A Practical Guide to Preventing and Solving Fuel Problems in Marine Applications

BELL PERFORMANCE

We Made It First. We Make It Best.

Marine fuels (gasoline and diesel) present different problems in marine applications than in on-road diesel truck operations, due to issues with stability, storage, aging, turbulence and use. As experts in fuel treatment, Bell Performance is pleased to offer the following practical suggestions to enhance your boating experience and minimize your fuel-related problems. **Remember, it is usually cheaper to prevent fuel-related issues than to treat the problems after the fact** – the cost to treat with our fuel additives usually averages less than two cents per gallon of fuel – almost no cost to keep problem free.

Understanding Fuel

Gasoline and diesel fuel are produced in a refinery (see Distillation Chart on next page). Crude oil is pumped into a furnace pre-heater and heated to high temperatures, where the heated vapor then goes into a tall distillation tower. The lighter vapor, composed of smaller molecules, is the gasoline fraction which rises to the top of the tower. This vapor is then condensed and collected as gasoline.

Heavier vapor, composed of longer and heavier molecules, condenses at a lower point on the tower over a broader temperature range than gasoline, and is collected as a mixture of kerosene, Jet A, home heating oil and diesel fuel. Thus these products are called "middle distillate" fuels. The fact that these vapors are collected over a wider temperature range than gasoline means that the end product (diesel fuel) is not as pure as gasoline.

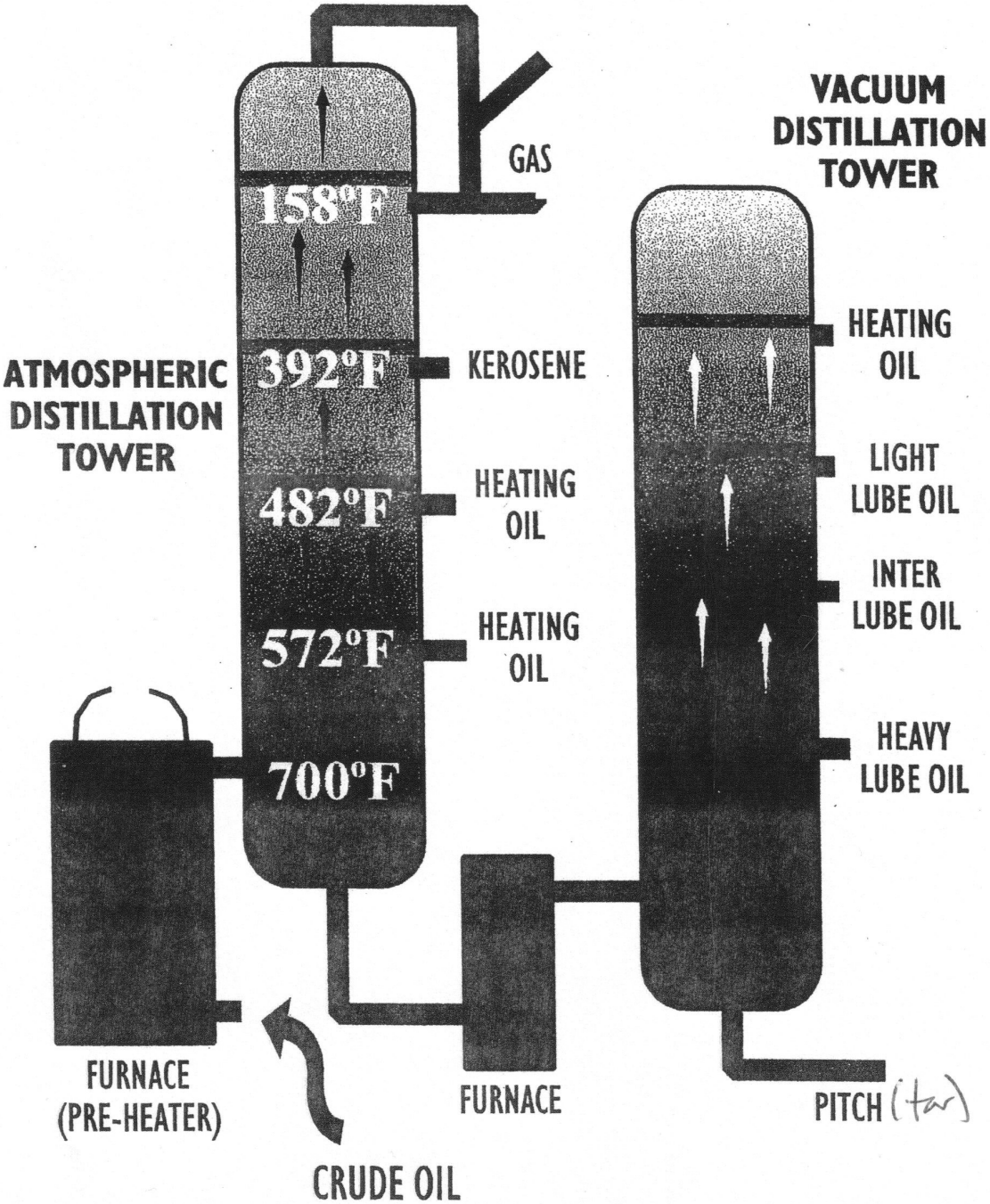
Makes sense so far, right?

