Better decisions, faster
Developments in marine lube oil analysis

By Keith Macaluso, Director, Kittiwake Americas

Whether owning or managing a marine or industrial operation, one of the key ingredients to successfully navigating today's turbulent economic seas is realising efficiencies in every possible area. Using time, energy and resources without waste and making assets work harder are, these days, core components of our daily lives. And although this article explores lubricants and oil analysis in a marine setting, the parallels with industrial lubricants are easy to draw.

The direct correlation between uptime and revenue is indisputable even when shipping rates are low, and therefore the criticality of preventing costly downtime is equally as plain. Increasing operational profitability through preventative maintenance of critical equipment and machinery in order to minimise equipment downtime is hardly a revelation to anyone in the shipping industry. However identifying and employing the most effective tools to achieve this is a continuous quest as new discoveries have the potential to reap significant financial rewards.

With the spectre of downtime ever present in marine engineer's minds, monitoring and alarm systems are the first means of defence in diagnosing problems with the ship. Sending samples off to the laboratory for analysis is an effective means of condition monitoring, if you are graced with the blessing of time - something a modern ship owner / operator is not.

Gratefully, increasing demand has driven significant advancement in oil analysis over the past few years, both within and outside of the laboratory environment. The condition monitoring arena has been influenced by a number of innovations which today allow marine engineers to enjoy the benefits of onboard and lab testing working in unison. More detailed, but potentially delayed sample results from a laboratory supplement the real time information delivered by onsite testing.

Test parameters
To diagnose a suspect piece of equipment, a lubricant sample can be taken and quickly tested onboard. Obtaining a representative lubricating oil sample is one of the most important parts of a scheduled oil analysis program. If a sample does not represent the true condition of the lubricant and component at the time of sampling, the reliability of both the test result and its interpretation is compromised. Using a representative sample to apply the following test parameters to is essential to maintain and protect equipment, preventing damage in advance.

Viscosity
Viscosity is the most important property of the oil and is fundamental to providing optimum film strength, with minimal frictional losses, preventing metal-to-metal contact, scuffing, microwelding and wear of sliding surfaces. The viscosity of engine oil may fall due to fuel dilution, by topping up with an incorrect oil grade, or shear of polymer additives. Conversely, viscosity may increase due to excessive soot loading (insolubles content), water in the oil or if the filtration system is not operating correctly. For all oils, ageing caused by oxidation and thermal degradation may lead to thickening and an increase in viscosity.

Water in oil
Water in lubricating oil can enter from many sources including condensation, leakage and malfunction of oil treatment systems. Water contamination will cause corrosion and cavitation, compromise the stability of additive packages and encourage the growth of microbes, yeasts, moulds and bacteria that will clog filters and rapidly corrode fuel systems. Water can displace the oil at contacting surfaces, reducing the effective amount of lubrication and activating surfaces which may themselves act as catalysts for degradation of the oil. Water is the biggest enemy of the oil and very often contaminates the oil quickly and without any warning. Therefore, regular lab testing alone can be too late in raising the alarm.

Total Base Number (TBN)
Diesel engine oil is continuously exposed to acidic combustion products and these must be neutralized before they can corrode engine parts. Alkaline additives are present to neutralize both

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the acids derived from combustion (mainly strong sulphuric and nitric acids) and those weaker, organic acids resulting from oxidation of the oil during its ageing. The TBN of an oil is the measure of this alkaline reserve.

Insolubles

Insolubles are a build up of combustion related debris and oxidation products. Contamination comes mainly from combustion products; fuel ash, carbon and partially oxidized fuel, plus a small contribution of oil oxidation products and spent lubricant additive. High insoluble levels will cause increased oil viscosity, wear of bearings and running surfaces and blockage of oil ways and filters.

Particle Content

The presence of particulate contamination in hydraulic fluids can cause rapid wear and failure of seals, pumps and other critical components. Particulate contamination within hydraulic systems can arise from internal sources, such as the top-up oil and the surrounding air, or generated internally within the systems.

