion liters) annually of waste cooking oil: vegetable oil as well as animal fats, tallow, and lard. It's a rich resource. The remainder of the biodiesel industry limits itself to virgin vegetable oils.

Soybean growers have been responsible for much of the commercialization of biodiesel as a result of declining prices for their harvest coupled with overproduction, although lately that's changed. Approximately 400,000 farms grow commercial soybeans in 29 of the United States.

It's interesting to note, at this point, that roughly 60 gal (227 l) of biodiesel could be produced for every acre of soybeans; 125 gal (473 l) for rapeseed; 140 gal (530 l) for mustard; and 650 gal (2,460.5 l) for palm.

Historically, most of the U.S.-based industry has favored soybean oil as the primary feedstock for biodiesel production. But, about two years ago that pattern began to change, according to Denny Sulick. He's general manager of VA BioDiesel Refinery LLC, Virginia's largest biodiesel refiner, and the person responsible for purchasing the plant's feedstock. (See the sidebar on next page.)

Sulick: "There's been a tremendous shift to other feedstocks and away from soybean oil. The rapidly escalating price of soybeans during this time has made it virtually prohibitive for use in biodiesel production. Reduced crop plantings as a result of a shift to corn [much of it for ethanol production], exports to Asia and other countries, and other speculative demands have placed soybean oil into a reduced-demand scenario from the perspective of the biodiesel industry."

From a ratio-efficiency standpoint, the average U.S. farm consumes about 9 gal (34 l) of conventional distillate diesel per acre for planting, harvesting, and production. Similarly, when viewed from unplanted farmland to fuel in your tank, it requires about one unit of energy or gallon of diesel fuel to produce 2.5–3.2 units/gal of biodiesel. This relationship is known as the *energy yield*, which compares quite favorably to ordinary distillate diesel, whose energy yield is a scant 0.84. (The entire process for the latter fuel, from drilling and extraction to refined product, takes more fuel than it makes.)

A study not long ago by the U.S. Department of Energy's National Renewable Energy Laboratory went looking for even more efficient sources of vegetable oil. The results point to great promise for a type of algae that has a nearly 50% natural oil content. Algae farms, the research indicates, covering roughly 7 million square acres (about the size of the land mass of Hawaii), could produce enough biodiesel for all U.S. domestic transportation needs.

These algae are capable of growing in fresh, salt, or waste water, and consume carbon dioxide as they grow and reproduce. Here's one measure of the real-world promise held by biodiesel based on pond scum: an acre of corn produces about 300 gal (1,136.6 l) of ethanol a year; an acre of soybeans, about 60 gal of biodiesel per year. By contrast, an acre of algae can, in theory at least, produce in excess of 5,000 gal (18,927 l) of *biofuel* (including diesel and jet fuel) per year, while feeding on emissions from power-plant smokestacks. And, it doesn't require land that would otherwise be needed to grow food crops.

Okay. If biodiesel is so good, then why aren't there biodiesel pumps at every filling station and fuel dock?

I'll try to answer that question with a straightforward discussion that emphasizes the technical context. Obviously, there are economic and political components involved, but my explanation below will be largely technical.

Right now, the primary disadvantage of biodiesel, and the hurdle it must overcome in order to become more widely adopted in this country, is its high cost. The popular "cut" or mixed varieties of biodiesel include *B20*, *B5* (the maximum dilution recommended by some engine manufacturers), and *B2*; these consist of ordinary (distillate) diesel fuel mixed with 20%, 5%, or 2% biodiesel, respectively.

Thecut varieties typically cost between \$.02 and \$.08 more per gallon than distillate diesel, and those prices may fluctuate, depending on the price of the feedstock, be it soybeans, rapeseed, waste animal fats, or vegetable oils.

Note that when the price of distillate diesel goes up, that drives up the cost of biodiesel as well. Why? Because production and transportation costs increase with the price of "conventional" diesel fuel.

Price is by no means the only obstacle faced by biodiesel. There are also the factors known as *high cloud* and *pour points*.

