Everything you need to know about fuel treatment

Technical
Documentation

Wilhelmsen Ships Service

Introduction

Ships trading internationally are burning over 100 million tons of residual fuel per year but the quality of marine fuel (refinery residues) has deteriorated in recent years. This is due to the introduction of secondary refining methods and, in particular, the increased severity of the viscosity-breaking process used by petroleum refiners to meet the increasing demand for automotive and aviation fuels. There is therefore an increasing need for fuel additives to improve the properties of marine fuel and to ensure more efficient and clean combustion in marine diesel engines.

Shipping companies purchase marine fuel from oil companies and/or from independent suppliers or traders. These fuels are generally a blend of residuals and different cutter stocks, which are also available on the market. The suppliers meet the ship owner’s/ISO specifications by blending and, as long as the product they sell meets the agreed specifications, their contractual obligation has been met. These accepted specifications, however, are not a good guide to the real quality of the fuel when presented to the engine or boiler for combustion.

Efficient and economical engine operation largely depends on this fuel quality. This varies significantly depending on the supplier and location to which it is delivered. It is therefore highly desirable to modify the fuel properties to achieve a more stable and more easily combusted product. This will improve efficiency, aid reliable engine operation and reduce emissions.

The accepted (mechanical) ways to treat fuels on board are by settling, separation and filtration, all of which have a limited physical effect on fuel combustibility. Fuel problems often begin in the refining process and are then aggravated or increased during shipping and blending. Many of these problems can be solved by additional chemical treatment. Fuel treatments are a proven economic solution to improve the quality of the fuel and to enhance its properties to a reliable level for the ship operator.

As a supplier of fuel treatment chemicals, we have seen the increasing need for fuel additives to improve the properties of marine fuel and to ensure efficient and clean combustion in marine diesel engines and boilers. Fuel treatment chemicals can be divided into three categories, pre-combustion, combustion and post-combustion additives. The types of additives available today are often combinations of these categories, designed to solve the different problems end users are experiencing.

Pre-Combustion

Dispersant/detergent additives have been developed for residual fuel stabilisation where asphaltene agglomeration results in sludge formation in the tanks and fuel system. They will allow the blending of heavy and light components as well as mixing fuels that may become unstable when blended and will keep bunker tanks, filters, strainers and fuel heaters clean. This means less maintenance, less downtime and less sludge. A homogenous fuel helps reduce the separator workload and improves fuel injection, atomisation and combustion efficiency.

Combustion

Supplying a homogenous “stable” fuel is the first step to improving fuel combustion. A second step is looking at the fuel properties to determine the carbon content, the percentage of asphaltenes and the amount of ash in the fuel. Combustion additives are “catalysts” that help to burn up the available carbon in a fuel droplet in a shorter amount of time. Combustion catalysts ensure a more complete combustion, reducing the build-up of sooty deposits. This reduces engine maintenance and increases the time between overhauls.

Post-combustion

Post-combustion additives have an effect on the ash material found in the fuel and will have an effect on the melting temperatures of the various compounds that are created during combustion. If the fusion temperature or “stiction” temperature can be increased above the operating temperatures of exhaust valves and turbo-charger nozzle rings, then these ash compounds will not attach themselves to the engine or the exhaust gas boiler. Hot and cold-end corrosion can also be affected with post-combustion additives. Fuel with high amounts of sodium or other salts can be treated chemically to minimize the effects of the sodium compounds, which have the lowest melting points, thus creating problems for engines and boilers. To overcome this particular problem, we have developed an ash inhibitor and combustion catalyst. It keeps exhaust valves and turbo chargers free from hard ash deposits and prevents the formation of ash deposits by raising the melting point of the ash compounds.

Field tests confirm that our products significantly reduce the risk of turbo charger breakdown and exhaust gas boiler/economiser soot fires. When applied, the additives increase efficiency and decrease the fuel consumption.

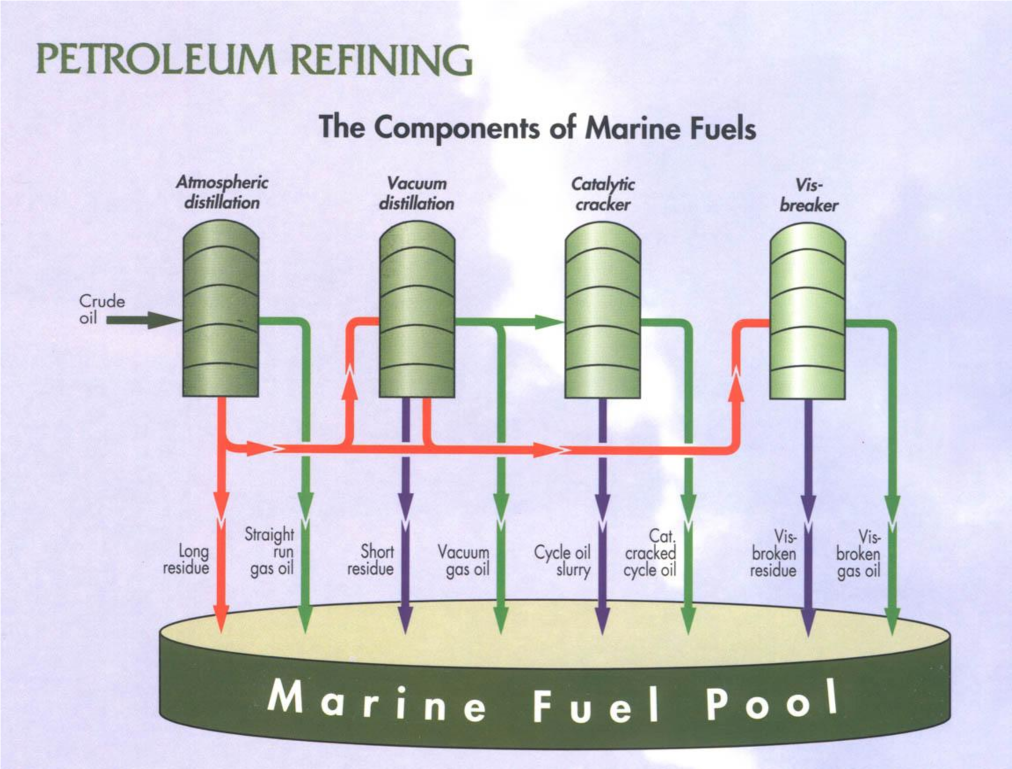
Conclusion

From fuel storage through combustion to the exhaust funnel, we can offer a broad range of treatments for solving fuel oil related problems in the shipping industry.

Supported by long-term field experience and independent bench testing, our fuel treatments can effectively increase the reliability and performance of engines running on a range of fuel qualities whether they are blended fuels, high-asphaltene/MCR fuels or high-vanadium/sodium fuels that are burnt in engines with high exhaust temperatures.

The Marine Market

FUEL AND FUEL SPECIFICATION



Refineries purchase crude oil according to market demand and refinery requirements. The choice of crude oil is dependent on the refinery market for finished products, from the “heavy end” petroleum coke, road asphalt and residual fuels through to the “lighter end” lubricant base stocks, chemical feed stocks, and aviation and automotive fuels.

In most world markets there is an increasing demand for the lighter end products and a decreasing demand for the heavy end.

The reasons for this are:

The increase in use of the lighter end fuels by the transportation sector, i. e. cars, trucks and aircraft.

The decrease in use of residual fuels due to environmental and economic reasons.

From the economic standpoint, the lighter products command higher prices and the residual fuel is sold at prices lower than the cost of crude oil.

Refineries purchase the lowest price crude oil to fulfil their market requirements. Crude oil is purchased under long term contract, short-term contract, or on the spot market. This means that the refinery will not be running the same crude all the time. For the marine market, there will be changes in the properties of residual fuels as the crude feedstock changes.

The economic pressure on refineries to produce higher value light products has resulted in a change from the historic simple atmospheric distillation process. There are still a few refineries in the world that operate purely with atmospheric distillation, but most refineries have introduced secondary, more sophisticated methods of extraction, catalytic cracking and viscosity breaking.

The introduction of secondary refining resulted in some of these operational problems:

Incompatibility due to mixing fuel in the same storage tank

Heavy sludge formation in the tanks due to precipitation of asphaltenes

Fouling of filters and centrifuges with sludge

Poor atomisation

Poor ignition and combustion

Damage to fuel pumps, piston rings and liners due to catalytic fines

Increasing need to change injectors and overhaul pistons

High temperature deposits and erosion of exhaust valves

Fouling of turbo-charger nozzle rings and rotor blades

Fouling of exhaust gas economisers

Pollution of the environment due to unburned fuel

The change to secondary refining and the introduction of fuel specifications has required the refiners to change the way they prepare marine fuels for the market. The main source of residual fuels supplied to the marine market is now highly viscous residues from secondary refining. These residues are blended with cutter stocks immediately on extraction to reduce viscosity for easier handling. Cutter stocks are lower value, low viscosity cycle oils from the catalytic cracker, and sometimes higher value kerosene or vacuum gas oil from the atmospheric and vacuum distillation towers. Cutter stocks are not only used to reduce viscosity but are also added to the residue to meet the appropriate ISO specifications and market requirements.