Heavier residues, also referred to as "heavy bottoms," are the longest and heaviest molecules that collect at the bottom of the distillation tower. Some of these products are asphalt, heavy oil and tar or pitch, which can be further treated to form heavier end products.

A number of years ago, scientists determined that by using catalysts combined with higher temperatures and pressure, they could break (crack) these longer molecules into smaller molecules similar in length to gasoline or diesel fuel. This effectively increased the amount of gasoline and diesel that could be distilled from a barrel of crude, making it more profitable for refineries.

The only problem with a "cracked" molecule is that it has open sights on the molecule – it is "unsaturated." These open sites look to be filled ("saturated") by combining with impurities such as oxygen from the air or metals in the fuel

FRACTIONAL DISTILLATION



(vanadium, copper or iron); this lowers the quality and stability of the fuel and can lead to fuel-related problems like handling problems, aging, hard starting, smoke and particulate problems when the fuel is burned. Hence, you can see why fuels produced today have more of these type of problems than fuel from two or three decades ago – the need to use "cracking" techniques to extract more money from each barrel of crude has led to a lower quality of fuel being produced.

At Bell Performance, we have been involved with producing products to solve fuel-related problems since 1909. Our founder, Robert J. Bell, invented the first fuel additive on record. The customers who buy our products – utility stations, ocean-going vessels and truck fleets – absolutely need to keep their machines moving while avoiding fuel-related problems. We know fuels, whether it be gasoline, diesel, Jet A and kerosene, home heating oil and heavy fuels. We know the potential problems they can cause and offer time-tested solutions to solve these fuel-related problems. Whatever your issue, we can offer some simple, logical recommendations to keep your marine engine running reliably and as maintenance-free as possible. We are available to answer any questions at 1-800-659-2355 or visit www.bellperformance.net.

Recommendations for Gasoline-Powered Engines

Gasoline is a fairly pure fuel refined over a narrow temperature range and tends to have great reliability.

The biggest problem with gasoline can involve the variation of its quality when it is stored for periods of time. This is especially true if it is stored in a humid climate (including marine environments) or if it contains a percentage of alcohol. Water and oxygen can accelerate the decomposition of gasoline, changing its color and decreasing its starting ability. Gasoline that is stored or not used for a period of time should be treated with a gas stabilizer product; many of these types of products are available in the marketplace, including Bell Performance's **MARINE MXO**, which is designed to address this and other problems associated with the use of gasoline in high-humidity marine environments.

The practice of adding ethanol to gasoline ("gasohol") in marine markets has increased in frequency in recent years due to concerns about emissions and the environment. Some problems have been reported because of this, including hard starting, rough idling, stalling, injector deposits and the fouling of injectors and carburetors. Ethanol and other alcohols are very good at attracting water from the environment into the fuel, which can lead to these aforementioned problems as well as increased sludge, deposits and corrosion in the fuel storage tank.

In situations like this where marine operators are experiencing these fuel-related problems, we have recommended the addition of our **MARINE MXO** at a rate of 16 oz. to 125 gallons of fuel and have seen an immediate cessation of these problems.

Be especially careful never to add any alcohol-based additive product or any product claiming to be "dry gas" to your gas tank. If you read the label ingredients and it lists methanol, ethanol, isopropanol or anything ending with an "ol", it is probably a type of alcohol and should be avoided. Alcohols like these will actually absorb water from the humidity in the air due to their chemical nature. The alcohol in such additive products used to treat gasoline can contain from one to five percent water, which you don't want to introduce into your fuel tank. For these reasons, none of Bell Performance's fuel additive product contain any alcohols.

