TRIBOCARE

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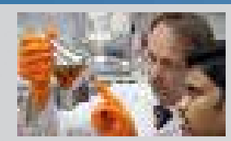
RELIABLE ANALYSIS



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ABOUT

Publisher

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GENERAL

Used Oil Analysis is a service, which is provided by Tribocare Laboratory.

We offer two levels of service:

- Standard – analyses the condition of the lubricating oils. It focuses on large systems such as main engines and hydraulic systems to ensure that the oil is fit for continued service.
- Enhanced – monitors the condition of the equipment in addition to analysing the condition of the oils. Analysing the oil which is in contact with the machinery enables you to monitor the performance of this machinery. The oil of a small system can be easily replaced but for a critical system it might still be a useful service to prevent machinery breakdown.

In general, the service describes the key oil characteristics such as kinematic viscosity, base and acid numbers. It evaluates the external contaminants, the trends of different wear elements, the size of particles, the ISO cleanliness index as well as the water content. The analysis reports also show new oil characteristics and OEM limits, which serve as a reference and form the basis for interpreting the Used Oil Analysis results in accordance with industry standards.

The Cylinder Scrapedown Analysis is an additional tool for monitoring the operation and condition of two-stroke engines and cylinder lubricants. It does not replace regular inspections; these are still essential to ensure safe operation.

The cylinder scrapedown sample is taken from the piston underside during operation. A representative sample from each individual unit and a sample of used system oil are analysed in our laboratory. In order to optimize the cylinder oil feed rate, the remaining alkalinity reserve, the iron content and other properties are analysed during a procedure, which MAN for example calls the sweep test. During this procedure the cylinder oil feed rate is reduced step by step and the oil quality is monitored with the help of Cylinder Scrapedown Analysis, at each step. The results are then used to establish the optimum cylinder oil feed rate for economical and safe operation.

SAMPLE BOTTLE KIT

Contents:

- 12 sample bottles and sample submission forms
- Used Oil Analysis sampling and shipping instructions
- Self-addressed envelopes for returning lubricant samples in batches of 4 or less
- EC safety data sheet
- Pro forma invoice

Please note:

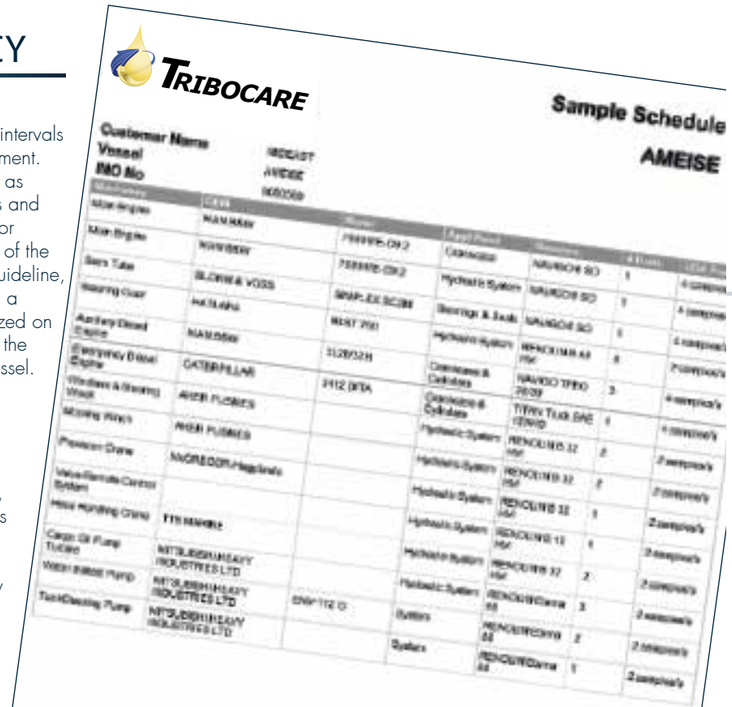
- When you receive the sample bottle kit, the analyses are already paid. So every sample bottle represents a paid analysis. Please use the sample bottles for lubricant analysis only.

- Please use only Tribocare sample bottles for the Tribocare Used Oil Analysis service. The laboratory will not analyse any samples in third-party bottles.

SAMPLE FREQUENCY

We recommend following the sampling intervals recommended by the OEM of the equipment. Beyond that, classification societies such as DNV GL, LR and ABS provide guidelines and offer e.g. "Extended dry-dock interval", for which used oil analysis reports form part of the required documentation. As a general guideline, "Tribocare Marine Lubricants" also offers a Sample Schedule which can be customized on request and will be provided along with the Lubrication Chart for every contracted vessel.

A set of cylinder scrapedown samples should be taken after every significant change in the Sulphur content of the fuel, the engine load or the climatic conditions in which the ship is operating. It is also good practice to take additional sets of cylinder scrapedown samples after every overhaul.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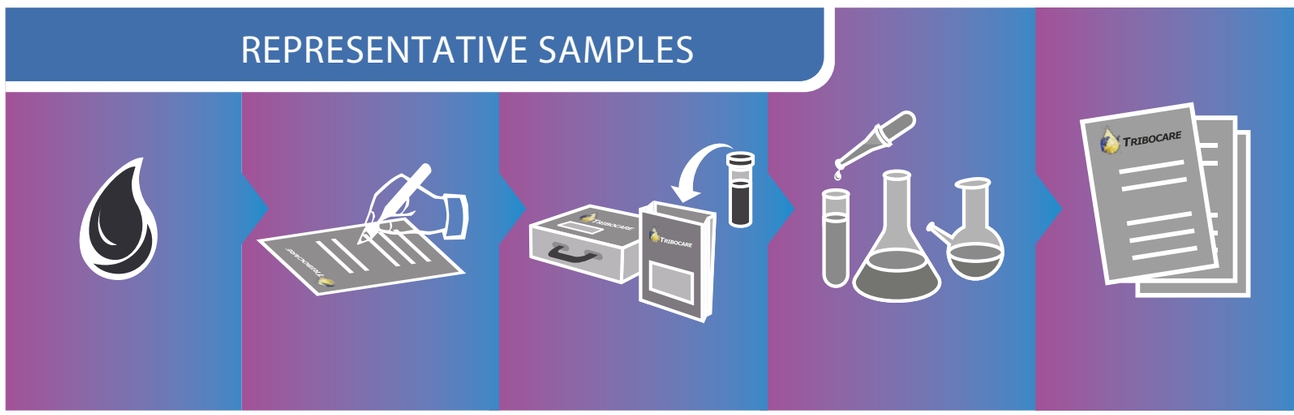
Sample Schedule

AMEISE

Customer Name
Vessel
IMO No

REPRESENTATIVE SAMPLES



Obtaining a representative lubricant sample is one of the most important steps for a successful lubricant analysis program. If the sample does not represent the true condition of the lubricant and component at the time of sampling, then the reliability of both the test result and its interpretation will be affected.