High cloud is the temperature at which a fuel begins to form wax crystals, which makes it look cloudy and will clog fuel filters until the temperature rises. Pour point refers to the fuel's ability to remain in a liquid state.

Due to the vegetable oil in its composition, biodiesel when cooled will thicken at a relatively high temperature. (Place a bottle of ordinary vegetable oil in the refrigerator and you'll see this in action). The cloud and pour points of B100 range between 12°F and 60°F (–11°C and 15.5°C) and between 5°F and 55°F (–15°C and 12.7°C), respectively. The type of feedstock accounts for much of the variation, since animal fats tend to solidify at higher temperatures than plant-based oils. This is a comparatively wide gap and one that would cause some concern even in temperate areas. Practically speaking, problems begin to arise at about 40°F (4.4°C).

Remember, most of these issues occur with B100, which is not commonly used. The values for cut varieties of biodiesel are typically much closer to those of distillate diesel. By way of comparison, conventional No. 2 diesel fuel, or 2D, ordinarily has a cloud point between +15°F and +34°F (–9.4°C and 1°C). It should, however, be at least 10°F (5.5°C) below the lowest ambient temperature at which the vessel's engine will be operated.

Pour point varies by season, region, and refinery; it usually ranges from 0°F to +10°F (–17.7°C and –12.2°C). Many automotive and some marine diesel engines utilize fuel filter heaters to contend with extreme cold weather operation; these are "aftermarket" items, available for marine diesel filters. They are not necessary unless the engine or tankage compartments are allowed to cool below those temperatures.

There are additional challenges for biodiesel—namely, *stability* and *storage*. Biodiesel has a greater tendency than distillate diesel to absorb water,

The Neighborhood Refinery

When I visited VA BioDiesel Refinery in West Point, Virginia, it wasn't at all what I'd expected. Situated in an industrial area adjacent to a concrete plant and a beer distributor, VA BioDiesel occupies a nondescript metal industrialbuilding. Other than a couple of storage tanks and a sign, there's no indication of what goes on here: no smell, no fumes, no smoke, very little noise, and no flames burning off excess gases. For all anyone knows, the building could house a carpet loom or a creamery.

I met general manager Denny Sulick in the parking lot. A chemical engineer and corporate manager from Pennsylvania who retired a few years ago, in 2006 he was tapped by the refinery's owners to run this facility. He spotted me and said my diesel VW was the giveaway. All of the facility's Ford diesel pickup trucks operate on the plant's product with no apparent maintenance problems. (They're well out of warranty, with over 100,000 miles on the odometers, running on B100 fuel all summer and B20 during Virginia's relatively short winter.)

Above—*VA BioDiesel's facility, nestled among soybean fields and industrial buildings, gives little indication of its biofuel mission.*

oxidize, and support microbial growth, and those factors, as we've previously seen (*Professional Boat-Builder* No. 115, pages 112 and 122) already plague conventional diesel fuel. While responses vary, most refiners agree that B100 is good for between six months and a year, although a John Deere bulletin says that biodiesel blends up to B20 must be used within 90 days, and anything above B20 within 45 days, from the date of the biodiesel's manufacture. The wide variation in the fuel's potential useful life depends on storage temperature and moisture ingress. The higher the temperature, the faster fuel degrades. Above-ground storage tanks, especially those in warm, sunny climates, could hasten biodiesel's thermal degradation.

Furthermore, biodiesel is hydroscopic; the more readily water "mixes" with the fuel, the more difficult it is for a filter to separate the two. Because of its higher fuel density and viscosity, biodiesel is more likely to cause crankcase lube-oil dilution. If the crankcase lube-oil level rises while an engine is running on biodiesel, it should be changed immediately and analyzed for biodiesel dilution. Some engine manufacturers recommend halving standard oil change intervals, or carrying out regular oil analysis, when running high concentrations of biodiesel (B20 and above). Engine manufacturers also recommend additives for biodiesel users; these include oxidation stabilizers, cold-flow enhancers, and microbiocides.

