

2-STROKE MARINE ENGINES OPTIMIZATION

CYLINDER OIL DRAIN ANALYSIS
SWEEP TEST /QUICK TEST
ENGINE SCREENING



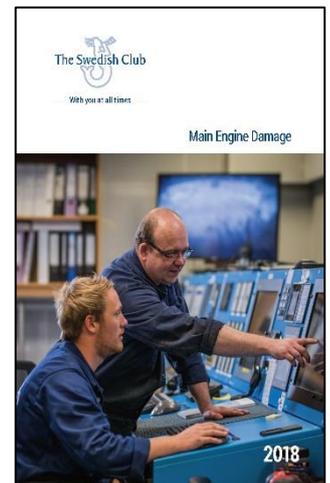
SINGAPORE – GREECE -UNITED ARAB EMIRATES – GERMANY – HONG KONG

WHY CYLINDER OIL DRAIN ANALYSIS?

Lubrication of 2-stroke Marine engines is becoming more complex and challenging with new regulations in Shipping, new Engine designs and a wide variety of fuels and lubricants in the market.

There is no doubt that 2-stroke Engines is the most valuable asset of your vessels. *Swedish Club Main Engine Damage report* (July 2018), noted the following significant points concerning engine lubrication:

- “Main engine claims account for 28% of all machinery claims and 34% of the costs, with an average claims cost close to USD 650,000. The average cost of main engine claims has increased by 21% compared with the period 2010-2014.”
- “Statistically a vessel will suffer between one and two incidences of main engine damage during its life time.”
- “Lubrication oil related failure is the most common cause of damage.”



Under lubrication, leads to increased abrasive and corrosive wear resulting in unplanned maintenance costs. **Over lubrication**, on the other hand increases lubrication costs and cause a build-up of potentially damaging deposits.

An effective drain oil analysis program can be the difference between substantial engine maintenance overheads and lubrication cost efficiency, or between over lubrication of an engine and optimization of your feed rate.



OEM Testimonials



“It is MAN’s experience that, in addition to regular scavenge port inspections, drip oil analysis can be a very useful tool to monitor combustion and cylinder condition. Drip oil analysis can detect changes in cylinder liner wear and help with cylinder oil feed rate optimization programs.”

Win GD: “Measuring the total iron content of piston underside oil provides a very valuable feedback of the piston running conditions in each cylinder, and allows operator to optimize cylinder oil feed rates for a specific set of operating conditions.”

FEATURES AND BENEFITS

Cylinder Oil Drain Analysis or Cylinder Scrapedown Analysis is an additional tool for monitoring the operation and condition of two-stroke engines and cylinder lubricants.

While CODA does not replace regular inspections, which are still essential to ensure safe operation, it allows evaluating the cylinder condition and engine wear condition.



The Cylinder Scrapedown Analysis allows the operator to assess the performance of each cylinder unit separately.

The Cylinder Scrapedown Analysis service is a tool to:

Check and optimize cylinder oil feed rate.

Increase the time between overhauls, by extending the lifetime of cylinder liners and piston rings.

Monitor stuffing box performance.

Reduce system oil consumption.

The residue oil taken from the piston underside and the system oil give an indication of:

Wear performance, e.g. by measuring the content of Iron (Fe), Copper (Cu) and Chromium (Cr).

Remaining base number (BN), which is an indicator of protection against corrosive wear.

Contaminants such as water or system oil.

Combustion quality

Benefits for Ship Operators



Improved operational safety with the reduced risk of machinery breakdown.



Savings on engine spare parts and maintenance



Optimized engine operation through oil condition monitoring.



Reduced risk of off-hire



Extended time between overhauls



WHY CHOOSE TRIBOCARE FOR CODA?

Tribocare Laboratories in Sharjah and Singapore possess vast experience on the analysis of Marine Lubricants. This is proven by the fact that we are trusted by Lube Oil Majors, like **Lukoil** and **Gulf Oil Marine** for their Used Oil Analysis Program, as well as Research and Development of their products.