- Areas where lubricant flow is restricted or where contaminants and wear products tend to settle or collect should be avoided as sampling points.

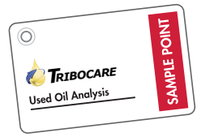
- Lubricants should be sampled while the machinery is running, provided it is safe to do so, or within 30 minutes after shutdown. This ensures that wear products and lubricant contaminants are thoroughly mixed with the lubricant and that any heavier wear particles have not settled out.
- Thoroughly purge the sampling connection to remove any debris before taking the sample.
- Use a Tribocare sample bottle and take a sample. Please ensure that the bottle is 90% full.
- Once a proper sample point and method is chosen for a particular component, oil samples from that component should always be taken from the same point with the same method.

- Please take extra care when completing the sample submission form for the first time for each machinery system.

To ensure the consistency of the Cylinder Scrapedown Analysis results, the sample should be taken under the following conditions:

- Up to one week after cleaning the piston underside
- At representative load at calm sea
- Ideally in extreme operating conditions: when burning high Sulphur fuel (e.g. 3.5%) in humid areas
- At low and high continuous rating

SAMPLE POINT

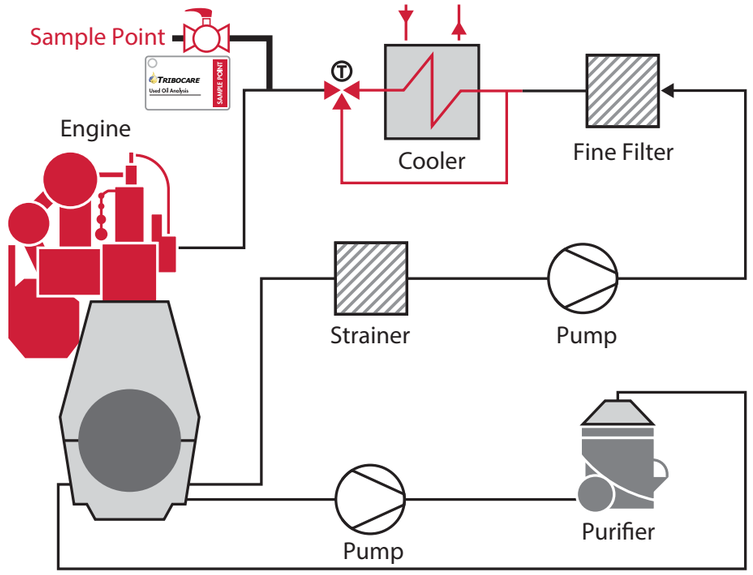


In order to ensure the reliability and the consistency of the analysis result, the oil samples should be taken from the correct sample points. The sample points are labelled with a Tribocare sample point tag to ensure that the samples are always taken at the same point. This is a requirement for comparable data and conclusive trending. If there is more than one sample point at one piece of machinery, we recommend marking each sample point tag accordingly. The details of the machinery system should be noted on the submission form every time in such a way that the samples can be allocated correctly at the laboratory.

On the next two pages please find suggested sample points for each piece of equipment.

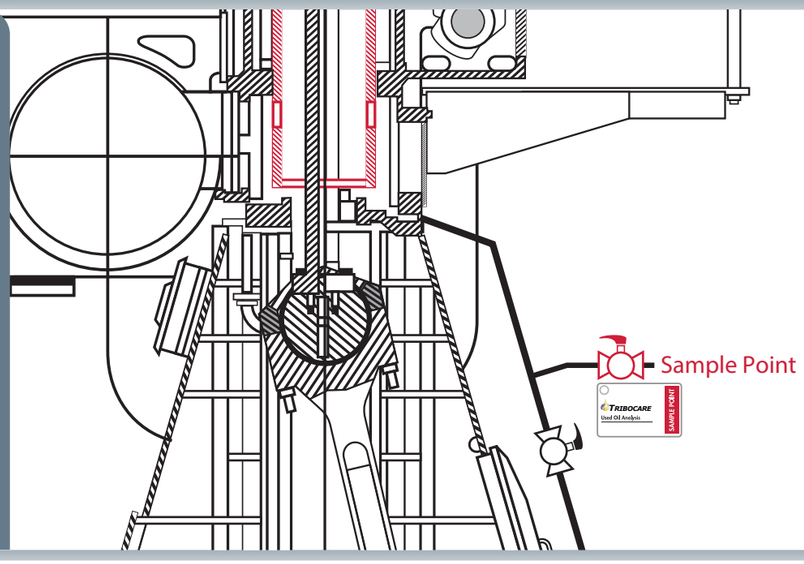
Main Engine, Auxiliary Engine

- Sample Point is between the cooler and the main engine/ auxiliary engine.



