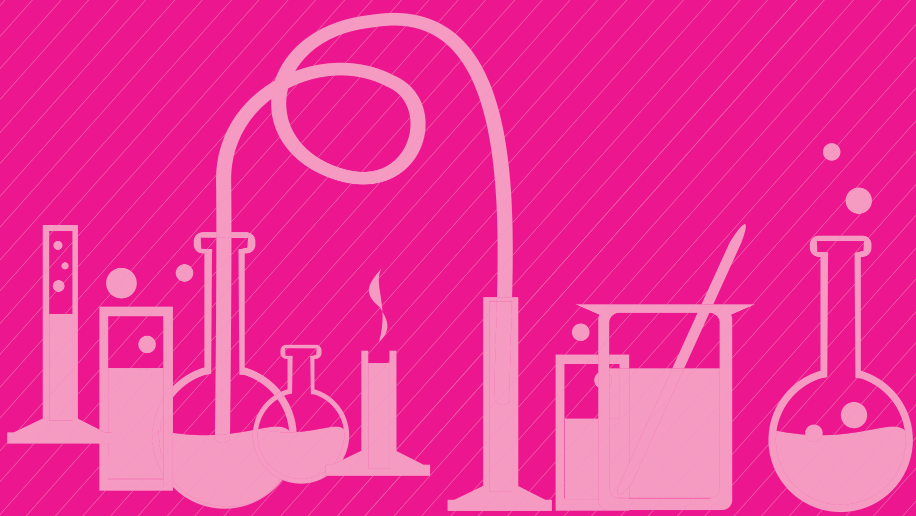
Chapter 3

Used oil Analysis



ELIN MARINE LUBRICANTS
OIL SAMPLING

1. Objective of sampling

Regular analysis of used lubricant can act as a preventive maintenance tool, by providing customer:

- Advice based on the sample analysis
- A comparison of customer's equipment performance compared with that of similar machines
- A historical record of customer's machinery

2. Frequency of sampling

Sampling has to be done on a regular basis in order to achieve statistically valid information. The frequency of sampling depends largely on experience, and adjustments can be made on the basis of the results of previous samples.

For a more detailed sampling scheme please refer to your contact person at Elinoil Marine department.

3. How to sample

Since relatively small quantities of oil are taken for analysis, extreme care must be taken to assure a representative sample. The following precautions should be carefully observed:

- The samples must be taken in the standard "Elin Marine Q-test" bottles.
- Samples bottles must be clean, dry and free of possible contaminants.
- All samples should be taken when the oil is circulating and the equipment is in service.
- It is suggested that the sample is taken after the filters and before the lubricant enters the equipment.
- The sample bottle should be labeled immediately after sampling and the sample card should contain the following information:
    - i. Elin Marine Q-test customer code
    - ii. Elin Marine Q-test machine code
    - iii. Product name and viscosity grade
    - iv. Service hours – oil
    - v. Service hours – machine
    - vi. Top-up (l), oil change (yes or no)
    - vii. Sampling date
    - viii. Sample place
    - ix. Other information (remarks, special reason for sampling etc.)

4. Samples Dispatch

The labeled samples, with the correctly completed sample cards, should be forwarded to your contact person at Elinoil Marine department.

5. New customers – how to proceed

New Elinoil customers wishing to commence with Elin Marine Q-test should forward the following information to their contact person at Elinoil Marine department:

Customer information

- Name
- Address
- Contact name
- List of machinery (in the case of vessels, include the name of the vessel)

For each machine

- Internal identification number (if possible)
- Manufacturer (OEM)
- Model
- Type
- Fuel
- Oil content
- Lubricant that will be used

This information will be entered into the system and identification codes will be given for each machine. From that point on, the customer can start sending samples as detailed above.