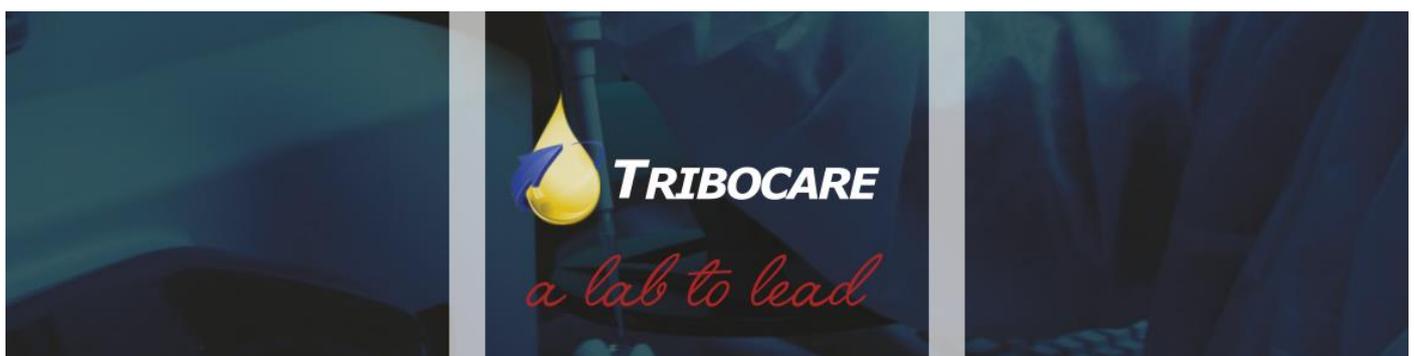
The quality of our analysis and our reports cannot be doubted. Our laboratories are 17025 accredited for all parameters required from OEMs and we strictly follow their guidelines.

Having analysed a huge number of CLO samples and having monitored the performance of all-types of vessels, we are confident that we can offer the best available CODA program in the market.

Such programs are ineffective without expertise. When lacking the correct information, knowledge or specific guidance, data simply remains data.

Underlining OEM advice on drain oil monitoring programs, Tribocare aims to simplify ship operators' daily operations by offering Cylinder Drain Oil Analysis services that ensure that lubrication onboard your vessel is optimized.

Our CODA program is designed to monitor and fine-tune the lubrication of marine two stroke engines, all driven by the expertise and professional advice of our highly-trained laboratory and technical teams.



WHAT WE OFFER...



Specially designed Sampling Kits directly to our client's vessels or Stock Point.



Detailed Step-by-Step Instructions for correct sampling.

Cylinder Scavange Drains Analysis Sampling Procedure

Sampler to be collected

- Main Engine Systems Oil in the (Crankcase)
- Cylinder Drain Oil (from sample port cylinder)

Step by Step Sampling Instructions

Obtaining a representative lubricant sample is one of the most important steps for a successful maintenance program. This manual covers the correct method of oil collection and inspection at the time of sampling, from the reliability of both the test and the representative of the oil itself.

- Take the System Oil sample at the point pointed above. Thoroughly purge the sampling equipment to ensure a clean sample. Use a 200ml sample bottle and a sample. Please ensure that the bottle is 95% full.

Cylinder Scavange Drains Analysis Sampling Procedure

Following Steps should be followed for each individual cylinder.

- The system should be flushed to prevent non-representative accumulated dilute from entering the sample bottle.
- Close the Oil Drain cock. Open each Sampling Cock for a moment to draw out air and to empty the cock. The Oil Drain should be replaced to avoid.
- Keep sampling cock and Drain Oil Cock Closed to allow oil to accumulate for about 10 minutes to allow complete expansion level of the fuel.
- After enough oil has accumulated, open the sampling cock slowly and carefully when you are still in a bucket. When the sampling cock and sampling pipe or hose is fully open, close the sampling cock.
- Repeat the engine operating conditions. The performance improvement can be used data reported on Tribocare's performance form.

Cylinder Scavange Drains Analysis Sampling Procedure

- Fill up the Sample Kit with the information and send to logistics@tribocare.com with appropriate packaging.
- Open request of service. We will inform you of arrival with appropriate packaging.