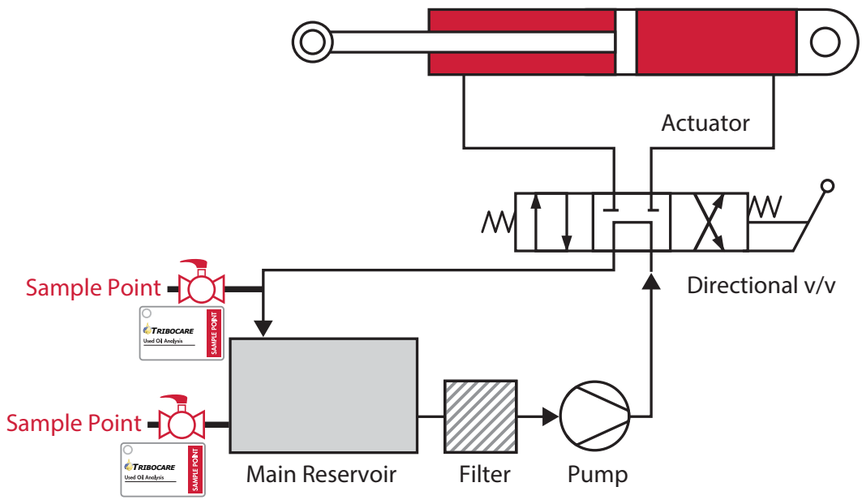
Crosshead Engine

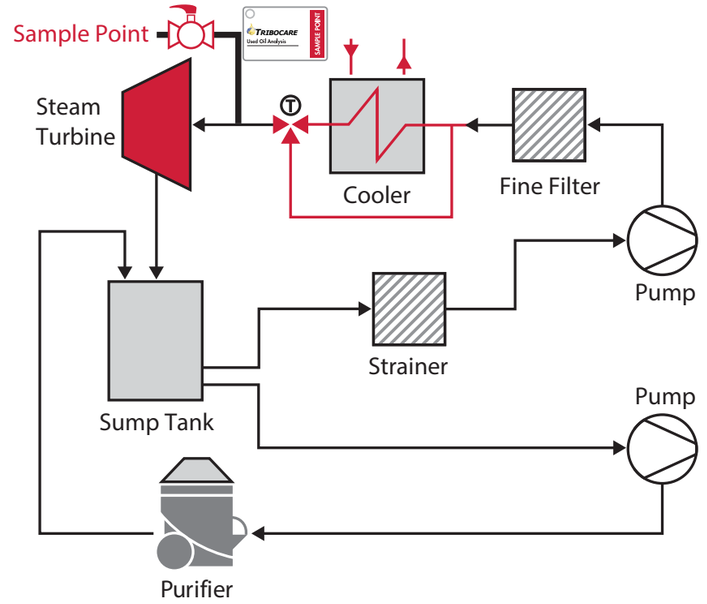
- Sample point for cylinder scrapedown oil from piston underside is the drain line of each unit.



Hydraulic System

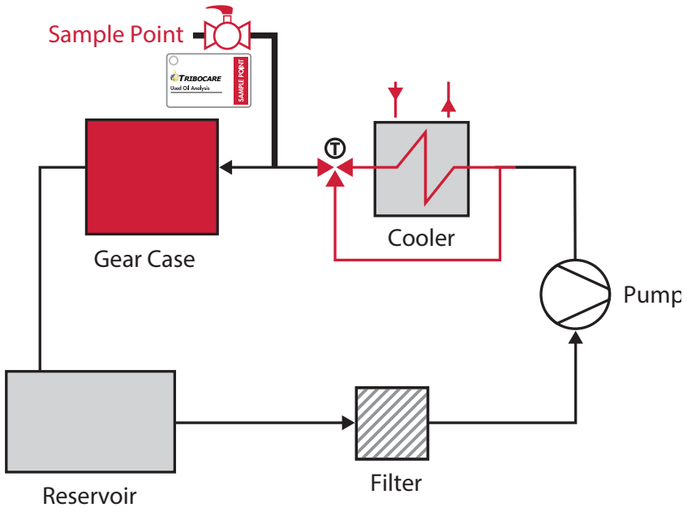
- Sample Point is either in the system return pipe or midpoint of main reservoir.





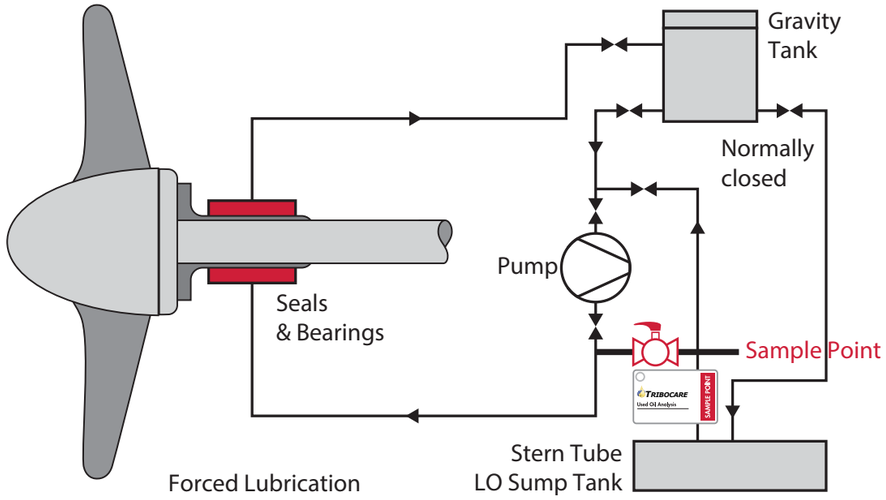
Steam Turbine

- Sample Point is between the cooler and the turbine.



Gearbox

- Sample Point is between the cooler and the gear case.



Stern Tube

- Sample Point is either in the system return pipe or midpoint of main reservoir.
- Forward seal sample is not suitable.

SUBMISSION AND DISPATCH PROCESS

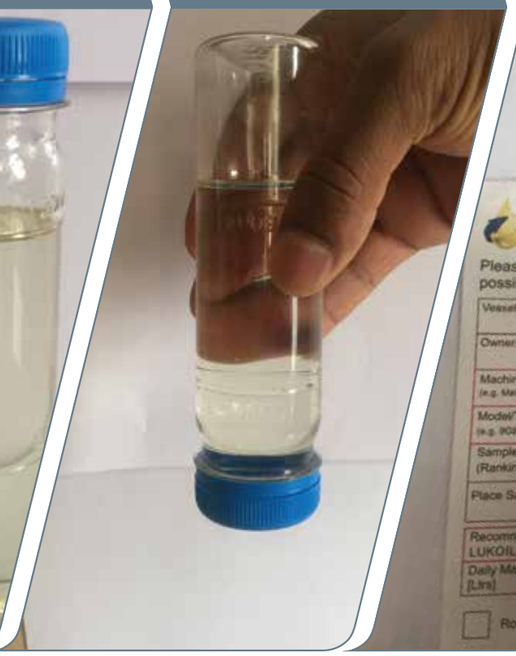
1.