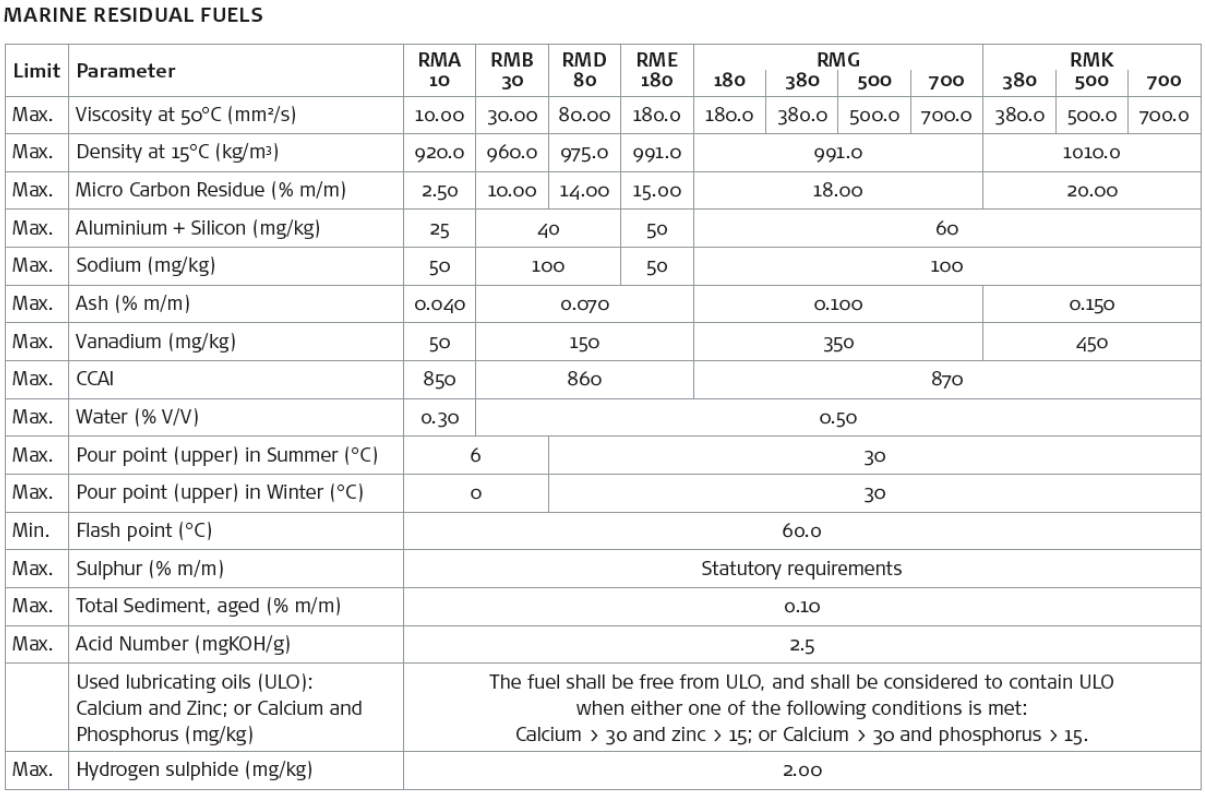
The nature of the vis-broken residues will depend on the origin of the crude oil and the severity of extraction of the lighter products during the vis-breaking process. In other words, the quantity of light products extracted during vis-breaking can be adjusted. The greater the amount of light products extracted, the more “severe” the process.

Recognising that the refinery is under economic pressure to maximise the amount of light high value products and minimise the amount of low value residue, the tendency is to aim towards greater severity of extraction. The greater the severity, the greater is the tendency for the residues to become unstable. “Instability” in this context means that the asphaltenes may tend to precipitate out of the residues or may precipitate when the residues are blended with a cutter stock. Severe vis-breaking will also increase the density of the residues and the carbon residue value.

Fuel Oil Specification

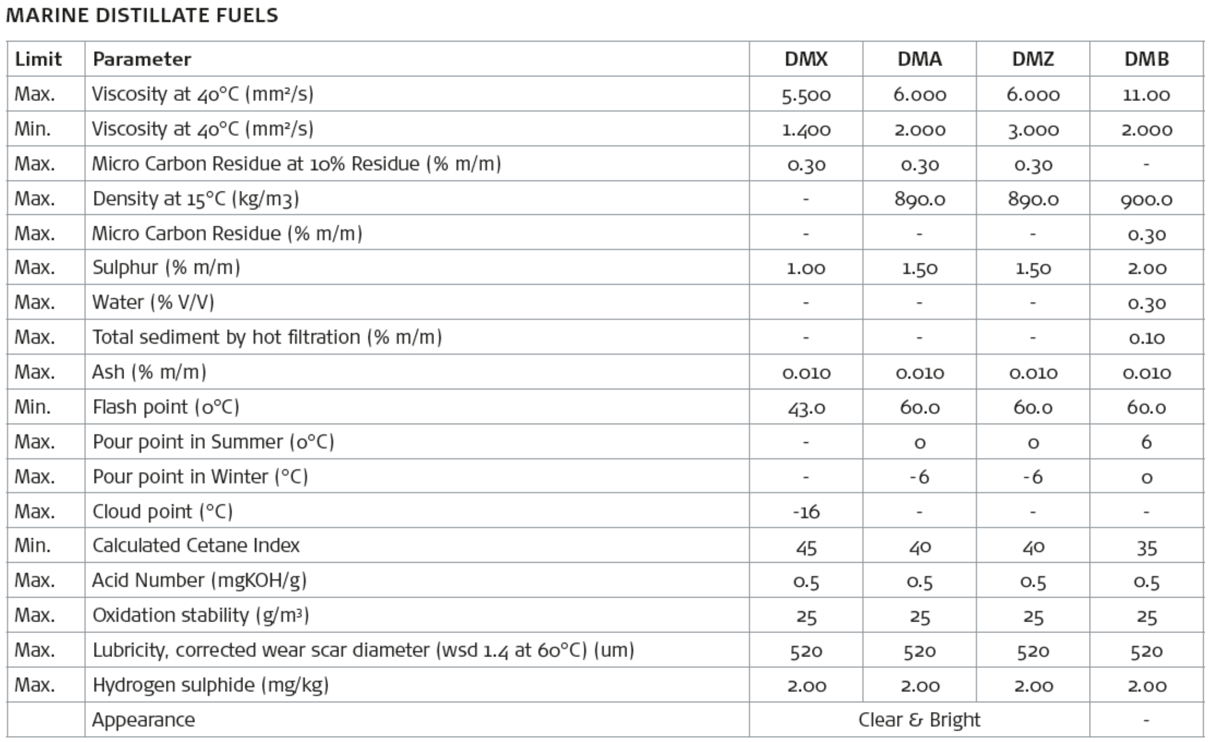
Over the years there has been development of the ISO 8217 marine fuel specification. The first edition was issued in 1987 and the latest is the 2010/2012 specification. There has been five updates to the specification from the initial 1987 in 1996, 2005, 2010 and 2012.

The table below shows the current international fuel specification limits, ISO 8217:2010/2012, of the most common grades of fuel supplied to the marine industry.



MARINE RESIDUAL FUELS

Limit	Parameter	RMA 10	RMB 30	RMD 80	RME 180	RMG				RMK		
						180	380	500	700	380	500	700
Max.	Viscosity at 50°C (mm²/s)	10.00	30.00	80.00	180.0	180.0	380.0	500.0	700.0	380.0	500.0	700.0
Max.	Density at 15°C (kg/m³)	920.0	960.0	975.0	991.0	991.0				1010.0		
Max.	Micro Carbon Residue (% m/m)	2.50	10.00	14.00	15.00	18.00				20.00		
Max.	Aluminium + Silicon (mg/kg)	25	40		50	60						
Max.	Sodium (mg/kg)	50	100		50	100						
Max.	Ash (% m/m)	0.040	0.070			0.100				0.150		
Max.	Vanadium (mg/kg)	50	150			350				450		
Max.	CCAI	850	860			870						
Max.	Water (% V/V)	0.30	0.50									
Max.	Pour point (upper) in Summer (°C)	6		30								
Max.	Pour point (upper) in Winter (°C)	0		30								
Min.	Flash point (°C)	60.0										
Max.	Sulphur (% m/m)	Statutory requirements										
Max.	Total Sediment, aged (% m/m)	0.10										
Max.	Acid Number (mgKOH/g)	2.5										
	Used lubricating oils (ULO): Calcium and Zinc; or Calcium and Phosphorus (mg/kg)	The fuel shall be free from ULO, and shall be considered to contain ULO when either one of the following conditions is met: Calcium > 30 and zinc > 15; or Calcium > 30 and phosphorus > 15.										
Max.	Hydrogen sulphide (mg/kg)	2.00										



MARINE DISTILLATE FUELS

Limit	Parameter	DMX	DMA	DMZ	DMB
Max.	Viscosity at 40°C (mm²/s)	5.500	6.000	6.000	11.00
Min.	Viscosity at 40°C (mm²/s)	1.400	2.000	3.000	2.000
Max.	Micro Carbon Residue at 10% Residue (% m/m)	0.30	0.30	0.30	-
Max.	Density at 15°C (kg/m3)	-	890.0	890.0	900.0
Max.	Micro Carbon Residue (% m/m)	-	-	-	0.30
Max.	Sulphur (% m/m)	1.00	1.50	1.50	2.00
Max.	Water (% V/V)	-	-	-	0.30
Max.	Total sediment by hot filtration (% m/m)	-	-	-	0.10
Max.	Ash (% m/m)	0.010	0.010	0.010	0.010
Min.	Flash point (0°C)	43.0	60.0	60.0	60.0
Max.	Pour point in Summer (0°C)	-	0	0	6
Max.	Pour point in Winter (°C)	-	-6	-6	0
Max.	Cloud point (°C)	-16	-	-	-
Min.	Calculated Cetane Index	45	40	40	35
Max.	Acid Number (mgKOH/g)	0.5	0.5	0.5	0.5
Max.	Oxidation stability (g/m³)	25	25	25	25
Max.	Lubricity, corrected wear scar diameter (wsd 1.4 at 60°C) (um)	520	520	520	520
Max.	Hydrogen sulphide (mg/kg)	2.00	2.00	2.00	2.00
	Appearance	Clear & Bright			-

Problems & Solutions

Pre-combustion

Fuel Storage, Handling and Treatment

Fuel Storage (Bunker) Tanks:

Generally, there are two types of fuel storage tanks on board a ship: double bottom and wing tanks. The number and positioning of the tanks will depend on the type of vessel, ballast requirements and, most of all, required fuel capacity. The majority of ships will have a mixture of these tanks although modern tankers will only have wing tanks.