Also take extra precautions for sampling at following areas. kindly check with the following sample collection arrangements.

ENGINE TYPE	ENGINE TYPE	ENGINE TYPE
MAN B&W	MAN B&W	MAN B&W
MAN B&W	MAN B&W	MAN B&W
MAN B&W	MAN B&W	MAN B&W
MAN B&W	MAN B&W	MAN B&W
MAN B&W	MAN B&W	MAN B&W

Sample Transportation arrangements through our Logistics Program.

Dispatch Instruction for Lubricating Oil Samples

Table of contents

Sl. No.	Section	Page Number
1.	Engine Oil Sample	1
2.	Engine Oil Sample	1
3.	Engine Oil Sample	1

BRAZIL AND CHINA SAMPLE COLLECTION ARRANGEMENT

BRASIL

- Fill up the Sample Kit with the information and send to logistics@tribocare.com with appropriate packaging.
- Open request of service. We will inform you of arrival with appropriate packaging.

CHINA

- Fill up the Sample Kit with the information and send to logistics@tribocare.com with appropriate packaging.
- Open request of service. We will inform you of arrival with appropriate packaging.

Sample Collection Arrangement for China

For the first time, we have arranged a program of sample collection for China. This has an arrangement with a local logistics company to collect samples from the client's vessels. This arrangement is made for the client's convenience. The client should make arrangements for sample pick up in China.

- Fill up the Sample Kit with the information and send to logistics@tribocare.com with appropriate packaging.
- Open request of service. We will inform you of arrival with appropriate packaging.

Expert CODA sample analysis and reports according to OEM guidelines.

Summary Report for TEST VESSEL (5000000) dated 30 Nov 2017

OIL RATING

Summary Report of stability (SFI) in the oil, above the optimum level. Causes correct trend, with engine response for engine oil performance. Consumption, oxidation, oxidation and color change to indicate the oil's condition and engine oil's condition.

UNIT RATING

High oil stability is recommended for use with the optimized feed. The stability test performance is evaluated by the slope of SFI. The oil's stability test performance is evaluated by the slope of SFI. The oil's stability test performance is evaluated by the slope of SFI.

Stuffing box performance

The stuffing box performance is evaluated by the slope of SFI. The stuffing box performance is evaluated by the slope of SFI.

IN ENGINE CYLINDER SCRAPEDOWN

IN-COIL (SFI) vs. Time (hr)

IN-COIL (SFI) vs. Time (hr)

Oil Analysis Data

Parameter	Value	Unit
Oil Viscosity	150	mm²/s
Oil Density	0.88	g/cm³
Oil Color	Light Yellow	-
Oil Odor	Normal	-
Oil pH	7.5	-
Oil Water	0.1	%
Oil Sulfur	0.05	%
Oil Nitrogen	0.02	%
Oil Phosphorus	0.01	%
Oil Calcium	0.01	%
Oil Magnesium	0.01	%
Oil Sodium	0.01	%
Oil Potassium	0.01	%
Oil Chlorine	0.01	%
Oil Fluorine	0.01	%
Oil Bromine	0.01	%
Oil Iodine	0.01	%
Oil Selenium	0.01	%
Oil Tellurium	0.01	%
Oil Zirconium	0.01	%
Oil Niobium	0.01	%
Oil Molybdenum	0.01	%
Oil Vanadium	0.01	%
Oil Chromium	0.01	%
Oil Manganese	0.01	%
Oil Cobalt	0.01	%
Oil Nickel	0.01	%
Oil Copper	0.01	%
Oil Lead	0.01	%
Oil Tin	0.01	%
Oil Silver	0.01	%
Oil Gold	0.01	%
Oil Platinum	0.01	%
Oil Palladium	0.01	%
Oil Antimony	0.01	%
Oil Arsenic	0.01	%
Oil Bismuth	0.01	%
Oil Cadmium	0.01	%
Oil Mercury	0.01	%
Oil Thallium	0.01	%
Oil Lead	0.01	%
Oil Tin	0.01	%
Oil Silver	0.01	%
Oil Gold	0.01	%
Oil Platinum	0.01	%
Oil Palladium	0.01	%
Oil Antimony	0.01	%
Oil Arsenic	0.01	%
Oil Bismuth	0.01	%
Oil Cadmium	0.01	%
Oil Mercury	0.01	%
Oil Thallium	0.01	%

Customer Based Specific Feed Rate Optimization Advising.

