Oil Analyzers INC.

USER'S GUIDE TO OIL ANALYSIS SERVICES

What is Oil Analysis?

- Oil analysis is a chemical and physical evaluation of a used lubricant.
- As in the analysis of human blood, oil analysis provides insight as to the internal condition of equipment and the oil itself.

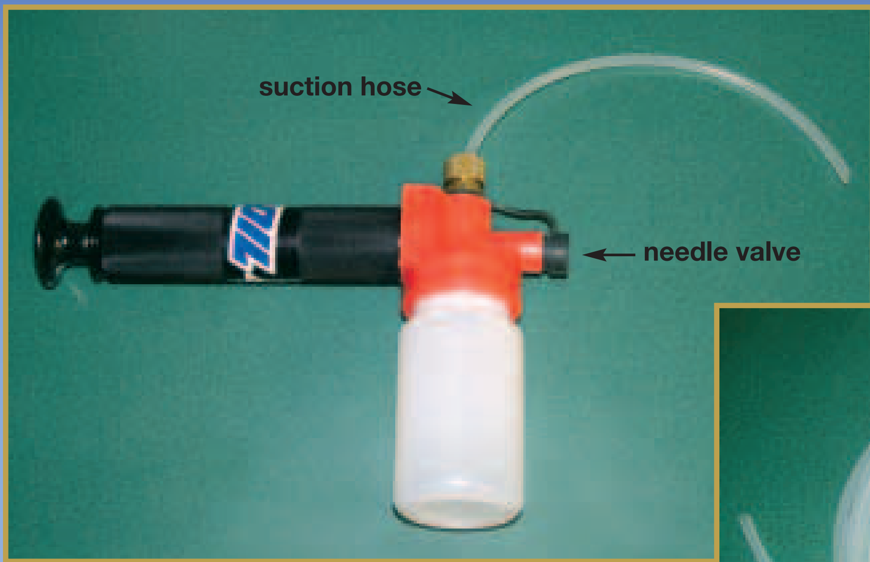
What Are the Benefits of Oil Analysis?

Oil analysis enables you to:

- Obtain optimum equipment life by preventing premature equipment failure.
- Reduce maintenance costs by reducing unscheduled downtime.
- Identify pending problems before they become catastrophic.
- Schedule preventive maintenance when it is convenient.
- Calculate optimum drain intervals to reduce lubricant and disposal costs.
- Enable better assessment of equipment and lubricant performance.

Table of Contents

The Tools of Oil Analysis

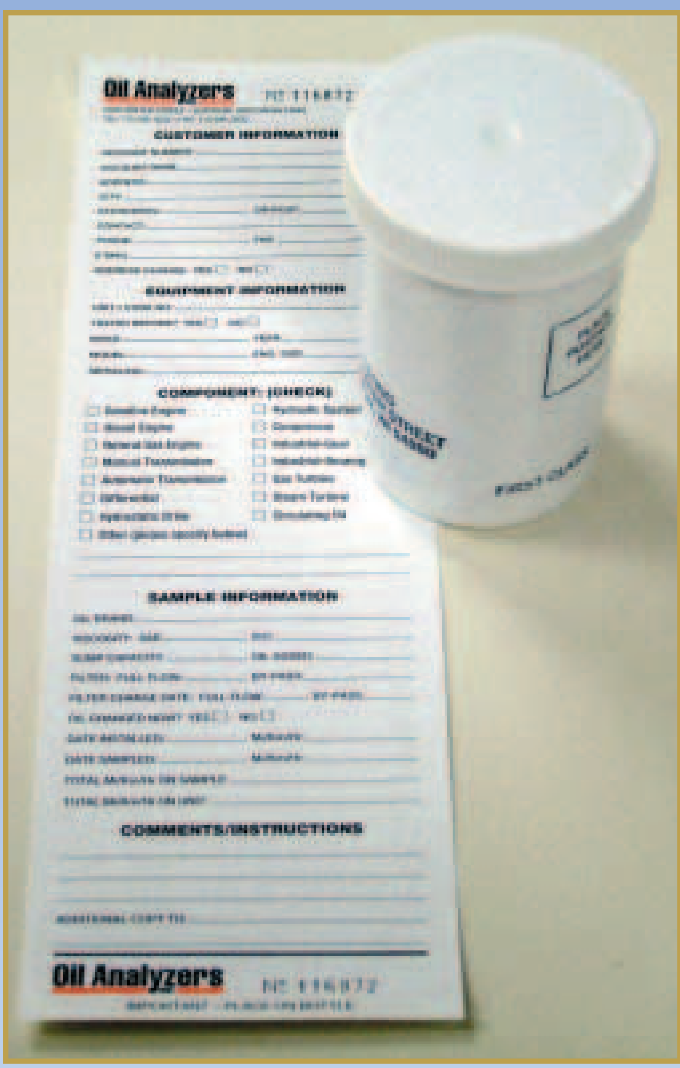


G-1206 Oil Analysis Pump

The G-1206 oil analysis suction pump comes with sample tubing and instructions for use. It draws samples from all types of equipment quickly and easily. Use it with Oil Analyzers test kit bottles, which screw on to the bottom of the pump.

