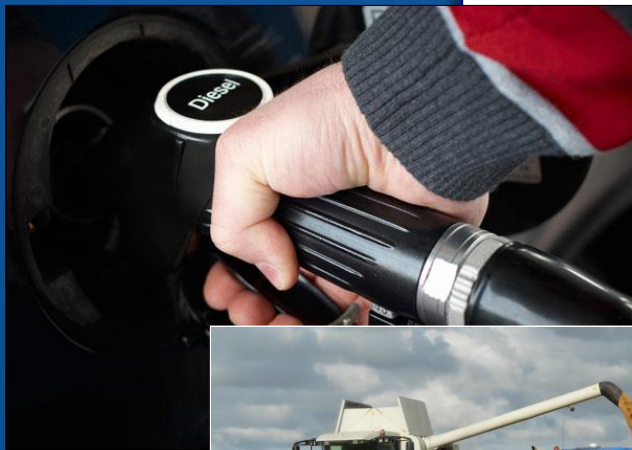


Diesel Fuel Analysis Service

How Clean is your Oil?



FA-ST Diesel Fuel Analysis Service



To have Diesel Fuels analysed by FA-ST then all you need is one of our PRE-PAID Diesel Fuel sampling & analysis kits. This kit comes with everything needed to extract samples and sent them in to our independent ISO accredited laboratory. Once received the at the lab we will e-mail a PDF report 2-3 days (an follow up report will be sent after 5 days once bug counts have completed their incubation period), after receipt of the sample. The report will have details on critical factors such as Wear levels, Contamination and Chemical make-up of the fuel and our laboratory technicians' comments and recommended actions if required.



Why Have Diesel Fuel Analysed?

FUELKIT1 - FA-ST Diesel Fuel Analysis Kit

Diesel Fuel serves in a wide range of applications all over the world. With current engine designs providing higher levels of performance the tolerance of components has been lessened to enable this performance increase. Due to this monitoring the condition of the fuel used can prevent failures occurring due to the fuel being in poor condition causing damage to engine components such as injectors, or if contaminated with things such as petrol or other flammable liquids can cause catastrophic engine failure. Having your fuel analysed with FA-ST can help you protect and monitor the condition of the fuel ensuring that issues don't occur when used. In order to do this in the most cost-effective way FA-ST have developed a bespoke EN590 testing service covering critical aspects of the fuel for a reasonable price. The full EN590 testing is available however this is a very costly test and should only be carried out should a preliminary analysis say that this is required.

Detect & Identify contamination

- Diesel Fuel oils sent into our laboratory for analysis will all have the **ISO 4406 Cleanliness** code determined. Knowing the Cleanliness of an oil is vital to prevent additional wear occurring and dirty fuel can block and damage injectors leading to costly repair bills.
- We will test all diesel samples for the presence of flammable liquids via the flashpoint method.
- As diesel in storage whether that be a bulk storage tank or a fuel tank ready to use diesel will "sweat" and therefore water will build up in tanks. To monitor this build up we carry out a K.Fisher water test to detect water build up.
- As well as these test we also will test for the biodiesel levels (FAME) in the fuel, these levels should be no higher than 7% or damage could occur.

Wear Analysis

For diesel fuel a ferrous wear index is taken, when carried out on diesel this is not like of oils as diesel gets burned in use. We test the ferrous levels to monitor the tank conditions, rust an metal particales that can flake off tanks and enter the diesel are another damaging particle that can break components such as injectors.

Chemical Analysis of Diesel Fuel

When looking at these factors the standard two tests are carried out for the density of the fuel and will test for any diesel bug infections that might of began developing in the system

A sulphur test is also provided in our FUELKIT2 and is not a standard test, however this should only be carried out by Marine vessels, users of older diesel fuel or anyone who suspects that sulphur might be in the fuel they are using.



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Ferrous Wear / PQ Index

Using the 51FW meter

As the ICP analysis only covers particles up to 15 micron without becoming blocked then a method of detecting larger particles is required. This is carried out via the ferrous wear Index (FW Idx). Ferrous particles are selected for this as in most common equipment ferrous metal tend to represent the most common metals in components, also the FW Idx can be quickly, and cost effectively measured.

