The Lubricant Company

STAR Sample Guidelines

Service • Testing • Analysis • Response

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Reduce maintenance costs and improve plant reliability

STAR is one of today's most advanced condition monitoring programmes, designed to generate substantial operational and financial benefits for you.

STAR provides a programme of Service, Testing, Analysis and Response, delivering up-to-date trend analysis, and regular custom-designed action reports that enable easy implementation.

Benefits of STAR Oil Analysis

The early detection of lubricant degradation, destructive contaminants and potential equipment failure will avoid costly fleet downtime. Considerable cost savings can be made through the prevention of lost production and reduced maintenance costs.

STAR is independent of all oil companies, and we have unique service-based audit processes and reporting programmes to optimise your oil life, improve the overall performance of your equipment life and implement action plans.

Sampling guidelines

The drawing of an oil sample in a correct and repeatable way is critical to the value of the analysis result. This is an extremely important part of the programme. The ideal sample must be representative of the oil in circulation and from a repeatable source.

Personal safety

Under no circumstances is personal safety to be compromised when drawing an oil sample. The permit to work system in force within the plant must be rigorously enforced. If you feel there is any risk of personal harm insist on a safety audit being conducted and adhere to the findings. The use of Personal Protective Clothing (PPC) is required to reduce the risk of personal harm.

Key safety areas

- Make sure your eyes and skin are protected
- Avoid inhaling fumes
- Wipe up any spillage promptly
- Do not obtain the sample by breaking a connection, draining a hose or taking it from a reservoir or sump drain valve

In addition to the dangers presented within the plant, be aware that high temperatures and high system pressures may make the process potentially dangerous. Also check with the plant operator that no oil contaminant will compromise your safety. For example a sample drawn from a refrigeration system will contain some of the refrigerant in solution, ammonia is a particular case in point and the fumes must not be inhaled. Special postal considerations may be required and warning of possible contents posted to protect the laboratory staff.

"STAR identified a defective air induction system during the routine monitoring of an important engine. Without the analysis report, a failure would have been unavoidable as we were not looking for a fault and would not have found it. This saved us replacing the engine which would have cost £1000's. The system is simple to use and works well."

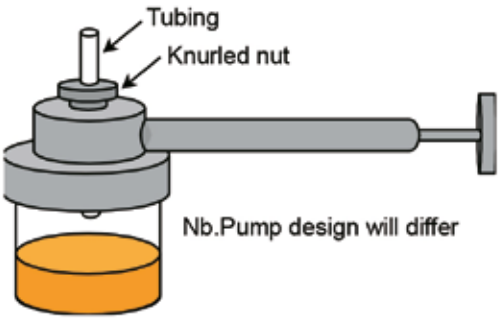
Step by step guide

To take a sample correctly

In drawing a sample of oil for analysis it is important that it is representative of the lubricant in use and that for accurate trending, that future samples are drawn from the same point in the system.

Key points:

- Always use a new sample bottle and keep sample containers sealed until the time of sampling. Sensitive analytical instruments will measure the smallest particles of airborne dust and give a false result.
- Always sample from the same point in the system, as repeatability is the key. Install a sample outlet or tap specifically for sampling, or use a sampling pump and take the sample from the middle of the reservoir.
- Whenever possible and only if safety allows take samples while the machine is operating, or immediately after shutdown (within 20 minutes). A sample taken following a long rest period will not be representative, as contaminants may have settled on the bottom of the reservoir as the oil cools.
- Take the sample from a point before the main filter.
- If the system drain is the only practical place to take the sample, flush the valve and discard a small amount of oil before drawing the sample to be tested. This will minimise contamination from around the drain plug.
- If possible, the lubricant should have been in use for at least an hour or a period of time consistent with full circulation.



Step 1 Wipe the surface around the reservoir fill pipe and cap before removing. Check fill cap for proper fit then remove. Inspect inside of cap for moisture and ensure that the breather is clean and functional.