Use a Tribocare bottle to take a lubricant sample. Please ensure that the bottle is 90% full.

2.

To prevent oil leaks, close the lid tight until you hear a click (locking) sound.

Test for any leakage.



3.

Complete the Tribocare submission form, in particular all the mandatory fields highlighted in red.

4.

Attach the submission form to and wrap it around the bottle.

Place the bottle in the plastic bag and seal it tightly with the provided cable tie.

5.

If you return all 12 bottles, please use the cardboard box for shipping. If you send less than 12 bottles, place 4 bottles in one envelope.

Seal the envelopes using the clips included in the sample kit.

Please copy the MSDS provided with the sample bottle kit; include it in the envelope or box when submitting the samples.

6.

Hand over the package to your agent or courier.

You do not need to fill in any return address. All samples are addressed to:

TRIBOCARE FZC
A2-074, SAIF Zone
Sharjah, UAE
Phone +97 165 528 799

Please use the provided self-addressed envelopes for returning lubricant samples. Upon landing, please ensure that your agent uses a courier company like DHL, UPS, etc. for shipping UOA samples. Failure to do so may result in the samples being rejected or lost.

7.

Analysis reports can be received online (http://uoa.tribocare.com), via email or on your mobile phone using Tribocare's app. The online system also serves as an administration tool to monitor sample frequencies.

Analysis results not received:
Normally the analysis reports will be available within 3 working days after the laboratory received the samples.

If for any reason you do not receive the analysis reports within this time, please contact: reports@tribocare.com

ANALYSIS REPORT

TRIBOCARE

ENAS NAL 075 17025

Summary Report for EXAMPLE SHIP (0000000) dated 18 March 2015

Machine Name	Comments	Action	Rating
Generator Engine No.2	The oil contains negligible levels of both water and soot/insolubles. The viscosity, however, shows a further reduction and is now significantly lower than the engine manufacturer's recommended upper limit. It is recommended that the oil is renewed	It is recommended that the oil is renewed at the earliest opportunity.	
Generator Engine No.3	The oil contains negligible levels of both water and soot/insolubles. The viscosity, however, shows a further reduction and is now significantly lower than the engine manufacturer's recommended upper limit. It is recommended that the oil is renewed	These values will be closely monitored as sampling progresses.	
Generator Engine No.1	The oil contains negligible levels of water and low levels of soot/insolubles. The viscosity is lower than the new oil value but acceptable and the oil contains an adequate reserve alkalinity (base number). The oil is suitable for continued service.	No Action Required	
Main Engine	The oil shows improvement and contains negligible levels of both water and soot/insolubles. The viscosity is close to the new oil value and the oil contains an adequate reserve alkalinity (base number). The oil is suitable for continued service.	No Action Required	
Stern Tube	The oil contains negligible water. The viscosity is close to the new oil value and the oil is suitable for continued service.	No Action Required	

Immediate Action Required Can Continue Normal

Vessel and machinery details including sample point and shipping details

Machinery data at the time of sampling

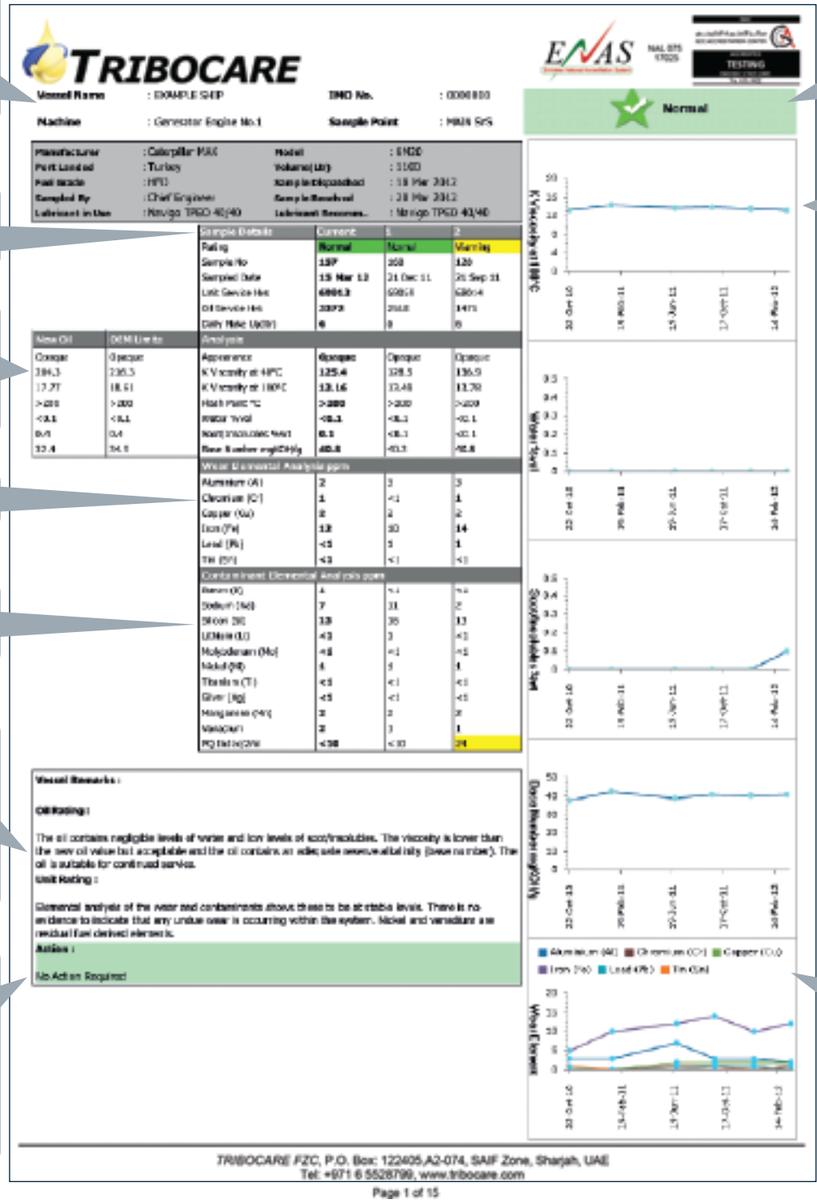
Fresh oil values, OEM limits as well as analysis results of the last three samples