The configuration of double bottom tanks is shallow with a large surface area that will assist in the removal of water and sediment, whereas wing tanks are of high narrow construction due to cargo/space requirements.

Fuel tank sludge caused by mixing incompatible fuels

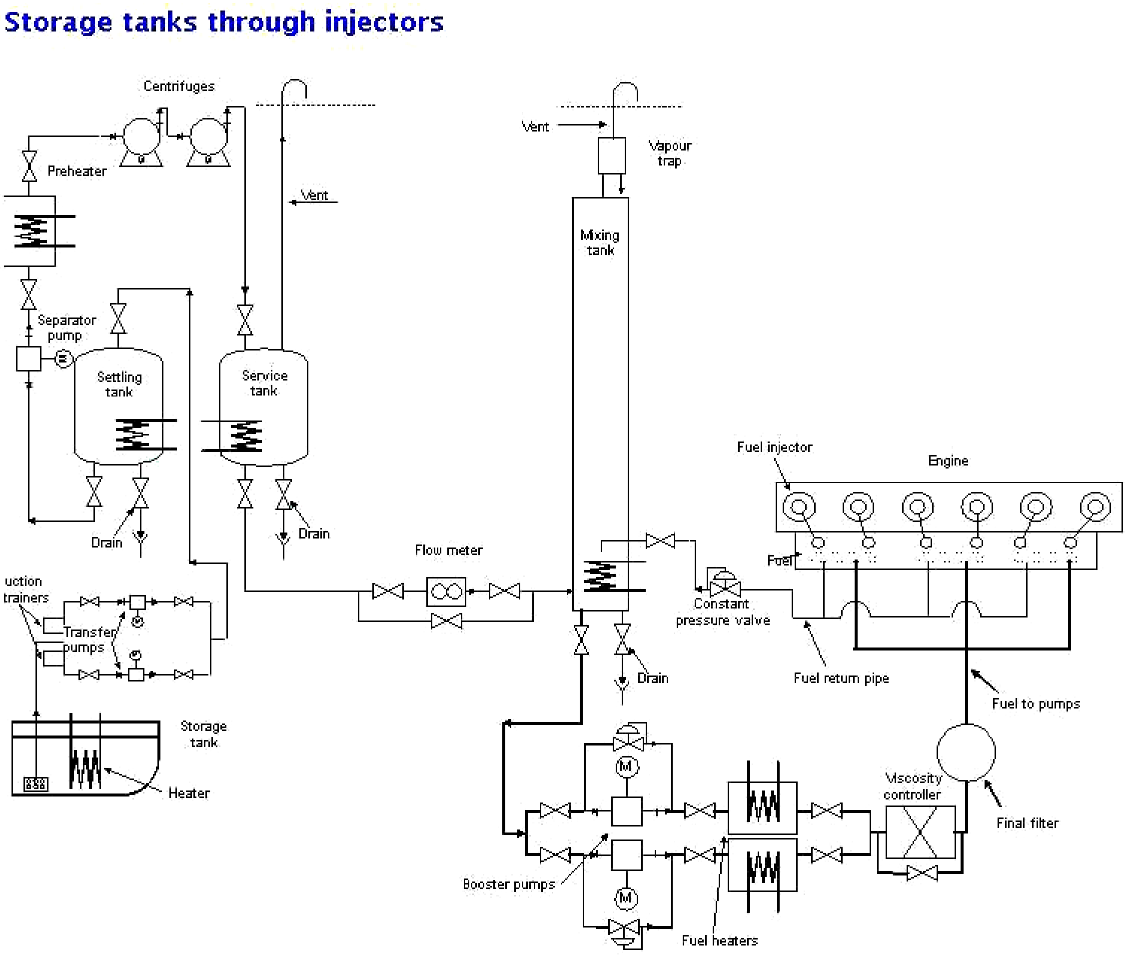
Double bottom tanks are more susceptible to sludge accumulation due to the difficulty in completely emptying the tanks, whereas wing tanks can normally be emptied, because of the tank's shape.

The most common problems arising in storage tanks are from unstable and incompatible fuels. Unstable fuels can degrade during storage and cause stratification and/or sludge precipitation. Incompatible fuels can cause excessive sludge precipitation when different fuels are mixed in the same tank.

Asphaltenes that agglomerate will form sludge, and in doing so can entrap water and “cat fines” making separation extremely difficult. Excessive water contamination can result in water/oil emulsions and, depending upon the fuel characteristics, form stable emulsions that are difficult to “break”.

Depending on the viscosity of the fuel, the storage tanks will require heating to around 40°C to enable transfer. Most transfer pumps can handle fuels up to 1,000 cSt.

Fuel Transfer System:



The fuel in the storage tanks is transferred to a settling tank by a transfer pump, normally situated in the engine room. However, some vessels do not have a settling tank and transfer fuel direct to a day or service tank (This can increase water and sediment removal problems due to reduced residence or settling out time).

Depending upon the pipe system, some vessels may have the capability to re-circulate the fuel around the same storage tank or transfer to another tank.

The fuel transfer pump will have a relatively coarse suction filter to protect the pump internals, but even this filter can become blocked by sludge if there has been excessive sludge

Settling Tanks:

It is desirable to have two settling tanks on board ship, each with a 24-hour or more supply capacity. Usually, due to space restrictions, however, there will only be one settling tank and a service or day tank.

The service tank supplies fuel to the engine after centrifuging, while the fuel in the settling tank is allowed to settle for around 24 hours. Residual fuel in the settling tank is maintained at a temperature of about 50 – 55°C to help in the gravitational settling out of any solids, sludge or water. These are drained off periodically to a slop tank. With high specific gravity cracked fuels, the settling out process is slow due to small differences in density between the fuel and water.

A shallow tank with large surface area assists separation. Double bottom tanks on board ships are ideally suited to the gravity settling-out process, but when solids and water settle out, they are difficult to remove. If excessive amounts of water settle out in the double bottom tanks, re-mixing will occur during fuel transfer to the settling tank.

Installation of shallow tanks in the engine room is usually not possible because of space limitations and it is not desirable due to ship movement. As these tanks are usually slack, excessive liquid surges can occur, increasing the tendency for the ship to list causing stability problems. Shallow tanks, even with baffling, tend to re-mix any settled out solids and water, due to ship movement.

Aboard ship, deep narrow tanks have to be accepted, and are generally preferred. A tapered or sloping bottomed tank with a drain located at the lowest point facilitates water and sludge removal and reduces the tendency for solids and water to remix. A large surface area flat bottom tank will have the reverse effect.

Normal shipboard practice is to segregate different fuels into separate storage tanks to avoid incompatibility problems. However, at certain times, different fuels will have to be mixed in the settling tank when changing over to a new storage tank containing a different fuel source.

Two settling tanks are therefore preferred so fuel from different crude origins and refinery processes are not mixed.

Centrifuge Supply Pumps:

It is usual practice to have a separate positive displacement type pump to supply oil from the settling tank to the centrifuge. Fuel is drawn from the settling tank from either a low or high suction through a suction strainer, and discharged through a pre-heater to the centrifuge. If there is an appreciable amount of sludge accumulation in the settling tank, the suction strainer will require frequent cleaning.

Centrifuge Heaters:

Electric heaters may be used, but steam heaters are more common. Fuel oil from the settling tank is heated to a temperature of 98°C, or higher for residual fuel, to assist the separation process.

Centrifuge Arrangements:


Deposits in purifier

Two suitably sized centrifuges, each capable of handling the maximum engine fuel requirements, are usually required. If the fuel is very dirty, or has a high water content, it may be necessary to operate two machines in series at reduced throughput to provide maximum separating efficiency.

The preferred method of operation is to use the first centrifuge as a purifier to remove solids, sludge and water, and the second as a clarifier to remove any fine solids remaining in the fuel. Since a clarifier does not require a water seal, the temperature of the fuel can be raised to above the boiling point of water, increasing the separation efficiency. This is advantageous if the fuel is contaminated with very fine abrasive materials such as cat fines.

Modern technology has seen the introduction of centrifuges that combine the two processes of purification and clarification in one machine.

However, the efficiency of water removal can be compromised if stable water/oil emulsions have formed during storage time.

Excessive sludge separation will be seen in the centrifuge if high-density sludge agglomerations have formed during storage.