G-1571 Replacement Hose

The G-1571 replacement hose for the G-1206 oil analysis pump is also available from AMSOIL INC. The hose is a high temperature Poly Ethylene hose that is suitable for automotive applications. A new section of hose should be used with the pump every time a sample is taken for testing. It can also be used to draw from hard to reach locations on equipment.



Oil Analyzers Sample Kit

Oil analysis kits, used to return your oil samples to Oil Analyzers Inc., are available in the following quantities:

Postage Paid Kits (available in U.S. only - include two-way postage)
G-1451 - (1) sample kit
G-1454 - (50) sample kits
G-1455 - (100) sample kits

Non Postage Paid Kits
G-1318 - (1) sample kit
G-1321 - (50) sample kits
G-1322 - (100) sample kits

Oil analysis kits, pumps and replacement hose sections are available from AMSOIL INC. Order online at www.amsoil.com or call toll free 1-800-777-7094.

Oil Sampling Tips

- Equipment should be sampled at operating temperature and just after shut down. This ensures that insoluble material is suspended evenly throughout the system. Samples taken from equipment that has been inactive will not be representative.
- When drawing a sample from tubrocharged high performance engines, idle the engine down, turn off the motor and let it cool down for 20 minutes.
- Each sample should be taken in the same manner and from the same point, i.e. sample port, petcock valve and sump oil fill port, or in automotive applications, dipstick guide tube or sump drain plug port. Avoid pouring oil out of a filter or oil drain pan if possible.
- Do not sample equipment directly after an oil change or if make up oil has been added. Always sample before changing filters or adding makeup oil.
- Use a clean, dry, unbreakable container. Oil Analyzers analysis kits are recommended to expedite the process. Never reuse sample containers or sample tubing. Never submit a sample in a glass bottle or jar. Seal the bottle tightly and wipe clean. To ensure your sample survives the rigors of USPS shipping and processes, attach a band of tape around the lid of the mailing container to secure it. Also, placing the sample information ticket in a small zip lock bag will help ensure that the data will be legible for laboratory data entry.
- CAUTION: Engine crankcase oil and some industrial oils can exceed 200°F and represent a health risk with prolonged exposure. To avoid personal injury use protective equipment such as gloves, safety glasses and protective clothing.

Sampling Frequency

The frequency of sampling the oil depends on the machine type, application, condition and operating environment, among other variables. Equipment that operates in harsh environments, such as heavy equipment for construction, requires shorter sampling intervals. This usually means a sample every 100 to 300 hours. Other equipment such as gearboxes or hydraulic systems used inside production facilities requires quarterly sampling intervals. The following table lists generic sampling frequencies for common equipment types and is provided as a *guideline only*.

EQUIPMENT TYPE	TEST PACKAGE	RECOMMENDED SAMPLING FREQUENCY	
Motor Vehicles			
Diesel Engines	Basic with TBN	100-500 hours, 3,500 - 20,000 miles	
Gasoline Engines	Basic with TBN	50 - 200 hours, 2000 - 7500 miles	
Transmissions	Basic with TAN	30,000 - 100,000 miles	
Gears, differentials, final drives	Basic with TAN	30,000 - 100,000 miles	
Industrial Equipment		**Normal Use**	**Intermittent Use**
Hydraulics	Basic with TAN	750 Hours or Monthly	Quarterly
Gas Turbines	Basic with TAN	750 Hours or Monthly	Quarterly
Steam Engines	Basic with TAN	1500 Hours or Bimonthly	Quarterly
Air or Gas Compressors	Basic with TAN	750 Hours or Monthly	Quarterly
Refrigeration Compressors	Basic with TAN	Quarterly	-------
Natural Gas Engines	Basic with TAN	750 Hours or Monthly	-------
1500 Hours or Bimonthly	Basic with TAN	1500 Hours or Bimonthly	Quarterly

Oil Sampling Methods

1. Sample Pump Method (G-1206)

Purchase a reusable oil analysis pump when ordering your first oil analysis kit.