Wear elements at a glance

Contaminant elements at a glance

Oil rating explaining the analysis results, possible explanatons for the current oil condition and recommendation of corrective measures

Unit rating is only possible when a number of sample results is available as it depends on analysis trending and combinations of test results



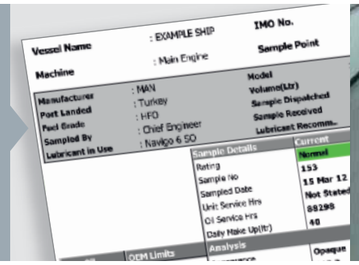
Color coded rating of analysis result

Most important data trends illustrated over a longer time span (more than the last three results)

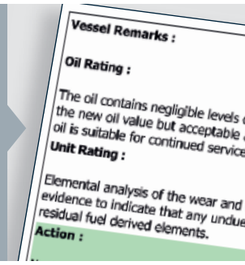
Trends of the most important elements combined in one graph

Representative samples and complete data sets ensure conclusive results and maximum benefit.

Suitable test methods and professionalism provide accurate data as fast as possible.



Adressing customer needs and maximizing benefits with ratings and recommendations.



ROUTINE ANALYSIS TESTS & METHODS

Depending on machinery system and application, the laboratory performs different tests on the lubricant samples.

LABORATORY TEST	UNITS	TEST METHOD	MACHINERY SYSTEM
Appearance		Visual	All
Kinematic Viscosity @ 40°C	mm^2/s	ASTM D 445	All
Kinematic Viscosity @ 100°C	mm^2/s	ASTM D 445	Engine only
Flash Point	°C	ASTM D 3828	Engine and heat transfer
Water	v/v-%	ASTM E 2412/ ASTM D 6304	All
Soot/ Insoluble	m/m-%	ASTM E 2412 IP316	Engine only
Base Number	mg KOH/g	ASTM D 2896	Engine only
Acid Number	mg KOH/g	ASTM D 664	Non-engine except gas engine
Strong Acid Number	mg KOH/g	ASTM D 664	Non-engine only
Carbon Residue	m/m-%	ASTM D4530-11	Heat transfer only
ISO code	4/6/14 µms	ISO 4406	Hydraulic only
PQ Index	/2ml	Manufacturer	All
Elemental Analysis	ppm	ASTM D 5185	All
System Oil Dilution	v/v-%	Proprietary	Cylinder Scrapedown only
Oxidation	Abs/cm	DIN 51453	Gas engine only
Nitration	Abs/cm	DIN 51453	Gas engine only
Sulphation	Abs/cm	ASTM E 2412	Gas engine only
Glycol	m/m-%	ASTM E 2412	Gas engine only
ipH		pH electrode	Gas engine only

Glossary of Terms

cSts Centistokes

IP Institute of Petroleum

PQ Particle Quantifier

ASTM American Society for Test and Materials

FTIR Fourier Transform Infrared Spectrometry

ISO International Organisation for Standardisation

ICP Inductively Coupled Plasma

µms microns

The **Kinematic Viscosity** is an important property of lubricants and must be accurately monitored. It is defined as the resistive flow of a liquid under gravity and monitored at 100°C for engine oils and at 40°C for non-engine oils. Recommendations of oil grades for specific applications are based on their load, speed and temperature.

Fuel ingress into the engine oil can be determined by assessing the **Flash Point**. High levels of fuel contamination in the engine oil can lead to crankcase explosion.

Determining the **Water Content** is one of the most critical tests because water contamination in lubricating oil has severe impacts on the oil quality and machinery. It can lead to corrosive wear in the machinery, especially if it is saline water or if the engine is burning high Sulphur fuel. Water contamination is mostly caused by leakage from the cooling system, tank condensation due to temperature fluctuations, seal failure or humidity. Water ingress above 0.2% requires immediate action to prevent further ingress and improve the purification process.

The **Soot**, or oil-insoluble parts, consists of contaminants such as asphaltenes or partially burned or unburned fuel in the lubricating oil. Simple and cheap infrared (IR) technology detects only certain levels of soot and might be sufficient for lubricants used in engines running on distillate fuel. However, for lubricants in engines running on heavy fuel oil this test is not sufficient and would for example not detect **n-heptane-insoluble** matter as per IP316. Hence, either the blotter spot test or centrifugation according to IP 316 is used.Soot contamination is a common reason for viscosity increases in engine oils. It indicates whether purification and filtration work well and, finally, whether continuous low load or high blow-by leads to increased amounts of oil-insoluble contaminants.

The **Base Number** or Total Base Number describes the amount of alkaline substances in the oil. Crankcase lubricating oil has to neutralize the acidic components formed during combustion to prevent the risk of corrosive wear on the cylinder liner and other parts of the engine. This neutralization capacity is maintained by topping up with fresh oil on a regular basis to replace the oil that has been consumed and to maintain the oil filling at its maximum. The depletion of the BN depends on on the fuel Sulphur content and has to be regularly monitored. The oil needs to be replenished with fresh oil when the BN drops below the recommended level.

