- Charles Navarro -

Used Oil Analysis

Failure prevention through predictive analysis

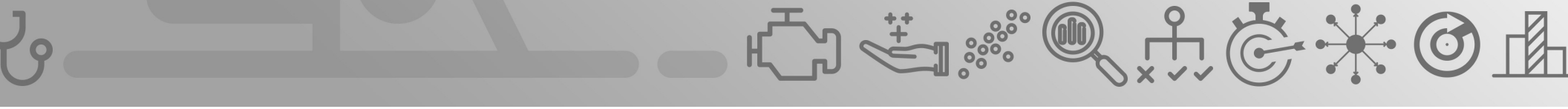
Who am I?

- Charles Navarro, Founder and President of LN Engineering LLC.
- Developer and Manufacturer for Automotive Aftermarket
- One of the first to identify reduction of ZDDP as cause of engine failures.
- Driven Oils European Development Partner

Do you get an annual physical?

Lab Testing

Timely and accurate lab results are critical to diagnosing health problems both seen and unseen.



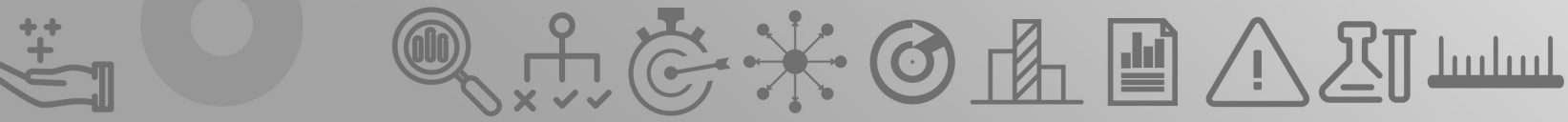
Used Oil Analysis

A physical for your engine for problems both known and unknown.

Benefits

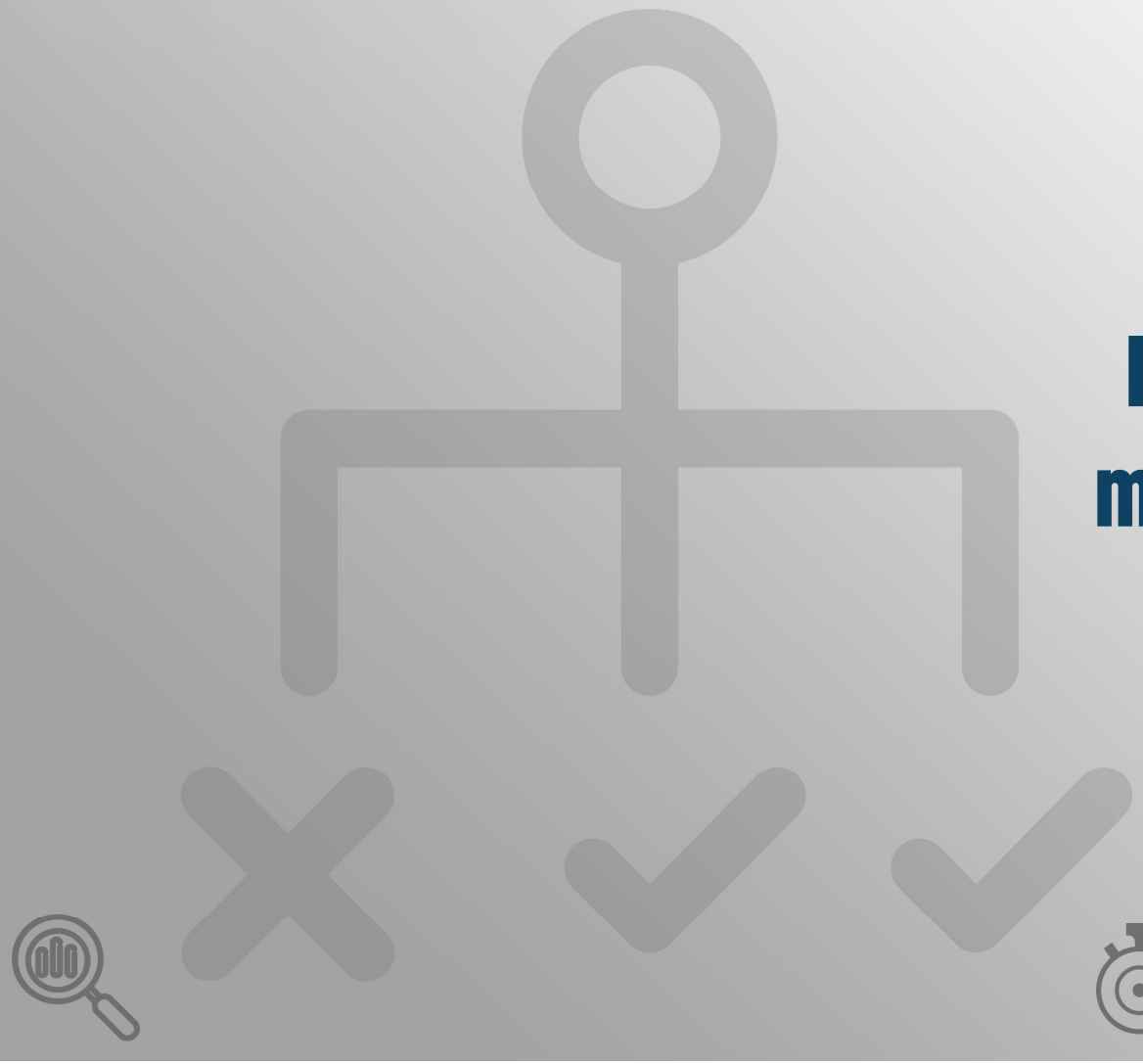
Used oil analysis provides actionable data to prevent catastrophic failures through predictive analysis