The pump comes with complete instructions. The oil analysis pump is the cleanest fastest and easiest way to collect a sample. To use the pump for automotive applications:

1. Turn off engine and remove dipstick.
2. Cut a length of sample tube at a 45 degree angle and approximately twice as long as the dipstick.
3. Attach a sample bottle to the oil analysis pump.
4. Measure the dipstick and mark that measurement on the sample tube for visual reference to the end of the tube so that it matches the length of the dipstick. This ensures that the tube is not inserted deeper than the center of the reservoir.
5. Insert the tube into the engine reservoir through the dipstick guide tube and stop at the mark which was made on the sample tube. The tube should now be in the engine reservoir no deeper than the length of the dipstick.
6. Insert the opposite end of the sample tube into the top of the oil analysis pump until it reaches approximately one half inch below the top of the sample bottle.
7. Tighten the compression collar fitting onto the sample tube.
8. Hold the pump and bottle in the upright position. Pump the handle to draw the oil into the sample bottle. Fill the bottle to within 1 inch from the top. Do not overfill the bottle.
9. Remove the sample bottle from the pump, seal it and place the numbered sample information ticket sticker on it.
10. Remove the sample tube from the dipstick guide and pump and discard.
11. Replace the dipstick.

IMPORTANT NOTICE

1. DO NOT use the pump when the engine is operating.
2. Be extremely careful of hot surfaces around the engine compartment.
3. Use the sample tube only ONCE, and properly discard it after taking the sample.
4. Do not overfill the sample bottle.
5. Thoroughly clean the pump after each sample.

NOTE: Draw the pump handle slowly and monitor the flow of oil through the hose carefully. The oil will flow for several seconds after each pump cycle. Repeated pumping cycles can cause oil to back up into the pump and overflow.

2. Sample Valve Method

Your oil analysis pump is equipped with a needle probe valve assembly, which is used for drawing samples from minimess valves on circulating pressurized oil lines.

Needle type sampling valves are typically found on pressurized circulating lubrication and hydraulic systems used in industrial settings. To use the needle probe valve for sampling, unscrew or remove the protective cap on the minimess valve if present. Wipe the valve clean with a clean, dry lint free cloth. Slowly push the needle valve probe onto the sampling valve.

BE CAREFUL! Pressurized fluid lubrication and hydraulic lines can release oil with great force when the valves are opened. To collect a representative sample, discard the first sample to purge the valve. Seal and mark the sample to be analyzed immediately. Be sure to recap the minimess valve with its protective cap or plug.

3. Petcock Method

Petcock valves work on the same principle as a water faucet. These valves use either a turn handle or a push button to actuate the flow of the oil for sampling. To take a sample using the petcock valve, remove the protective cap if present and wipe the valve off with a clean lint free cloth. Turn the handle or depress the push button slowly to avoid a sudden burst of oil. Draw 4-5 ounces of oil and discard it. This purges the valve of stagnant oil and debris. Next, collect the sample to be analyzed, filling the bottle to within one inch from the top. Seal the bottle tightly, wipe it clean and apply the information ticket number sticker. Complete the form and return it via mail.

4. Oil Drain Method

Wipe the area around the drain plug with a clean dry cloth to avoid sample contamination. Be aware of hot surfaces around the underside of the engine or equipment. Remove the drain plug and allow the oil to drain for two to five seconds before catching a sample. Place a clean dry sample bottle in the oil stream and fill to within one inch from the top. Seal the bottle tightly and wipe the bottle clean. Apply the information ticket number sticker. Complete the form and return it via mail.

NOTE: Do not attempt to catch an oil sample by performing a “partial drain” from the oil sump on the equipment. Opening the drain port and then attempting to close it can lead to personal injury from burns and can also cause complete loss of the equipment’s oil sump supply.

Reading Your Oil Analysis Report

The oil analysis test measures a lubricant's physical and chemical properties, including contaminants, additives and wear metals. All of the properties are interdependent and are evaluated individually to determine the overall quality and serviceability of the oil. Recommendations are then made regarding the condition of both the equipment and the oil. The evaluator's commentary and recommendations are included on the report. This book includes a diagram that illustrates what a typical analysis report will look like, along with definitions explaining which properties are tested and what they mean.

Physical Properties

Viscosity

Viscosity is defined as a fluid's thickness, or resistance to flow, at a specific temperature. Oil viscosity is measured using a viscometer - a "U" shaped calibrated glass tube submerged in an oil bath at a temperature of 100° celsius and 40° celsius depending on the type of fluid. The fluid is timed as it flows downward through the tube and up the other side. The oil's viscosity is measured by the number of seconds it takes to flow through the calibrated tube, known as flow time, multiplied by the tube constant. The units of measurement used to express viscosity are called centistokes, or cSt. Centistoke values are easily converted to SAE (Society of Automotive Engineers) viscosity grades by using the chart supplied on page 15. Auto gear lubes, ATF's and engine oils are tested at 100° C. All others, including industrial oils like gear and hydraulic oils, are tested the same way, but at 40° C, and are also expressed in centistokes, but are listed under the International Organization for Standardization (ISO) viscosity grade classification. ISO viscosity grades are also included in the chart.