Service Tank or Day Tank:

The fuel from the centrifuge(s) is then discharged to a daily service tank. Since the centrifuge throughput should be maintained slightly above the engine fuel consumption, a re-circulation pipe or overflow line is lead back to the settling tank. Providing the centrifuges are operating properly, there should be little or no water or sludge in the day tank.

Viscosity Controllers:

When burning residual fuels, it is essential to inject the fuel at the required viscosity to ensure efficient atomisation. This is determined by the delivered viscosity of the fuel, design of the fuel system and engine manufacturer’s requirements, and is generally between 12 and 17 cSt. Usually, the cleaned fuel from the service tank is pumped by a booster pump, at a low pressure (5 to 8 bar) through a heater and fine mechanical filter, to the engine fuel pumps and then to the injectors. The viscosity controller is fitted immediately after the fuel heaters. The viscosity is controlled automatically and the desired viscosity at the injectors is pre-set.

The advantages of automatic viscosity controllers include a constant injector viscosity, regardless of the fuel viscosity or specific gravity. This is important where separation of blended fuels occurs due to incompatibility or when there is a change in the fuel viscosity.

If the injector viscosity is temperature controlled, then any changes in fuel viscosity will affect the final viscosity and therefore the spray pattern and droplet formation during atomisation.

Fuel Heaters:

Fuel systems designed for high viscosity fuels should have heaters capable of providing sufficient heat to raise the fuel to the desired injection temperature, and therefore the correct viscosity as required by the engine manufacturer. Over time the performance of the fuel heaters may be reduced due to the formation of carbon deposits on the heating elements or localised overheating causing cracking of the fuel with subsequent coke deposits impairing heat transfer efficiency.

Hot Fuel Filters:

The purpose of a hot filter is to remove particles and impurities which may have entered the fuel system after the centrifuges or may have been unsuccessfully removed by them. The filters are intended to protect the engine and are therefore fitted immediately before the fuel is supplied to the engine fuel pumps and are normally either a duplex or auto back-flush type.

On newer ships the auto back-flush type is more commonly used. Auto back-flush filters are self-cleaning and normally operate by differential pressure activating the cleaning cycle although they can also operate either manually or on a timer. During the cleaning cycle, dirty oil plus a certain amount of good oil is flushed to a waste oil or slops tank, although on some vessels the oil is flushed back to the settling tank. This practice can be extremely dangerous as abrasive material such as “cat fines”, that are intended to be removed by fine filtration, will be re-circulated through the fuel treatment system.

The mesh size of the filter elements varies but is usually between 10 – 40 microns. The size of the mesh should be small enough to remove any abrasive particles that could damage engine mounted fuel pumps and fuel injector internals. It is possible that abrasive particles, especially cat fines below 10 microns size, may pass through the injector nozzles and enter the engine cylinder causing wear and abrasion to cylinder liner and piston ring surfaces. Therefore, an additional filter of smaller mesh size is often included in the engine fuel supply line immediately before the engine. The use of this filter may only be required if the fuel analysis alerts the operator that there are high levels of alumina and silica in the bunker fuel, otherwise the filter can be by-passed.

Engine Mounted Fuel Pumps:

These are mechanically driven pumps actuated by a camshaft and timed to the engine crankshaft position. Timing of the fuel pumps is of utmost importance in order to deliver a specific quantity of fuel at high pressure to the fuel injectors when the piston has attained the correct firing position. Fuel supplied to the fuel pumps should be free of abrasive particles otherwise extensive damage will occur owing to the fine clearances of pump internals.

Fuel Injectors:

It is essential that the fuel injectors are maintained in good condition to ensure efficient combustion in the engine. High nozzle tip operating temperatures, due to the increased preheat temperature of heavy residual fuels and high heat release in the cylinders of both 2-stroke and 4-stroke engines, help cause deposit problems.

Excessive carbon deposits on injector nozzle tip often referred to as

A common problem when burning residual fuels, particularly cracked fuels with high asphaltene content, is the formation of "trumpets" or “flowers” on the nozzle tip. With the high temperatures involved the fuel cracks as it leaves the orifices and the more volatile fractions burn off, while the unburned heavy ends form coke deposits on the tip. These deposits adversely affect the spray pattern, impairing combustion and increase “after burn” resulting in higher exhaust temperatures. If one or more of the orifices in the fuel nozzle is blocked, all the fuel is forced out of the other holes, increasing the fuel pressure and causing an uneven spray and flame pattern. The uneven spray pattern can impinge on the liner walls and piston crown causing wear down, and in extreme cases, thermal cracking.

Summary of Pre-Combustion Problems:

Common problems relating to the storage, handling and on board treatment of heavy residual and blended residual fuels are:

Excessive sludge precipitation from unstable and/or incompatible fuels

Filter blockage

Centrifuge overload

Water removal from partial and stable emulsions

Cat Fine removal

Fuel heater fouling

Fuel injector tip fouling

Poor atomisation

Abrasive wear

Summary of Pre-combustion Solutions:

We recommend treating the fuel where instability and incompatibility problems originate, i.e. during storage in the fuel storage tanks.

The powerful dispersion and stabilisation effects of these products will:

Stabilise secondary refined residues so that the aspaltenes will remain in suspension when blended with cutter stocks

Disperse existing asphaltene agglomerations

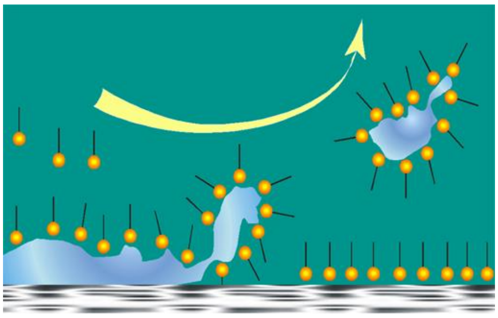
Reduce incompatibility problems when different fuels are mixed

Reduce filter blockage and fuel heater fouling

Improve the efficiency of centrifuging and filtration, reducing the amount of fuel sludge and increasing the amount of useful fuel pumped to the engine

Improve the efficiency of centrifuging, allowing easier removal of cat-fines in the fuel

Ensure good atomisation by maintaining the fuel in a homogenous condition

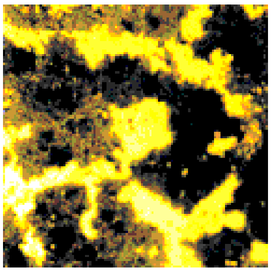


Dispersing and removal of existing sludge

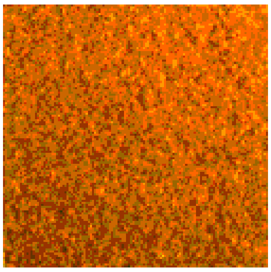
Examples of products (Pre-Combustion)

An asphaltene dispersant-stabiliser will keep the fuel homogenised and the fuel system clean. The dispersant-stabiliser prevents fuel from stratification and the asphaltenes from agglomerating. This will greatly reduce sludge formation in fuel tanks and helps to keep separators, filters, fuel heaters, viscometers and injector (burner) tips clean, resulting in less maintenance and downtime.

An asphaltene dispersant-stabiliser uniquely combined with a combustion catalyst will keep the fuel system clean and improve fuel combustion. The dispersant-stabiliser prevents fuel from stratification and the asphaltenes from agglomerating. This will reduce sludge formation in fuel tanks and helps to keep separators, filters, fuel heaters, viscometers and injector (burner) tips clean, resulting in less maintenance and downtime. Completely homogenous fuel also helps reduce the separator workload and improves the fuel injection, atomization and combustion efficiency. Asphaltenes and other fuel components with high C/H ratio are more easily burned due to the dual action of effective asphaltene dispersion and addition of the combustion catalyst which lowers the energy level needed for complete carbon burnout.



Untreated
Aphaltenes



Treated

Our products

For solving pre combustion problems we can offer the following products.

FuelPower Demulsifier – Our new and updated demulsifier to cope with even tougher water in oil emulsions.

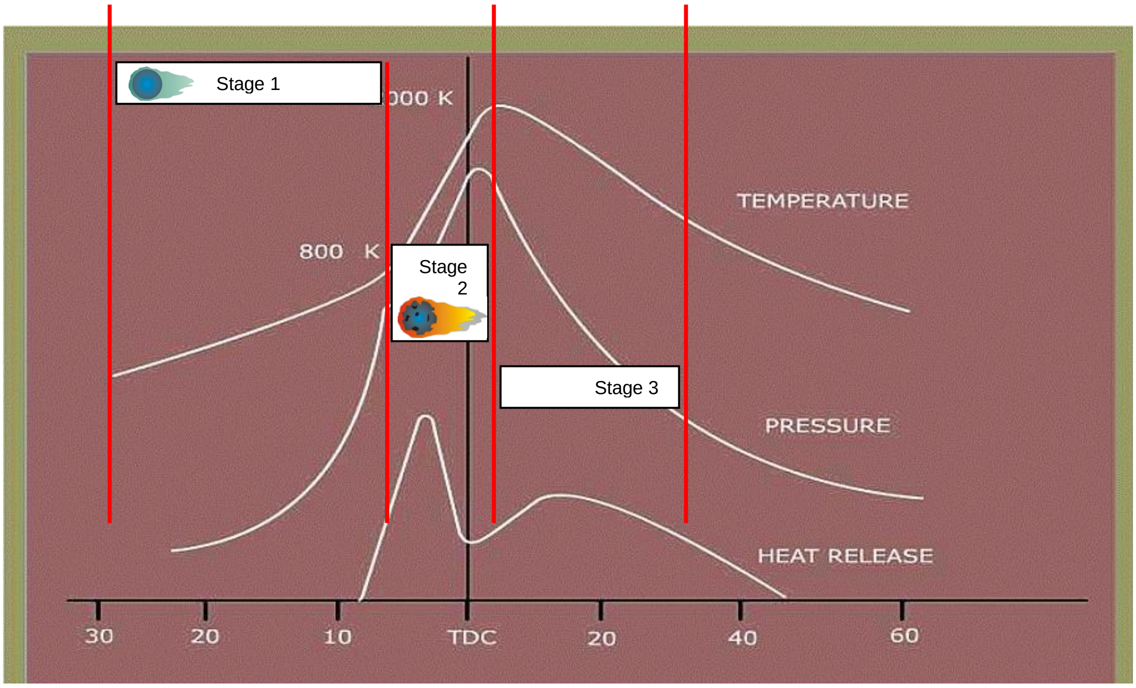
FuelPower Conditioner – Our new fuel conditioner is a state of the art treatment for unstable and incompatible fuels. Improves the reliability of the fuel used through the fuel system and combustion.