Still another impediment to widespread acceptance of biodiesel is the engine manufacturers. Granted, they're nearly unanimous in their desire to embrace alternative fuels, especially those that fall under the umbrella of government incentives or environmental legislation. But most engine makers stop short of actually *endorsing* biodiesel.

The list of potential problems associated with burning biodiesel detailed by one engine manufacturer is downright frightening: power loss and "dangerous" increased power, corrosion of fuel injection systems, injector nozzle deposits, lacquering and seizure of internal injection components, injection pump failure caused by water ingestion, sludge formation, and reduced engine service life.

That lineup of possible fuel-related problems would be enough to scare any potential end-user away—but so might the warnings on the back of most over-the-counter pain medications. Once you get past the extreme scenarios, even engine manufacturers concede the realities of running biodiesel are comparatively tame.

Consider Caterpillar's literature, for example. It says, "Caterpillar neither approves nor prohibits the use of biodiesel fuels," but then goes on to say, "Biodiesel [fuels] meeting the requirements listed in Caterpillar's

Sulick eyed the camera on my shoulder and asked that I not take any photos inside the plant. He and the owners of the facility, the largest biodiesel refinery in Virginia, are protective of their methods for churning diesel fuel out of a variety of feedstocks, from soy oil to poultryprocessing by-products.

The plant is immaculate and consists mostly of large stainless-steel and aluminum "reactors," where the chemical cracking and transesterification of the oils take place. The primary materials that go into refining here are the feedstock along with potash and methyl alcohol. The B100 produced on site meets the stringent ASTM 6751 standard for biodiesel.

More specifically, VA BioDiesel Refinery's feedstocks encompass soybean, canola, and palm oils, as well as yellow grease and recycled cooking oils. You won't see bales of soybean plants entering one side of the plant and tanker trucks coming out the other. Raw materials arrive at the plant in "crude" oil form, essentially as unrefined oils. At the time of my visit the feedstock of choice was poultry fats, owing to their low cost and high cloud point suitable for summer production and

A large sequential system is the final step in fuel filtration. Vertical filter sections above the two containers are compressed to prevent blowby; and biodiesel is then pumped through them.

consumption. (See the main text for an explanation of the *cloud-point* phenomenon.) As the temperature drops, the refinery will add more soybean oil to the mix, lowering the cloud point for cold-weather use.

Although soybeans get much of the media attention where biodiesel is concerned, they are not employed as widely as they once were, because of an increase in their market price. Interestingly, the land surrounding the refinery is rich with soybean farms.

This particular processing plant has the capacity to produce 8–10 million gal (30–37.8 million l) of biodiesel a year, often operating three shifts around the clock, seven days a week. Sulick proudly pointed out during my tour that the poultry waste the crew was then processing to manufacture biodiesel isn't part of the food chain and therefore does not infringe upon production of food crops. The only waste product that leaves this facility—other than the water from the bathrooms—is magnesium silicate (also known as talc), which absorbs methanol, water, and glycerin during the biodiesel refining process. It has a relatively low environmental impact and is disposed of at a sanitary landfill.

—*Steve D'Antonio*

John Deere's agricultural equipment is frequently employed to harvest biodiesel feedstock—here, soybeans. The company prefers a 5% blend (B5), but concentrations of up to 20% blend (B20) in petroleum diesel fuel can be run in all its engines.

biodiesel specification, or meeting either ASTM 6751 or DIN 51606, are acceptable. [Biodiesel] may also be blended in any percentage with an accepted fuel, provided the diesel meets the requirements outlined in Table 6 prior to blending.... The use of biodiesel fuels does not affect Caterpillar's materials and workmanship warranty."

Or, here's what Cummins has to say: "Cummins neither approves nor disapproves of the use of biodiesel blends. The use of biodiesel fuel does not affect Cummins materials and workmanship warranty.... It is expected that blending up to a 5% volume concentration should or most probably will not cause serious problems."