NOTE: Oil viscosity is effected by contaminants that build up in the oil. Some contaminants will thicken oil; others will make the oil thinner.

Water/Antifreeze Contamination

Water contamination can be caused by condensation, especially in colder winter climates where wide temperature extremes cause water to form in the engine at cool down. It can also be caused by radiator or transmission oil cooler leaks, defective seals, a blown head gasket or contamination during the sampling process. Water causes rust and corrosion, impedes oil lubricity and neutralizes oil additives. When antifreeze contamination is present, glycol and coolant additives thicken the oil and turn it acidic, cause corrosion of engine components and destroy the oil's ability to lubricate. Glycol/antifreeze contamination is serious and should be corrected immediately to prevent costly engine damage. The hot plate or crackle test, Forrier Transformed Infrared Spectroscopy (FTIR), visual inspection and the Karl Fischer test can identify the presence of water. Glycol contamination is detected by colorimetric tests which react a reagent with the glycol present in the oil.

Fuel Dilution

Fuel dilution can be the result of leaking or defective injectors, excessive idling, incomplete combustion, improper timing, poor fuel quality and leaking fuel pump or lines. The effects of fuel dilution include oil thinning which may cause poor oil lubricity, poor performance and poor fuel economy. Fuel dilution is identified by sample odor, visual inspection and by laboratory FTIR scan, gas chromatography and flash point testing.

Soot and Solids

Soot is a contaminant caused by incomplete combustion and is typically a concern in diesel engines. Causes include defective injectors, a clogged air filter, excessive idling, improper air to fuel ratio and intake/exhaust valve guide problems.

NOTE: Newer model diesel engines used in over the road trucking may experience more soot generation due to delayed timing and new emissions control equipment.

Effects include increased viscosity, clogged filters, excessive emissions, abnormal wear and poor engine performance. Fuel soot is expressed as percent by volume and is detected by the FTIR scan. Other solid insoluble matter may include wear debris, dust, gasket material, manufacturing assembly debris or by-products of oxidation and nitration.

Oxidation

Oxidation occurs when lubricating oil undergoes a chemical change under the influence of high operating temperatures or while operating over extended drain service intervals. This can create acids which cause corrosion, increase viscosity and deplete additives. The process is accelerated by heat, metal catalysts and the presence of water, acids or solid contaminants. Oxidation can also cause filter plugging, lacquer build up, sludge deposits, overheating and increased wear. Oxidation is measured by an FTIR scan.

Nitration

Nitration occurs during the fuel combustion process when combustion by-products mix with the engine oil. This occurs during normal engine operation but is also a result of abnormal blow-by. The products of nitration are highly acidic. Their effects include accelerated oxidation, oil thickening, corrosion, increased wear and poor engine performance. Nitration is measured by infrared analysis or FTIR.

Other indicators that may suggest abnormal nitration levels are a rapid reduction in the oil's reserve alkalinity (Total Base Number).

Total Base Number (TBN)

Depending upon the application, different oils have different blends of additives designed to maintain the oil's lubricating properties and protect equipment. Base (alkaline) additives are present in automotive engine oils to neutralize acidic by-products of combustion. New oils start out with the strongest TBN they can possess, depending upon the base oil and the additive chemistry used to make them. Over its service life, a motor oil will lose its ability to neutralize acids. Measuring the TBN strength of the oil is very important when extending oil drain intervals, as the TBN value indicates the capability of the additives to protect the engine from acidic corrosion. The standard test for measuring an engine oil's acid neutralizing strength, or Total Base Number, is the ASTM-D 4739 Reserve Alkalinity Test. TBN is expressed using a value number, which decreases as nitration and oxidation values rise over the service life of the oil. Because an oil's characteristics are interdependent, TBN depletion reflects other characteristics of the engine oil that are out of acceptable range. This may indicate that the oil's service life has ended and the oil should be changed.

Diesel and Gasoline Engine Guidelines

Physical Properties, Contaminants and Degradation

	NORMAL	ABNORMAL	EXCESSIVE
Glycol	0	Trace	Trace
Water	< 0.05%	0.05%	> 1.0%
Fuel Dilution	< 1.0%	2.0%	3.0%
Viscosity	In grade	± One SAE/ISO Viscosity Grade Change	± Two SAE/ISO Viscosity Grade Change
Solids	< 1.5%	2.0%	> 4.0%
Soot (diesel only)	< 2.0%	3.0%	> 4.0%
Oxidation*	Expressed as absorption units per cm^{-1}		50.0 Synthetic 30.0 Petroleum
Nitration*	Expressed as absorption units per cm^{-1}		50.0 Synthetic 30.0 Petroleum
TBN	Change oil when TBN strength diminishes to < 2		
TAN (industrial)	1 - 3	3 - 4	> 4

* - Under normal conditions, the level of oxidation will be similar to the level of Nitration.

