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LUBES'N'GREASES

A Korean Giant Stirs

Open Wide for Oil Analysis

An Open-and-shut Case for Oil Analysis

By Steve Swedberg

For the last 20 years, the Technology & Maintenance Council (TMC) of the American Trucking Associations has maintained a recommended practice for used engine oil analysis (RP 318). This useful guidance has undergone three prior revisions and is in the process of being updated again. The newest edition is being balloted by truck fleet maintenance managers and other TMC members now, and should be ready for publication next month.

The updated RP includes a number of changes which focus on sampling and data analysis. Each of these changes adds value to the used engine oil analysis process, according to Michael Forgeron, president and CEO of testing laboratory giant Analysts Inc., who was active in the work to revise the practice. "Fleets that understand and utilize RP 318 will recognize improved savings and benefits for their operations," the Torrance, Calif.-based executive told *Lubes'n'Greases*.

Used oil analysis is a frontline tool for fleet maintenance, but it wasn't always so. It was first used in the 1940s by the railroads to monitor locomotive engines. When it proved successful, used oil testing was expanded and by the '80s formed the basis of condition-based maintenance on most North American railways.

Seeing the early success of the railroads, the U.S. Navy began using instrumental oil analysis to monitor jet engines in the 1950s. The Army and Air Force both followed shortly with similar programs. By the early 1960s the first commercial oil analysis laboratories were born (with Analysts being one of the pioneers).

RP 318 begins with a review of the purpose and benefits of oil analysis. Basically, used engine oil analysis is a preventive maintenance tool, and a key factor in the successful operation of fleets around the world. With proper analysis, engine life can be extended, equipment failures are caught early and overall vehicle safety is enhanced.

Reaping the Benefits

But doing oil analysis right is essential if truck operators hope to capture these benefits. Forgeron noted that oil analysis is least valuable when the testing performed is not appropriate to meet the goals and expectations of the user. Inconsistent sampling intervals and poor sample-taking techniques can also limit the laboratory's ability to identify all problem areas, which will reduce the benefits/value of the program.

In reality, most heavy-duty engine oil analysis is done by independent labs that are contracted by the fleet, oil marketer or original equipment manufacturer. When choosing a lab, RP 318 urges, the fleet owner needs to ask these basic questions:

1. What are the testing program's goals and expectations?
2. What will it cost?
3. What types of reports will be generated?
4. What are the warning guidelines?
5. What are the notification processes?
6. What is the report turnaround time?
7. Does the laboratory conduct itself in a professional manner?
8. Does the laboratory have written quality-control standards and procedures?
9. Is on-site support and training provided?
10. Does the laboratory offer references?

Sampling Techniques

Sample-taking procedures are also described in RP 318. In fact, the procedure for sampling may be one of the most important parts of used


Photo: Freightliner

oil analysis. It must be consistent and provide truly representative oil samples, without introducing dirt or contaminants that will skew the test results. Basically, there are two preferred methods for taking a sample: oil galley and siphon. Forgeron said RP 318 does a good job explaining the importance of proper sampling techniques and the equipment used.

"In order of preference, sampling is best done via a sample valve or port; siphoning through an oil fill hole or dipstick; and lastly from the drain plug," he advised. (Another method, automatic oil evacuation, is also explained in the RP.)

The oil galley sampling method is probably the most accurate, in that the oil is taken directly from the engine block or from a low-pressure oil line. This requires inserting a positive-closed valve, which remains securely closed except when a sample is taken. One advantage is that the engine doesn't need to be shut down for the sample to be drawn.

The siphon method involves taking the sample through the oil dipstick tube. It requires that the oil be at steady temperature and well circulated. The engine is then shut down and the sample taken as soon thereafter as possible.

Other important steps include using clean, dry oil sample containers and properly labeling the sample. In addition, always sample before adding make-up oil and make sure the engine is at operating temperature or at least has been run for 15 minutes before sampling.

Sampling intervals are another choice the fleet owner must make. First, ask whether your goal is to have a regular sampling program, to do spot checks or to troubleshoot when problems arise. Each of these has its place but in order to add the most value to the fleet owner, regular sampling is preferred, TMC's RP urges. This gives the fleet owner the best opportunity to extend engine life, catch equipment failures early and enhance overall vehicle safety.

Forgeron believes that successful used oil analysis programs rely on samples being taken on a regular basis. The frequency of the sampling will vary based on the maintenance manager's objective(s), the type of oil in use, the environment in which the vehicles operate and the age of the fleet.

Soot, Oxidation, TBN

This latest revision to RP 318 pays more attention to the impact of low-sulfur diesel fuel (15 ppm) and enhanced emissions systems. Both of these can increase soot loading in the oil. Another area of emphasis is which tests to run (*see table below*). For example, infrared analysis is recommended for checking oxidation, since engines are operating at higher temperatures. Oxidation is measured by comparing the infrared absorbance of used oil samples versus that of the new oil.

The RP's discussion of total base number (TBN) has changed to include more than one test method. ASTM D-2986 has good precision, and is recommended for testing new oils since it measures both so-called "hard" base (due to metallic carbonates) and "soft" base which includes other oil components. With used oils, however, D-2896 only measures the amount of sulfuric acid in the oil and misses nitric acid and other organic acids. The second method, ASTM D-4739, captures the acidic contribution of both sulfuric and nitric acids, so for many used engine oil analysis programs, D-4739 is preferred.