All oil analyses are done at independent laboratories, which meet the appropriate requirement (ISO certification, etc) on behalf and under strict supervision of Elinoil, and deals mainly with the lubricants used in the ship's engine. Here are the different types of analysis that can be carried out:

- Water content
- Viscosity at 100°C
- Flash point open and closed up
- Basicity: TBN
- Fuel Dilution – Residual Detergency
- Insolubles
- Wear metals (Cu, Al, Fe, Pb, Sn, Cr)
- Contamination metals (Si, Na, V, Ni)
- Additive metals (Mg, P, Ca, Zn)

1. Water content

The presence of water in an engine oil can give rise to a whole series of problems. Corrosion, possible precipitation of additives (resulting in decreased detergency), oxidation catalysis, formation of deposits and sludge in various parts of the engine and in the oilways, resulting in poor lubrication and even complete engine seizure.

Salt water is much more harmful than fresh water.

Contamination by water is difficult to avoid, particularly in engines with water-cooled pistons. Therefore, the ship's engine room personnel should inspect the oil for water at least once a month. Presence of water can be detected by either visual inspection, or the crackle test. Oils containing water will be cloudy or emulsified. They will crackle when heated in a test tube or dish over a silent flame or on a hotplate. If the check indicates the presence of significant amount of water, an oil sample should be submitted for analysis. The amount of water present can be determined in the laboratory.

Normal setting and centrifuging will usually keep the water content down to trace amounts. If not, the effectiveness of the centrifuge should be checked. When easily measurable quantities of water are present (0,2 % or more), immediate steps should be taken to remove it. If the presence of water persists, the machinery should not be operated for extended periods of time with circulating oils containing more than 1% water.

When the water content of the oil exceeds 0,2%, continuous centrifuging should be recommended immediately. Batch purification should follow as soon as possible. Oil temperatures of of 90oC to 95oC are recommended for both purification steps.

Salt water should always be removed by centrifuging only. If removal is attempted by heating in a vented storage tank alone, it will merely evaporate the water and leave the salt behind in the oil.

2. Viscosity at 100°C

Viscosity is the most important physical property of an oil. Every engine requires an optimal viscosity. Below this viscosity, there is a danger of the oil film breaking down and causing premature wear. Above this value, internal friction increases and causes loss of power.

Unless the system is topped up by mistake with a different viscosity grade, a change in viscosity indicates that a problem – either oil or engine-related – has occurred.

The viscosity of the oil may be decreased particularly by dilution (fuel), by shearing of the thickening polymer in the case of multigrade oils, by topping up with oil of a lower viscosity etc.

Viscosity may be increased by the presence of soot and carbon, by oxidation products, by water (inverse emulsion), by topping up with an oil of higher viscosity, by excessive evaporation of the light fractions in the case of a low viscosity or wrongly formulated lubricating oil.

When the viscosity of an oil in use shows no change compared with the value for the "new oil", it should not be overlooked that it is possible for a thickening effect to be counterbalanced by a diluting effect.

A dilution of about 5% by volume by gas oil, which reduces the viscosity of an oil approximately 25%, is a clear indication of the need for an oil change, and also of the need to seek and rectify the cause of the trouble.

3. Flash point and Dilution Measurement

A sizeable reduction in the flash point of an engine oil in service is a positive sign of fuel dilution. The effect of fuel dilution on the flash point of the engine oil is especially pronounced in engines operating on marine diesel fuel.

Heavy fuels, containing a much smaller number of "low flash" components, lower the flash point of an engine oil to a much lesser degree.

Fuel dilution not only reduces the viscosity and lubricating properties of the oil but also introduces readily oxidizable substances, which encourages the formation of deposits. This has the effect of reducing the detergent dispersant properties of the oil and shortening its service life.

Fuel dilution of the engine oil may occur due to leaking fuel pumps (worn plungers) or lines, and as result of poor combustion caused by bad injector performance. The presence of fuel in the engine oil can be detected from a decrease in flash point, often from its smell and sometimes from a decrease in viscosity (if low viscosity diesel fuel is used and this effect in not masked by viscosity increase due to oxidation).

Fuel cannot be removed from engine oils by shipboard purification and it is therefore very important to trace the cause of fuel dilution as soon as possible and to eliminate the problem by mechanical means (new fuel pump plunger, new injectors, correction of leaks, etc.).