FuelPower Stabiliser – If a low dosage combustion enhancer and stabilizer is needed this product will perform well

Combustion

Atomisation:

Atomisation is an integral part of ensuring good combustion and a very important step towards complete combustion but it does not impact the physical/chemical reaction of combustion..



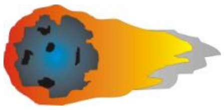
The graph shows a typical, generic combustion diagram where the three stages of combustion can be seen.

The three stages of physical/chemical combustion are as follows:

The droplet enters the chamber and begins to heat up. As the temperature increases, light fractions evaporate from the droplet at an increasing rate. Assuming that the heating of the droplet is fairly even due to the convective movement of the fluid in the droplet, when the vapour around the droplet reaches a certain concentration or is “saturated” enough, ignition of the vapour will occur. This concludes the first stage.

Stage 1

The second stage is a continuous evaporation of the lighter fractions from the droplet. The graph shows that the temperature within the droplet increases at an elevated speed. This is because the lighter fractions are disappearing and only heavier fractions remain. The droplet starts to solidify. Part of the fraction is being cracked to lighter hydrocarbons that leave the droplet during this phase. The heavier hydrocarbons are going through polymerisation reactions where they become even heavier and solidify to become a part of the carbon skeleton, known as cenospheres. The extinction of the enveloped flame concludes the second stage.



Stage


Stage

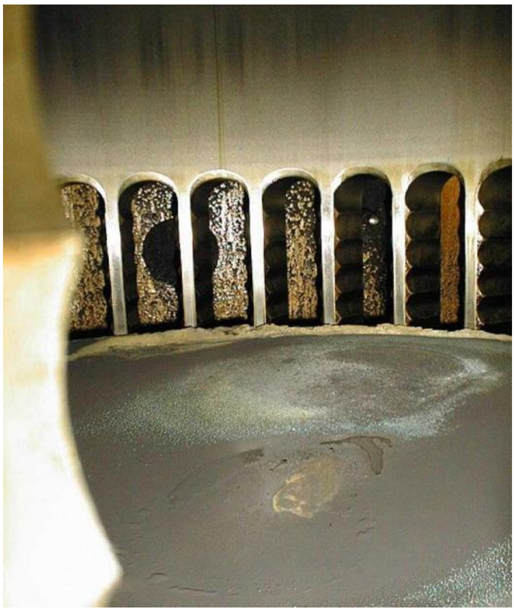
The third stage is called the carbon burnout phase. When the enveloped flame is gone, oxygen can reach the surface of the carbon particle and start oxidising the carbon. This process is slow and very dependent on the particle size, surface area of the particle, asphaltenes inside the shell and type of carbon residue. If complete burnout is not reached, the remaining cenosphere is very closely related to the initial size of the droplet.

Combustion Air:

In a diesel engine, the charge air volume is fixed. The turbocharger delivers the air to the cylinders with the charged air cooled to increase the mass of oxygen supplied. The air/fuel ratio is determined by the design of the fuel oil injection components and charge air supply system.

One of the problems of highly pressure-charged engines is the separation of water from the charge air after the water coolers, particularly in humid conditions. Compressed air not only carries a small amount of water in solution, but can also carry as much as 6% water in very fine suspension. If cooled below its dew point, the charge air may release some, if not all, of the water in droplet form. This problem is compounded when the engine is operating at reduced loads and if the charge air is over-cooled.

In two stroke crosshead engines, the water in the air can cause the cylinder oil film to be washed away from the liner walls. Sulphur oxide droplets, present when the air enters the cylinder, will condense into a weak sulphuric acid, causing pitting corrosion on liner walls. If the air is salt laden, as in sea-air, then the problem is compounded in relation to high and low temperature corrosion.


Acid droplets condensed on piston

Modern two and large four stroke engines are fitted with water separators to help alleviate this problem. This is more difficult to accomplish in medium speed engines because of space considerations. The air temperature in medium speed engines should be at least 5°C above the dew point temperature. Since the dew point is not always known, it is recommended that the cooling water outlet temperature be at least 25°C and the air outlet temperature from the cooler about 40 - 50°C.

Ignition:

The charge-air to the cylinder is highly compressed to a temperature well above the fuel's spontaneous ignition temperature (SIT). Fuel is injected near top dead centre at a high pressure and, hopefully, the correct viscosity. Once the vapours reach their SIT, they burst into flame. The shorter the flame, the more rapid and complete the combustion.

Ignition delay is a physical delay in the time required to atomise the fuel, mix it with air, vapourise it and produce a combustible mixture of fuel vapour and air. A secondary chemical delay is due to pre-flame oxidation reactions and is related to the fuel's chemical structure. As the temperature around the outside of the fuel droplet increases, the fuel droplet begins to crack, forming volatile gases at the same time that the cylinder's high pressure encourages the separation of slower burning carbon and asphaltenes.

Factors influencing the commencement of ignition:

The size of the fuel droplet

Pressure of the fuel at the injector tip

Velocity of the droplets entering the dense air mass

Air pressure and temperature in the cylinder

Air turbulence in the cylinder

Ignition delay properties of the fuel

Surface tension of the fuel droplets

Engine design

Composition of the fuel

Combustion in diesel engines is intermittent. The air compression pressure in the cylinder can be between 75 and 110 bar when the fuel is injected and the maximum pressure during combustion can be over 140 bar. The maximum temperature can reach 1850°C. Both temperature and pressure drop rapidly as the piston moves down the cylinder until the exhaust ports or valves open. Exhaust gas temperatures vary but are normally in the range of 330°C to 370°C in two- stroke engines and from 380°C to 440°C in four-stroke engines.

To be able to achieve efficient scavenging, there is always excess air present, which is very suitable for high temperature oxidation. Diesel engines burning residual fuels containing sulphur, vanadium, sodium and nickel create a perfect environment for high temperature corrosion and ash deposits. The vulnerable surfaces in a diesel engine are the piston crown, exhaust valve sealing faces and turbo-chargers. Hydrocarbon compounds formed by incomplete combustion will readily adhere as sticky semi-solids to metal surfaces and act like flypaper trapping other more corrosive deposits.

Slow Steaming

Over the last few years slow steaming has become a way to improve efficiency and reduce the environmental impact on today’s marine market.

Slow Steaming has so far been successful used at reducing the fuel needed for a voyage and at the same time reduce the carbon emissions significantly.

A speed reduction of 20% can lead to a 40% cost saving of the fuel used but also lead to similar reduction of the green house gas, carbon dioxide.

The pressure on cost and efficiency improvements together with the need and wish to reduce greenhouse emissions has been driving the move over to Slow Steaming and will continue to be a big motivator in the coming years as well. With all these positives the primary disadvantage with slow steaming is the poor combustion properties of the engine at low loads which can reduce the efficiency of engine through build up of soot deposits in the engine and exhaust gas economizer.

Wilhelmsen Ships Service can offer a product package that will help to minimize the formation of soot and soot deposits by adressing three main problems. Good fuel atomisation and active combustion catalysts together with deposit modifying properties will ensure the best possible conditions while you slow steam to keep your engine free from soot and at optimal efficiency longer

Summary of Combustion:

The fuel passes through a number of phases during the combustion process:

A delay period between the beginning of injection and the start of ignition

Rapid combustion of the fuel accompanied by a rise in pressure

Steady combustion of the remainder of the fuel as it is being injected

An after-burning period during which remaining unburned fuel mixes with oxygen and combustion is complete (please refer to graph on previous page)

Summary of Combustion Problems:

Common problems relating to the combustion of heavy residual and blended residual fuels are:

Poor atomisation

Slow burning fuel

Incomplete combustion

Piston fouling/crown erosion

Premature piston ring failure-loss of tension/seizure/breakage

High cylinder liner wear

Scavenge air port/valve fouling and increased under piston deposits (2-stroke engines)

Piston fouling, ring seizure and loss of tension

Scavenge port

Piston crown corrosion/erosion

Summary of Combustion Solutions:

We recommend treating the fuel with a combustion catalyst or combination of combustion catalyst and dispersant/stabiliser product to reduce or eliminate combustion problems.