1 Customer Unit Information

This section of the report lists the identification of the unit sampled, equipment manufacturer, model and oil brand and type. This information is supplied by the customer.

2 Unit Information

Make, model, oil brand and type are reported here. This information is supplied by the customer.

3 Sample Data

Indicates date sample was tested and the hours/miles on the oil and unit. The laboratory sample number is used to track the unit history.

4 Spectrochemical Analysis

Determines component wear, airborne dirt, cooling system contamination and oil additive concentrations. Information is reported in parts per million (ppm).

5 Physical Properties

Changes in the physical qualities of the lubricant are determined and evaluated. These changes can have a dramatic effect on the lubricant's ability to protect the component from wear or failure.

6 Oil Degradation

Total Base Number (TBN) measures the alkaline reserve remaining in crankcase lubricants to neutralize acidic byproducts of combustion. For non-crankcase lubricants, the measurement of Total Acid Number (TAN) provides a good indication of a lubricant's condition.

7 Graphical Analysis

Charts wear metals trends as the sample history develops.

8 Recommendations and Additional Test Results

Our data provide specific information about the lubricant and your equipment. In case of imminent danger or pending catastrophic failure to a piece of equipment, the customer is alerted to the emergency by phone or fax when available. Reporting of additional test results may also be detailed in this area.

2206 WINTER STREET
SUPERIOR, WI 54880
(715) 395-0222, FAX (715) 392-3097

CUSTOMER NO.: 3
UNIT NO.: 9
DESCRIPTION: S
END USER: S
END USER LOCATION: S

SAMPLE DATA

LAB#	SAMPLE DATE / RECEIPT DATE	TIME ON OIL / TIME ON UNIT	IRON	CHROMIUM	LEAD	COPPER
28995 NORMAL	11/14/2002 02/03/2003	85 14227	15	0	0	2

3

LAB#	TBN	OXID	NITR	F-SOOT	CHANGE
28995	10.74	9.0	7.0	0.42	NO

ADDITIONAL TESTS

6

Key
A: Abnormal ***C:*** Critical

DAN HORN
AMSOIL
2206 WINTER STREET
SUPERIOR, WI 54880

EXAMPLE REPORT

Oil Analyzers INC.

0002
80G
AMPLE ENGINE
AMPLE CONTR.

UPERIOR, WI 54880

1

MAKE:	CAT
MODEL:	3406
OIL BRAND:	AMSOIL
OIL TYPE:	AME 15W-40
SERIAL NO.:	
FUEL TYPE:	DIESEL

2

NO. COPIES: 1

SPECTROCHEMICAL ANALYSIS (ppm)

PHYSICAL PROPERTIES

COPPER	TIN	ALUMINUM	NICKEL	SILVER	SILICON	BORON	SODIUM	MAGNESIUM	CALCIUM	BARIUM	PHOSPHORUS	ZINC	MOLYBDENUM	TITANIUM	VANADIUM	POTASSIUM	FUEL (% VOL.)	VIS @ 40 C cSt	VIS @ 100 C cSt	WATER (%)	SOOT/SOLIDS (% VOL.)	GLYCOL
20	0	4	0	0	6	2	6	28	3854	0	1187	1306	0	0	0	0	< 1	N/A	16.26	0	0.4	NEG

4

5

GRAPHICAL ANALYSIS

No History to Graph

7

LAB#	ANALYSIS RECOMMENDATIONS
28995	RESULTS OF TEST PERFORMED INDICATE NO CORRECTIVE ACTION REQUIRED.

8

ELEMENTAL INTERPRETATION GU

This chart is to be used as a *guide only*. Levels *will* vary. Levels listed in parts per million. Levels are based on manufacturer recommended fluid drain interval. Shortened or extended intervals may present varied wear metal levels.

Spectrochemical

Element	Diesel*			Gasoline			Transmission			Final Drive		
	N	A	E	N	A	E	N	A	E	N	A	E
Iron	10/40	100	300	5/25	350	500	50/200	300	400	150/300	400	50
Chromium	1/8	12	15	5/20	25	40	10	20	30	10	20	30
Lead	15	30	75	30	70	150	20	50	150	20	50	15
Copper	3/15	50	150	5/30	100	300	5/250	325	400	50/150	250	30
Tin	15	20	30	20	30	40	10	20	30	10	20	30
Aluminum	10	15	25	5/20	30	40	10	30	50	-	-	-
Nickel	5	10	15	5	10	15	10	15	25	10	15	25
Silver	3	10	30	3	10	30	-	-	-	-	-	-
Silicon†	15	25	30	20	30	40	30	40	50	30	40	50
Sodium	25	100	150	20	100	150	30	40	50	50	150	20

N = Normal **A** = Abnormal **E** = Excessive

Manganese, Boron, Magnesium, Calcium, Barium, Phosphorus, Zinc and Molybdenum - Fluid additive sys cases contaminate. No standard levels.