Used oil analysis tests for particles you can't see with your naked eye.



Methodology

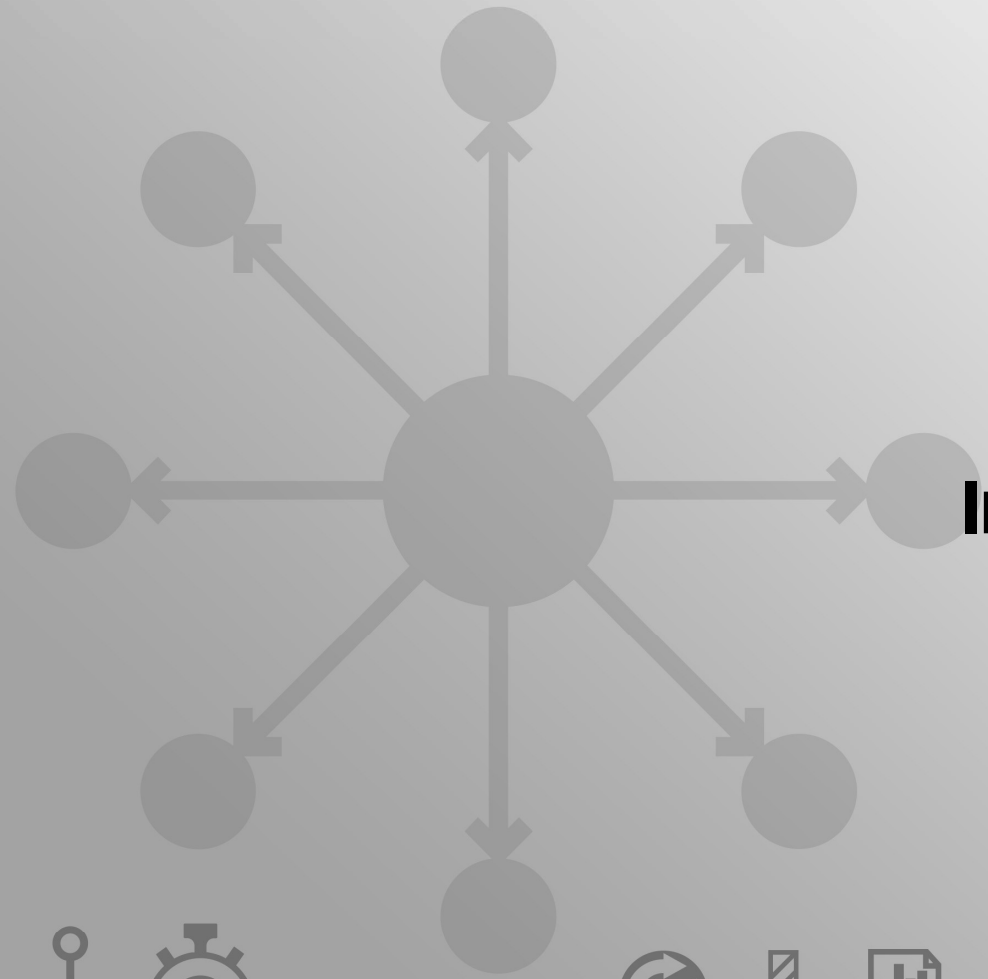
Utilizing atomic emission spectroscopy, used oil analysis reveals the amount of wear occurring within an engine and reports it in parts per million of each element.