Wear Debris

Wear Debris Analysis, or Analytical Ferrography, is a method of predicting the health of equipment in a non-intrusive manner by studying the wear particles present in the lubricating oil. The continuous trending of wear rate monitors the performance of machine components and provides early warning and diagnosis of worn parts. This technique can diagnose active machine wear earlier than using vibration techniques.

Trending of these critical lubricant test parameters is extremely important for the ship's engineer and the more regular the information the better; even with the best sampling practices, occasional laboratory results can be unrepresentative and sometimes cause false alarms. The collection and analysis of intelligent data to monitor the condition of critical machinery and facilitate proactive rather than reactive maintenance is vital for productivity and therefore key to revenue generation.

Recent breakthroughs in onboard and online testing have ensured growing attention and acceptance. There is a clear benefit in knowing what is going on at an exact point in time - not just when the engineer can get to a machine for a routine, scheduled sample and analysis. Onsite kits enable rapid testing and action, and online sensors remove sampling errors, which are often responsible for un-representative samples. Online, of course, refers to sensor technology, which is advancing at a furious pace. Dependable sensors mounted in the oil circuit provide an early warning system designed to monitor remotely and in real time, the bearing and gear wear debris, lubricant health and remaining life, as well as lubricant moisture content.

Monitoring wear

Continuously and automatically providing complete sets of trend data showing levels of wear in all critical equipment and machinery enables immediate action during the ships passage to the next port, or even a route change if necessary, should the results warn of an imminent breakdown. Spotting problems at such an early stage can ultimately make the difference between damage control and financial catastrophe.

The liner is one of the most crucial and costly components of a ships engine and monitoring wear not only extends its life but also protects against considerable financial pain, as the average insurance claim for an unexpected liner loss is over $250,000. It also has the potential to provide valuable data that offers insight into related issues.

An example of the latest technology for this purpose is LinerSCAN, which uses magnetometry to quantify the iron in used cylinder oil, reporting changes caused by abrasive wear and even routine inspection, and highlighting periods of increased physical or thermal stress. This allows preventative maintenance during the ships passage to the next port, or even a route change if

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necessary, and insures against potentially costly ship downtime. The LinerSCAN sensors are fitted to each cylinder of the vessel engine to continually monitor the scrapedown oil for ferrous wear. Multiple output options and bespoke software provide the onboard engineers with actionable and trend-able readings which can be used to minimize liner wear, detect ingress of CAT fines, decrease sampling and testing costs and improve maintenance scheduling.

Progress in sensor technology has not only enhanced the efficacy of the sensors themselves, but has also spilled over into the field of portable instrument testing. ANALEX Alert is an example of onboard but offline equipment that is also a quantitative iron analyser. Although it does not provide continuous readings, it does enable the frequent measurement of wear condition.

Optimizing lubricant feed rate

Effective maintenance translates into obvious cost savings, but this on and offline condition monitoring equipment also helps to optimize lubricant feed rate. An average container ship can spend US $12 million on cylinder lubrication in its life and many ship owners currently use laboratory testing of the scrapedown oils to alter the lubrication. Dependent upon trade, load, running hours and other factors, real-time monitoring is a vital tool in optimizing cylinder lube oil feed rate and, as a result, improving efficiency, decreasing lubricant costs and avoiding issues related with over and under lubrication. Existing users, including German shipping company, Reederei Hermann Buss GMBH, are reducing cylinder oil consumption by up to 50%, representing annual savings of over $100,000.

Equipment efficiency and reliability are the cornerstones of a successful shipping operation, and as its lifeblood, it is essential that lube oil is monitored and its properties properly understood. Relying solely on men in white coats to analyze and interpret test results is no longer necessary – onboard diagnostic equipment now provides laboratory grade results and empowers engineers to make fast and informed decisions with confidence. The impact of successful troubleshooting using a combination of the state-of-the-art diagnostic equipment available can, and does, equate to millions of dollars in savings.

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