† = Over oil baseline

Titanium, Vanadium and Cadmium wear elements - no standard levels established.

* = Automotive Diesel

Normal levels will vary due to operating conditions, component age and manufacturing differences.

Wear Metals Analysis
(Spectrochemical)

Wear metals identified by spectrochemical analysis are expressed in parts per million (PPM) of the environment they inhabit. The sizes of wear metal particles that can be identified by spectrochemical analysis are between 3 and 10 microns. To put the linear measurement of a one micron particle into perspective, 1 micron = 0.000039/inch. When equipment is in operation, it generates wear metal particles which are carried by the lubricant as it flows through the components of the machine. Under normal conditions, the generation of wear metals is very gradual and increases slowly as the equipment is used. It is important to remember these points concerning wear metals:

- No two pieces of equipment wear at the same rate.
- Even identical pieces of equipment will exhibit variation in their rate of internal wear.
- How equipment is used will affect wear rates. Vehicles, for example, which are subjected to continuous stop

UIDE

	Automatic Transmission			
	N	A	E	
0	50	100	250	
)	5	10	20	
0	30	70	150	
0	50	100	250	
)	5	20	50	
	10	30	50	
5	10	15	25	
	-	-	-	
)	30	40	50	
0	30	100	150	

stem and/or in certain

and go driving or heavy towing will experience a greater rate of internal wear than those operated continually at highway speeds with no tow load.

- When equipment is new, initial break in wear rates will be higher. When equipment is reaching the end of its service life internal rates of wear will also increase.
- The amount of time or miles on the oil reflects the level of wear metals present in the sample. For example, when using extended drain capable motor oils and extending oil drains beyond conventional recommended intervals, wear metals will exhibit an accumulative effect which indicates higher PPM levels.
- Repairs made to the equipment can affect the wear metal rate by skewing the PPM of metals present in the fluid. Opening an engine or replacing a component can expose the engine's lubricating oil to outside contaminants, manufacturing residual particulate and seal material residue.
- Chips or metal particles visible to the eye are not detected by spectrometric analysis. Equipment failure can sometimes occur without significant production of detectable wear metals, as in cases where rapid failure or fatigue failure takes place.

An elemental interpretation guide has been provided in this book. Please remember that these range limits are to be used as a *GUIDELINE* only. Many factors will influence the wear metals results your sample receives based upon your particular application. The range limits stated in the interpretation guide are based upon recommended petroleum oil drain intervals. Wear metal source charts, which are also included in this book, can help identify the source of wear metals that may have been tested as abnormal.

SPECTROCHEMICAL ANALYSIS (ppm)																				PHYSICAL PROPERTIES					
IRON	CHROMIUM	LEAD	COPPER	TIN	ALUMINUM	NICKEL	SILVER	SILICON	BORON	SODIUM	MAGNESIUM	CALCIUM	BARIUM	PHOSPHORUS	ZINC	MOLYBDENUM	TITANIUM	VANADIUM	POTASSIUM	FUEL (% VOL.)	VIS @ 40 C cSt	VIS @ 100 C cSt	WATER (%)	SOOT/SOLIDS (% VOL.)	GLYCOL
15	0	0	20	0	4	0	0	6	2	6	28	3854	0	1187	1306	0	0	0	0	< 1	N/A	16.26	0	0.4	NEG
Gasoline and Diesel Engine Wear Metals								Oil Additives																	

As is illustrated above, iron, chromium, lead, copper, tin and aluminum are wear metals specific to gasoline and diesel engines. These are listed to the left on the spectrochemical analysis report. Nickel and silver are rarely seen in an analysis report.

Oil additives and some contaminants are listed to the right on the spectrochemcial analysis. These cover a range of items from silicon to potassium.