And Yanmar: "...up to 5% volume blend RME or SME blend, which complies with the existing quality standards, *should not give end users any serious problems.*" (The emphasis is mine.) A Yanmar service bulletin is more direct: "Yanmar, through this advisory, clarifies the acceptance of biodiesel blend in diesel fuel only when the blend does not exceed over 5% biodiesel."

John Deere, whose stake in the production of biodiesel is significant, since its agricultural equipment is frequently employed to harvest the feedstock, takes a more liberal stance. "While 5% blends are preferred (B5), biodiesel concentrations of up to 20% blend (B20) in petroleum diesel fuel can be used in all John Deere engines. Biodiesel blends of up to B20 can be used ONLY if the biodiesel meets ASTM D6751 (US), EN 14214 (EU), or equivalent specification.... Expect a 2% reduction in power and a 3% reduction in fuel economy when using B20."

Finally, Detroit Diesel weighs in with this statement: "Biodiesel up to B20 is acceptable. Detroit Diesel... permits the use of biodiesel derived from virgin soy methyl ester and rapeseed methyl ester when blended up to 20% maximum in diesel fuel."

I find it interesting that a few engine manufacturers go so far as to specify the feedstock: SME or RME.

While the excerpts above are not exactly ringing endorsements of biodiesel, they do not prohibit it either. At the same time, there are some impressive biodiesel testimonials.

In June 2008, the 78′ (23.7m) Cummins-powered trimaran *Earthrace* completed a 24,000-mile circumnavigation on nothing but B100 for fuel. The engines reportedly ran well and without any major failures other than the replacement of a few fuel pumps.

The previous July a 60′ (18.2m), twin-screw Caterpillar C-18-powered yacht successfully toured the south coast of the United Kingdom running on B30.

Based on engine-manufacturer research, it does appear that engines equipped with rotary and high-pressure common-rail fuel injection are most sensitive to fuel problems, including those created by biodiesel. Statements and guidelines regarding biodiesel are available at the engine manufacturers' Web sites, though they are not prominently displayed. Another source of engine information is the biodiesel promotional Web site: www.biodiesel.org. Be aware that this is a secondary source, and therefore possibly less accurate or up to date than information provided directly from the engine manufacturers.

Let me repeat: nearly all the major diesel-engine makers exclude fuel-related problems from their warranties, regardless of whether it's bio- or distillate-based fuel. They warranty their engines on the basis of materials and workmanship. In general, it's unlikely that a manufacturer will void such a warranty simply because of the use of biodiesel per se. As the examples above indicate, most engine manufacturers do make recommendations regarding the type of fuel that should be run in their engines, typically citing an American Society for Testing and Materials and/or European Union standard.

Knowing what you or your customers are buying in the way of biodiesel may present a problem. In an effort to improve biodiesel's acceptance, the National Biodiesel Board has created a "Certified Biodiesel Producer/Marketer," or BQ-9000, seal of approval. This seal, where displayed, indicates that the biodiesel offered meets the ASTM standard 6751 (EN 14214 in the E.U.) for biodiesel. A list of approved producers and marketers is available at www.bq-9000.org.

If a biodiesel product does *not* carry this seal, it does *not* mean it's *not* compliant; it may only mean the producer or marketer hasn't sought BQ-9000 accreditation, which includes inspection by an independent auditor. The essential detail for the buyer is whether the product meets the ASTM D975 or EN 590 standard. If it does, and this can be verified by the producer or marketer, then it's a known commodity.

Because nearly any diesel engine will run on a wide variety of vegetable or animal-fat oils—Rudolph Diesel's first compression ignition diesel engine ran on peanut oil—the uniform quality of the product isn't assured by the mere functioning of the engine. Certification serves to mitigate the problem of bootleg biodiesel and its undesirable side effects: poor lubricity, improper cloud and pour points, contamination, and other out-of-spec features.

Because biodiesel degrades some rubbers and plastics, in the early '90s engine manufacturers began altering the materials in their fuel systems. Boatbuilders and tank manufacturers, as well as manufacturers of other products that come in contact with fuel, may still face a compatibility adjustment period.