Step 2 If sampling via the filler point using the thief pump, remove strainer and inspect for breaks in screen. Insert the suction hose into the reservoir until it reaches the bottom, and then withdraw it approximately 3 inches. Fill the sample bottle half full to purge the pump and discard the oil, then refill the bottle.

If the drain plug is the only access to the system, take the sample and discard to eliminate any sediment and refill the bottle with a representative sample.

Step 3 Record all data for example:

- Operating temperature
- Top up rate
- Conformation of grade in use
- Local conditions i.e. dirt water etc
- Any additional factors that may assist analysis, e.g. Odours, possible contaminates and air

Step 4 Replace the strainer and fill cap. Check the system for leakage, loose or crimped lines, improper line anchors and noise.

Test suites

The following list the typical tests carried out on an oil sample

TEST	TRANSMISSION SYSTEMS	GEAR OILS	HYDRAULIC OILS	ENGINE OILS
Viscosity @ 40°C	X	X	X	X
Viscosity @ 100°C			X*	X
Viscosity Index	X*	X*	X*	X*
Water	X	X	X	X
Glycol	X		X	X
Oxidation			X	X
Insolubles Blotter	X			X
Colour		X	X	
Appearance OCI	X	X	X	X
Particle Quantifier	X	X		
TAN			X	
TBN				X
Particle Count			X	X
WEAR METAL				
Silicon	X	X	X	X
Iron	X	X	X	X
Chromium	X	X	X	X
Aluminium	X	X	X	X
Copper	X	X	X	X
Lead	X	X	X	X
Tin	X	X	X	X
Boron	X	X	X	X
Sodium	X	X	X	X
Nickel	X	X	X	X
Titanium	X	X	X	X
Silver	X	X	X	X
Molybdenum	X	X	X	X
ADDITIVE				
Manganese	O	O	O	O
Barium	O	O	O	O
Calcium	O	O	O	O
Magnesium	O	O	O	O
Phosphorus	O	O	O	O
Zinc	O	O	O	O
ADDITIONAL TESTS				
Neutralisation Value		X	X	

KEY
X Tested and reported
X* Reported only for high viscosity index oils
O Tested, not reported, part of additive package.

Commonly used tests, their meanings and control limits

Oil Appearance

Colour is not related to the quality or performance of oil and is not a useful indicator of remaining oil life. It can however be a useful indicator of changes in oil condition.

- Darkening of the oil may be the result of oxidation (ageing of the oil) or contamination with another grade.
- Lightening of the oil is very unlikely but may occur if the oil grade was mixed significantly with lighter coloured oil.
- If the oil appears to be cloudy then it may be possible that some water contamination has occurred.
- Finely dispersed air trapped within the oil sample can give a similar appearance to wet oil i.e. hazy. Close examination will reveal small bubbles on the surface of the oil. Venting the sample and allowing the oil to stand will clear the air. As there will be no trace of the air, its presence must be noted for reference.

Any visible solid debris will be reported in the analysis. The laboratory uses an appearance rating – see table below.

Appearance Rating System

There are no controlling limits and the appearance should be looked at in conjunction with the other test results.

Viscosity

The resistance to flow is measured by the time taken for a given volume of oil to flow under gravity between two points in a calibrated viscometer tube. This is measured in centistokes (cSt) at 40 °C. Controlling limits are generally: maximum +/- 15% of nominal viscosity.

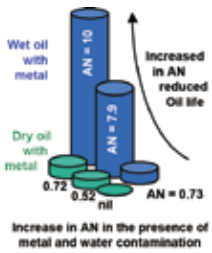
- An increase in the viscosity can indicate contamination with a higher viscosity oil, oxidation or water contamination. In an engine oil sample contamination with soot from a poor combustion process is a common cause of high viscosity.
- A decrease in the viscosity may be due to contamination with a lighter viscosity oil or contaminant. Fuel is a common cause of lower oil viscosity in an oil sample taken from a diesel engine.