WEAR METAL REFERENCE GUIDE - Engine

When trace metals are detected, the following components could be the source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings		X	X	X			X		
Bushings		X	X	X			X		
Cam Shaft	X								
Coolant Additives					X	X		X	X
Crankshaft	X								
Cylinder Walls	X					X			
Exhaust Valve	X					X			
Anti-Friction Bearing	X								
Gasket Materials		X			X				
Gasoline Additive			X					X	
Housing/Castings	X			X	X				
Ingested Dirt					X			X	
Oil Additive		X			X			X	
Oil Cooler		X							
Oil Pump Bushing		X	X	X			X		
Oil Pumps	X			X					
Pistons	X			X			X		
Rings	X					X			
Thrust Washers		X	X	X			X		
Timing Gears	X								
Turbo-Charger/Super-Charger	X			X					
Valve Guides	X	X							
Valve Train	X								
Wrist Pin-Bushings		X	X	X			X		
Wrist Pins	X								

WEAR METAL REFERENCE GUIDE - Manual Transmission

When trace metals are detected, the following components could be the source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Bushings		X	X	X			X		
Clutch Faces	X	X							
Coolant Additives					X	X		X	X
Anti-Friction Bearings	X								
Gears	X								
Ingested Dirt					X				
Oil Additives					X				
Oil Cooler		X		X					
Pumps	X			X					
Thrust Washers		X	X				X		
Gasket Materials or Silicon Sealant		X			X				
Housing/ Castings	X			X	X				

WEAR METAL REFERENCE GUIDE - Automatic Transmission

When trace metals are detected, the following components could be the source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings	X	X	X	X			X		
Bushings		X	X				X		
Coolant Additives					X			X	X
Anti-Friction Bearings	X								
Gasket Materials and Silicone Sealant					X	X			
Gears	X	X							
Ingested Dirt					X				
Shafts	X								
Thrust Washers		X	X				X		
Valves	X								
Housing/Castings	X			X	X				

WEAR METAL REFERENCE GUIDE - Differential Drive

When trace metals are detected, the following components could be the source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings		X	X	X			X		
Bushings		X	X				X		
Anti-Friction Bearings	X								
Gears	X								
Ingested Dirt					X				
Oil Additives					X				
Oil Pump		X		X					
Road Salt								X	
Shafts	X								
Thrust Washers		X		X			X		
Gasket Materials and Silicon Sealant		X			X				
Housing/Castings	X			X	X				

WEAR METAL REFERENCE GUIDE - Industrial Gears

When trace metals are detected, the following components could be source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings		X	X				X		
Bushings		X	X				X		
Anti-Friction Bearings	X								
Gasket Materials or Silicone Sealants		X					X		
Gears	X	X							
Ingested Dirt					X				
Oil Additives					X				
Pumps	X	X		X					
Shafts	X								
Thrust Washers		X		X					
Housing/Castings	X		X	X					

WEAR METAL REFERENCE GUIDE - Hydraulics

When trace metals are detected, the following components could be the source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings		X	X	X			X		
Bore & Rods	X					X			
Bushings		X	X	X			X		
Cylinders	X			X					
Anti-Friction Bearings	X								
Gasket Materials or Silicone Sealant		X			X				
Gears	X								
Guides		X							
Ingested Dirt					X			X	
Motors	X			X					
Oil Additives		X			X				
Oil Cooler		X		X					
Pistons	X	X							
Pumps	X			X					
Rods	X					X			
Spools	X	X				X			
Thrust Plates		X							
Valves	X								
Vanes	X								
Housing/Castings	X			X	X				

WEAR METAL REFERENCE GUIDE - Air Compressor

When trace metals are detected, the following components could be source:	Iron Fe	Copper Cu	Lead Pb	Aluminum Al	Silicon Si	Chromium Cr	Tin Sn	Sodium Na	Potassium K
Journal Bearings		X	X	X			X		
Bushings		X	X				X		
Coolant Additives					X	X		X	X
Crankshaft	X								
Cylinder	X								
Anti-Friction Bearings	X								
Ingested Dirt					X				
Oil Additives		X			X			X	
Oil Cooler		X		X					
Oil Pump	X			X					
Pistons				X					
Rings	X					X			
Rotors	X								
Screws	X			X					
Shaft	X								
Thrust Washers		X	X				X		
Wear Plates	X	X	X				X		
Housing/Castings	X			X	X				
Gasket/Sealants		X			X				

SAE ENGINE AND GEAR OIL VISCOSITY GRADE @ 100° C (AUTOMOTIVE FLUIDS)

SAE ENGINE OIL GRADE @ 100° C	Min cSt.	Max cSt.
20	5.6	>9.3
30	9.3	>12.5
40	12.5	>16.3
50	16.3	>21.9
60	21.9	>26.0
SAE Gear Oil Grade @ 100° C	**Min cSt.**	**Max cSt.**
90	13.5	>24.0
140	24.0	>41.0
250	41.0	No Req.