No matter the test, trending is always the most useful method for identifying impending issues, however one additional correlation may be made between ferrous content and iron by elemental spectroscopy. If the iron by elemental spectroscopy is elevated, but ferrous wear concentration remains low, it may be surmised that the wear particles are small (<10 microns) and therefore from normal wear modes. When results from both tests are elevated, then the wear mode is likely transitioning from normal to abnormal; and if iron by elemental spectroscopy is low or consistent, but ferrous wear concentration is elevated or increasing, then the wear particles are likely large (>10 microns) and considered to be due to abnormal or severe wear modes.

Pros: Provides a count on total number of magnetic particles irrelevant of size.

When used in correlation with ICP analysis allows users to see if normal or abnormal wear is occurring.

Cons: Not all methods of calculating the FW Idx are the same.

Contamination Testing on Diesel Fuels

Particle Counting (ISO 4406 Standard)

The ISO particle count determines the cleanliness level of an oil. With oils main function being to provide lubrication to components, having dirt trapped within the oil will lessen the lubricity and cause scouring to components increasing wear levels are reducing component life span. To allow us to determine the cleanliness levels then we use the ISO 4406:2017 standard. When used to gauge cleanliness levels this standard will count particles at 4-micron, 6-micron, and 14-micron in size. Once this has been done the total number of particles in of each size can be correlated with the ISO classification table and the cleanliness can be determined. Particle counting does not distinguish between wear and dirt particles and provides at total number of particles within the oil.

Understanding the ISO 4406:2017 Standard

As stated, the ISO counts look at particles that are 14 micron and above, 6 micron and above and 4 micron and above. **The following is for example purposes only** if we look at a typical 100ml sample of oil, then we would expect to see:

450,000 particles within the oil that are **14 micron and above**

120,000 particles within the oil that are **6 micron and above**

14,000 particles within the oil that are **4 micron and above**



The table below shows how to convert the number of particles into ISO classification numbers.

ISO 4406 Standard Classification table		
Number of Particles From	Number of Particles To	ISO classification number
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64,000	130,000	17
32,000	64,000	16
16,000	32,000	15
8,000	16,000	14
4,000	8,000	13
2,000	4,000	12
1,000	2,000	11
500	1,000	10
250	500	9
130	250	8
64	130	7
32	64	6
16	32	5
8	16	4
4	8	3
2	4	2
1	2	1

If we take our example then we would have the **ISO code of 19/17/14** this is due to:

The number of particles is between 250,000 and 450,000 per 100ml of oil then the Classification number would be 19.

As we can see from the table if the number of particles is between 64,000 and 130,000 per 100ml of oil then the Classification number would be 17.

As we can see from the table if the number of particles is between 8,000 and 16,000 per 100ml of oil then the Classification number would be 14.

Water Count

Using Karl Fisher ASTM D1744

Water Counts conducted using the Karl Fisher method are determined by, having a reagent that reacts with water and then converts the water into a non-conductive chemical. Samples analysed in our independent laboratory the coulometric Karl Fisher approach is used. In this method the reagent and solvent (normally Methanol or ethanol) are combined in the titration cell. Once a sample is added to the cell an electrical current is passed through, the total water count is calculated by measuring the current required to make the water in the sample react with the reagent.

Pros: Able to detect water content from 1ppm to 100%

Cons: Additives that contain elements like phosphorus can provide erroneous water counts.



Flash Point

Via closed cup method

All flammable liquids have a flashpoint. It is defined as the lowest temperature at which the liquid can form an ignitable mixture in air. All flammable liquids have a vapour pressure. The vapour pressure is closely related to the liquid's temperature. So, as the temperature increases, so does the vapour pressure. When the vapour pressure increases, the concentration of evaporated flammable liquid in the air increases. It is therefore clear that the temperature determines the concentration of evaporated liquid at equilibrium. In essence, **the flashpoint is the lowest temperature at which enough fuel vapour exists that it will ignite.**

For standard Diesel Fuel (cars, bulk tanks etc) must not be positive below 56°C.

For Marine Diesel Fuel must not be positive below 61°C.