4. Basicity: TBN

TBN, or Total Base Number is the quantity of acid (expressed in terms of the equivalent number of milligrams of potassium hydroxide) that is required to neutralize all basic constituents present in 1g of sample.

Engine oils often contain alkaline additives to neutralize acid products of combustion.

The choice of the alkalinity reserve of these oils depends on the sulphur content of the fuel used; the TBN may vary from 10 to 55 to suit fuels with a sulphur content of 1% to 5%.

The determination of the TBN of oils in service indicates their residual alkalinity. The TBN gradually decreases as the detergent additives decompose or become neutralized by the acid products of combustion.

It is therefore necessary to monitor this decomposition to ensure that there is always an adequate alkaline additive reserve (detergent) to perform its function in the piston ring zone.

Generally an oil change (complete or partial) is recommended after a decrease by a maximum of 50% of the original TBN.

5. Residual detergency

An engine oil containing adequate amounts of active detergent and dispersant additives holds the particles of soot and other solid contaminants in suspension; carbon and oxidation products would otherwise precipitate and cause engine fouling.

The spot test is a relatively simple method but its correct interpretation necessitates a degree of experience. A drop of oil deposited on a porous filter paper diffuses the soot and other impurities over a wide area as it spreads, in the case of an oil with adequate detergent – dispersant properties. If there is a lack of detergency, the carbon and oxidation products are confined to the center of the spot. This test can also give an indication of the content of carbonaceous matter and sometimes even enable the presence of water or heavy dilution to be detected.

The spot generally has the following characteristics:

- A central area, the opacity of which indicates the degree of contamination of the oil; it is usually surrounded by a halo of darker color, representing the limit of migration of the carbon particles.
- A more or less dark diffusion area, indicative of the dispersant properties of the oil.
- A translucent area. More or less tinted, depending on the degree of oxidation of the oil.

If it is simply a case of monitoring, the spot tests are made at ambient temperature or at a relatively high temperature after stopping the engine.

However, to obtain a more precise assessment of the performance of the oil in the upper parts of the engine, it is advisable to make an additional spot test by raising the oil to a higher temperature (e.g. 230°C).

<u>EVALUATION OF THE DISPERSANT AND DETERGENT PROPERTIES OF THE OIL.</u>

- The central area of the spot indicates the degree of contamination of the oil, its color depending on the amount of carbonaceous matter present. A dark grey, sometimes black, and not very clearly defined ring is usually observed. To some extent, it represents the boundary between the central area where the large (flocculate) carbon particles are localized and the diffusion area, which indicates the dispersant properties of the oil. With the type of paper used (porosity), only oils containing a minimum of suspended particles smaller than 0.5μ in size produce a diffusion area.
- If the central area is grey and the diffusion area is almost non-existent or indented, it indicates that
  - o The residual concentration of additives is nil or becoming depleted
  - o The dispersant properties are inadequate
  - o There is a danger of the hot parts of the engine (rings) becoming fouled.

If the detergency is insufficient, an oil change is necessary.

6. Soot content (insolubles/ carbonaceous matter)

The function of an engine oil is to lubricate the moving parts of an engine and to cool certain other parts, particularly the bearings, pistons and rings. In the presence of air at high temperature, the oil may become oxidized. The oxidation products have a tendency to polymerize and form varnish on the pistons and in the ring grooves. The properties of the engine oil must be such that they not only prevent or retard oxidation but also help to hold the oxidized products in suspension at both low and high temperatures.

Quantitative determination of insolubles / carbonaceous material present, based on the blackening of the oil, can be measured gravimetrically or by means of an areolar photometer, and by relating this result to depletion of dispersal power; an indication of the dispersancy reserve still available may also be obtained.

Particularly in trunk piston engines, carbonaceous matter is derived from products of incomplete fuel combustion carried to the circulating system by blow-by and cylinder oil scrapings, as well as from carbonization of the circulating oil itself.

Carbonaceous matter, if allowed to build up in an engine oil, may deposit in critical parts of the engine, plug oil lines and cause bearing failures.

