Diesel Fuel

The Diesel Engine

Diesel engines, known as compression-ignition engines run on middle distillate fuels which are mid-way between a lubricating oil and gasoline (Petrol). Diesel engines use compression to ignite the fuel and no spark is required. To enable the diesel engine to start easily it is normally fitted with a glow plug to allow the fuel to ignite before the engine properly warms up. Marine diesel engines do not have very sophisticated engine management systems seen on modern cars and are relatively simple and tolerant of a variety of fuel types. Under extreme conditions or at the end of maintenance schedules these tolerances diminish and fuel quality is vital for engine performance.

Diesel engines also perform at their best under load, i.e. at higher engine temperatures. Many boat engines run at idling or slow speeds while coming in and out of ports and often do not reach full operating temperatures. Under these conditions the diesel fuel does not burn well and bores and rings can become contaminated with gums and varnishes. Injectors too build up with residues and spray patterns deteriorate resulting in poor atomisation and subsequent loss in power, starting and increased fuel consumption.

(TIP: When running engines to charge batteries do so with the system in gear to load to the engine. Make sure the boat is secure before doing so!)

Diesel Types

The best quality and most stable diesel fuels are made from "straight run" stocks derived directly from crude oil. Most commercial fuels however also contain a proportion of catalytically cracked material. In the distribution chain for diesel fuels there are also holding tanks at distribution centres, tankers and storage tanks at the fuel berth. In today's commercially competitive world brand loyalty is often sacrificed for economy and the fuel you eventually use in your craft may be a combination of fuels from a variety of sources. The fuel may also be fresh or quite old.

In the EU the control of diesel quality is defined by EN590, details of which are at the end of this paper.

The two critical factors for diesel performance are "Heating Value" and "Cetane Number" The **heating value** is a measure of the energy content of the fuel so shipping companies and railway operators go for maximum heating value provided that other basics are met.

Cetane number is a measure of how easily the fuel burns. The higher the number the easier the burn. Low revving large marine engines on ships can tolerate fuels with CN's as low as 20 while some high-speed automotive diesels require 55CN fuels to perform correctly.

Fuel Performance Criteria

We have covered the two most important aspects of your fuel quality, Heating Value and Cetane Number. (TIP: You will not be able to tell what you are getting when you fill up of course!)

The following also apply to diesel quality and performance:

Viscosity is a measure of how the fuel flows. A viscous or thick fuel will not atomise well at the injectors and give poor fuel consumption and high emissions. If it is too thin excessive wear can occur in the injection pump. Low speed engines can use thicker fuel than high speed ones. A minimum viscosity is set to ensure minimum protection of pumps.

Low temperature flow is affected by the amount of paraffins in the fuel. At low temperatures these can form waxes that prevent the fuel from flowing as frequently reported from lorry parks by the media during cold winters. (TIP: It is worth noting that the refiners alter their formulations seasonally so that they do not pay for anti-freezes when they do not need to. You however may not know in what season your fuel has been made. Also at lay-up you will probably have fuel in the tank that was summer grade)

Storage stability: In storage fuels may be attacked by atmospheric oxygen which can cause varnish deposition. In the presence of water, bacterial action can cause a build-up of slime near the fuel/water interface resulting in blocked filters or fuel lines. Even small amounts can cause diesel-powered heaters to fail. Even without water some bacteria can exist and they have been known to eat through ½ inch steel plate! (TIP: These anaerobic types can be recognised by a bad egg smell being given off from the fuel.)

Component compatibility: Diesel fuels are injected into the engine through precision pumps acting at high pressure. Dirt and water contamination must be avoided to protect these critical components. The specifications give tight limits for these and some fuel retailers fit extra filters at the pumps to help prevent against dirt picked up in the distribution system. (TIP: Check your fuel filter regularly and remember to drain the water from the separator. Fuel atomising pumps are extremely expensive.)

Sulphur content: Sulphur occurs naturally in all crude oils and is present in refined products. The combustion of sulphur gives sulphur oxides that are measured for the purposes of emissions control. They are believed to form acid rain. With the introduction of more stringent controls on emissions low sulphur fuels have been introduced especially as sulphur can poison emission control devices. The treatment of diesel fuel to remove sulphur compounds also removes other chemicals from the stock. This can lead to the fuel having poor lubrication properties and reduced stability. Suppliers now add extra additives to overcome this problem, as there is potential for rapid pump wear.

Lubricity: In many diesel fuels the fuel itself can provide lubrication for the injection pumping system.

Water content: ALL DIESEL FUELS CONTAIN SMALL AMOUNTS OF WATER. The amount of water that a fuel can hold is controlled by temperature, hydrocarbon type and distribution. As temperature decreases the water drops out and collects with any water that has built up as a result of condensation or in-leakage. If EU specifications are adhered to (see below), the allowable water content before any condensation is added could be 20ml in a 100 litre tank – almost half a wineglass. That is sufficient to grow a huge number of bacteria. This water provides the conditions for proliferation of diesel bacteria (**Diesel Bug**) in the fuel tank. (TIP: This can be overcome with the regular use of biocides.)

Biodiesel: Many of you will have heard of biodiesel. This is a diesel fuel made from agricultural products such as soybean, rapeseed, palm and coconut oils. Normally this is converted to a methylester for fuel use. This can be blended with normal diesel stock or used neat. Biodiesel can have good lubricity but is often quite viscous and can give high injector deposition and poor cold flow.

Diesel Specification for the EU

Grade	EN590 (2004)
Cetane Number, min	51
Cetane Index, min	46
Density (Kg/M3 @ 15C)	820-845
Viscosity (cSt @ 40C, max	2.0-4.5
Distillation,max	
T85 C	350
T95 C	360
Sulphur ppm, max	350 until 31.12.04 and then 50 ulsd 10 max
Polyaromatics (%vol) max	11
Flash point C Min	55
CCR 10% (%wt) max	0.3
Total contaminants (%wt) (%vol) max	0.0024
Water (%wt) max	0.02
Lubricity @ 60C (HFRR) microns max	460