Before you choose a test methodology, understand your options

Speed and Accuracy

Like with medical tests, UOA results are only as valuable as their speed and accuracy.



Inductively Coupled Plasma (ICP) method

Inductively Coupled Plasma (ICP) method detects particles 0 < X < 5 microns.

Rotating Disc Electrode (RDE) method

Rotating Disc Electrode (RDE) method detects particles 0 < X < 10 microns.

What about oil life?

TBN and TAN are no longer accurate indicators of oil life!

Fourier-Transform Infrared Spectroscopy (FTIR)

Engine manufacturers such as GM and Cummins recommend and use Fourier-Transform Infrared Spectroscopy (FTIR).

FTIR

FTIR provides a direct read on the oxidation level of the oil as well as detecting contaminants such as fuel and anti-freeze missed in normal lab testing.

How do I integrate used oil analysis into my program?

Know the health of oil and equipment quickly to:

- Identify which parts are wearing
- Spot small issues before they become big, expensive problems
- Optimize lubricant choice
- Determine optimal OCI (oil change interval)
- Make decisions based on data, not speculation

Reporting

A good report will highlight and provide guidance related to contamination in plain English.

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How To Know You're Good To Go

Results Color Codes	
Results outside the normal range are highlighted red	
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Oil Analysis Report - Explained

Name:	The name of the customer	**Sample Type:**	The type of equipment the sample was taken from
Unit ID:	The ID of the equipment sampled	**Condition:**	The overall condition of the sample

Sample Information	
Sample ID #:	ID Number from the sample bottle. Each SPEEDiagnostix sample kit features a unique ID number that provides traceability for each sample.
Sample Date:	The date the sample was taken. Knowing when samples were taken is very important in the trend analysis process.
Oil Brand:	The brand of the oil used. This information can be used to compared the used oil results to the specifications of the new oil (if available).
Viscosity Grade:	The viscosity grade of the oil. The results of the lab viscosity test is compared to the new oil viscosity to gauge the health of the oil.
Mileage:	The number of miles on the oil. This is critical information in the evaluation and calculation of the wear rate.

Oil Health	Test Descriptions
Viscosity @ 100C:	Viscosity measurement to check whether or not the oil is still in the correct viscosity range. A change in viscosity means a change in oil health.
Oxidation Value:	Oxidation is the chemical breakdown of the oil. The higher the number, the greater the oxidation, which means greater oil degradation.
Fuel Dilution:	Fuel dilution lowers the viscosity of the oil and indicates tune up or fuel delivery problems. POSITIVE indicates abnormal fuel dilution levels.
Water:	The presence of water in the oil indicates a problem. Water can come from a coolant leak or from extended low temperature operation.
Glycol:	POSITIVE indicates glycol contamination, which typically comes from a coolant leak. Glycol will destroy the lubricating properties of the oil.
Potassium:	Potassium can also indicate coolant contamination, which typically comes from a blown head gasket. Potassium levels under 10 are normal.
Silicon:	Silicon can come from the anti-foam additive in the oil, airborne dust entering the engine, silicone sealants, or piston and Alusil bore wear.
Additives (ppm):	Different types of oil will contain various additives, so the individual additive types and levels will vary according to application.
Calcium	is a detergent additive that keeps parts clean, prevents rust and neutralizes acids. It is typically found in motor oils and transmission fluids.
Sodium	is also a detergent additive that keeps parts clean and neutralizes acids. It is found in some motor oils.
Magnesium	is also a detergent additive that keeps parts clean and neutralizes acids. It is found in some motor oils and transmission fluids.
Phosphorus	is an anti-wear additive, and it typically comes from ZDDP. Phosphorus is a key anti-wear additive, and it is limited in API licensed oils.
Zinc	is an anti-wear additive and anti-oxidant, and it also comes from ZDDP. Combined with Phosphorus, Zinc is a key anti-wear additive in motor oils.
Molybdenum	is a multi-functional additive. Molybdenum provides anti-wear protection, reduces friction and inhibits oxidation.
Boron	reduces friction and reduces wear. Boron is typically used in combination with Molybdenum and ZDDP.