The effects of these products will:

Maintain the fuel in a homogenous condition ensuring good atomisation.

Reduce thermal cracking of cylinder liners caused by flame impingement due to irregular/distorted spray patterns

Reduce piston crown erosion

Improve combustion by promoting more complete and earlier completion of combustion

Reduce piston fouling due to less unburned fuel deposits.

Improve piston ring integrity due to reduced deposit ingress into ring grooves

Prevent burning of cylinder lubricant oil film, reducing friction wear of liners and piston rings

Improve cylinder liner condition by reducing scuffing or polishing effect from piston crown deposits

Reduce under piston space deposits and possibility of scavenge fires

Examples of Products (Combustion)

We have metal free, organic combustion improvers, formulated to improve combustion in engines and boilers. A more complete combustion will reduce unburned carbon deposits and maintain engine and exhaust system cleanliness. Improved cleanliness will result in improved efficiency, improved fuel economy, increased power and a longer life for pistons, exhaust valves, turbo chargers and economisers. A more complete combustion will also reduce particulate emissions to the environment.

We have concentrated combustion catalysts specially formulated to improve combustion of fuels with high C/H ratio which are slow burning. Faster and more complete combustion will reduce unburned carbon deposits and keep the engines and boilers clean.

Improved combustion means reduced unburned carbon emission (particulates) to the atmosphere. Fewer deposits in a diesel engine means improved efficiency, better heat transfer, increased power, less corrosion and longer life for pistons, exhaust valves, turbochargers and economisers. For trunk engines, fewer deposits mean cleaner lubricating oil, lower lub oil consumption and reduced smoke and soot emissions from the funnel at varying loads. In boilers, cleaner tubes and reduced excess air will increase efficiency.

Our products

For solving pre combustion problems we can offer the following products.

FuelPower Catalyst – An upgraded technology makes this a very effective combustion catalyst to reduce soot emissions and carbon deposits.

FuelPower Slow Steaming – Is soot build up a challenge for you while slow steaming? Our new product for slow steaming contains two different catalysts to really reduce the soot formation and carbon build up. This product will allow you to slow steam longer between overhauls.

Post-combustion

Exhaust/particulate emissions:

There are two major factors associated with exhaust emissions:

Material from the organic part of the fuel

Unburned hydrocarbons (smoke)

Particulates formed via gas phase combustion or pyrolysis (soot)

Cenospheres produced from cracked fuel (carbon and ash)

Material from the inorganic part of the fuel

Ash in the form of metals, sand etc

The inorganic material causes problems with corrosion, deposits, erosion and abrasion. Problems associated with solid material will effect the lifetime of the hardware in the fuel system.

Soot:

The formation of soot is a very complex process that involves a gas phase reaction process involving fuel pyrolysis, hydrocarbon polymerisation, particle growth and burnout. A nucleus forms that rapidly grows and agglomerates into a filament-like structure. Soot, of course, is more likely to form under fuel rich conditions. There are a number of factors that will influence soot formation:

Flame temperature

Local oxygen concentration within the flame

Pressure

Viscosity (determines atomisation characteristics)

Volatility of the fuel (the final boiling point)

Thermal stability (tendency of the fuel to crack)

Higher C/H ratio and high aromatic content

Chemical treatment (catalysts)

Coke:

Coke particles are formed in liquid-phase processes and contain all the non-soot carbon and also part of the ash material. Coke particles are nearly spherical and usually range in size from 1 to 100 μm but are sometimes even larger. The coke particles are called cenospheres.

Cenospheres cause problems, because they have a very long burnout time and can take up 50% of the total combustion time. The much longer burnout time is explained by the oxidation process which is now dependant on the diffusion into the cenosphere surface and this depends on the chemical reactivity of the coke, temperature, oxygen concentration, size and porosity of the particle.

So far, there are no techniques to prevent formation of cenospheres so it is therefore sensible to accelerate their removal by chemical fuel treatment.

Ash:

Ash consists of all inorganic parts present in the fuel oil. There are three different sources of ash in fuel oil:

Naturally fuel bound ash

Ash from refinery process, Al/Si

Contaminants, e. g. rust, scale, sand and sediments

Ash accumulates in the residual fuel during the refinery process but has negligible content in distillate fuels. The main components of ash are vanadium, sodium, aluminium, silicon and nickel. Typical values of ash in residual fuel are 0.03-0.07 w-%, but they vary depending on the crude source and handling.

NOx:

There are three different types of NOx formation

Thermal NOx

Prompt NOx

Fuel bound NOx

"Thermal NOx" accounts for the main part of the NOx and involves post flame reactions between the charge air nitrogen and oxygen. The rate of thermal NOx formed is a function of temperature. The formation rate is significant above 1200°C and rapid above 1500°C. Therefore, the formation of thermal NOx is significant in the diesel engine's high temperature combustion process.

"Prompt NOx" is formed in the flame zone by a series of rapid stages, particularly under fuel rich conditions. These stages involve the temporary inclusion of atmospheric nitrogen and partially combusted hydrocarbons to form HCN and either N or HN intermediaries, prior to the eventual formation of NO. This is only responsible for a small portion of the total NOx formed.

"Fuel bound NOx" also comes from a series of reactions. The formation of HCN intermediate may progress to form either NO or N2. Under highly favourable conditions, 25% of the total NOx can be from fuel bound Nitrogen.

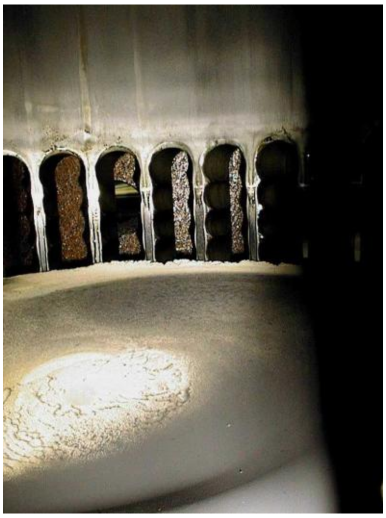
The only way to reduce the formation of NOx is to lower combustion temperatures and minimise combustion gas exposure to elevated temperatures.

SOx:

The formation of SOx is a direct result of the sulphur content of the fuel. During combustion, fuel bound sulphur will rapidly oxidise to SO_2. Some 3-5% of the SO_2 may be oxidised further to SO_3. The actual amount depends on excess air, pressure, temperature and fuel sulphur content. Vanadium is one of the best catalysts to promote higher conversion of SO_2 to SO_3. Water and SO_3 form sulphuric acid vapour below 450°C that will condense in cold areas, below the acid dew point temperature, to cause acid corrosion. The acid dew point is a function of sulphur content, water content and pressure. Sulphur also makes the sticky salt compounds of Vanadium/Sodium/Zinc/Nickel more fluid and this increases the rate of high temperature corrosion.

System/cylinder lubricating oil:

Lubricating oils contain minerals such as calcium, zinc and phosphorus. Burning lubricating oils will contribute to deposits and emissions in the exhaust system.



Excessive calcium deposits on piston

Cold Corrosion:

Cold corrosion occurs due to the formation of sulphuric acid in cooler areas below the acid dew point temperature, which is usually around 140-150°C. Corrosion can be either in the exhaust system or over cooled areas within the engine. The main areas that are susceptible to acid corrosion are:

Cylinder liner walls

Exhaust valves

Exhaust valve casing

Exhaust trunking

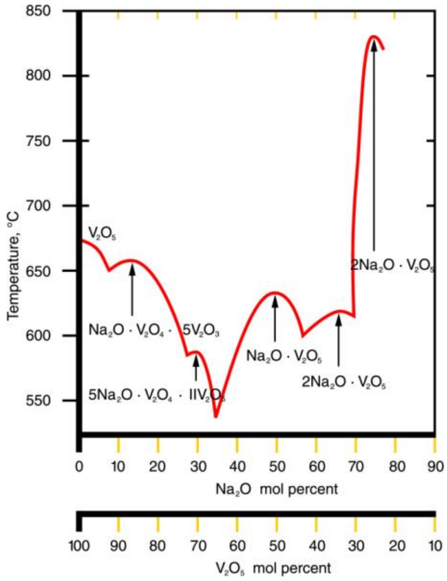
Exhaust gas economisers

Funnel casing

Hot Corrosion:

Hot corrosion is a result of sticky ash compounds of vanadium, sodium, zinc and nickel oxides that adhere to hot metal surfaces. The ratio of 3:1 of vanadium and sodium is usually considered to be the most critical for hot corrosion. The table below shows some common eutectic melting temperatures:

Vanadium Pentoxide	V_2O_5	690°C
Sodium Metavandate	$Na_2O.V_2O_5$	630°C
Sodium Pyrovanadate	$2\ Na_2O.V_2O_5$	640°C
Sodium Orthovanadate	$3\ Na_2.V_2O_5$	850°C
Sodium Vanadyl Vanadate	$Na_2.V_2O_4.5V_2O_5$	625°C
Pentasodium Vanadyl Vanadate	$5\ Na_2.V_2O_4.11V_2O_5$	535°C
Ferric Metavanadate	$Fe_2O_3.2V_2O_5$	860°C
Ferric Vanadate	$Fe_2O_3.2V_2O_5$	855°C
Sodium Sulphate	Na_2SO_4	880°C



Stiction temperatures of Vanadium/Sodium compounds

A blend of 35% NaSO4 and 65% V2O5 will have a stiction temperature of about 300°C which is considerably lower than engine exhaust temperatures. Sulphur in the fuel will contribute to make the ash deposits more fluid and easier for oxygen to penetrate the melted deposit. When ash deposits stick to a metal surface, they eat away the outer protective oxide layer. This makes the metal more vulnerable to further degradation.