24/7 Technical Customer Care

THE ANALYTICAL PROTOCOL



It must be understood that the drip oil is analysed to evaluate the condition inside the combustion chamber. There is a common misunderstanding that the only parameters that play a role is Iron Content and the residual BN. The reality is that they are the most significant parameters.

Nevertheless, in order to assess the true condition and subsequently engage to the necessary corrective actions, there are many other factors to take to consideration and need to be checked.



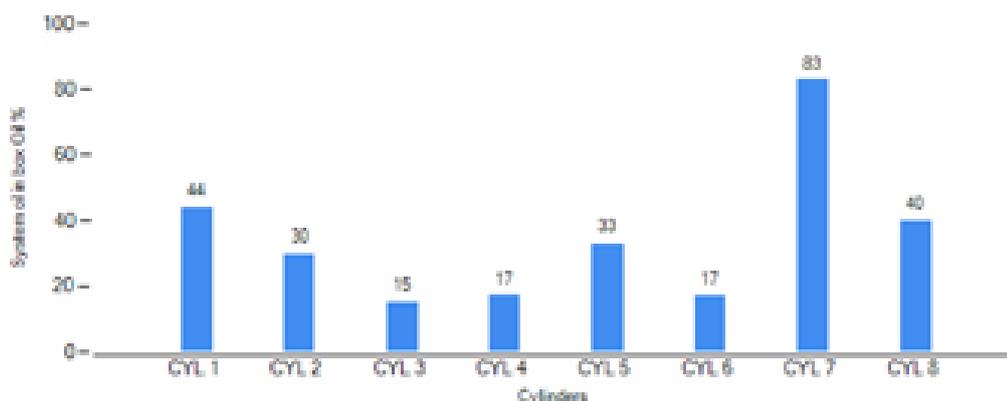
PARAMETERS	METHODS	PURPOSE
Base Number (BN)	ASTM D 2896	The base number describes the alkalinity of the oil, which is necessary to neutralize the acidic components formed during combustion to prevent the risk of corrosive wear.
Iron (Fe)	ASTM D 5185	Is, beside the base number, the most important indication for any problem in the liner. It can indicate corrosive or abrasive wear. Corrosive wear is due to acid condensation on the liner wall. Abrasive wear is most probably due to liner or ring wear.
Kinematic Viscosity (KV)	ASTM D445	Changes in Kinematic Viscosity can indicate contamination.
Flash Point	ASTM D 3828	change in the Flash point of the oil shows fuel ingress or contamination.
Soot/Insoluble	ASTM E2412/ IP316	The soot or oil-insoluble level in the oil gives an indication on combustion quality.
System Oil Dilution	In-house method	The System oil dilution shows the performance of the stuffing box and helps to make the necessary corrections in the test results for viscosity, BN, Fe and PQ Index.
PQ Index	Manufacturer	The PQ Index identifies ferromagnetic particles in the oil. This allows to assess the iron wear level and to categorize it as abrasive or corrosive wear.
Wear elements: Aluminium (Al), Chromium (Cr), Copper (Cu), , Lead (Pb), Tin (Sn)	ASTM D 5185	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 sources of the particles.
Contaminant elements: Sodium (Na), Silicon (Si), Molybdenum (Mo), Nickel (Ni), Silver (Ag), Vanadium (V)	ASTM D 5185	

INTERPRETATION OF RESULTS



The drip oil that is collected in the piston underside space, contains not only the Used CLO, but also System Oil that has leaked through the Stuffing Box.

This means, that actually, the results of the analysis of the Drip Oil do not reflect the true condition inside the Cylinder and they have to be corrected according to the extent of the System Oil Dilution.



Example on Stuffing box performance by system oil leak rate per unit.