Equipment Health		Test Descriptions
Wear Trend:	**Wear Metals (ppm):**	The parts per million (ppm) of metals in the oil from worn parts in the engine, transmission, gear box, etc....
	Iron	is the main element in steel and cast iron, so the presence of iron in the used oil indicates wear of cast iron and steel parts. Rust increases Iron levels.
	Chromium	is an alloy combined with iron to make steel, so the presence of Chromium in the oil indicates wear of steel parts.
	Copper	is an alloy combined with tin to make bronze, which is a common material used to make bushings. Also, copper is used to make Babbitt bearings.
	Tin	is an alloy combined with copper to make bronze, which is a common material used to make bushings. Also, tin is used to make Babbitt bearings.
	Lead	is an alloy in Babbitt bearings, which are commonly used in automotive engines. Lead is also an anti-knock compound that is found in leaded fuels.
	Aluminum	is the main element in most pistons, and some engines utilize aluminum cylinder bores. So, the presence of Aluminum indicates piston and bore wear.
	Manganese	is an alloy used in Manganese Bronze, which is a high strength bronze often used in valve guides. Levels above 5 ppm indicate valve guide wear.
	Titanium	is a lightweight metal that is sometimes used in racing engines to make parts such as valve spring retainers. Also, Titanium is an additive in some oils.
	Vanadium	is an alloy combined with iron to make steel, so the presence of Vanadium in the oil indicates wear of steel parts such as crankshafts or gears.
	Total Metals:	The total of all wear metals in parts per million (ppm) from the sample. This is helpful in determining the overall wear rate.
	Wear / 1,000 miles:	This is the wear rate, and it is a calculation of the total wear metals divided by the number of miles on the oil to yield the rate of wear per 1,000 miles

Comments / Recommendations

*** Wear Trend: Statistical analysis of the trend in wear rates for each wear metal over the history of samples taken from this piece of equipment. The wear trend can help detect problems before the wear levels ever reach caution or warning levels. Taking used oil samples on a regular basis is important because wear trend analysis is a powerful tool for extending the life of equipment.

Unit Averages and Warning Limits

A diesel engine with a life span of several million miles is very different than a race engine that might have a life span measured in hours or even minutes.

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Oil Analysis Report

Name:	[redacted]	Sample Type:	Engine
Unit ID:	TUF918 / 152970 / 1959 356	Condition:	Warning

Sample Information				Previous Samples			
Sample ID #:	204		203	243			
Sample Date:	8/19/18		8/19/18	7/19/18			
Oil Brand:	Motul		Motul	Mobil 1			
Viscosity Grade:	15W-50		15W-50	15W-50			
Mileage:	2000		2000	1300			
Oil Health	**Test Results**	**Legend**		**Previous Sample Results**			
Viscosity @ 100C:	15.9	cSt Flow Measurement	15.9	16.4			
Oxidation Value:	9.8	Oil Life	9.8	8.4			
Fuel Dilution:	Negative	Contamination	Negative	Negative			
Water:	Negative	Contamination	Negative	Negative			
Glycol:	Negative	Contamination	Negative	Negative			
Potassium:	2	Contamination	1	1			
Silicon:	24	Anti-Foam, Dirt	20	6			
Additives (ppm):							
Calcium	1923	Detergent	2208	963			
Sodium	12	Detergent	10	21			
Magnesium	125	Detergent	84	530			
Phosphorus	1107	Anti-Wear	1081	1202			
Zinc	962	Anti-Wear	1157	1058			
Molybdenum	0	Friction Reducer	0	63			
Boron	51	Friction Reducer	53	74			
Equipment Health		**Test Results**	**Legend**		**Previous Sample Results**		
Wear Trend:	Wear Metals (ppm):						
Iron	75	Valvetrain, Cylinder Bore Wear	36	14			
Chromium	2	Piston Ring Wear	1	0			
Copper	43	Bushing, Bearing Wear	40	11			
Tin	10	Bearing Wear	4	0			
Lead	179	Bearing Wear	177	10			
Aluminum	24	Piston, Aluminum Bore Wear	13	3			
Manganese	4	Valve Guide Wear	2	0			
Titanium	0	Wrist Pin, Retainer Wear	0	0			
Vanadium	0	Gear, Crank Wear	0	0			
Total Metals:	337	Total Wear Metals	273	38			
Wear / 1,000 miles:	168.5	Wear Metals / 1,000 Miles	136.5	29.2			

Comments / Recommendations

Analysis

Quality Results meet Precision Insight

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Oil Analysis Report

Name:	Daniel Brown	**Sample Type:**	Engine
Unit ID:	KBM-128	**Condition:**	Warning

