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What is the best way to stay on top of oil and fuel analysis and maintenance projects to ensure you are not eventually faced with major problems?

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For more than 20 years S.J. Perkins has been directly involved with lubricant and fuel analysis in the marine industry. The company carries out various types of analysis on various types of vessels.

Sterntube oil analysis

The company provides regular routine oil analysis for the various machinery systems on a chemical tanker with a deadweight of 30,957 metric tons. Consecutive samples taken from the sterntube system showed an increasing trend in the level of tin from 3ppm to 16ppm.

The vessel was dry-docked and the tail shaft withdrawn to enable the sterntube bearing to be inspected. Figure 1 shows the bearing damage, which was due to poor original bonding of the white metal to the backing shell. The shaft itself was not marked. The cost to manufacture a replacement bearing was €80,000 and the cost of installation €12,000.

It is possible that without regular analysis of the sterntube lubricant, prolonged service of the damaged bearing may have caused further damage to the shaft and other components.

Marine distillate fuel analysis

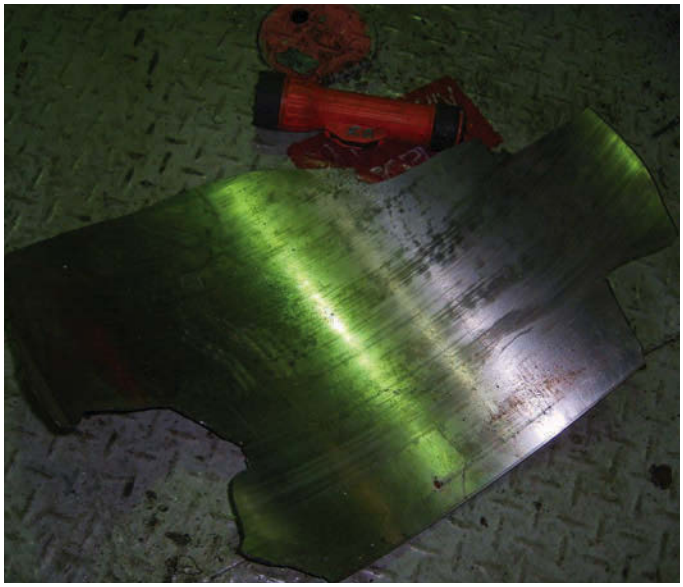
A motor yacht, with a gross tonnage of 2,157 metric tons, was experiencing wide deviation in exhaust gas temperatures for its MTU16V4000 main engines. The temperatures ranged from 467°C to 644°C. The fuel injectors were removed for inspection, and damage to the injector needles was found.

Fuel samples were received and tested by the company and the analysis indicated a flash point of 49°C, which is below the legal requirement by SOLAS. Further testing by Gas Chromatography–Mass Spectrometry (GC-MS) confirmed that the fuel was contaminated with approximately 1% gasoline.

A refit was planned for the vessel and a full endoscopic inspection of the main engines carried out. The results indicated no visible damage to the piston crowns, liners or valves, and it was not necessary to lift the cylinder heads. All the injectors on these common-rail main engines were replaced and the fuel was off-loaded.

The company carried out marine distillate fuel analysis on another motor yacht, with a slightly smaller gross tonnage of 2,054 metric tons. The vessel in question recently bunkered 80,000 liters of automotive diesel and began experiencing problems when using the fuel. One symptom was sticking fuel injector poppet valves in the Caterpillar C18 generator engines. Further inspection of the fuel system revealed a sticky residue in the Alfa Laval purifier bowl. The chief engineer reported that it was an ongoing procedure to remove this residue from the purifier. On examining the fuel tanks, they, too, were found to have a thin coating of the sticky residue lining the walls and tank bottoms.