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. Main Engine / Cyl.1)		Maker (e.g. MAN)	
Model/Type and /Version (e.g. 9080ME-C 9.2)		Serial No.	
<input type="checkbox"/> M/E <input type="checkbox"/> A/E <input type="checkbox"/> Stern/Tube <input type="checkbox"/> Crane <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> Others _____			
Application Point			
<input type="checkbox"/> Crankcase		<input type="checkbox"/> Enclosed Gear	
<input type="checkbox"/> Hydraulic System		<input type="checkbox"/> Compressor	
Fuel In Use (e.g. RMF700)		Fuel Sulfur Content [%wt]	!!! Please attach a copy of Bunker Analysis Report
Sample Point		Sampled by (Ranking)	Sample Date (Day/Month/Year)
Port Landed		Unit Running Hours (Hrs)	
Daily Make up (Ltrs)	Oil Capacity (Ltrs)	Hrs Since Last Oil Change	
Recommended Grade		Grade In-use	
Cylinder Scrapedown Analysis ONLY *** The below data shall be taken at the same time of CSA sampling.			
Important!			
Actual / Effective Feed Rate [g/kWh]	Basic / Nominal Feed Rate [g/kWh]	Feed Rate Factor	AGO Factor
Cyl. Lubricator Type (e.g. Alpha MK1 or MK2)		MCL Consumption by measuring tank [l/d]	Ambient Temp. [°C]
Engine Power MCR [kW@_RPM]	Liner Running Hours	Ambient Humidity [%]	
Engine Load [%]	Piston Crown Running Hours	Scavenge Air Temp. [°C]	
Engine RPM	Piston Ring Running Hours	Abs. Scavenge Air Press.	
M/E Hours when Scav. Space Last Cleaned	Fuel Valve Running Hours	Water from Scavenger [l/d]	
iCOlube (if applicable) [Please land a fresh xMCL sample from MCL day tank]			
MCL Concentration	Required Feed Rate @ lubri.	BN Specific Feed Rate	
Remarks:			

Total evaluation takes place, after obtaining the corrected values and in accordance with the info given in the submission form.

Investigations have shown, that engines of the same design may experience very different piston running behaviours. The factors that influence the

- Operation pattern
- Engine load
- Fuel
- The cylinder lubricant applied
- The specific engine tuning

Our technical team will give tailor-made instructions for the optimization of Cylinder Oil feed rates, based on all the above information.

SWEEP TEST

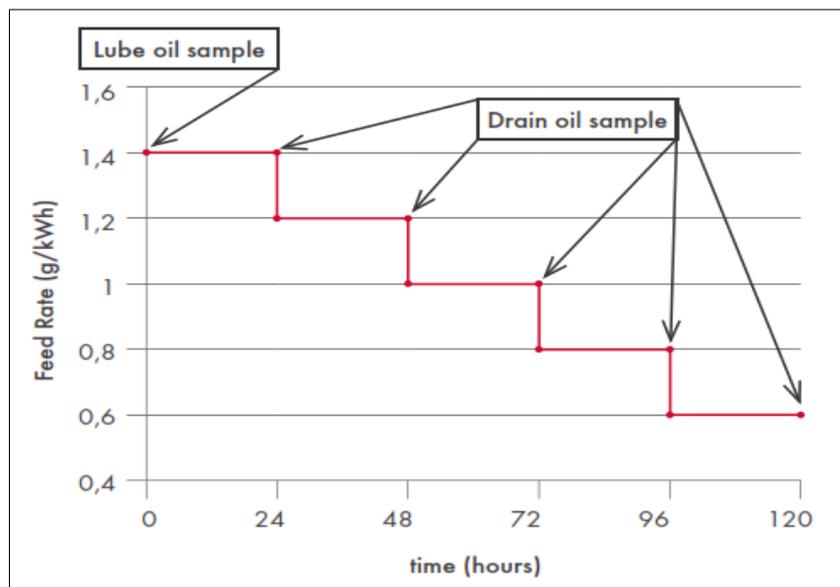


MAN Energy Solutions
Future in the making

The sweep test is a tool to optimize the feed rate of MAN engines, with Alpha Lubricators. Each engine is different and should be individually evaluated.

