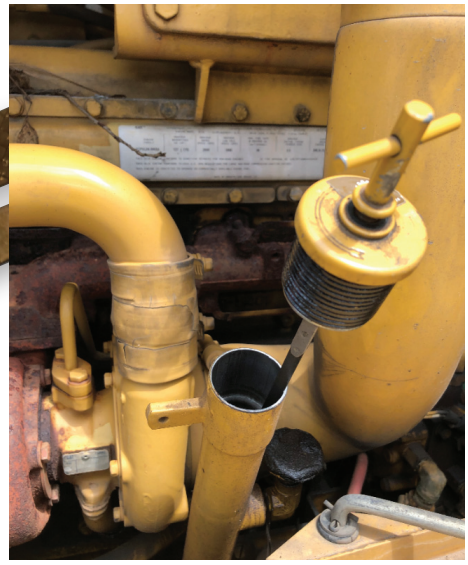
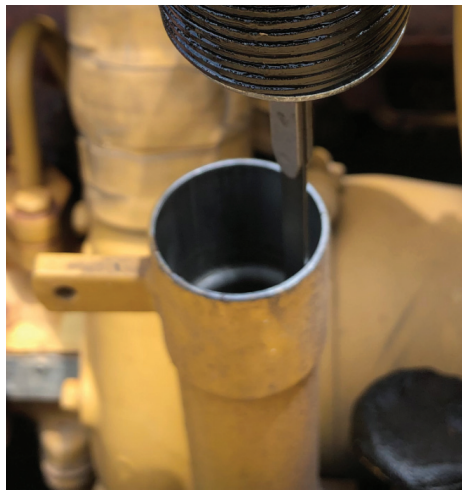
Getting Under The Hood

Oil analysis offers a peek into your diesel engine's future

BY **STEVE SCOTT**





Diesel engine fortune teller? Ever wonder what is really happening inside there?

No, this article is not about Tarot cards, Ouija boards, miracle additives, synthetic oils, hybrids, or electrification. The science of engine oil analysis is real, and it has been around for decades. It is far less expensive than most believe and may save you a fortune in the long run. Testing the life blood of your engine can give you a peek into what is really going on in there. When you pull that dipstick out and see the glitter of metal, or what appears like a misdirected chemistry project, it is likely too late.

Oil analysis is more than just the condition of the oil, it also provides element and contaminate levels. Oil and fluid analysis programs are common in some industries, and yet shunned or almost unheard of in others. Some regard these lab tests only for the benefit of extending oil change intervals, but the preventative maintenance savings of an ongoing oil sampling program can far outweigh the low cost and effort that testing requires. The keys are consistency, finding a trusted lab, staying with a specific brand/type of oil and additives, and having the engine oil tested on a routine basis. It is critical that you inform the lab of any major changes in oil, additives, maintenance, or repairs since those can affect the test results. Labs offer various levels of tests and will likely have one predesigned to meet your level of interest. The lab will track the condition of the oil, trace elements, histories, and trend lines. What you may find most important are the lab's comments and recommendations. If the lab does not provide these, find one that does.

Pictured below is an example of the information commonly reported from the lab. Points of interest are clearly labeled. From these you can decide how in depth you care to investigate the details.

Hours or miles between samples

Hour meter reading (if equipped)

Trace sample and test dates

Elevated levels are often color coded. Yellow indicates a caution. Red indicates an action is needed.

Trace elements are listed in PPM (parts per million)

Sample Information						ASTM D5185 Metals in Used Lubricating Oils By ICP-AES Results (ppm)															
Sample	**Qts/Gal**	**Hours/Miles**	**Meter**	**Date Rec.**	**Date Sampled**	**Cu**	**Fe**	**Cr**	**Al**	**Pb**	**Sn**	**Si**	**Ca**	**Mg**	**Zn**	**P**	**Mo**	**B**	**Ag**	**Ni**	**Na**	**X**
Lab #	0	1500	8211	02/19/20	02/11/20	2	4	0	2	42	0	2	1221	10	342	292	10	2	0	0	0	0
1459077	Job#		Comments: Lead appears high. This shows possible wear to the bearings. Check the filters for metal. Check the engine for a loss of oil pressure. Change oil and filters and resample in a short period. NOTE1: The Copper and Tin levels are relatively low and would be high with serious bearing wear. NOTE2: No Oil Change.																		
Lab#	0	1000	4708	01/28/20	01/21/20	1	3	0	2	15	0	2	1315	11	369	311	11	2	0	0	0	0
1454605	Job#		Comments: Lead appears high. This shows possible wear to the bearings. Check the filters for metal. Check the engine for a loss of oil pressure. Change oil and filters and resample in a short period. NOTE1: The Copper and Tin levels are relatively low and would be high with serious bearing wear. NOTE2: No Oil Change.																		
Lab#	0	1800	3276	11/27/19	11/22/19	0	1	0	1	0	0	1	1079	9	351	331	18	3	0	0	0	0
1443668	Job#		Comments: All elements are acceptable. Change oil and filters and resample at normal interval. NOTE: No Oil Change																		
Lab#	0	1000	2557	10/23/19	10/18/19	1	3	0	2	1	1	2	1412	12	402	357	28	4	0	0	0	0
1437121	Job#		Comments: All elements are acceptable. Change oil and filters and resample at normal interval. NOTE: No Oil Change																		