Fatty Acids Methyl Esters (FAME) count

Value given as a percentage

The FAME test is to detect the level of bio-acids that are in biodiesel. Biodiesel is now the standard road diesel used in the UK, EU and most other places. Instead of just having standard diesel from the refinery an allowance of biodiesel can be blended with the fuel to provide a cleaner green fuel for consumers. This issue is that biodiesel contain by nature of what they are fatty acids that build up and can cause damage to engine components. Due to this there is a current level of 7% FAME allowable in the fuel, above this and current engine components such as injectors, pumps, filters etc in standard road cars not converted to run on biofuels will develop issues.

FAME levels should only be detected in road diesel samples as **Marine Diesel should be 0%**

Testing Chemical Make-up of Diesel Oils

Specific Gravity

How heavy the fuel is and has a relationship with Cetane rating, this indirectly can point to other sources of contamination. Density of diesel fuel varies slightly depending on the ambient temperature. Diesel fuel varies between 0.815 g/cm³ and about 0.87g/cm³ between 15 degrees Celsius and about 25 degrees Celsius (Can vary depending on diesel type). The specific gravity of a liquid is basically the ratio of the density of a substance when compared to a standard. In most cases that standard is water.

Diesel Bug, Mould & Fungus detection

This is microbiological growth that forms in diesel fuels and can block filters causing engines to cut out. It tends to develop in dirty wet fuel however once a tank is infected will need treating with biocide to remove the growth (see below for further details).

Bugs/ Yeast - These are reported in **cfu/ml (Colony forming units per ml)**.

10⁻² = 100 cfu

10⁻⁴ = 10000 cfu

10⁻⁷ = 10000000 cfu

Fungus is reported as **slight, moderate or heavy**, because it doesn't form cfu's in the same way as bacteria.



Sulphur

Measured by parts per million (ppm)

Sulphur was a common additive in diesel fuel with allowable levels up to 3000 parts per million. However, in 2007 these levels were dropped to 500 ppm for marine fuel and removed from road diesel due to the environmental impact of sulphur oxide emissions that are created. We test all diesel fuel for sulphur as an additional test in our FUELKIT2 ONLY as this test these days is only relevant for marine diesel, old diesel users or suspected sulphur in the diesel fuel.



Company: Filtration Analysis Services Technology Ltd
Address: Unit 4, Foxwood Road
Dunston Trading Estate
S41 9RF
Phone: 01246268900
Email: info@fa-st.co.uk



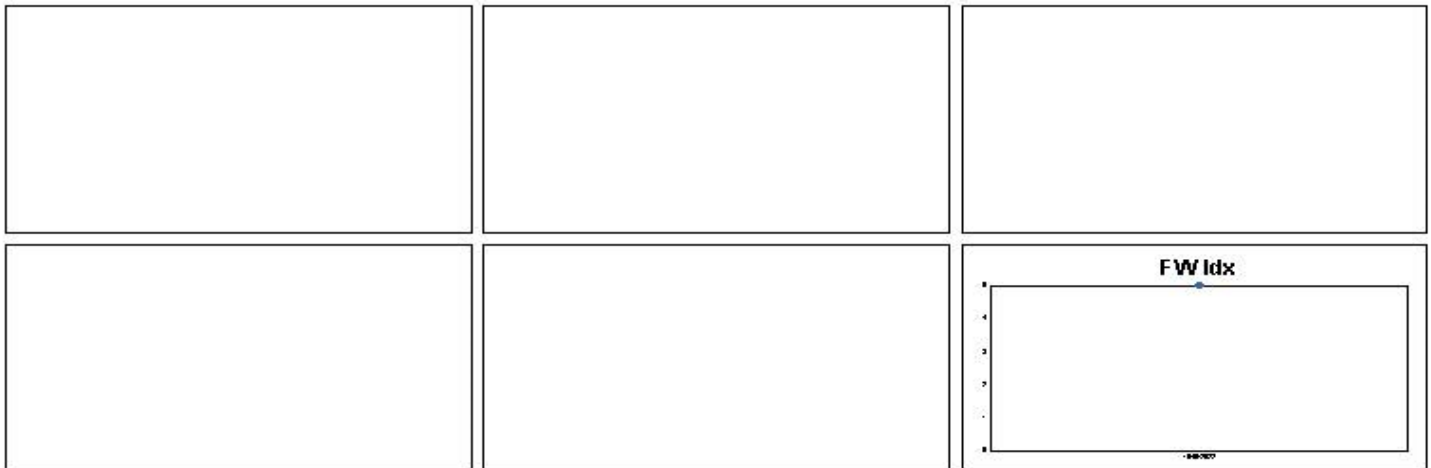
Sample Num: ****30	Sample Date: 01/01/2022	Database: FAST
Area:	FA-ST Database	
Equipment:	FA-ST tank	
Point:	Diesel Tank	
Comments:	LEAD LEVEL IS A LITTLE HIGH AND TENDS TO INDICATE BEARING WEAR BUT COULD ALSO BE ATTRIBUTABLE TO LEACHING FROM AN OIL COOLER ? FERROUS WEAR LEVEL IS A TOUCH HIGH. A SINGLE, SMALL SIZED FERROUS PARTICLE WAS PRESENT. VISCOSITY LOOKS SLIGHTLY LOW. ALL OTHER READINGS ARE FINE AND THE OIL IS DRY. RESAMPLE AT HALF NORMAL SAMPLING INTERVAL TO MONITOR. OIL MAY NEED CHANGING SOON.	