Water

Water contamination can lead to a variety of problems: Controlling limit – 0.1% (1000ppm) water max (no free water visible).

Acid Number (AN)

One way that oil can degrade over time is by oxidation. Oxidation is promoted by temperature and oil contact with the air. Two key indicators of oxidation are an increase in the viscosity and increase of the AN value. The AN is measured in mg (KOH)/g and gives us a value of the acidity of the oil. Controlling limit – 1 mg (KOH)/g max for hydraulic oils.



Base Number (BN)

It is usual to measure the BN for engine oil. To protect the crankcase from acid attack by corrosive acids produced in the combustion chamber, the lubricant contains a degree of reserve alkalinity. The reserve alkalinity is expressed as mg of KOH/g of oil and is expressed as the BN.

Controlling limit – a drop of more than 50% of the initial BN value suggests the oil should be replaced.

ISO Particle Count

ISO particle count is the statistical representation of the degree of contamination. The higher the number, the higher the contaminant level. Controlling limit – warning greater than 18/15 NB. Special limits may be in place on key plant. For example CNC Hydraulics.

Debris

This is a measure of the Iron debris in oil. It is measured on an arbitrary scale and is most useful for trending purposes.

Controlling limit for gear oils
(for an oil life of 500 hours) – <200 ppm – normal
>200 ppm – <240 cautions
>240 ppm – serious

Wear metal control limits

The concentration of a number of metallic elements are measured and quoted as parts per million (ppm). The controlling limits for these are very dependent upon the materials used in the construction of the component. For example, one would expect to see iron if any of the components is made from iron. Trends can be built up over a period of time and any significant deviations from the norm would be flagged and an investigation would be necessary.

Table of most commonly found metals

ELEMENT		TYPICAL SOURCE	
Ba	Barium	Oil additive	
B	Boron	Oil additive	Anti-corrosion additive added to cooling water.
Ca	Calcium	Oil additive	
Mg	Magnesium	Oil additive	
P	Phosphorus	Oil additive	And copper alloy in phosphor bronze bearings and worm wheels.
Na	Sodium	Oil additive	Or water contamination.
Zn	Zinc	Oil additive	
Ag	Silver	Wear metal	Bearing plating material.
Al	Aluminum	Wear metal	Pistons, casings, bearings, thrust washers.
Cr	Chromium	Wear metal	Piston rings, rolling element bearings, hydraulic rods and valve stems, seal rings.
Cu	Copper	Wear metal	Alloy in Bronze and Brass Bearings, bushes, cooling pipes Friction clutch plates. Worm wheel alloy, brass cage component in rolling element bearings.
Fe	Iron	Wear metal	Most commonly found element cylinder liners, gears, roller element bearings.
Li	Lithium		Grease component.
Mn	Manganese	Wear metal	Alloy steel components.
K	Potassium		Contaminate from coolant.
Mo	Molybdenum	Wear metal	Piston rings, seals and alloy steel components. Or solid lubricant additive.
Ni	Nickel	Wear metal	Alloy steel components rolling element bearings compressor tubes.
Pb	Lead	Wear metal	Old EP additive, plain bearings, solders.
Si	Silicon	Wear metal	Airborne dust, casting sand gasket material or lubricant additive.
Sn	Tin	Wear metal	Plain bearings
Ti	Titanium	Wear metal	Alloy heavy-duty steel, dirt and paints (whitening element).
V	Vanadium	Wear metal	Alloy steel, valve stems, and fuel.

Control limits are set per system or may be determined by the equipment manufacturer.
Please contact The Lubricant Company for advice on the specific limits set for your equipment.

Physical characteristics (Limits)

Viscosity Max change of ±15%
Viscosity Index recorded as required normally for high VI oils only.
Insolubles limit 2.5% wt

Water in oil 0.1% i.e. 1000 ppm max. At this level oil should be changed.
Water free Nil
Additives will be checked and reported as satisfactory or depleted as relevant.

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