7. Detection of wear and contamination metal by ICP

By means of a plasma spectrograph (ICP) wear metals and mineral contamination metals can be measured. The results of the spectrographic analysis are recorded in the form of data showing the concentration of the various chemical elements observed in ppm (1ppm = 1 part per million = 0.0001% = 1mg/kg).

To relate these values to possible engine damage, it is first necessary to draw up a complete list of all the materials that may be found in it, and also their location. An example is shown in table 1.

The results obtained are of no significance in themselves and it is only progressive development of the concentrations, which must be taken into account. A marked irregularity in the development of the concentrations indicates the necessity for an investigation into any changes, which may have occurred (change of operating conditions, unscheduled oil change, oil top up, unreported maintenance work on the engine). A second sample must be taken immediately for verification.

In fact, it is impossible, a priori, to specify alarm levels for the concentrations, that is to say levels above which the engine must be overhauled, Wear rates are very variable and depend on several parameters:

- Type of operation
- Operating conditions
- Type of engine and its accessories, etc.

ELEMENTS WHICH MAY BE FOUND IN OIL AND THEIR MOST PROBABLE ORIGIN

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ELEMENT		ORIGIN	DEFECT, CAUSE OF PRESENCE
Iron	Fe	- Liners, rings, cams, tappets, etc. - Dust	- Wear
Chromium	Cr	- Chromium plated rings - Chromium plated liners - Cooling water (Na or K chromate anti-corrosion additive)	- Wear - Leak in cooling circuit
Aluminum	Al	- Pistons - Al-Sn bearings	- Piston wear - Bearing wear
Silicon	Si	- Atmospheric dust - Pistons - All Al-Si parts - Cast Si liners - Anti-foam additive in the lubricant - "Silicon" gaskets - Anti-corrosion additive	- Defective air filter or supplementary air - Engine wear - Gasket wear - Leak in cooling circuit
Boron	B	- Lubricant additives - Anti-corrosive in the cooling water	- Leak in cooling circuit
Lead	Pb	- Cu-Pb bearings - Residue of fuel combustion	- Bearing wear - Tinning of containers
Copper	Cu	- Cu-Pb bearings - Bronze bushes	- bearing wear
Tin	Sn	- Cu-Sn, Al-Sn or tin flashed bearings	- bearing wear
Silver	Ag	- Bearings	- bearing wear
Barium	Ba		
Calcium	Ca	- Lubricant additive	
Magnesium	Mg	- Lubricant additive	
Phosphorus	P	- Lubricant additive	
Zinc	Zn	- Lubricant additive	

Complementary tests

SAN-TAN

If necessary, the “Elin Marine Q-test” system can be used to determine TAN and SAN in the case of excessive dilution, and TBN decrease, for the purpose of assessing the degree of oxidation of the oil.

Obviously, these tests are time-consuming and considerably reduce the speediness of the “Elin Marine Q-test” system.

ACIDITY: TAN-SAN

- TAN or Total Acid Number: the quantity of base (expressed in milligrams of potassium hydroxide) that is required to neutralize all acidic constituents present in 1g of sample.
- SAN or Strong Acid Number: the quantity of base (expressed in milligrams of potassium hydroxide) that is required to neutralize the strong acidic constituents present in 1g of sample.

Strong inorganic acids are determined as SAN. The organic acids originating in additives (anti-rust, anti-wear, etc.) or in oxidation products are determined as TAN, which at the same time includes the SAN.

Thus, a new oil may have a TAN in the absence of any oxidation products.
It is the increase in the TAN and not its absolute value, which must be taken into account when making an evaluation.
The principal source of the strong inorganic acids is the sulphur in the fuel which produces sulphuric and sulphurus acids during combustion.
The presence of strong acids indicates the need for an oil change.

VISCOSITY AT 40°C

Measurement of the used lubricants viscosity at a second temperature of 40°C will facilitate the assessment of the temperature dependence of this critical parameter.