Sample Num	****30	Sample Number is Very important, use this if contacting FA-ST so we can find your sample
Sample Date	01/01/2022	
Unit Usage	400	
Oil Usage		
Oil Added		

Wear		
FW Idx	10	Total Magnetic Metal Index
		A Ferrous Wear (FW Idx) is also carried out to identify magnetic particles in the oil. The ICP will only detect particles up to 15 in size. The FW Idx will provide a total count on magnetic particles irrelevant of size

Contamination			
Cnts >4	106681	Number of Particles above 4 micron	Counts >4,>6 and >14 are used to work out the ISO cleanliness code ISO 4, 6 and 14
Cnts >6	43308	Number of Particles above 6 micron	
Cnts >14	3028	Number of Particles above 14 micron	
Cnts >21	404	Number of Particles above 21 micron	K.Fisher monitors water levels in the oil.
Cnts >25	83	Number of Particles above 25 micron	
Cnts >38	4	Number of Particles above 38 micron	Flash Point is the temperature that the vapour of the fluid will ignite.
Cnts >56	2	Number of Particles above 56 micron	
Cnts >70	1	Number of Particles above 70 micron	
ISO >4	24	ISO Cleanliness Rating	
ISO >6	23	ISO Cleanliness Rating	
ISO >14	19	ISO Cleanliness Rating	
Water K.Fish	4	Water in PPM or Percentage	
Flash Point	56	Point of ignition in Degrees Celsius	

Chemistry			
Specific Gravity	0.870	Pass Between 0.815–0.870 otherwise fail	Specific Gravity to be within specification, otherwise this will be contaminated with foreign fluid
Bacteria TC	1000	cfu/ml(colonies forming unit/millilitre)	Measurement of bacterial/mould growth.
Fungus/Mold	1000	cfu/ml(colonies forming unit/millilitre)	



Oil & Fuel Sampling

With our wide range of sample bottles and containers our customers can take a wide range of samples including oils, diesel fuel, coolants, glycols and a selection of chemicals and other fluids. Supplying our customers with:

Vacuum Sampling Pumps
Sample Bottles
Sample Tubing
Complete Oil & Fuel Sampling Kits



Oil Analysis

FA-ST provide a comprehensive range of oil testing allowing you to determine the cleanliness, contamination, chemistry and identify wear particles in lubrication oils, diesel fuel, coolants, and greases etc. at our independent oil analysis laboratory.

With the support of the FA-ST oil analysis program you can consistently monitor the quality of the fluids used on your machinery & equipment, detect potential component failure, reduce maintenance costs and help decide the correct oil change intervals.



Oil Filtration

FA-ST have an extensive range of oil filtration equipment especially designed to remove particulate, water and magnetic particles from oils, diesel fuel, coolants & glycols. Working with some of the industries leading businesses we aim to bring you the finest filtration equipment on the market including:

Oil, Diesel & Glycol Filtration Systems
Filter Cartridges for a wide range of fluids
Magnetic Pre-Filters
Bypass Filter Systems



How Clean is your Oil?

For all your oil sampling, filtration & Analysis needs contact FA-ST:

Phone +(0)1246268900
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Visit: www.oilsampling.co.uk