As with any new technology, biodiesel comes with its own learning and acceptance curve. One complicating factor is the tendency of biodiesel to oxidize (basically: *rot*), absorb water, support microbial life, and turn acidic over time. Thus, one of biodiesel's strengths is also one of its weaknesses. Proponents tout it as environmentally friendly because it will biodegrade, but that characteristic is a potentially huge liability. Rotting, waterlogged fuel that's eating away at fuel tanks is not exactly something most boat builders or owners care to have aboard.

In some of the engine-manufacturer literature relating to biodiesel, vessel operators are warned to: keep the boat's fuel tanks as full as possible; protect them from extreme temperatures; and limit extended storage of biodiesel. But, since the words "extreme" and "extended" are not defined, those warnings are rendered nearly worthless. While it's difficult to keep distillate diesel fuel from being contaminated and going sour, operators or yards responsible for engines running biodiesel fuel must be doubly cautious about the above-mentioned fuel issues, among others.

Another vexing problem is biodiesel's propensity to degrade certain rubber and plastic components such as fuel lines, plastic bowls, and in some cases plastic or fiberglass fuel tanks. There are biofuel-resistant resins available. But, it can be difficult to determine whether they've gone into the fabrication of an existing FRP tank, or to obtain them to build a new tank. Anecdotally, it seems that common biodiesel blends have no effect on *most* FRP resins, although some lab testing has shown evidence to the contrary. Likewise, there's literature indicating that any natural rubber components will be affected, whereas other technical documents say biodiesel will affect only fuel system components made before 1994.

The list of potentially affected materials includes Buna-N tank gaskets, nitrile, and natural rubber. Fluorocarbon or viton "rubber" components are considered biodiesel safe. Copper and copper alloys such as bronze and brass, as well as lead, tin, and zinc, tend to hasten the oxidation of biodiesel (as they do to distillate diesel), and can create deposits in the fuel system.

Biodiesel's impact on fuel systems over time is, in fact, still something of an unknown, though a growing pool of end-users on shore and afloat is providing new data all the time. Evidence to date suggests that biodiesel concentrations of B5 and below do not cause problems, and that complications associated with blends up to B20 are also relatively rare. Indeed, many vessels and countless land vehicles are running much higher concentrations with few problems in material deterioration.

Biodiesel's list of *positive* attributes is impressive and lengthy. Perhaps most important, it can be produced domestically and relatively easily. And, unlike other alternative fuels such as hydrogen, biodiesel's infrastructure for supply, distribution, and service is already in place: every road and dockside diesel fuel pump can pump biodiesel, and every diesel engine can run on it, with little or no modification. All the necessary production technology exists and is in operation. It's not experimental; it's reality. A biodiesel refinery operates in West Point, Virginia, just half an hour from my home, and it's one of many around the United States (see **sidebar**, page 30).

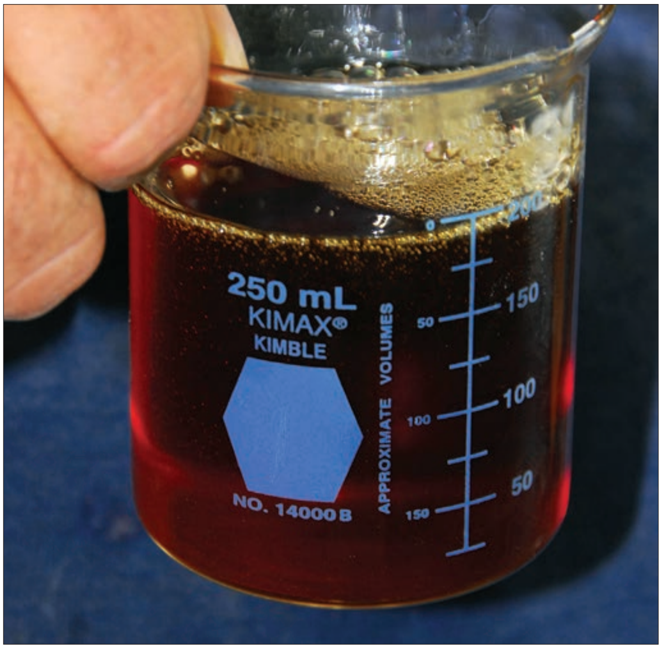
Biodiesel production in the U.S. was approximately 30 million gal (113.5 million l) in 2004. By 2007 it had jumped to 450 million gal (1.7 billion l), with the reported capacity of the country's 170-plus plants at 2.24 billion gal (8.3 trillion l).

