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USED OIL ANALYSIS

BY CHARLES NAVARRO

Used oil analysis is easy to carry out and should be part of your regular maintenance routine. Beyond what oil you use, what car you have, and how it is driven, used oil analysis provides accurate measurements that allow you to make educated decisions based on facts rather than opinions.

Follow the provided instructions which have you collect a small, three ounce sample, fill out the form, enclose the sample and form in the box, put the prepaid label on the box, and send it in. In a few days you will get the results, accompanied by expert analysis.

Results will be provided to you electronically and will include details that will help gauge the severity of a problem and provide details for troubleshooting to help determine the proper course of action.

VISCOSITY

Viscosity is defined as a lubricant's resistance to flow at a specific temperature. Viscosity changes of 20 percent or greater is considered critical as the lubricant cannot perform properly, leading to increased wear or engine failure.

WEAR METALS

Understanding the results from used oil analysis requires understanding what oil additives are normal as well as what elements are actually indicative of abnormal wear. Elemental analysis looks at the concentration of wear metals, contaminants, and additive components. As a rough rule of thumb, changes of up to 20 ppm (part per million) are not immediately indicative of a problem. Changes from 20 to 50 ppm should raise a yellow flag and anything over 50 ppm change is a red flag. A change of 100 ppm and you should stop immediately and seek professional assistance. This is why regular testing is so important, as it is these changes that we are looking for and having trend data for each engine or component is critical to being able to identify engine problems before they become catastrophic.

Wear metals include iron, aluminum, copper, lead, tin. Typical sources of iron are from camshaft, lifter, and ring wear and in engines with iron bores, from the cylinders. Aluminum comes from pistons and cylinders. Most street engines with normal service intervals will have elemental levels of these wear metals in high single or low double digit ppm levels, under 20 ppm. Copper, lead, and tin are most commonly from rod and main bearings.

WEAR METALS- CT'D

These wear metals should be near zero or low single digit ppm and typically presence of these elements in the used oil are sign of wear to bearings that may indicate damage from oil starvation if the car has been tracked.

With engines with Alusil or Lokasil bores, the skirt coat is iron based and when it wears, it will be identified as iron in the elemental analysis. The bores themselves are aluminum with high silicon concentration, so expect aluminum and silicon to be higher in those elemental analysis results.

It is important to note that used oil analysis looks at particles in the oil smaller than 10 microns. Case in point, wear debris from the IMS bearing is larger than 10 microns, so you cannot rely on used oil analysis to determine the condition of the IMS bearing in 1997-2008 models with the M96 and M97 engine. In cases like this, inspection of the oil filter is very important. Even spin on filters with metal bodies can easily be opened up with a filter cutter to allow inspection of wear material collected in the pleats.

CONTAMINANTS

Oil does not break down. The additives get used up or break down and oil becomes contaminated from poor intake air filtration, fuel intrusion, moisture, and combustion byproducts. Operating in severe conditions subjects your engine to added stress and contamination of engine oil, leading to increased engine wear. Used oil analysis helps to identify the presence of contaminants and allows the source to be identified or to determine what changes must be taken to eliminate or reduce the source of the contaminants, to hopefully extend lubricant and engine life.

Typical elements considered contaminants include silicon and potassium. Sodium and boron can be contaminants, however some oils use sodium and boron as part of their detergent or anti-wear packages, so knowing the elemental composition of your oil is key to understanding the results of used oil analysis.

Moisture in your oil is a critical source of contamination. Water is not a lubricant. It combines with combustion byproducts to create acids, leading to corrosive wear to engine components. Moisture also reduces the load-carrying ability of an engine oil,

CONTAMINANTS - CT'D

reflected in loss of viscosity and also degrades the oils additive package. In water-cooled engines, test for presence of glycol can also detect head gasket failures as well as cracked cylinders or heads, failing oil to water heat exchanges, and other sources of intermix before they cause irreversible engine damage. Oil should typically have no trace of water.

Fuel dilution is another source of contamination that can lead to severe engine damage. Not only does it cause a loss of viscosity and degrade lubricant additives, over-fueling caused by bad injectors washing bores down can lead to scored bores, among other issues. Normal fuel intrusion should be less than 1% and anything over 5% is of concern and the source should be identified.

On the surface, testing may seem complicated or expensive, but regular testing can save you thousands of dollars from unexpected failures. Although testing a single sample will give you an idea of your current engine condition, regular and repeated testing will give you invaluable information, allowing for trend data to identify a problem before it becomes catastrophic.

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UOA RESULTS EXPLAINED

Results Color Codes	
Results outside the normal range are highlighted red	
Results with borderline values are highlighted yellow	
Results within the normal range are highlighted green	

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.

SAMPLE RESULT SHEET

Results Color Codes	
Results outside the normal range are highlighted red	
Results with borderline values are highlighted yellow	
Results within the normal range are highlighted green	

Oil Analysis Report

Name:	John Doe	**Sample Type:**	Engine
Unit ID:	Porsche 911	**Condition:**	Good

Sample Information		Previous Samples			
Sample ID #:	108				
Sample Date:	6/20/18				
Oil Brand:	Unknown				
Viscosity Grade:	5W-30				
Mileage:	3000				

Oil Health	Test Results	Legend	Previous Sample Results			
Viscosity @ 100C:	11.7	cSt Flow Measurement				
Oxidation Value:	26.2	Oil Life				
Fuel Dilution:	Negative	Contamination				
Water:	Negative	Contamination				
Glycol:	Negative	Contamination				
Potassium:	1	Contamination				
Silicon:	0	Anti-Foam, Dirt				
Additives (ppm):						
Calcium	1653	Detergent				
Sodium	7	Detergent				
Magnesium	36	Detergent				
Phosphorus	1009	Anti-Wear				
Zinc	1009	Anti-Wear				
Molybdenum	2	Friction Reducer				
Boron	10	Friction Reducer				

Equipment Health		Test Results	Legend	Previous Sample Results			
Wear Trend:	**Wear Metals (ppm):**						
	Iron	9	Valvetrain, Cylinder Bore Wear				
	Chromium	4	Piston Ring Wear				
	Copper	6	Bushing, Bearing Wear				
	Tin	0	Bearing Wear				
	Lead	4	Bearing Wear				
	Aluminum	5	Piston, Aluminum Bore Wear				
	Manganese	0	Valve Guide Wear				
	Titanium	0	Wrist Pin, Retainer Wear				
	Vanadium	0	Gear, Crank Wear				
	Total Metals:	28	Total Wear Metals				
	Wear / 1,000 miles:	9.3	Wear Metals / 1,000 Miles				

Comments / Recommendations

All results within normal ranges. No corrective actions or investigations needed. Based on the oxidation value, the drain interval can be extended by 20%. Resample at next oil change.