Sample Information			Previous Samples
Sample ID #:	AAA-0452		AAA-0433
Sample Date:	9/18/18		8/24/18
Oil Brand:	Mobil 1		Mobil 1
Viscosity Grade:	0W-30		0W-30
Mileage:	314		273

Oil Health	Test Results	Legend	Previous Sample Results
Viscosity @ 100C:	10.8	cSt Flow Measurement	11.0
Oxidation Value:	7.1	Oil Life	7.3
Fuel Dilution:	Negative	Contamination	Negative
Water:	Negative	Contamination	Negative
Glycol:	Negative	Contamination	Negative
Potassium:	2	Contamination	3
Silicon:	26	Anti-Foam, Dirt	13
Additives (ppm):			
Calcium	973	Detergent	1095
Sodium	3	Detergent	4
Magnesium	488	Detergent	740
Phosphorus	2049	Anti-Wear	2301
Zinc	2056	Anti-Wear	2248
Molybdenum	1450	Friction Reducer	1675
Boron	51	Friction Reducer	57

Equipment Health		Test Results	Legend	Previous Sample Results
Wear Trend	**Wear Metals (ppm):**			
	Iron	196	Valvetrain, Cylinder Bore Wear	48
	Chromium	19	Piston Ring Wear	3
	Copper	15	Bushing, Bearing Wear	4
	Tin	3	Bearing Wear	5
	Lead	5	Bearing Wear	13
	Aluminum	10	Piston, Aluminum Bore Wear	6
	Manganese	2	Valve Guide Wear	0
	Titanium	0	Wrist Pin, Retainer Wear	0
	Vanadium	3	Gear, Crank Wear	4
	Total Metals:	253	Total Wear Metals	83

Comments / Recommendations

Wear levels are severe! Silicon content is elevated and Iron levels are extremely high. Do not continue to use the engine.

Frequency

A single snapshot is great, but multiple samples taken and tested through the life of a component with statistical trend analysis is required to spot potential problems early on.

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Oil Analysis Report

Name:	Driven Racing Oil	**Sample Type:**	Engine
Unit ID:	1999 Boxster	**Condition:**	Good

Sample Information			Previous Samples			
Sample ID #:	Post Parade		Pre Parade	Post Break-In		
Sample Date:	8/5/17		3/3/17	1/6/17		
Oil Brand:	DT40		DT40	DT40		
Viscosity Grade:	5W-40		5W-40	5W-40		
Mileage:	7,809		4,600	3,472		

Oil Health	Test Results	Legend	Previous Sample Results			
Viscosity @ 100C:	12.5	cSt Flow Measurement	12.5	12.5		
Oxidation Value:	0.0	Oil Life	0.0	0.0		
Fuel Dilution:	Negative	Contamination	Negative	Negative		
Water:	Negative	Contamination	Negative	Negative		
Glycol:	Negative	Contamination	Negative	Negative		
Potassium:	0	Contamination	2	3		
Silicon:	9	Anti-Foam, Dirt	11	19		
Additives (ppm):						
Calcium	1603	Detergent	1617	1768		
Sodium	4	Detergent	7	14		
Magnesium	8	Detergent	7	9		
Phosphorus	1071	Anti-Wear	1078	1622		
Zinc	1209	Anti-Wear	1184	1648		
Molybdenum	403	Friction Reducer	415	450		
Boron	54	Friction Reducer	125	130		

Equipment Health		Test Results	Legend	Previous Sample Results			
Wear Trend:							
	Iron	5	Valvetrain, Cylinder Bore Wear	6	8		
	Chromium	0	Piston Ring Wear	0	0		
	Copper	1	Bushing, Bearing Wear	2	3		
	Tin	0	Bearing Wear	0	2		
	Lead	0	Bearing Wear	0	0		
	Aluminum	3	Piston, Aluminum Bore Wear	1	2		
	Manganese	0	Valve Guide Wear	0	0		
	Titanium	0	Wrist Pin, Retainer Wear	0	0		
	Vanadium	0	Gear, Crank Wear	0	0		
	Total Metals:	9	Total Wear Metals	9	15		
	Wear / 1,000 miles:	1.2	Wear Metals / 1,000 Miles	2.0	4.3		

Comments / Recommendations

All wear metals within normal ranges. The inital silicon levels were elevated, but that was likley from engine seals breaking-in. The trend analysis shows overall wear rate decreasing, which indicates excellent engine health.