About circulating oils for 2 stroke engines…

Contamination with spent cylinder lubricant is generally not a problem in crosshead engines if they are in good mechanical condition. These engines have fairly complete separation between the cylinders and crankcase. However, if the engine is in poor repair, spent cylinder oil, or drip oil from the cylinders, will leak through the stuffing box and/or diaphragm into the circulating oil system. It carries with it carbonaceous matter, heavily oxidized products, spent cylinder oil additives, wear particles, and sometimes strong acids.

These contaminants are generally harmful to circulating oil and the oil system. They promote oil oxidation, reduce the demulsibility of the oil, increase wear, and lay down deposits in the circulating system. Strong acids will corrode bearings. All of these things will increase the maintenance costs of the engine and decrease its reliability. Therefore, the stuffing boxes, diaphragm, scraper rings, etc., should be kept in good condition to prevent this type of contamination.

For the same reason, deliberate addition of cylinder drip oil to the circulatig oil for economy reasons is undesirable, and could be a false economy. Even if the oil has been centrifuged and filtered, the contaminants will not be entirely removed.

Also, cylinder lubricants, both fresh oil and cylinder drip oil, are usually more viscous than circulating oil and will tend to increase the viscosity of the circulating oil.

In trunk-piston engines, the circulating oil is continuously being contaminated with spent cylinder oil and the product of combustion it carries with it. This cannot be avoided. Fortunately, the modern practice is to use lubricants specially formulated to protect against the effects of these contaminants. Nevertheless, it is most important that adequate centrifuge capacity be provided for these engines and that this is used continuously when the engine is operating in order to remove them.

GENERAL RELATIONSHIP BETWEEN CONTAMINANTS, THEIR EFFECT ON THE OIL AND THE ENGINE, AND THE PRINCIPAL INVESTIGATION PROCEDURES

PROBABLE CAUSES	INVESTIGATION PROCEDURE	CONTAMINANTS	EEFFECT ON LUBRICANT AND ENGINE
- Condensation at low operating temperatures - Extensive blow-by - Leak in cooling system through cylinder head gasket, seals	Infra-red differential Water content Spot test	- Water and glycol	Increase of: - Sludge deposits - Emulsion - Rust and corrosion - Lacquer deposits Decrease of: - Oil stability - Oil detergency
petrol engines - mixture too rich, defective choke - poor carburation due to worn or stuck rings, valve deterioration - defective ignition due to spark plug fouling - extensive blow-by - operation at low temperature, frequent starting diesel engines - gas oil feed excessive - poor combustion due to defective injector and bad atomization, stuck rings - leaks in the fuel pump, pipes - extensive blow-by	- Infra-red spectrometry - Comparative viscosities - Flash point	Fuel	Increase of: - Engine wear - Lacquer and varnish deposits Decrease of: - Viscosity - Oil stability
- Unsuitable air or oil filters - Inadequate maintenance of air oil filters - Leak in the induction system - No filter in the crankcase - Contaminated fuel and bad filtration - inadequate cleaning of engine after manufacture - Careless handling of the lubricant	- Emission spectrometry - Microscopic examination - Filtration	Dust and dirt	Increase of: - Abrasive wear - Deposits - Foam - Clogging of air and oil filters ventilation
- Engine wear - In relation to ingress of dust - Foundry fragments - Unsuitable lubricant - Unsuitable oil filter	- Emission spectrometry - Microscopic examination - Filtration - Centrifuging	Metal particles	Increase of: - Oil oxidation due to catalytic effect - Formation of deposits - Abrasive wear - Incrustation in bearings - Clogging of oil filter

PROBABLE CAUSES	INVESTIGATION PROCEDURE	CONTAMINANTS	EEFFECT ON LUBRICANT AND ENGINE
- Poor combustion, mainly in diesel engines - Defective injectors, bad atomization - Excessive blow-by and wear due to worn and stuck rings - Defective air input	- Spot test - Photometry - Filtration through porous membrane - Insoluble in various solvents - Microscopic examination	Soot-carbonaceous matter	Increase of: - Oil blackening - Oil viscosity - Formation of deposits, flocculation - Clogging of oil filter
- Temperature of oil in crankcase too high - Hot parts of engine – piston crown and upper cylinder - Oil in use too long - Weak fuel/air ratio - Defective ignition - Poor crankcase ventilation - Excessive blow-by - Engine overloaded	- Infra-red differential - Spot test	Oxidation products, solubles and insolubles	Increase of: - Varnish and lacquer deposits - Bearing corrosion - Oil viscosity - Grey discolouration of oil - Acidity of oil Decrease of: - Oil stability - Oil detergency
- High water content - High soot content - Oil excessivly oxidized	- Spot test - Filtration through porous membrane - TBN - Microscopic examination at high temperature	Reduction of detergency	Increase of: - Deposits - Engine wear

