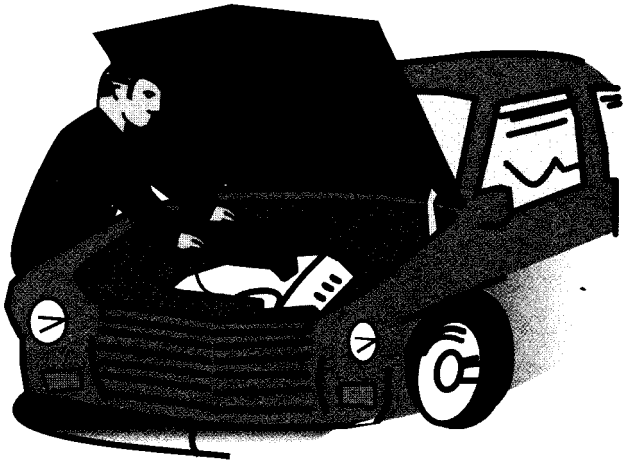
OIL LIFE EXTENSION

Best Environmental Practices for Fleet Maintenance • November 1999

Why test your engine oil?

Fleet maintenance facilities generate a tremendous amount of used oil from routine engine maintenance. Engine oil changes are typically performed according to mileage or calendar schedules that are based on average data for a wide variety of vehicles. As a result, engine oil changes are often performed more frequently than necessary. If this is the case at your facility, you are purchasing and throwing away more oil than you need to. This fact sheet describes how a testing program can extend engine oil life and thus lower oil consumption, reduce used oil generation, and decrease operating costs with no risk to your vehicles.



Advantages of oil testing.

Resource Conservation. Oil is a nonrenewable resource; oil supplies are decreasing, which will drive prices higher. By extending engine oil life through testing, you can help save this nonrenewable resource!

Source Reduction. Reducing oil change frequency through testing reduces used oil generation at the source.

Cost Savings. Extending oil life reduces oil purchase and disposal costs as well as labor spent on changing oil.

Monitoring Maintenance Practices. After a few tests, you can identify trends to verify that routine maintenance is performed adequately.

Keeping Minor Repairs Minor. Testing provides early warning of engine component problems before they become serious, which will: 1) reduce repair costs, 2) help you anticipate vehicle down time, and 3) minimize "hit and miss" disassembly and inspection.

ENVIRONMENTAL ISSUES WITH USED OIL

1. 2.7 billion gallons of oil is sold annually in the U.S.
2. 50% of oil is consumed and 50% becomes used oil; 31% of the used oil, or about 420 million gallons, is never recycled! Much of it goes into the environment.
3. Used oil is recycled by being burned for energy or re-refined. Burning oil results in air pollution that includes sulfur and hydrocarbon emissions.
4. 3 to 5% of the used oil that is re-refined ends up as hazardous waste sludge.

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Create an oil life extension program at your facility

There are four aspects of a successful, cost-saving oil life extension program: I) establishing baseline information, 2) conducting engine oil sampling, 3) testing oil, and 4) evaluating test results.

1) Establishing baseline information

Documenting the following baseline data for each of your vehicles provides information that will help you evaluate test results and make decisions about extending oil life:

- Oil change intervals
- Operating environment
- Recent maintenance or repair work
- Brand and type of oil used
- Vehicle age

2) Conducting engine oil sampling

Engine oil sampling should be performed at regular intervals. Begin your program by sending samples to an off-site laboratory for testing.

Consider this: Collecting engine oil samples does not require much extra labor, particularly if samples are collected during scheduled preventive maintenance and safety checks. Sampling labor is usually offset by reductions in oil change labor.

Sampling tips:

- Run the engine, and then sample soon after turning off the engine.
- Collect a sample by 1) installing a valve to draw off oil just before the filter, 2) withdrawing oil through a narrow hose inserted in the dipstick tube, or 3) taking a sample when the oil is changed (within 15 minutes of engine shutoff).
- Keep hands out of sample bottles and keep bottles tightly capped before and after sampling to minimize foreign contamination.
- Consult oil testing companies for sampling equipment and methods.

METAL CONTAMINATION AND ITS SOURCES

Aluminum	• Piston or bearing wear • Hydraulic system pumps • Transmission components
Chromium	• Piston rings • Roller bearings in geared compartments • Valve stem wear
Copper	• Thrust bearing wear • Oil cooler core "leaching" • Transmission or steering disc wear
Iron	• Gear, shaft, or liner wear
Lead	• Bearing wear

3) Testing oil

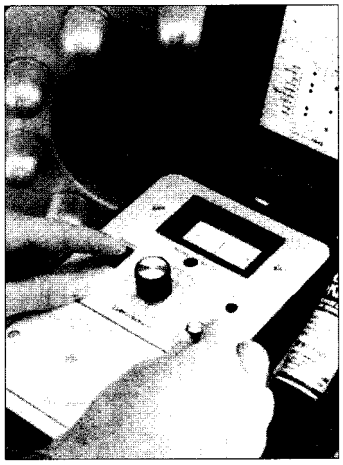
The following are sources of engine oil contaminants.

- Antifreeze contaminates engine oil through a coolant leak, causing bearing damage and piston, ring, and liner wear. The first sign of a coolant leak is detection of sodium, potassium, or boron in the oil.
- Metals from engine wear contaminate engine oil (see table below, "Metal Contamination and its Sources").
- Fuel contaminates engine oil as a result of faulty injectors and can reduce oil lubricating qualities, lower oil viscosity, and lead to bearing failure. As little as 1% fuel content decreases oil viscosity by 4 to 6 percent.
- Sand and dirt (silicas) enter engine oil from outside sources and cause abrasive wear of engine parts.
- Water contamination of engine oil is usually caused by condensation in the crankcase. Large amounts of water contribute to formation of metal-corroding acids that can damage pistons, rings, and the liner. Oil performance is affected when its water content exceeds 0.3 percent.