The main areas susceptible to hot corrosion are:

Exhaust valves

Piston crowns

Turbocharger nozzle ring

Turbocharger blades

Damaged exhaust valves caused by hot corrosion

Turbochargers:

Turbochargers are essential for high combustion efficiency. Turbochargers utilise the heat energy in the exhaust gases and convert it to mechanical energy by passing the exhaust gases through a nozzle ring where there is rapid expansion and an increase in velocity. After the nozzle ring the gases are directed onto a turbine rotor that drives a fan type air compressor that pumps combustion/scavenge air into the engine.

Any decline in turbo-charger efficiency will have a significant effect on engine performance.

Factors impairing turbo-charger efficiency are:

Blockage of the nozzle ring ports and or deposits on the rotor blades due to

Unburned carbon deposits from poor combustion

Vanadium/sodium deposits from ash contaminants in the fuel

Calcium deposits from burnt lubricating oil

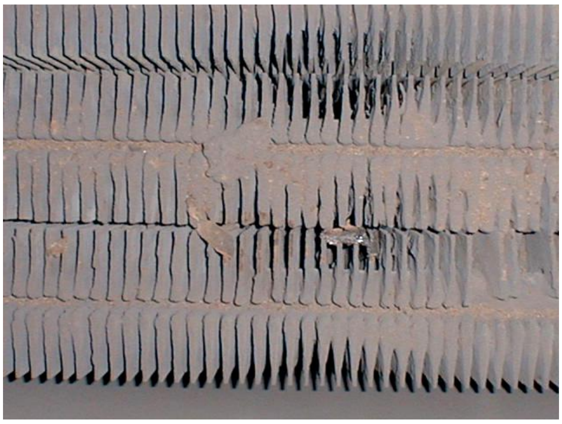
Vanadium deposits on nozzle ring

Exhaust Gas Economisers:

Exhaust gas economisers are situated upstream of the turbo-chargers and utilise the remaining heat in the exhaust gases to generate steam for shipboard purposes before the gases pass to atmosphere. The more common types of economisers are the horizontally mounted tube and fin constructions where water is circulated through the tubes and the exhaust gases pass over the outside of the tubes. The improved design and efficiency of exhaust gas economisers provides a natural entrapment area for unburned fuel emissions due to the compactness of the tube and fin elements. It is therefore extremely important to keep the economiser tube-stack clean and to prevent excessive fouling which causes a back-pressure on the turbo-chargers and/or overheating of the tubes resulting in a possible soot fire.

It is also important to keep the exhaust gas temperature above the acid dew point to prevent low temperature corrosion attacking the tube elements.

Economiser Fire



Economiser blockage/fouling

Summary of Post-Combustion Problems:

Common problems relating to the post-combustion of heavy residual and blended residual fuels are:

High temperature corrosion

Low temperature corrosion

Exhaust valve pitting/corrosion

Piston crown corrosion

Turbo-charger fouling from carbon/ash deposits

Economiser fouling and corrosion

Soot fires

Funnel emissions

Rapid degradation of sump oil (4-stroke engines) due to combustion by-products

Excessive acid production causing high depletion of TBN in cylinder oils (2-stroke engines)

Summary of Post-Combustion Solutions:

WSS recommends treating the fuel with a combustion catalyst or combination of combustion catalyst and ash inhibitor to reduce or eliminate post-combustion problems.

The addition of a combustion catalyst to the fuel will:

Improve combustion by promoting more complete and earlier completion of combustion

Improve exhaust valve sealing due to reduction of carbon particulate

Maintain cleanliness of turbo-chargers

Improve cleanliness of economiser reducing the risk of soot fires

Prevent overloading of sump oil with carbonaceous debris (4-stroke engines)

The effects of an ash inhibitor will:

Inhibit further deposition and remove existing high temperature corrosive deposits on piston crowns, exhaust valves and turbo-chargers by raising the melting temperatures of ash-forming compounds of vanadium, sodium and nickel in combination with sulphur.

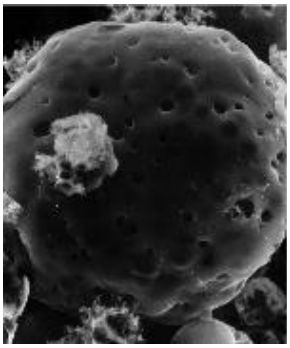
Reduce low temperature corrosion of cylinder liners, exhaust valve casings, economisers and exhaust trunking by reducing and neutralising sulphuric acid formation.

Maintain adequate TBN level (alkaline reserve) of cylinder oil when burning high sulphur fuels, reducing liner wear from acid corrosion (2-stroke engines)

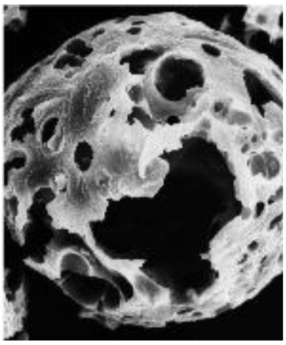
Examples of Products (Post-Combustion)

An ash inhibitor and combustion catalyst for residual marine fuel will keep exhaust valves, turbochargers and superheater tubes free from ash and unburned carbon. The product is soluble in all grades of residual fuel and is intended for use in diesel engines and boilers.

Prevents ash deposits by raising the melting point of the ash higher than the stiction temperature, which prevents the ash deposits from adhering to exhaust valves, turbochargers or boiler tube surfaces and increases the efficiency of heat transfer. This is particularly important with fuel that is high in ash (e.g. vanadium, sodium, nickel, aluminium, silica, calcium, potassium). The combustion catalyst also reduces unburned carbon, so less economiser cleaning is required due to fouling and there is less downtime and savings in man-hours.



Untreated



Our products

For solving pre combustion problems we can offer the following products.

FuelPower AshFree – A multipurpose product with the ability to reduce high and low temperature corrosion and deposits. The product also has a catalyst so it helps to reduce carbon build-up and soot emissions.

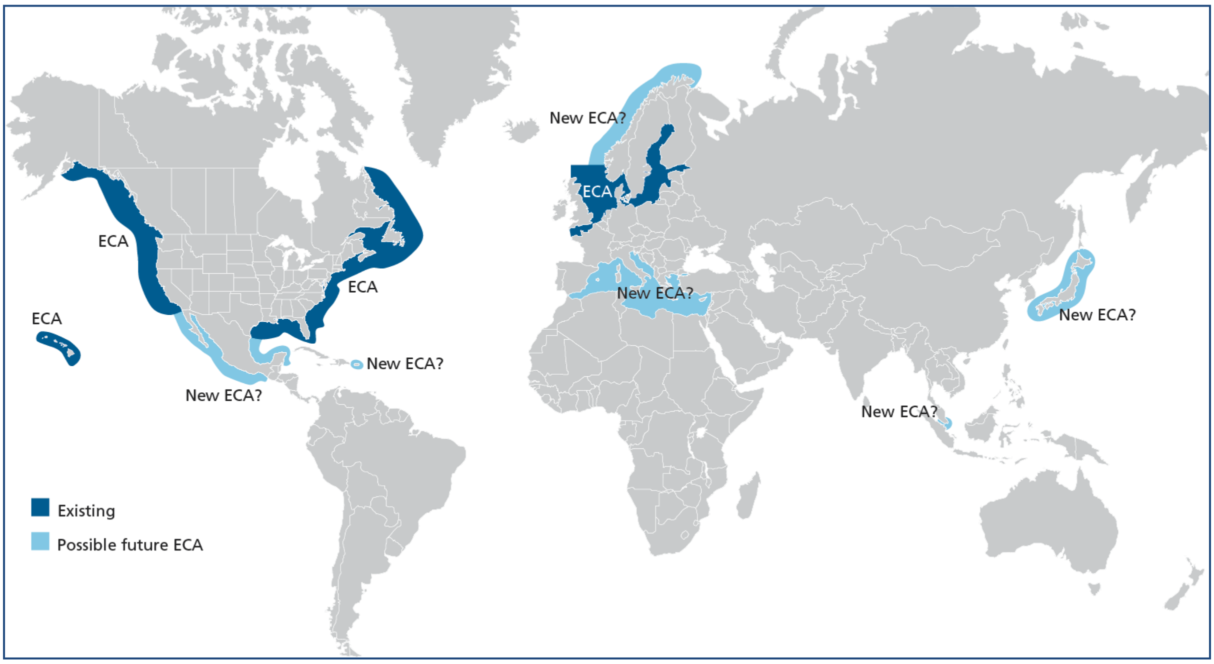
FuelPower Soot Remover Liquid – This product will help you to protect your exhaust gas boilers from soot deposits. This product is a good treatment when slow steaming and the product is active down to 200°C and will protect the exhaust gas boiler to make sure it runs as efficiently as possible. With our automatic dosing station we can offer a trouble free operation.

FuelPower Soot Remover – Our powder solution for protection of exhaust gas boilers. A free running powder that can easily be injected via our portable or fixed injection equipment.