The **Acid Number** is a measure of acidic components in the oil and is monitored in non-engine oils. The fresh oil acidity is mainly related to the additives used in the lubricant production. The acidity of an oil increases due to thermal degradation, oxidation and ageing of the oil. It is very important to consider the baseline Acid Number value of the fresh oil while monitoring the Acid Number increase. The **Strong Acid Number** will only be tested if the acid number has been found below the specified minimum level. **Carbon Residue**, also known as coke, gives an indication of the ageing process of the oil and is influenced by heat, oxidation and the material in contact with the oil such as pipework and particulates circulating within the fluid itself. It can lead to carbon deposit-choked pipes and, hence, fire hazards.

The **Particle Count** as per **ISO Code** quantifies the particulates in the lubricant, differentiating between 4, 6 and 14 µm particles. This test shows how efficiently the filtration system works in removing particulates from the oil to avoid obstructions of the sensitive control valves of high-pressure hydraulic systems. Testing the **PQ Index** in the used oil identifies ferromagnetic particles in the oil. The elements are measured by inductively coupled plasma (ICP) spectroscopy, provided that the particle size is below 5µm. In combination with tests for larger particles, this allows to assess the iron wear level and to categorize it as abrasive or corrosive wear, especially with Cylinder Scrapedown Analysis (CSA).

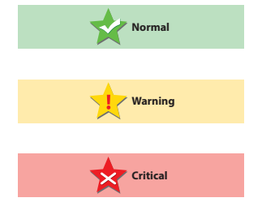
Wear and Contaminant metals are either wear particles in the oil caused by abrasive or corrosive wear on machinery parts or ingress of external contaminants. Elemental spectroscopy analysis by ICP can precisely determine all metals, including wear, contaminant and additive metals from trace level to higher concentrations. For some elements, there are several possible sources. For example, silicon in the oil can be caused by wear (piston crown material), antifoam additives or contamination (dirt or sand). Only by evaluating the complete set of results is it possible to determine the exact source of the particles.

INTERPRETATION OF THE RESULTS

The Used Oil Analysis (UOA) report is based on the hands-on experience of our analysts and associated engineers and their in-depth knowledge of the manufacturing process and application of lubricating oil, especially in the marine sector.

Our UOA reports present the results in such a way that all end users – with or without technical background – can easily understand even highly technical aspects and implement the necessary preventive and predictive maintenance measures in order to protect their machinery and avoid expensive breakdowns.

For quick and easy orientation and assessment whether the oil is fit for continued service, the oil condition is rated in three color coded categories:



OIL TEST	CONDITION	PROBABLE SOURCE	UOA	CSA
Viscosity	Increase	Soot/ insolubles/ unburned fuel	✔	✔
		High amount of neutralized acid	✔	✔
		Oxidation or elevated oil temperature	✔	✔
		Heavy fuel oil dilution	✔	✔
		Use of higher viscosity lubricant	✔	✖
		Water ingress	✔	✔
	Decrease	Distillate fuel dilution	✔	✔
		Use of lower viscosity lubricant	✔	✖
		Wrong sampling location e.g. stuffing box drain instead of residue drain	✖	✔
		System oil dilution	✖	✔
Water	Increase	Water cooler leakage	✔	✖
		Sealing water solenoid valve of purifier leaking	✔	✖
		Condensation (high humidity)	✔	✔
		Water ingress through header tank or vent line	✔	✖
		Leaking seal/ gland (stern tubes)	✔	✖
		Defective charge air cooler water catcher	✖	✔
		Blocked scavenge drain line	✖	✔
		Leaking water cooling system	✖	✔
		Leaking steam from scavenge space fire extinguishing system	✖	✔
Soot/ Insolubles	Increase	Combustion products either due to poor combustion or blow by/ piston ring performance.	✔	✔
		Heavy fuel oil dilution		
		Oxidation or elevated oil temperature	✔	✔
		Wear debris	✔	✔
		Extraneous dirt	✔	✔
Base Number	Increase	Topping up bigger amount of fresh oil	✔	✖
		Contamination with cylinder oil	✔	✖
		Use of higher BN lubricant	✔	✔
		Lower sulphur content of the fuel	✔	✔
	Decrease	Normal due to additive depletion	✔	✔
		Rapid depletion indicates a problem - presence of water or poor combustion	✔	✔
		BN of engine or cylinder oil in use not sufficient	✔	✔
		Cylinder oil feed rate too low for fuel in use	✖	✔
		High Sulphur content of the fuel	✔	✔
PQ Index	Increase	Presence of ferrous debris normally magnetic iron	✔	✔

OIL TEST	CONDITION	PROBABLE CAUSE	UOA	CSA
Acid Number	Increase	Oxidation or deterioration of oil	✔	✖
	Decrease	Bigger amount of fresh oil or of a lubricant with lower TAN was added	✔	✖
ISO Code	Increase	Inadequate filter control, dirt ingress through seals and/ or header tank	✔	✖

ELEMENT	PROBABLE SOURCE	PROBABLE ORIGIN OF THE ELEMENT	UOA	CSA
Aluminium (Al)	Catalyst fines in Fuel	In combination with Silicon: contamination	✔	✔
	Pistons	Wear particles	✔	✖
	Bearings	Wear particles	✔	✖
Silicon (Si)	Catalyst fines in Fuel	In combination with Aluminium: contamination	✔	✔
	Sand and Dust	Contamination	✔	✔
	Antifoam additive	Lubricant	✔	✔
	Silicon gaskets	Wear particles	✔	✖
	Liner, Piston	Wear particles	✔	✔
	Water conditioner additive	Contamination	✔	✔
Chromium (Cr)	Rings	Wear particles	✔	✔
	Piston Grooves	Wear particles	✔	✔
	Cooling water conditioner	Coolant leak	✔	✖
Copper (Cu)	Bearings	Wear particles	✔	✖
	Bushings	Wear particles	✔	✖
	Rocker arm bushes	Wear particles	✔	✖
	Camshaft bushes	Wear particles	✔	✖
	Piston skirts and rings	Wear particles	✖	✔
	Stuffing box rings	Wear particles	✖	✔
Iron (Fe)	Liners	Wear particles	✔	✔
	Pistons and rings	Wear particles	✔	✔
	Cams	Wear particles	✔	✖
Lead (Pb)	White metal bearings	Wear particles	✔	✖
Manganese (Mn)	Piston crown	Wear particles	✔	✔
Molybdenum (Mo)	Piston	Wear particles	✔	✔
Tin (Sn)	White metal bearings	Wear particles	✔	✖
Boron (B)	Additive	Use of Boron-containing lubricant	✔	✖
	Water conditioner	Contamination	✔	✖
Sodium (Na)	Saline water	Contamination	✔	✔
	Fuel oil ingress	Contamination	✔	✔
Silver (Ag)	Engine bearings	Wear particles	✔	✖
Vanadium (V)	Fuel oil ingress	Contamination	✔	✔
Nickel (Ni)	Fuel oil ingress	Contamination	✔	✔