ELIN MARINE LUBRICANTS
“*elin* MARINE Q-TEST” REPORT

The standard report includes the last 3 analyses, showing trends of wear metals, detailed and automatic comments as well as the degree of wear.

OVERVIEW” THE 5 STEPS
“*elin* MARINE Q-TEST” REPORT

1. The customer mails the sample to Elinoil (attention to contact person).

2. Elinoil receives the sample and sends it to the laboratory where it is registered.

3. The entirely computerized and automated laboratory runs the different analysis programmes.

4. Elinoil interprets the results

5. The customer receives a diagnosis and detailed recommendations.

ELIN MARINE LUBRICANTS
DEMO ANALYSIS | EXAMPLE A

I. SAMPLE IDENTIFICATION

AS PROVIDED	NEW 0505C0052.ELN	PREVIOUS 0405C0172.ELN
VESSEL		
SAMPLING POINT	MAIN ENGINE	MAIN ENGINE BEFORE
ENGINE TYPE	NOT REPORTED	NOT REPORTED
OIL GRADE	ELIN CDS 30	ELIN CDS 30
OIL HOURS	NOT REPORTED	NOT REPORTED
ENGNE HOURS	NOT REPORTED	NOT REPORTED
SAMPLING PORT	NOT REPORTED	NOT REPORTED
SAMPLING DATE	20.03.2005	NOT REPORTED
DATE RECEIVED	14.04.2005	16.12.2004

II. METHODOLOGY AND ANALYSIS RESULTS OF REQUESTED DETERMINATIONS

PARAMETERS		NEW	PREVIOUS	METHODOLOGY
Kinematic Viscosity at 40°C	(cSt)	112,5	120,4	ASTM D 445
Kinematic Viscosity at 80°C	(cSt)	21,8	22,5	ASTM D 445
Kinematic Viscosity at 100°C	(cSt)	12,3	12,5	ASTM D 341
Water content	(% w/w)	0,16	0,14	ASTM D 1744
Flash Point	(°C)	>200	>200	ASTM D 92
Insolubles content	(% w/w)	0,49	0,40	ASTM D 4055mod
TBN	(mgKOH/g)	6,8	5,1	ASTM D 2896
Iron	(ppm)	8	**35**	Plasma Spectroscopy
Sodium	(ppm)	6	51	Plasma Spectroscopy
Vanadium	(ppm)	4	**20**	Plasma Spectroscopy
Nickel	(ppm)	4	**9**	Plasma Spectroscopy
Copper	(ppm)	7	**31**	Plasma Spectroscopy
Aluminum	(ppm)	5	2	Plasma Spectroscopy
Silicon	(ppm)	3	5	Plasma Spectroscopy
Lead	(ppm)	<1	2	Plasma Spectroscopy
Magnesium	(ppm)	12	20	Plasma Spectroscopy
Chromium	(ppm)	<1	<1	Plasma Spectroscopy
Tin	(ppm)	<3	<3	Plasma Spectroscopy

III. COMMENTS

Water content was measured at the commonly given as acceptable levels. Sodium results however suggest possible contamination by elevated salinity water.

Spectroscopy analysis did not show evidence of significant wear.

Lubricating oil suitable for further use.