The sweep test should be done at steady load above the lubrication breakpoint and preferably on high Sulphur fuel. The feed rate is adjusted to different values. Each feed rate must be operated for 24 hours before taking a sample and switching to the next feed rate.

Overview of the sweep Test Procedure



The sweep test procedure is very similar to the standard CSA sampling procedure:

- Clean piston underside of all cylinder units.
- Take one FRESH cylinder oil sample from cylinder oil day tank.
- Take one USED system oil sample at the engine inlet during engine operation.
- Take drain oil samples at each feed rate after operating the engine for 24 hours.
- Fill in the submission forms at the time of each sampling.

Detailed instructions and guidance is given to operators by our technical experts.



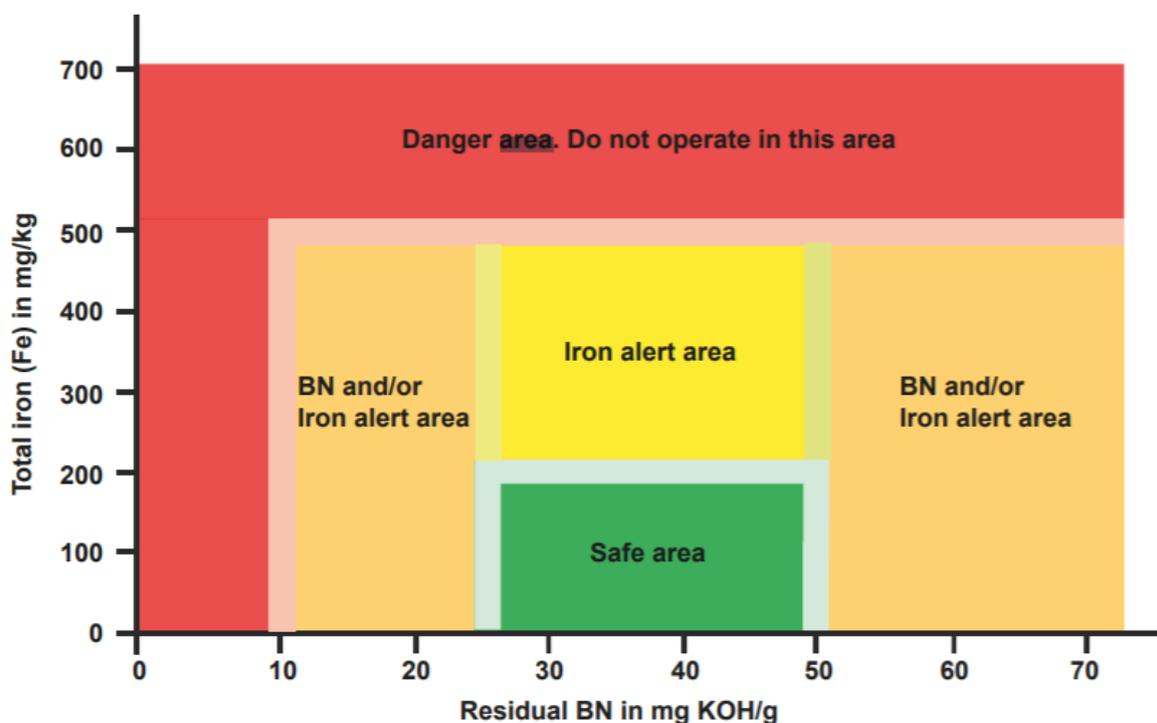
Win GD has a similar procedure with Sweep Test, called “Quick Test”.

Further to that they have come also with an Engine screening procedure which is somewhat different

After you have done the running-in of the engine, you can get initial data for the engine.

WinGD recommends to do an engine screening procedure as follows:

- 1) Set the base feed rate to 0.9 g/kWh of the selected cylinder oil.
- 2) Operate the engine at different loads, eg 10%, 20%, 30% etc related to the sailing conditions.
- 3) For each load do a piston underside drain oil sampling.
- 4) For each load do an interpretation of the oil analysis.



Detailed instructions and guidance is given to operators by our technical experts.



Optimize the efficiency of your engines....



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