



FUEL SYSTEM DESIGN AND INSTALLATION THE FLEMING YACHTS WAY

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FUEL SYSTEM ISSUES

It's a truism: diesel engine problems experienced aboard recreational craft are attributable, more often than not, to fuel "issues." That's a broad statement, however, in that the definition of "issues" may vary substantially, from running out of fuel to fuel that's severely contaminated with anything from asphaltine to water, to name just a few of the more common maladies. Additionally, when the problem is described as "bad fuel," in my experience I have found that in

some cases the problem is indeed the fuel itself; while in many other cases the problem is, or has been exacerbated by, the design and/or installation of the fuel system.

While it's likely that most serious cruisers would place a high priority on a vessel's fuel system, I have found that in many cases it appears to be given far too little thought on the part of those designing and building today's cruising vessels. The criteria for a well-designed and -constructed fuel system includes a variety of aspects, from the material



Primary fuel filters and priming systems are located inboard of each engine. (top) Fuel transfer controls and override switches are clearly labeled and easily accessed. (bottom)

chosen for the fuel tanks and plumbing to the logic and ease with which the sys-



Supply and return valves are synchronized to prevent returning fuel to wrong tank.

tem may be understood and used by the crew. I have ventured into many engine rooms with boat owners and when asked about the position of the valves on the fuel manifolds a far too frequent refrain is, "I just leave everything the way it is and it seems to work fine." Sadly, that is a twofold statement—the first about the owner's failure to understand one of his or her vessel's most critical systems and second the lack of clarity with which the system is designed, installed or labeled. If it's too difficult to figure out, folks simply leave it as it is, which often leads to a problem of some sort or a failure to take full advantage of the system's various attributes and features.

A FRESH APPROACH

Recently, I spent several hours in the engine room of a Fleming 65, which was in the process of being commissioned. This was what I refer to as "gearhead quality time" in that I was able to remain for as long as I liked unencumbered by salesmen or builder's representatives; just me, my cameras and a notebook. What I came away with was a solid understanding and appreciation for Fleming Yachts' fresh approach toward fuel system design and installation.

As a former marine mechanic and boat yard manager there are several aspects regarding fuel systems that I hold sacred. These include a clear, easily understandable and easily used design and accessibility to the fuel system plumbing

components, hoses, valves, fittings, filters, etc. The former simply makes good sense, while the latter is not only good sense but also part of a guideline established by the American Boat and Yacht Council or ABYC, which specifies that provisions be made for access to fuel system components.

TANKS

Fleming 65s are equipped with four fuel tanks, two aft saddle or auxiliary tanks (these are ideally suited for long passages) of 230 gallons each, located outboard of the engines, and two main forward athwartship-mounted tanks of 650 gallons each. Filling is accomplished via port and starboard deck fills, which feed directly into the forward tanks and thence to the saddle tanks. Although the tanks are equipped with oversized vents to prevent such an occurrence, the fills are equipped with catchment sumps that will contain

and drain to the tank back-flooding or overflowing fuel. It is possible, however, to fill *all* tanks from one deck fill provided the appropriate valves are opened, allowing gravity to send fuel to each of the remaining tanks within the system. The transfer and balancing plumbing that interconnects the tanks has an inside diameter of 1.25 inches, allowing for a reasonably quick fill rate. However, for the occasions where this system is taken advantage of, it is unlikely that it could keep up with high volume dock-side pumps.

Each of the Fleming's free-standing tanks are made of 10 mm (minimum) fiberglass, using a fire retardant vinyl ester resin, an epoxy-like material that is especially resilient. The fully-baffled tanks are built in Fleming's own facility over male molds, ensuring an exceptionally smooth interior surface. This is important as it facilitates the movement of dirt and debris to sumps, drains and ultimately the polishing system's pick-up

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ESI fuel polishing system can polish fuel from any of the four tanks. (top left) Generator primary fuel filters use highly-effective Racor Turbine design. (top center) Additional engine primary filter provides triple filtration. (top right) High-volume fuel transfer pump can move fuel between any two tanks. (bottom)

tubes, all of which are incorporated into each tank. Flanged lids are then permanently fiberglassed in place. The exterior of the tanks is heavily coated with a fire retardant material that ensures they meet ABYC flame resistance guidelines. As far as fuel tank design and construction is concerned, fiberglass is among the most reliable and longest lived; it has, in my opinion, no equal. The only feature that would improve an already outstanding tank design is the addition of inspection ports. When I inquired about this the folks at Fleming stated they believe, because of the polishing system, that manual cleaning will never be necessary provided the system is used regularly. The good news is, adding a prefabricated inspection port to a fiberglass tank is relatively straightforward, should one ever be needed.