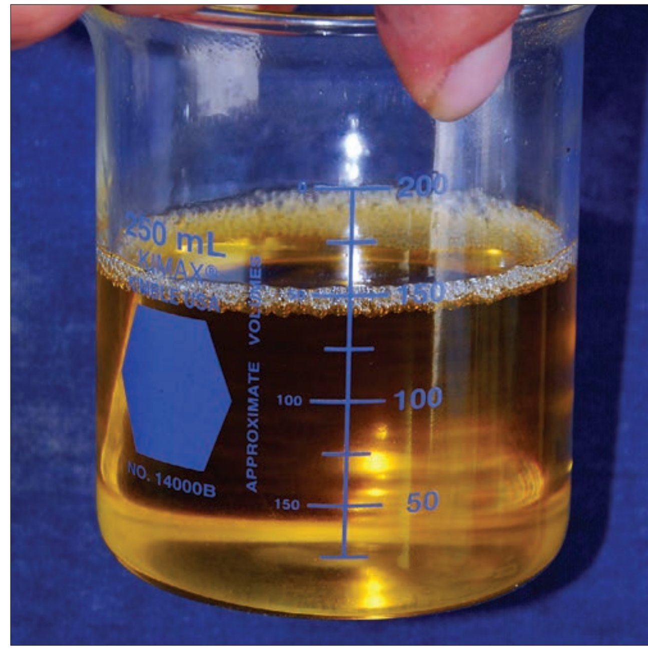
Additionally, it is environmentally friendly: greenhouse gas emissions, during both production and consumption, are approximately 68% less than those from the distillate version when measured in pounds per gallon. Diesel engines that run biodiesel will produce less unburned hydrocarbons, carbon monoxide, sulfates, aromatic hydrocarbons, and particulate matter.

I should note, however, that nitrogen oxide, a harmful pollutant, does increase slightly with the burning of biodiesel.

B100 users report that the noxious exhaust fumes normally associated with diesel are no longer evident; in their place is a rather pleasant aroma not unlike French fries or popcorn. I experienced this recently when a biodiesel exhaust I encountered came from fuel made from poultry feedstock; it smelled a bit like fried chicken.

Biodiesel advocates like to show off the clean-burning virtues of the fuel by placing a white handkerchief over the exhaust pipe during start-up.





Raw material, **left,** poultry-based oil in this case, and the finished product, B100, **right.** VA BioDiesel's pickup trucks run on B100 in summer (see the sidebar on page 30). Their tailpipe emissions smell like fried chicken and emit no smoke or soot upon start-up.

The handkerchief remains unsoiled. On the water, that soot reduction means cleaner transoms and hulls.

Here's another item of interest to those who care obsessively about their engines: biodiesel boasts higher lubricity and *cetane*. The latter is a measure of the fuel's ignition value, roughly equivalent to gasoline's octane index. Adding biodiesel to distillate diesel improves the traditional fuel's burning characteristics, increasing lubricity and cetane, while reducing smoke and the exhaust's unpleasant odor.

Some end-users of biodiesel report the need to change filters more frequently, at least initially. In heavily contaminated tanks, debris may lodge in fuel lines and fittings (such as the one shown here), valves, and other plumbing.