FTIR Analysis									ASTMD445 Viscosity cSt		Particle Count (ISO 4402, 4406; particles per fmL)							
Sample	**Oxidation A/cm**	**Nitration A/cm**	**Sulfation A/cm**	**Water %**	**Antifreeze Pos/Neg**	**Fuel %**	**Soot %**	**TBN mg KOH/g**	**@100C**	**@40C**	**ISO Class Code**	**4 micron**	**6 micron**	**10 micron**	**14 micron**	**25 micron**	**50 micron**	**100 micron**
Lab# 1459077	15	15	10	<1	0	0	0.14		2.40	14.5	0.0							
	Job#																	
Lab# 1454605	11	9	6	<1	0	0	0.14		2.07	13.9	0.0							
	Job#																	
Lab# 1443668	5	4	3	<1	0	0	0.13		1.51	13.5	0.0							
	Job#																	
Lab# 1437121	8	6	4	<1	0	0	0.13		1.75	13.6	0.0							
	Job#																	

Metals **Al** - Aluminum, **Ag** - Silver, **B** - Boron, **Ca** - Calcium, **Cr** - Chromium, **Cu** - Copper, **Fe** - Iron, **K** - Potassium, **Mg** - Magnesium, **Mo** - Molybdenum, **Na** - Sodium, **Ni** - Nickel, **P** - Phospherous, **Pb** - Lead, **Si** - Silicon, **Sn** - Tin, **Zn** - Zinc

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The lab comments and the color coding gives very useful insight into potential problems.

Interestingly, this owner has gone to the effort of implementing an oil analysis program, yet is not using the information. The lab suggests "change oil and filters and resample in a short period", but the owner opted to further extend the hours/miles before the final sampling, placing this engine at risk of greater damage.

A few common terms you will encounter in oil analysis are:

Viscosity – the most important trait of engine oil. It is the oil's resistance to flow and how it reacts to changes in operating conditions (speed, temperature, pressure).

TAN – (Total Acid Number) checks the acid neutralization of the oil. As oil degrades levels of corrosive acids increase

TBN – (Total Base Number) the ability to neutralize acid.

The elements found in the engine oil can indicate possible component wear or pending failure. An experienced lab can better identify the source(s) based on your individual application and lubricates.

To get consistent and accurate results, care must be used while taking the oil sample and getting the correct information to the lab to analyze. To be successful, the process must be clean, controlled, and accurate. The OE service manuals or Oil Analysis Labs have detailed instructions on how the samples need to be gathered and submitted.

(continued)

Elements	Examples of Sources in Engine Oil
Iron (Fe)	Liners, Valve Guides, Piston Rings, Gears, Castings, Crankshaft, …
Aluminum (Al)	Pistons, Blower, Housings, Bearings, Thrust Washers, …
Chromium (Cr))	Piston Rings, Liners, Valves, Leaks in Cooling System, …
Lead (Pb)	Main and Rod Bearings, Bushings, …
Silicon (Si)	External Sources, Ingesting Dirt, Defoaming Agents, …
Copper (Cu)	Barings, Bushings, Thrust Washers, Oil Coolers, …
Nickel (Ni)	Bearings, Valvetrain, Turbine Blades, …
Tin (Sn)	Bearings, Piston Rings, Seals, Solder, Valvetrain, Oil Cooler, …
Sodium (Na)	Coolant leaks, Salt Water, Additives, …
Zinc (Zn)	Anti-wear Additives, Corrosion Inhibitors, Bearings, …
Calcium (Ca)	Detergents, Contamination (water, airborne), …
Magnesium (Mg)	Oil Additives, Housings, …
Phosphorous (P)	Anti-wear Additives, …
Molybdenum (Mo)	Oil Additives, Housings, …
Boron (B)	Additives, …
Silver (Ag)	Cage Bearings, Soldered Joints, …
Potassium (K)	Coolant leaks, Airborne Contaminates, …