DEMO ANALYSIS | EXAMPLE B

I. SAMPLE IDENTIFICATION

AS PROVIDED	NEW 0505C0053.ELN	PREVIOUS 0405C0174.ELN
VESSEL		
SAMPLING POINT	DIESEL GENERATOR No 1	DIESEL GENERATOR No 1 BEFORE
ENGINE TYPE	NOT REPORTED	NOT REPORTED
OIL GRADE	ENERGOL IC-HFX 303	MOBILGARD 330
OIL HOURS	NOT REPORTED	NOT REPORTED
ENGNE HOURS	NOT REPORTED	NOT REPORTED
SAMPLING PORT	NOT REPORTED	NOT REPORTED
SAMPLING DATE	20.03.2005	NOT REPORTED
DATE RECEIVED	14.04.2005	16.12.2004

II. METHODOLOGY AND ANALYSIS RESULTS OF REQUESTED DETERMINATIONS

PARAMETERS		NEW	PREVIOUS	METHODOLOGY
Kinematic Viscosity at 40°C	(cSt)	115,2	114,4	ASTM D 445
Kinematic Viscosity at 80°C	(cSt)	22,1	22,0	ASTM D 445
Kinematic Viscosity at 100°C	(cSt)	12,4	12,3	ASTM D 341
Water content	(% w/w)	0,10	0,05	ASTM D 1744
Flash Point	(°C)	>200	>200	ASTM D 92
Insolubles content	(% w/w)	0,50	0,55	ASTM D 4055mod
TBN	(mgKOH/g)	24,6	27,2	ASTM D 2896
Iron	(ppm)	9	10	Plasma Spectroscopy
Sodium	(ppm)	8	14	Plasma Spectroscopy
Vanadium	(ppm)	**43**	**54**	Plasma Spectroscopy
Nickel	(ppm)	**15**	**17**	Plasma Spectroscopy
Copper	(ppm)	1	2	Plasma Spectroscopy
Aluminum	(ppm)	9	4	Plasma Spectroscopy
Silicon	(ppm)	10	12	Plasma Spectroscopy
Lead	(ppm)	<1	1	Plasma Spectroscopy
Magnesium	(ppm)	29	39	Plasma Spectroscopy
Chromium	(ppm)	2	1	Plasma Spectroscopy
Tin	(ppm)	<3	<3	Plasma Spectroscopy

III. COMMENTS

Water content was measured at the commonly given as acceptable levels. Sodium results however suggest possible contamination by elevated salinity water.

Vanadium and Nickel contents indicate that residual fuel and/or combustion products are entering the oil. Check for entrance of flue gazes and/or condition of fuel oil pumps (plunger and barrel, sealing) and/or leaking of fuel injector and/or condition of piston rings and piston grooves etc…

Lubricating oil fit for further use but monitoring is recommended.

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DEMO ANALYSIS | EXAMPLE C

I. SAMPLE IDENTIFICATION

AS PROVIDED	NEW 0505CO055.ELN	PREVIOUS 0405CO178.ELN
VESSEL		
SAMPLING POINT	DIESEL GENERATOR No 3	DIESEL GENERATOR No 3 BEFORE
ENGINE TYPE	NOT REPORTED	NOT REPORTED
OIL GRADE	ELIN TPD 330	ELIN TPD 330
OIL HOURS	NOT REPORTED	NOT REPORTED
ENGNE HOURS	NOT REPORTED	NOT REPORTED
SAMPLING PORT	NOT REPORTED	NOT REPORTED
SAMPLING DATE	20.03.2005	NOT REPORTED
DATE RECEIVED	14.04.2005	16.12.2004