Samples of the fuel were received by the company for analysis. The fuel was in two phases – a liquid and a solid. The analysis showed the liquid phase to consist primarily of diesel, fatty acid methyl ester (FAME) and water. The solid phase consisted of a trace of partially converted fat, namely monoglycerides and diglycerides, but mainly two types of



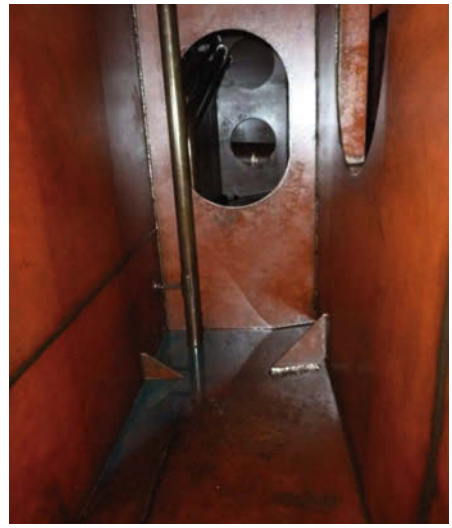


FIGURE 1 (TOP LEFT) AND ABOVE: **Sterntube bearing white metal damage**

ABOVE MIDDLE: **Starboard main engine no. 4 cylinder injector needle showing damage due to poor fuel**

OPPOSITE PAGE AND ABOVE TOP: **Alfa Laval purifier bowl and settling tank showing a sticky residue**

WEIGHT % ELEMENT

	C	Si	S	P	Mn	Ni	Cr	Mo	Ti
Exhaust metal sample	0.02	0.23	0.007	0.026	4.67	17.9	23.9	4.9	0.021
Specification 316Ti grade	0.08 max	1.00 max	0.030 max	0.045 max	2.00 max	10.0 to 14.0	16.0 to 18.0	2.0 to 3.0	5x%(C+N) to 0.7

carboxylic acid salts (soaps). These soaps are principally fatty acids that have reacted with metals and amino compounds. The origin of the fatty acids, in the case of FAME production from pure fats or vegetable oils, would be from incomplete conversion into FAME. This is a known problem and usually these by-products are removed successfully, but trace amounts of such contamination are acceptable. The vessel requested that the supplier off-loaded the fuel. In this case, the vessel requested that the supplier off-loaded the fuel.

Exhaust system metal analysis

The company was asked to investigate fatigue failures of the exhaust system elbow sections on a sailing yacht. A fragment of the section was analyzed by optical emission spectroscopy to determine if it met the specified 316Ti grade of stainless steel. The table (above) shows the results of the analysis and it can be seen that it indicates that the steel doesn't meet the specification. The level of titanium is below the typical specified value and the levels of manganese, nickel, chromium and molybdenum are higher than expected.

TEST PARAMETER	NEW OIL	USED OIL
Viscosity cSts at 40°C	118	52
Viscosity cSts at 100°C	15.5	9.22
Flash Point °C	227	>160

Generator engine oil analysis

S.J. Perkins carried out a generator engine oil analysis on a motor yacht with a gross tonnage of 3,268 metric tons. Analysis of a sample taken from the crankcase of a Deutz TBD616V16 generator engine shows the viscosity and flash point of the oil to be at unacceptably low levels. A reduction in both viscosity and flash point of a lubricant normally indicates dilution with distillate fuel.

The table (below left) shows the tested results compared with the new oil values expected for the multigrade lubricant.

The vessel was informed of the analysis and an internal inspection of the engine conducted. The chief engineer reported that a leaking fuel injector and damaged o-rings were found. The problems were remedied and the oil replaced with a new charge.

Main gearbox oil analysis

Oil samples taken from the ZF Marine main gearboxes on a 833 metric tonne motor yacht showed a marked reduction in viscosity from the expected new oil values. The results indicated a viscosity of 65cSt at 40°C instead of the expected value of around 100cSt for the 15W-40 multigrade oil in use.

It was recommended that a sample of new oil from the vessel's storage tanks be taken to confirm the viscosity of the oil in use. Analysis showed the viscosity to be consistent with a 15W-40 multigrade oil.

It was then apparent that viscosity shear of the viscosity index (VI) improvers in the oil's additive package had occurred. The VI of a fluid can be enhanced with these specialized additives, which are typically high molecular weight polymers designed to minimize the effect of temperature on viscosity. VI improvers swell with increasing temperature, which counteracts the decreasing viscosity of the base fluid. This results in a fluid that maintains sufficient oil film thickness at high temperatures. At lower temperatures, VI improvers shrink and the properties of the base oil dominate the viscosity of the fluid.

The gearbox manufacturer confirmed that the recommended lower limit for viscosity of the oil in these gearboxes was 20cSt at 40°C. It was therefore concluded that the oil was quite suitable for continued service. \\