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Pitfalls you want to avoid:

- Poor sampling practices
- Lack of accurate information
- Cross contamination
- Misunderstanding the report
- Lab that does not provide interpretation or recommendations in their reports
- Inconsistent sampling
- Delays in taking, sending, or reacting to test results

There are a variety of oil sample kits available, ranging from disposable to reusable pumps, and some engines are equipped with a port in the oil system (prior to the filter) for sampling. A new piece of tubing should be used for each sample, and all components need to be kept free of contaminates.

Engine oil is the life blood of an engine. Take the oil sample with the same level of professionalism your doctor uses while taking your blood sample. Make sure to tell them the meds (additives) used, changes in health history (maintenance) or lifestyle (operating conditions).

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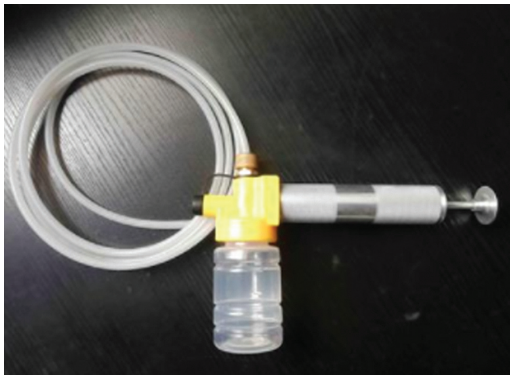
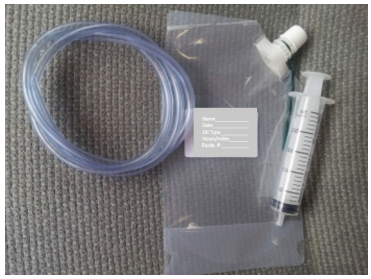
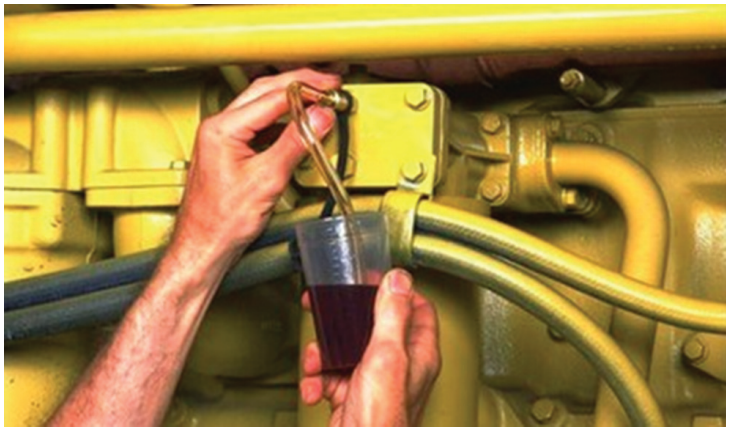


Engine Oil Sample Kits





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People and diesel engines have one thing in common: early detection is the best preventative to bigger problems in the future. My experience is that even with a few days off to recuperate, diesel engines, unlike people do not heal themselves. Looking into the future through oil sample analysis might just save you a fortune.■

Steve Scott joined the service department at IPD in 1982, working with parts, service and sales for a variety of equipment, diesel, and natural gas engines. Since 2004, he has been the director of product development and technical support for IPD. For more information, email sscott@ipdparts.com.

Clean Oil is Your Engine's Life Blood

Finding a source for testing your oil samples is easy as many major engine manufacturers (Cat, Cummins) offer a service, or you can go to one of the many, many independents such as the ones listed below. Most offer single use or multiple vial container kits to collect the samples with and have spares ready to go for the next opportunity.

- **Blackstone Laboratories**
  blackstone-labs.com
  260-744-2380
- **Test Oil**
  testoil.com
  216-251-2510
- **Oil Analyzers Inc.**
  oaitesting.com
  715-392-3097
- **Titan Laboratories**
  titanlab.com
  303-953-5794
- **Speed Diagnostix**
  speediagnostix.com
  704-794-8291