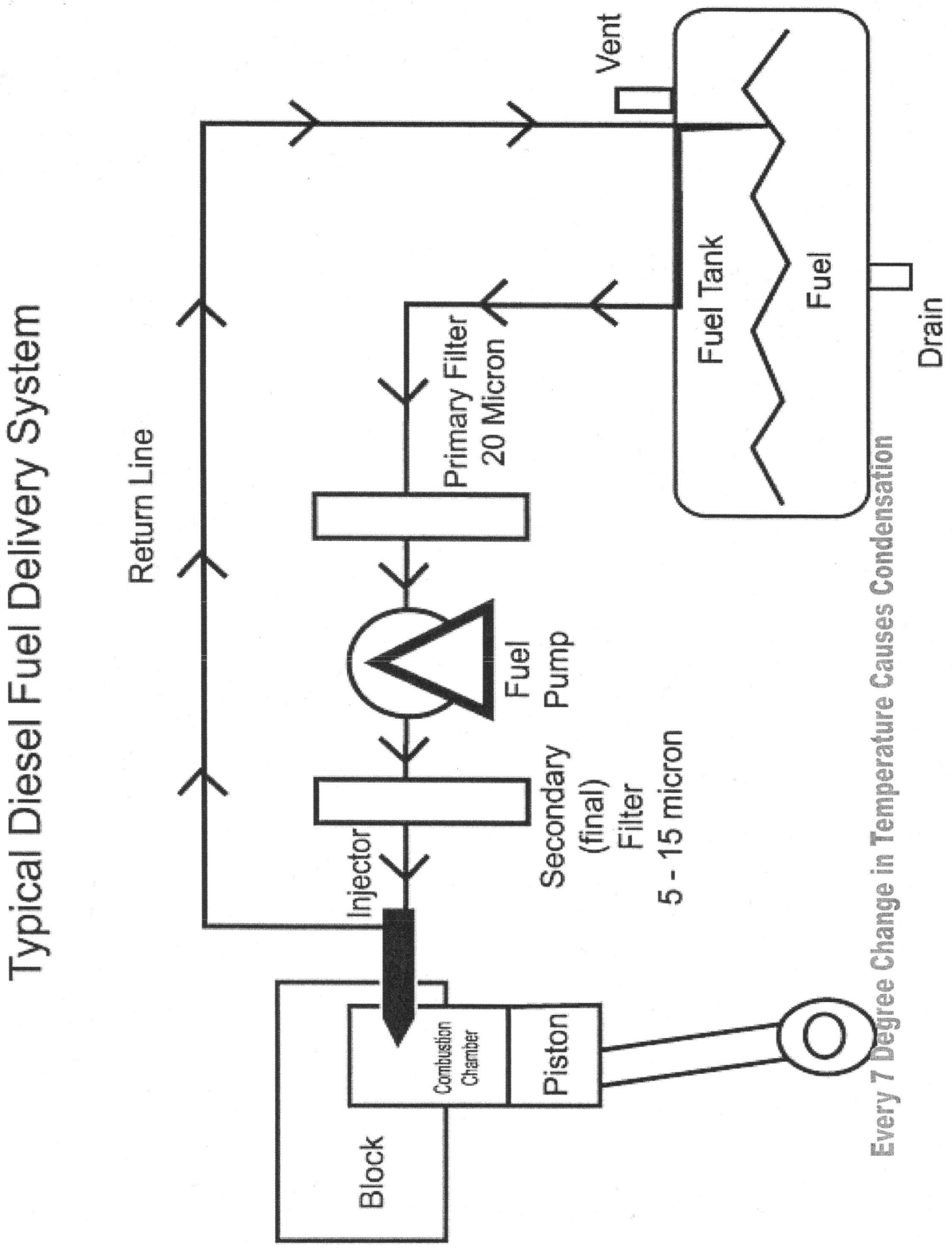
Recommendations for Diesel-Powered Engines

Diesel fuel and engines tend to present more problems than gasoline engines. Did you know that a diesel engine actually produces water, and that this water produced actually forms in the fuel tank?

Here's what happens: Diesel fuel is pumped to the injectors and sprayed into the combustion chamber where it is compressed by the piston (see next page – Flow Chart). This compression generates heat which ignites the diesel fuel above its auto-ignition temperature. The high temperatures in the combustion area create the need to cool the injectors exposed to such high temperatures; diesel fuel is used to cool the injectors and is then returned to the fuel tank.