Spectrographic analysis for metals has long been a major part of oil analysis programs, since the metals found in used oil can provide clues to potential problems in the engine itself (*see table, page 20*). RP 318 identifies nine wear-related metals, four metals related to contamination, and seven additive metals that are useful to track, and explains why. By watching for changes in the levels of these metals, fleet owners can be forewarned of such things as coolant leaks, ring and liner wear or air-filter problems. The presence of soot and iron might hint at problems with soot-induced wear, for example. Lead could be a red flag for worn bearings. And if the additive metals look wrong, it may be a sign the wrong oil was used in the first place.

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Engine Oil Analysis Tests and Procedures

Area of Concern	Property	Test Procedure
Lubricant Performance	Viscosity	ASTM D-445
	TBN	ASTM D-2896 (new oils); ASTM D-4739 (used oils)
	Oxidation	Infrared
	Soot	LEM, TGA or Infrared
Contamination	Dirt	Spectrochemical
	Fuel Dilution	ASTMD-3524 (gas chromatography)
	Water	Pops/crackle, Infrared
	Coolant	Glycol test kit, Spectrochemical, Infrared
Component Wear	Iron, Lead, Chromium, Aluminum, Copper, Tin, Silver, Nickel	Spectrochemical

Source: TMC RP 318(C)

Typical Metals Found in Heavy-Duty Engines

Element	Possible Sources
Iron (Fe)	Cylinder liners, engine block, gears, crankshaft, wrist pins, piston rings (cast), camshaft, valvetrain, oil pump
Chromium (Cr)	Piston rings, some roller & taper bearings, exhaust valves, EGR cooler
Molybdenum (Mo)	Piston rings
Nickel (Ni)	Valves, EGR cooler
Aluminum (Al)	Piston skirts, some bearings, some bushings, housings, oil pump bushing, thrust bearing, oil cooler, charge air cooler (will contain some elevated potassium and normal sodium)
Tin (Sn)	Pistons (overlay), bearings (overlay), bushings
Lead (Pb)	Bearings
Copper (Cu)	Wrist pins, bushings, bearings, cam bushings, valvetrain, oil cooler, thrust washer, oil pump, air compressor

Source: TMC RP 318(C)

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When to Drain

Of course, used oil analysis is an excellent tool for tracking the condition of the engine oil itself — its viscosity, cleanliness, fuel dilution, etc. — so the question for many fleet maintenance managers then becomes when to change the oil. Setting limits on changes in used oils is the last process required to make the best use of the data gathered. The three formats offered by RP 318 are as follows:

1. Set Limits. In this method, absolute maximum limits are set on wear metals and other oil properties such as viscosity. Such limits have been historically set by OEMs as a means of assuring long engine life. This is also one of the easier formats to understand.

2. Trend Analysis. Using this method requires that the fleet owner and oil laboratory establish baseline data from normal oil analyses. The oil laboratory then can report back results compared to the baseline. Allowable changes are reported as percentages of change from the baseline.

3. Set Action and Trend Wear. This format is basically a hybrid of the first two. The idea is first to set limits for critical parameters, such as abrasive wear metals, to avert any problems before they develop. Then, using data that you've developed to trend the wear, you can take actions (such as establishing longer or shorter drain intervals, or taking samples more frequently) that ensure the engine is protected successfully.

One very useful addition to the guidelines is a table of "used oil interpretation guidelines" for SAE 15W-40 diesel engine oils (the best-selling heavy-duty viscosity grade in the United States). While these are only general guidelines, not absolute, TMC said they can help maintenance managers understand if their oil samples are in the normal range, borderline, or critical. The table also offers some of the actions maintainers can take — such as changing the oil — when the results are outside the warning limits.

Leaning on the Lab

Test interpretation usually is carried out by the testing laboratory, the guidelines point out. These labs have more exposure to the test results, not only for a specific fleet, but across a large number of fleets. If a particular trend develops with one engine design, the lab will be more likely to catch it early than the individual fleet owner.

This is not to say that individual fleet owners cannot successfully review data and reach their own conclusions about oil condition. Some longtime fleet operators and their maintenance pros do evaluate laboratory data and make independent judgments about oil change intervals and equipment conditions.

One of the most important points to be made, Forgeron agreed, is that a used oil analysis program cannot be set up and then expected to run without any oversight. Each fleet operation should establish a department or individual who is responsible for engine oil sampling, proper labeling of the samples, and assuring that the samples are sent promptly to the testing laboratory.

Personnel also need to be trained to assure proper sampling is carried out as well as other aspects of the used oil program. When data are received from the laboratory, the recommendations should be communicated to the field for follow-up action.

In the end, Forgeron comments, "proper sampling and understanding the final reports are the bookends of a successful sampling program. The lab is responsible for the middle of the process — proper testing and complete evaluation/diagnostics — but it is incumbent that we help insure that fleet personnel are adequately trained to handle their responsibilities."

Someday, it is possible that heavy-duty diesel engines may be fitted with sophisticated oil monitoring systems, like those seen on passenger cars, but with many more features designed to analyze the oil. In that way, engines could be continuously monitored and potential problems caught before significant damage can occur. These systems would allow for optimized oil changes on a vehicle by vehicle basis.

Although laboratory tests may not be able unfailingly to predict engine failure, they are on the front lines when it comes to defending against wear and undesirable oil contaminants — and extending diesel engine life. ∎