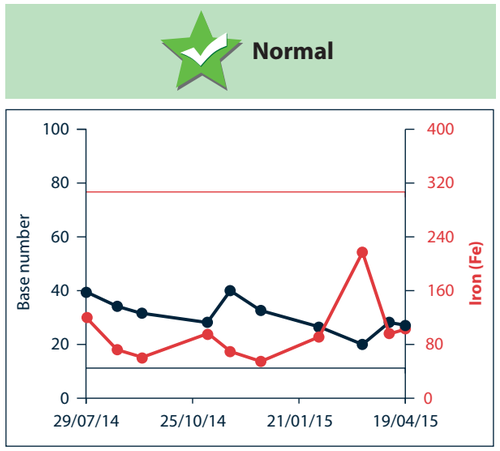
INTERPRETATION OF THE TREND

The trend analysis is a tool to monitor how the oil quality in various applications changes over a period of time compared to the levels which are considered critical for this particular application. A consistent rate of change leads to the conclusion that the machinery and the lubricating oil are doing a normal job. In order to derive sound data it is very important to work with representative samples, always taken from the same sampling points. It is equally important to provide correct sample data, e.g. service hours of unit and oil, sampling date, oil grade and brand, oil volume and information on environmental conditions such as humidity and temperature. Warning and Critical levels are specified for each individual parameter but beyond that wear and contamination patterns can be established by evaluating a combination of the data of different parameters. One example of this approach is the evaluation of saline water ingress, which is deduced from parameters such as Sodium, Magnesium and Chloride in combination.

In addition to the oil rating, our test report contains a unit rating, which provides an insight into the wear and tear as well as any abnormalities that might occur in the machinery, which can be diagnosed from the oil sample from the relevant piece of machinery.

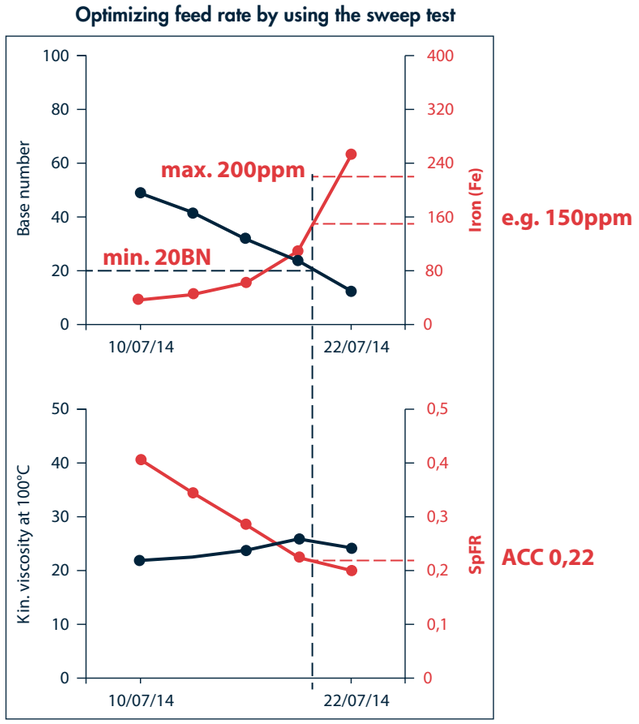
On the basis of the latest sample test data and the trending results, we include a recommendation of corrective action in our test reports if necessary.

The trending feature is also incorporated in our UOA application, which enables our customers to choose and compare various parameters with a single click.



Regular visual inspection is essential in order to ensure safe engine operation.

Optimizing the cylinder oil feed rate means optimizing the engine's operational safety and efficiency.



Before taking any corrective action recommended on the basis of the analytical results, it is necessary to re-confirm critical test results according to the following guidelines:

1. Check the maintenance log book for break down history and previous actions.
2. Establish visual checks and actively watch out for misalignment, excessive heat generation and vibration.
3. Explore the viability of in-situ analysis of the oil or system which has been evaluated as critical.
4. Arrange for another representative sample from the same source to be re-tested in the laboratory.
5. Are the limits for critical ratings of the lubricating oil in service general or specific to the maker/model/application?
6. Is the alert based on a single test result or on a series of test data?

REQUESTING ADDITIONAL SAMPLE BOTTLE KITS

To order additional sample bottle kits, please email your request to: **kitorders@tribocare.com**

Your purchase order should be as detailed as possible, including at least the following information:

- Full delivery details including agent name, telephone and email address
- Date of delivery
- Number of sample bottle kits (one kit contains 12 bottles)
- The purchase order itself

DISPATCHING

SUBMISSION FORM

If this is the first time you are using the Tribocare analysis program, please complete the sample forms with detailed machinery and lubricant descriptions.

With your next set of sample bottles we will include labels with unique identification numbers means you do not have to fill in all the information again every time you submit a sample. Ins can just stick the unique labels on the sample forms.

We will hold all the details matching each unique number in our computer system. This metho[illegible] correct data entries and thus improves test results significantly.

Details of the vessel sending the sample and wishing to receive the reports

Details contributing to the interpretation of the results; most important: oil grade

Information on the tests that will be carried out; e.g.state here if your hydraulic system requires an ISO code

Any extra tests or special treatment this sample requires

Details of the unit from which the sample was taken (machine ID or serial number must be consistent for trending)

Section relevant for Cylinder Scrapedown Analysis samples only

TRIBOCARE

Please fill in the sampling form thoroughly and legibly. To enable us to provide the best possible service to our customers fill all the boxes. – Mandatory boxes are marked in red!