Newer diesel engines have higher performance requirements which create even more injector heat than ever before, requiring as much as 60% returned fuel to adequately cool the injectors. The temperature of the returning fuel can be as high as 160 degrees F.

So what happens when hot fuel is returned to a partially-filled fuel tank containing much cooler fuel? Condensation takes place and water is formed. This water (8.3 lbs per gallon) is heavier than the fuel (7.1 lbs per gallon) in the tank and sinks to the bottom of the tank. This leads to more problems than the average boat owner might realize:


Typical Diesel Fuel Delivery System
Return Line
Vent
Fuel Tank
Fuel
Drain
Primary Filter
20 Micron
Fuel
Pump
Secondary
(final)
Filter
5 - 15 micron
Injector
Block
Combustion
Chamber
Piston
Every 7 Degree Change in Temperature Causes Condensation

(1) Water in diesel fuel may be emulsified (small droplets of water suspended in the fuel, creating a cloudy appearance) or free water (water that has separated out due to the difference in weight). If the water is free water, a fuel-water separator might be successful in removing it, but not in all cases. If the water is emulsified, it will not be removed by the separator and will find its way into the combustion chamber.

This is a concern for engine operators because it can cause serious problems, including pitting of metal surfaces. It can also cause the injector tip to wear or even explode (when the water expands upon contact with heat), destroying the injector and requiring the replacement of the entire injector. It can mix with the oil film on the cylinder liner and cause it to prematurely wear, leading to scuffing by piston rings. It can even mix with the crankcase oil, diluting it, forming a cloudy emulsion and reducing its lubricating power. All of these issues generally lead towards premature aging and increased maintenance costs for the diesel engine.

(2) Water in the diesel fuel storage tank provides a medium in which bacteria and fungi can grow. These microbes need the presence of water to survive, as they don't live in the fuel alone but live in the interface between the water and the fuel. Bacteria and fungi can grow very quickly in a warm environment, and the problem associated with their growth can lead to the shutdown of the entire fuel system. The symptoms of this problem are often blamed by operators on "poor fuel," when in fact they are indicative of a bacteria problem and fuel filter plugging which was caused by the buildup over time of water in the fuel storage tank.

(3) Water in the diesel fuel tank may cause corrosion of the tank and fuel lines. It will also cause the fuel to age faster and initiate the formation of sludges and varnishes which contribute to filter plugging, excessive engine deposits and injector deposits.

To control water in diesel fuel, we recommend the use of Bell Performance's **DFS PLUS**. One eight-ounce bottle will treat 240 gallons of diesel fuel. Simply add it to the fuel tank just before the addition of more fuel to assure good mixing. We recommend using this treatment every other fill-up, to eliminate problems related to water buildup in the fuel.

Slime and Bacteria Control

Excessive filter plugging is usually a sign of bacteria and slime in the fuel tank. Floating "mats" on top of the fuel or "smelly" fuel with the odor of rotten eggs, or fuel line plugging with mucous-like debris may also be an indication of bacteria and slime in the fuel tank. In rare instances, "bad" fuel may actually be to blame – old fuel which has darkened in color – but in most cases, a microbial contamination is to blame.

If you have a bacterial contamination in your fuel tank, you will need to sterilize your tank to kill the bacteria. The cost to do this is so inexpensive, we recommend the use of our EPA-approved biocide **BELLICIDE** twice a year – in the beginning of the season and again halfway through. Once you have a bacterial contamination, using a water control agent will only prevent the further growth of microbes – you must use a dedicated biocide to actually get rid of all the bacteria and fungi. Multi-purpose products which claim to be "biocides" are making false claims because the EPA requires biocides to be single purpose products which are extremely tightly regulated. There are no multi-purpose biocides on the market today.

Once bacteria is killed after use of the **BELLICIDE** product, the fuel filter may plug due to the dead bacterial carcasses, so be prepared with extra filters. The cost to eliminate bacterial contamination is very low – one 16-ounce bottle of **BELLICIDE** will treat up to 1,920 gallons of diesel fuel, meaning a treatment cost of less than two cents per gallon.