II. METHODOLOGY AND ANALYSIS RESULTS OF REQUESTED DETERMINATIONS

PARAMETERS		NEW	PREVIOUS	METHODOLOGY
Kinematic Viscosity at 40°C	(cSt)	115,2	129,0	ASTM D 445
Kinematic Viscosity at 80°C	(cSt)	22,4	23,3	ASTM D 445
Kinematic Viscosity at 100°C	(cSt)	12,5	12,8	ASTM D 341
Water content	(% w/w)	0,10	0,20	ASTM D 1744
Flash Point	(°C)	>200	>200	ASTM D 92
Insolubles content	(% w/w)	0,20	0,53	ASTM D 4055mod
TBN	(mgKOH/g)	7,5↓	19,0	ASTM D 2896
Iron	(ppm)	**41**	29	Plasma Spectroscopy
Sodium	(ppm)	40	29	Plasma Spectroscopy
Vanadium	(ppm)	**33**	**168**	Plasma Spectroscopy
Nickel	(ppm)	**11**	**51**	Plasma Spectroscopy
Copper	(ppm)	**26**	3	Plasma Spectroscopy
Aluminum	(ppm)	<1	5	Plasma Spectroscopy
Silicon	(ppm)	10	12	Plasma Spectroscopy
Lead	(ppm)	<1	4	Plasma Spectroscopy
Magnesium	(ppm)	22	39	Plasma Spectroscopy
Chromium	(ppm)	6	6	Plasma Spectroscopy
Tin	(ppm)	<3	<3	Plasma Spectroscopy

III. COMMENTS

Vanadium and Nickel contents indicate that residual fuel and/or combustion products are entering the oil. Check for entrance of flue gazes and/or condition of fuel oil pumps (plunger and barrel, sealing) and/or leaking of fuel injector and/or condition of piston rings and piston grooves etc…

Iron and copper contents were measured at the commonly given as concern levels. Abnormal wear may be taking place at piston rings and/or pistons and/or bearings and/or cylinder liners.

TBN result indicates that remaining alkalinity may be insufficient.

Analysis results suggest that the lubricating oil charge should be partly replaced by new oil. Retesting is recommended.

DEMO ANALYSIS | EXAMPLE D

I. SAMPLE IDENTIFICATION

AS PROVIDED	0505CO117.ELN
VESSEL	
SAMPLING POINT	MAIN ENGINE
ENGINE TYPE	MITSUI B & W 6L – 60 MCE
OIL GRADE	ELIN CDS 30
OIL HOURS	NOT REPORTED
ENGINE HOURS	NOT REPORTED
SAMPLING PORT	JINGTANG – CHINA
SAMPLING DATE	08.05.2005
DATE RECEIVED	01.06.2005

II. METHODOLOGY AND ANALYSIS RESULTS OF REQUESTED DETERMINATIONS

PARAMETERS		RESULTS	METHODOLOGY
Kinematic Viscosity at 40°C	(cSt)	112,5	ASTM D 445
Kinematic Viscosity at 80°C	(cSt)	22,0	ASTM D 445
Kinematic Viscosity at 100°C	(cSt)	12,5	ASTM D 341
Water content	(% w/w)	0,18	ASTM D 1744
Flash Point	(°C)	>200	ASTM D 92
Insolubles content	(% w/w)	0,55	ASTM D 4055mod
TBN	(mgKOH/g)	13,4	ASTM D 2896
Iron	(ppm)	**256**	Plasma Spectroscopy
Sodium	(ppm)	15	Plasma Spectroscopy
Vanadium	(ppm)	12	Plasma Spectroscopy
Nickel	(ppm)	7	Plasma Spectroscopy
Copper	(ppm)	**46**	Plasma Spectroscopy
Aluminum	(ppm)	3	Plasma Spectroscopy
Silicon	(ppm)	17	Plasma Spectroscopy
Lead	(ppm)	**9**	Plasma Spectroscopy
Magnesium	(ppm)	23	Plasma Spectroscopy
Chromium	(ppm)	3	Plasma Spectroscopy
Tin	(ppm)	**3**	Plasma Spectroscopy

III. COMMENTS

Copper, tin and lead concentrations suggest evidence of metal wear. Check possible sources eg. bearings etc...

Iron content was measured at the commonly given as immediate action level. Check and follow closely possible wear of liners,rings,cams,tappets,etc.

Relatively high insolubles content at concearn level. Check for any one or a combination of:

Incorrect operation of purifiers and filters and/or Condition of gears and pumps, leaking fuel injector and/or leaky stuffing box and/or Condition of pistons/piston grooves-rings and/or Possibility of too high operating temperatures.

Analysis results suggest that the lubricating oil charge should be partly (approximately 50% or more) or totally replaced by new oil. Retesting is recommended if partially replaced.