Vessel Name	IMO Number
Owner/Manager Name	VAT Number
Machinery / Unit # (e.g. Maine Engine / Cyl.1)	Maker (e.g. MAN)
Model/Type and Version (e.g. 9G80ME-C 9.2)	Serial No.
Sampled by (Ranking)	Sample Date (Day/Month/Year)
Place Sample taken/Port landed	Unit Running Hours [R/Hrs]

Recommended Grade	Used Oil Grade

Daily Make up [Ltrs]	Oil Capacity [Ltrs]	Hrs since last Oil change	Hrs since Filter change

☐ Routine sample of oil in use — Special / Other

☐ 2 Stroke /4 Stroke Engine — Fuel in Use (e.g. RMF180) — Fuel Sulfur Content [%wt]

Bunker Port
!!! Please attach relevant copy of Bunker Analysis Report.

☐ Hydraulic ☐ Gearbox ☐ Stern Tube ☐ Shaft Bearing

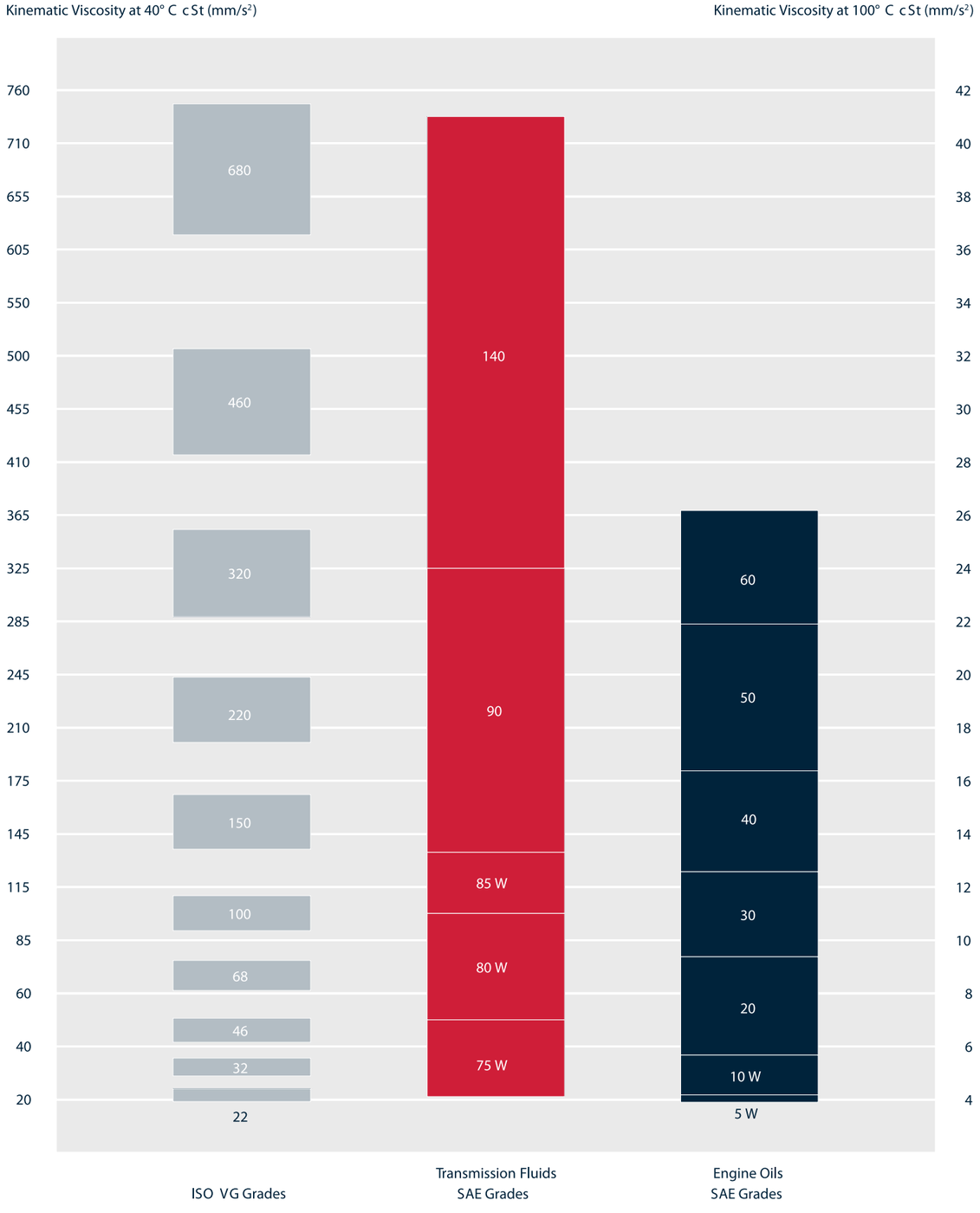
☐ Compressor — Operating Gas (e.g. R22, R407C, etc.)

Cylinder Scrapedown Analysis ONLY *** The below data shall be taken at the same time of CSA sampling.

Cyl. Lubricator Type (e.g. Alpha Mk1 or Mk2 ,Pulse CLU3, HJ Mechanical, Lubtronic SIPII, etc.)		MCL Consumption by measuring tank [l/d]		Actual Feedrate [g/kW/h]	
Engine Power MCR [kW]		Liner Running Hours		Ambient Temp. [°C]	
Engine Load [%]		Piston Crown Running Hours		Ambient Humidity [%]	
Engine RPM		Piston Ring Running Hours		Scavenge Air Temp. [°C]	
Abs. Scavenge Air Press.		Fuel Valve Running Hours		Water from Scavenger [t/d]	

Remark

VISCO SITY CLASSIFICATION



Note The kinematic viscosity at 40°C and 100°C are related horizontally for 95 VI Oils. The SAE specifications are at 100°C only and Multigrade Oil viscosities are not representative at other temperatures.

VISCO SITY – TEMPERATURE DIAGRAM