Fuel quantity is measured via two independent means. First, a tried and true sight glass system is installed in each tank. A scale provided within the owner's manual of every vessel allows users to convert inches or centimeters of fuel within the sight glass to the quantity of fuel in any of the four tanks. Keeping, once again, within ABYC compliance guidelines, valves are installed at the top and bottom of each sight glass; the bottom valve is spring loaded, making it impossible to leave it in the open position. This is a critical safety feature; in my experience most vessel operators tend to leave these valves open to facilitate quick and easy tank level readings. This approach is strongly discouraged in that a failure of the sight glass could empty the entire contents of the tank or, worse still,

if a fire were to occur the almost certain failure of the sight glass material would allow fuel within the tank to feed the fire. The spring-loaded valves eliminate these potentially dangerous scenarios.

The second method of fuel measurement utilizes a stainless steel electronic sender, however, this is no ordinary sender. Unlike conventional senders that are installed in the top of the fuel tank, these senders are instead located at the bottom of the tank, where they measure pressure of the fuel column rather than level. Via a microprocessor, the pressure is then converted to fuel level, gallons, liters, etc. and is read in the pilothouse using either a Computank or touch-screen fuel monitoring system. As a service feature, the sender is separated from the tank via a valve, making its replacement quick and easy.

PLUMBING

The plumbing and manifold arrangement offers both redundancy and security in that fuel may be transferred to or from any tank using either the dedicated fuel transfer pump, or the polishing system. The transfer pump has an impressive rated capacity of 21 gallons per minute and it's equipped with a flow meter, making it possible to monitor the progress of fuel movement. The polishing system pump, as polishing systems go, possesses an equally impressive 210 gallons per hour flow rate. The high flow rate of the polishing system ensures a cross flow of fuel through the tanks, which enhances the system's "scouring" effect during filtration periods. As men-

tioned previously, fuel can also be fed to a tank by a third means, gravity, to or from the saddle tanks, making it nearly impossible to create a scenario in which fuel is aboard but cannot be utilized for lack of a means to transfer it. When active means are used for fuel transfer, via the transfer or polishing system pumps, an electronic interlock switch located in each tank will prevent an overfilling scenario. An audible and visual alarm will also sound as a tank approaches the full mark. An added feature of the monitoring system is a display located at each of the two deck fills, making it nearly impossible to overfill a tank when taking on fuel. Fuel supply valves located on the forward tanks are equipped with emergency remote shut-off cables, making it possible to shut off the flow of fuel to the engines and generators in the event of a fire or other emergency without having to enter the engine room.

Labeling of valves and manifolds is clear and intuitive. There's little doubt about the function of any valve in the system and I was able to discern how to draw and return fuel from any tank before I was provided with a system



diagram (diagrams for each system, supply, transfer and polishing, are, like the valve labels themselves, clear and understandable). A centrally-located engine room fuel supply panel allows the user to easily select which tank will supply which engine or genset. The valves utilized by this system are fool-proof in that they employ a compound mechanism. Both supply and return valves are actuated simultaneously, making it impossible to return fuel to a tank from which it is not being drawn, thereby eliminating the risk of inadvertently overfilling a tank and consequently spilling fuel via the tank vent.

Plumbing components are comprised of only the highest quality materials: Trident USCG approved, flame-resistant A1 and A2 hoses, copper, brass, stainless steel and bronze fittings and valves. Noteworthy is the fact that all of the plumbing hardware used in conjunction with the primary filters is supplied by the filter manufacturer, ensuring compatibility and a leak-free installation, a seemingly small yet telling detail that is frequently overlooked by even high quality boat builders.

FILTRATION

The primary filtration system used for supplying fuel to the engines relies on the proven and easily serviced tandem Racor Turbine 1000 series units. These filters embody a host of attributes that are self-evident to anyone who has used them, a large and easily inspected collection bowl and a water separating coalescer as well as Racor's patented Aquabloc filter element. Like all Racor Turbine series filters, no tools are required for element replacement and a vacuum gauge is standard equipment, making the need for filter replacement unmistakable. Perhaps the most valuable asset of all, tandem filters offer the invaluable peace of mind of knowing that a clean filter waits in ready reserve should the operational filter become blocked. Simply turning the selector valve 180° brings the new filter on line. The contaminated filter can then be replaced, even while the vessel remains underway. Generators use the same Turbine filter in a smaller single version. In accordance with filter and engine manufacturer guidelines, Fleming spe-

cifically instructs vessel operators to use only ten micron elements.

Downstream of the Racor primary engine filters is yet another filter element, which is supplied by the engine manufacturer. Fleming's literature refers to this as a primary filter in that they are supplied by the engine manufacturer for this purpose. Finally, stock secondary (these could be thought of as "tertiary") filters are installed on the engines themselves. Should the need arise, a proprietary electric priming system is incorporated into the propulsion engine fuel supply plumbing, enabling the user to prime the primary filters and engines literally with the flick of a switch. Where filtration is concerned, therefore, little is left to chance.

Although it is unrealistic to assume any vessel is immune to problems associated with fuel or fuel components, where this critical system is concerned the care and attention to detail taken by the folks at Fleming Yachts have made it highly unlikely.

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