Naturally, there's a price to be paid for these advantages. Biodiesel is slightly less potent than ordinary diesel as a fuel. Straight B100 provides approximately 5% to 9% less heat value or energy per gallon than does distillate diesel fuel. There's a corresponding reduction in available horsepower and fuel economy. Blends in the B2 to B20 range suffer a less noticeable loss of power and economy.

As stated earlier, biodiesel absorbs water and oxidizes easily, making it essentially biodegradable. The advantage of this trait is that spilled B100 does not present nearly the ecological concern that spilled distillate diesel does, the former being biodegradable and considered nontoxic. Biodiesel is in fact *10 times* less toxic than table salt; you could even *drink* unadulterated B100, though I wouldn't recommend it. B100's flash point of 300°F (148.9°C) is roughly twice that of distillate diesel, making it safe enough to handle that the federal Occupational Safety and Health Administration classifies it as "non-flammable." This advantage, though, applies only to B100, not to blends.

When I first wrote about biodiesel several years ago, I said that it would be difficult to deny that there are very compelling arguments both for and against its use. Today, I'd say the balance has shifted markedly toward the "for" and away from "against," thanks to further experience in the marketplace, more research, and standardization of production.

If you or your customers are considering biodiesel, check with the appropriate engine manufacturer about the latest guidelines for the biodiesel grade you intend to burn. Every diesel engine manufacturer I've contacted has been responsive on the subject of biofuels; they all have service bulletins and suggestions on the subject.

Also, before you or your customers make the switch, it's advisable to obtain from the fuel retailer, in writing, the specification for the product he or she offers. Most engine manufacturers have agreed that for their engines to burn biodiesel, the fuel must meet certain agreed-upon standards, one of which is the ASTM 6751 standard already cited. If a retailer will not supply, in writing, the standard for the fuel he or she is selling, then you should look elsewhere.

Another complication reported by some first-time biodiesel consumers is clogging of fuel filters and lines. That's due to the solvent nature and scouring effect that biodiesel has on fuel tanks and other fuel-system components. While this purgative side effect may be advantageous in the long run, be prepared to either clean the tank preemptively or replace filters more often, at least upon initial use of biodiesel.

Biodiesel holds great promise for the marine diesel engine community. Increased demand and production could make it more economically competitive than ordinary distillate diesel fuel, which will mean increased use for all applications. Its adoption for marine service can be straightforward. The potential rewards of such a changeover range from the philosophical to the practical, but with some preparation can easily outweigh the limitations of the fuel.

The prospect of not smelling diesel fumes in a following breeze, and the reduction of environmental consequences in the event of a spill, are incentive enough to tempt a vanguard of boaters looking to builders, service yards, and engine manufacturers for a better course ahead. PBB

About the Author: A newly named contributing editor of this magazine and former full-service yard manager, the author now works with boat builders and owners and others in the industry as "Steve D'Antonio Marine Consulting Inc." His book on marine systems will be published by McGraw-Hill in 2009.

E Diesel Is Not Biodiesel

"E diesel" is the name given to an experimental form of fuel that is a mixture of diesel fuel and up to 15% ethanol. It is *not* considered biodiesel; does *not* meet ASTM or E.U. requirements for biodiesel; and it *does* pose serious risks to diesel engines and fuel systems.

Unlike the mixture of gasoline and ethanol, where the basic characteristics of the fuel remain unchanged, when ethanol is mixed with diesel the resulting product is considerably different from the relatively safe diesel fuel so well known to those in the marine industry. E diesel is much more like gasoline in its flash point and volatility. E diesel blend is considered a Class I liquid (with a flash point of less than 100.4°F/38°C), while distillate diesel is a Class II liquid (with a flash point between 100°F and 140°F/37.7°C and 60°C). This means that E diesel must be stored and handled in vessels much the way gasoline is. Few marine diesel-fuel systems are designed with this level of volatility in mind.

E diesel presents other potential operational concerns, among them reduced lubricity, phase separation, and cetane number, but its low flash point and tank vapor inflammability are the greatest risks. If someone offers you E diesel, just say no. —*S.D.*