Distillate fuels

Distillate fuels has so far been used in a limited amount for transport at see but with the upcomming legislations we will start to see a change to this, especially in the Emission Control Areas (ECA). From the 1st of January 2015 the sulphur limit in the ECA's will drop from 1% to 0,1% (1000 ppm) and this will change the fule used in these areas.

The current ECA areas are darker blue in the below graphe while possible future ECA's are lighter blue.



Regardless of any new ECA's the fuels used in the current ECA's will have to have a Sulphur content of 0,1% or lower from the 1st of January 2015. This will either change the fuel used in these areas or vessels will have to install alternative abatement methods.

It would seem that most vessles will have to turn towards distillate fuels in the ECA's to be able to manage the 0,1% Sulphur cap which means that the volumes of distillate used on the marine market will increase from 1st of January 2015.

Since distillate fuels are different from the heavire fules most vessels use today on their main engines the problems owners and operators will face will also be different. To go from a viscous black agglomeration to a clear and bright solution brings a new set of possible issues, especially if it will be allowed to use more than the di minis amount of biofules in distillates.

Lubricity

Most think that the reduction in lubricity of a distillate fuel comes from the reduction of Sulphur. The reduction of the sulphur is part of the reason but not the only reason the lubricity is reduced. When the sulphur content of a distillate fuel is reduced it goes through a process in the refinery called hydro processing, this process is the main responsibility the lubricity of the distillate fuel is reduced.

When the fuel goes through the hydroprocessing the main function for the process is to reduce the sulphur content. The hydroprocessing does not only remove the suplhur of the fuel it also removes the polar components in the fuel that also contribute to the lubricity. This is the reason the lubricity of a distillate fuel is difficult to predict, the lubricity is not directly related to the sulphur level of the fuel so a 500 ppm sulphur fuel can have better lubricity than a 2000 ppm sulphur fuel depending on the process ing its gone through and the nature of the feed used.

When testing lubricity of a fuel there is a standard way to do this through the ASTM D6079 by using and HFRR (High Frequenzy Reciprocating Rig). The rig uses a ball that is forced against a plate submurged in the fuel at a specific temperature. The ball oscilates against the plate which creates wear on the plate, wear scar. When the test is finished the wear scar diameter (WSD) is measured as a result towards the lubricity of the fuel.

The HFRR test has been used in the automotive industry for many years to measure the lubricity of automotive diesel fuels. For the automotive industry a typical HFRR limit for the wear scar diameter is 460μm.

From 8217:2010 the lubricity has been included in the marine fuel specification and is a requrement for fuels with a sulphur level of less than 500 ppm (0,05%). The maximum limit for the wear scar diameter in the marine fuel specification is 520μm.

A challenge with the fuel specification is that it may imply that fuels above 500 ppm of sulphur are safe to use form a lubricity point but as explained earlier lubricity is not only dependant on the level of sulphur but also on other polar compounds that are removed during the hydroprocessing.

Lubricity improvers

Lubricity improvers work by replacing the natural lubricity of the fuel that was removed when the fuel went through the hydroprocessing. What makes a fuel have poor lubricity is that the naturally occuring lubricating compounds that sit between the wall and the moving part is no longer there. The lubrication works by building a layer between the wall and moving part so they do not touch but there is a very thin layer that lubricates and keeps the surfaces from touching, this is called a boundary layer. When the naturally occuring lubricants are gone this layer collapses causing the surfaces to touch and this means wear that can lead to catastrophic results.

A lubricity improver replaces the naturally occusring lubricants in the fuel so the boundary layer can be kept intact keeping the surfaces apart and reducing the wear. There are several types of lubricants and it is important to make sure that the lubricant to use has gone through testing to prove that it has a good response on distillate fuels and that a recommended dosage can be given based on this testing.

Our products

For solving lubricity in distillate fuels we can offer the following product.

DieselPower Lubricity – This lubricity improver has gone though all the testing to make sure it gives you the performance you need in the fuel. This is a modern lubricity improver for low sulphur distillates.

Stability & degradation

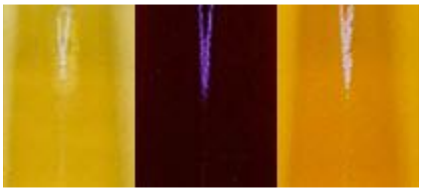
Distillate fuels are a mixture of different hydrocarbons that can deteriorate over time, mainly through the following processes:

- Oxidation
- Acid-base reactions
- Esterification reactions
- UV light

The refining plays an important role on the stability of the fuel and how easily it degrades, advnaced refining creates unsaturated hydrocarbons that are suseptible for oxidation and gum formation but the temperature, availability of oxygen and sunlight also plays an important role. When a distillate fuel starts to deteriorate a few things can happen to it:

- Color change
- Gum formation
- Sediment formation
- Deposit formation
- Corrosion

Below is an exmple of what a color change can look like, the left picture is fresh fuel while the middle show the color as it has been aged and the far right the sample comparison with treatment in it.



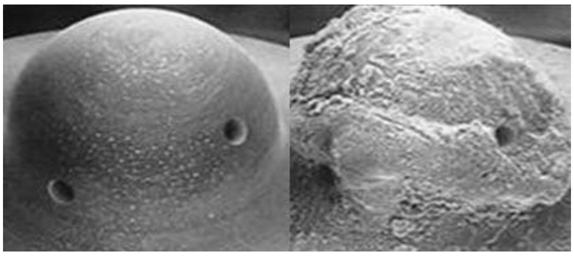
From the above picture it is easy to understand why the middle furl will create much more problem in the fuel system as the gum and sediment formation will follow with the colur change.

A distillate fuel that is undergoing degradation and forming sediment and gum through reactions with oxygen wil also have a tendacy to form deposits, especially on the fuel injectors. The reason the deposits end up on the fuel injectors is that when a fuel undergoing degradatin leves the injector to be atomised it tends to coke on the nozzle. The coaking starts to build and the spray pattern from the injection nozzle is effected negatively which:

- Reduces the fuel economy
- Increases emissions

- Reduces the engine durability

The below picture is a good exaple of an injector tip where the build up is clearly visible on the right side and the detramental effect on the spray pattern seen as the deposits have started to cover the injector holes.



To manage something like this a detergent needs to be used. The detergent will stop the formation of depsoit on the injector and it will also remove existing deposits.

If water is present in the fuel tanks there are risk for corrosion. The corrosion is more severe if the water contamination comes from salt water and this can cause severe pitting corrosion. A film bilding treatment or corrosion inhibitor willhelp the situation by protecting the surface against corrosion. The below is a picture where steel probes has been immersed in fuel and water for 24 hours where the middle probe has ben immersed in a solution that contains a corrosion inhibitor.

Our products

For solving Stability, degradation, depostis and corrosion in distillate fuels we can offer the following product.

DieselPower Enhancer – A multipurpose treatment for securing storage of distillate fuels. The product will stop fuel deterioration through aging and stop gum and sludge formation. It will also help to clean up deposits formed on the injection nozzles and protect the fuel system from corrosion.

Microbial contamination

Microbes live in the interface between the water and the fuel, they tend to live in the water phase while eating of the fuel. The water and the fuel are the two conditions that need to be available for the microbes to live and multiply. As little as 100 ppm (0,0001%) of water is needed for bacteria to grow in a fuel system so keeping a system free from water to avoid microbes growing is almost impossible.

Microbes in small quantities are not a big problem and do little harm to the on board systems and will recide in the water phase. If the number increase (>10^6 cfu/ml; CFU – colony forming units) the microbes start to form biofils in the systems that leads to sludge formation.

If the microbes establish themselves in the system filters will start to block and corrosion will occur in tanks and even injectors can be worn down by the residue from the microbes.

Sulphur and biodiesel or FAME (Fatty Acid Methyle Esters) together with the reduction of sulphur has the potential to create increased problems with distillate fuels. The sulphur seem to have a bio-static effect on the growth of the microbes and the reduction of sulphur in the distillate fules are likely to reduce this effect in distillates.

The biodiesel is potentially a much bigger problem due to its properties. Diesel fuel can sove about about 80 ppm of water into the diesel. Biodiesel is hygroscopic, it attracts and holds water to a greater extent than diesel and can solve more than 5000 ppm of water into the fuel. Biodiesel also act as emulsifiers which means that the water is more difficult to remove once it has been emulsified.

The biodiesel is also more sensitive to oxidation which means it will contribute to a quicker degradation of the distillate fuel which can have other effects such as color change, sediment and deposits.

It is important to be aware of the potential issues with distillates and the possible addition of biodiesel especially if more biodiesel will be added to the distillate fuels with the new ISO 8217 in 2015. There are however a few simple steps that canbe taken to reduce the risk of microbial contamination and that involves fuel hygiene:

- Drain water regulary from bottom of tank, including the hazy layer
- Test the fuel regularly, at least once per year
- Treat the fuel depending on result of testing

Biocides

Biocides are used to kill of microbial contamination. If a contamination is discovered through fuel testing it is important to limit the growth and to remove the from the system. There are different types of biocides with different active ingredients that are used to remove the microbes. All biocides are used to remove the microbes but some have a long term effect to protect the system from recontamination after it has been cleaned.

Our products

For solving microbes contamination, protect from corrosion on steel, copper and copper alloysand to give a long term efficacy in distillate fuels we can offer the following product.

DieselPower MAR 71 – This biocide has been especially formulated to manage microbial contamination in diesel fuel systems. The product quickly penetrates through the fuel to make sure all colonies are found and eliminated.