ISO VISCOSITY GRADE @ 40° C (INDUSTRIAL FLUIDS)

ISO Viscosity Grade @ 40° C	Min cSt.	Max cSt.
2	1.98	2.42
3	2.88	3.52
5	4.14	5.06
7	6.12	7.48
10	9.00	11.0
15	13.5	16.5
22	19.8	24.2
32	28.8	35.2
46 (AGMA 1)*	41.4	50.6
68 (AGMA 2)	61.2	74.8
100 (AGMA 3)	90.0	110
150 (AGMA 4)	135	165
220 (AGMA 5)	198	242
320 (AGMA 6)	288	352
460 (AGMA 7)	414	506
680 (AGMA 8)	612	748
1000 (AGMA 8A)	900	1100
1500	1350	1650

*AGMA (American Gear Manufacturers Association) viscosity specification

Oil Analyzers INC.

Phone: 1-715-395-0222 • Fax: 1-715-392-3097
Email: dhorn@oaitesting.com • Website: oaitesting.com

Oil Analyzers INC.

2206 WINTER STREET • SUPERIOR, WISCONSIN 54880
TEL: 715-395-0222 • FAX: 715-395-0222

CUSTOMER INFORMATION

ACCOUNT NUMBER: ______________________

ACCOUNT NAME: ______________________

ADDRESS: ______________________

CITY: ______________________

STATE/PROV.: __________ ZIP/POST: __________

CONTACT: ______________________

PHONE: __________ FAX: __________

E-MAIL: ______________________

ADDRESS CHANGE: YES ☐ NO ☐

EQUIPMENT INFORMATION

UNIT / CODE NO: ______________________

TESTED BEFORE? YES ☐ NO ☐

MAKE: __________ YEAR: __________

MODEL: __________ ENG. SIZE: __________

SERIAL/NO.: ______________________

COMPONENT: (CHECK)

- ☐ Gasoline Engine
- ☐ Diesel Engine
- ☐ Natural Gas Engine
- ☐ Manual Transmission
- ☐ Automatic Transmission
- ☐ Differential
- ☐ Hydrostatic Drive
- ☐ Other (please specify below)
- ☐ Hydraulic System
- ☐ Compressor
- ☐ Industrial-Gear
- ☐ Industrial-Bearing
- ☐ Gas Turbine
- ☐ Steam Turbine
- ☐ Circulating Oil

____

____

SAMPLE INFORMATION

OIL BRAND: ______________________

VISCOSITY: SAE: __________ ISO: __________

SUMP CAPACITY: __________ OIL ADDED: __________

FILTER: FULL FLOW: __________ BY-PASS: __________

FILTER CHANGE DATE: FULL FLOW __________ BY-PASS __________

OIL CHANGED NOW? YES ☐ NO ☐

DATE INSTALLED: __________ Mi/Km/Hr: __________

DATE SAMPLED: __________ Mi/Km/Hr: __________

TOTAL Mi/Km/Hr ON SAMPLE: ______________________

TOTAL Mi/Km/Hr ON UNIT: ______________________

COMMENTS/INSTRUCTIONS

____

____

____

ADDITIONAL COPY TO: ______________________

____

Oil Analyzers INC.

IMPORTANT – PLACE ON BOTTLE

Tips for Completing OAI Information Forms

The sample information sheet is a very important part of the oil analysis test kit. The amount of information a user provides about the unit being tested and the oil being used is directly related to the accuracy of OAI test results.

The following information is very important in expediting the processing of a test sample and getting the most accurate results:

1. **Your name** (An account number will be assigned to you from the lab.)
2. **Your complete address**
3. **Telephone number**
4. **Fax number** (If you have one.)
5. **The make, model and year of your equipment**
6. **The unit number** (A number designation or name of the component which identifies it - i.e. "vehicle #12." You may choose one for yourself if you do not already have a set number. Just be sure to identify the equipment with the same number each time it is tested.)
7. **The component type** (Gasoline engine, diesel engine, etc.)
8. **The oil brand and viscosity** (For gasoline and diesel engines, use the SAE grade - i.e. 5W-30 or 10W-40.)
9. **How much oil has been added since the last oil change**
10. **Filter change date and type of filters used**
    - **Full Flow** - This is the type of filter that a vehicle has mounted on its engine block.
    - **By Pass** - A by-pass filter is a type of add-on filtration that did not come with your vehicle.
11. **The date the current oil was installed**
12. **The date the current oil was sampled**
13. **The miles/hours on the vehicle or equipment**
14. **The miles/hours on the oil**

Add any notes you feel would be important or helpful in processing your sample to the bottom section of the form under the **COMMENTS/INSTRUCTIONS** heading.

NOTE: The numbered sticker on the bottom of the sample information form identifies the form with your sample. It is not an account number.

Oil Analyzers INC.

Oil Analyzers Inc., 2206 Winter St., Superior, WI 54880 (715) 395-0222
 G-2047 7/04