Engine Power Loss, Smoking, Rough Idling and Soot in the Exhaust

Any of these situations may be the result of poor quality of the diesel fuel being used or it may be the result of using old fuel that has darkened. A diesel engine is designed to ignite the fuel-air mixture under compression when the piston is at top dead-center position. If the fuel-air mixture starts to ignite before dead top-center, the expanding gasses push against the piston before it reaches its top position. The end result of this problem is power loss, incomplete fuel ignition, excessive engine vibration, engine noise and exhaust smoke.

To overcome this situation or to simply increase the power of a diesel engine, we recommend the use of a product called **SUPERTANE** at a treatment rate of 1 quart to 250 gallons of diesel fuel.

Here's how the **SUPERTANE** works:

Remember that diesel fuel is a mixture of different size hydrocarbon molecules, some short and some of longer length. As compression occurs and heat increases, the shorter-length molecules will combust first. Fuel which has a low cetane rating or diesel which is poor quality or has darkened, due to aging, will tend to have more of these shorter molecules, meaning a greater incidence of premature combustion during the power stroke, causing the problems mentioned before.

The **SUPERTANE** product is formulated to prevent this problem by retarding the premature combustion of these shorter molecules. Consequently, more of the fuel combusts when it is ideally supposed to and power is improved dramatically. **SUPERTANE** may be used at a double dose (1 quart to 125 gallons of fuel) as a dramatic power booster, for both on-road and marine diesel applications.

Beware of ULSD!

The use of ULSD (ultra low sulfur diesel) has been mandated by the United States Environmental Protection Agency (EPA) and is steadily making its way into the marine marketplace.

The old "low sulfur" diesel fuel which was sold starting in the mid-90s contained 500 ppm (0.05%) of sulfur. The ULSD mandate in 2006 saw the sulfur level in fuel decrease to just 15 ppm (0.0015%) – a tremendous drop! The purpose of this mandate was to lower sulfur levels in emissions.

Removing sulfur from diesel fuel leads to a variety of problems. One major problem is a dramatic loss of lubricity. Sulfur is a natural lubricant in fuel, helping to reduce wear on all moving parts in the pre-combustion area of an engine. The refinery processes used to remove sulfur not only take this away but also destroy some of the other compounds in diesel fuel which contribute to fuel lubricity. The result is premature wear to parts such as injector pump impellers or metering valves and fuel injector tips (pintles). All because of the mandated use of ULSD in all over-the-road applications.

As a boat owner, you should be prepared for the ULSD fuel that refineries are steadily introducing to the marketplace.

How do you know if you have received a load of ULSD? Ask your fuel supplier. If you notice hard starting, very rough idling, excessive engine noise, stalling at idle speed or a sudden increase in vibration, you probably have ULSD.

There are some lubricity additives on the market that have been proven to be effective through both ASTM laboratory tests and field tests. These additives are already in use in the trucking industry. These additives cannot be added at the refinery level and are banned from injection into pipelines. This means they must be added at the fuel storage or distributor level in the distribution grid. Will they be added? Who knows, because fuel distributors generally do not like to add additives and don't like to increase their costs, even by a few cents a gallon. Hence, any boat owner needing to avoid the inevitable problems caused by ULSD should add lubricity enhancers himself, just before fueling – this ensures proper mixing of the fuel and additive and enables the owner to know for sure what is in their fuel.

Bell Performance has developed a lubricity product called **LUBE-PRO** that dramatically increases the "slip" of ULSD and reduces engine wear. ASTM testing on ULSD treated with **LUBE-PRO** (one quart treats 250 gallons) showed a restoration of fuel lubricity to levels exceeding that of fuel from 20 years ago, when fuel sulfur reached levels of 5,000 ppm.

Multi-Purpose Additives for Marine Fuels

Bell Performance has a very good multi-purpose marine fuel additive which addresses almost of these previously discussed issues. **MARINE DEE-ZOL** contains a combustion improver, a lubricant to add lubricity, fuel stabilizer, deposit control agents and a powerful moisture eliminator to eliminate fuel-related problems commonly seen in marine environments. **MARINE DEE-ZOL** is a concentrated formula which treats almost 20 gallons of fuel with just one ounce of additive – 16 ounces of additive will treat 300 gallons of fuel.

We at Bell Performance hope this information on fuel and fuel problem solutions has been informative and helpful. Bell Performance is not a mass merchandiser of fuel additives – we sell our additives through marinas and marine repair shops that have a strong reputation and knowledgeable personnel that have been trained by Bell Performance. If we can answer any marine fuel-related problems, please call us at 1-800-659-2355 or email us at sales@bellperformance.net.

R Miller
Director of Research and Development