Selecting test methods: Most fleet maintenance facilities test engine oil for a variety of contaminants and therefore use more than one testing method. Common tests for oil life extension include testing for water, metals, viscosity, antifreeze, and dielectric constant (see table on next page, "Engine Oil Testing Methods at a Glance").

On-site testing: After you see how you can extend oil life based on the test results, consider purchasing on-site oil analysis equipment to lower your program costs and significantly reduce your waiting time for results.

On-site testing reduces the lag time between sampling and decision-making because test results are obtained almost immediately. On-site testing equipment ranges from small, hand held units which simply measure dielectric constant, to more complex analyzers that can identify specific contaminants and produce oil quality reports. Hickam Air Force Base in Hawaii used both a LubriSensor and a Computational Systems Inc. (CSI) Model 5100 oil analyzer to conduct their oil analysis program. They found that both provided comparable results to off-site laboratory analysis. The Lubri-Sensor costs about $600 and the CSI 5100 costs about $8,000.



Hand-held oil analyzers give test results quickly.

ENGINE OIL TESTING METHODS AT A GLANCE

The following test methods are commonly used to evaluate contaminant levels in oil. Costs vary depending on the level of detail required.

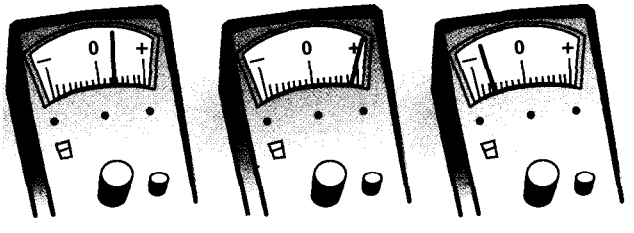
Method	Description	Sample testing cost at an off-site laboratory
Ferrographic analysis	Measures the concentrations of particles in oil caused by engine wear. Particle type, size, and number indicate the severity of wear.	$25
Spectrometric analysis	Measures concentrations of metal contaminants that indicate excessive engine wear.	$8
Water detection test	Two common water detection tests are the Crackle test and the FT-IR test. The FT-IR test is more sensitive.	$1 to $4
Viscosity test	Determines whether oil has (1) thickened due to excessive soot, oxidation, or coolant contamination or (2) thinned due to improper combustion or the presence of fuel. Oil viscosity increases over time; however, a decrease in viscosity is considered more serious.	$8
Dielectric constant test	Measures dielectric constant, which is altered by oil contaminants.	On-site

4) Evaluating test results

Most testing labs or equipment vendors will provide contaminant thresholds or action levels for specific test methods to help you decide when to change your oil. Having good baseline information is important when establishing fleet-specific action levels. The following rules of thumb apply to two common tests, the viscosity and dielectric constant tests:

- Action is needed if viscosity increases more than 20 percent, or decreases more than 10 percent, from the baseline.
- Changes in the dielectric constant indicate potential problems as follows:
  - A moderate increase indicates the presence of contaminants such as dirt, acids, soot, and oxidation products.
  - An extreme increase indicates the presence of water, antifreeze, or metal particles: immediate action is needed to prevent engine damage.

-A moderate decrease indicates the presence of fuel: immediate action is needed to prevent engine damage.



Moderate increase Extreme increase Moderate decrease

Making the change!

Extending oil change intervals safely- a step-by-step approach

I) Select a few vehicles that can be easily monitored.

2) Gather vehicle history data such as oil consumption, current oil change interval, and vehicle driving condition information. Collect and test oil samples from two consecutive oil changes to establish baseline conditions.

3) If the vehicle baseline data indicates no oil quality problems, increase the oil change interval by 15 to 25 percent (for example, if the engine oil is currently changed after 4,000 miles, extend the change interval to 4,800 miles).

4) Test oil at the new change interval (for example, 4,800 miles) for two consecutive oil changes, and compare the results with the baseline oil test data.

5) If test results at the change interval are favorable, consider extending the change interval further. If the results are not favorable, reduce the change interval and repeat the testing.

VENDOR CONTACT INFORMATION

LubriSensor (for measuring dielectric constant on site)	**For off-site oil sampling and Probilizer sampling ports**
Northern Technologies Int'l Corp.: (800) 328-2433	Titan Laboratories: (800) 848-4826
CSI 5100 (for on-site oil analysis)	**Websites**
CSI: (423) 675-2110	National Oil Recyclers Association: www.noraoil.com
For off-site oil analysis for various parameters	Oil Analysis.com: www.noria.com/index.html
Herguth Laboratories, Inc.: (800) 645-5227	

These vendors provided information for this fact sheet. This list is not complete: other vendors may provide similar or identical products and services.

Case studies:
Benefits of oil testing

Several fleet maintenance facilities (Eielson Air Force Base (AFB) in Alaska; Fort Lupton School District Maintenance Shop in Colorado; Hickam AFB in Hawaii; and the Idaho Engineering and Environmental Laboratory (IEEL), a Department of Energy facility) provided information about their oil testing programs for this fact sheet. As the following table indicates, each of these facilities realized environmental and cost benefits from extending engine oil life through oil testing.

	EIELSON AFB	FORT LUPTON SCHOOL DISTRICT	HICKAM AFB	IEEL
Number of vehicles	800 vehicles (heavy machinery, trucks, and vans)	23 buses	659 vehicles (trucks, vans, cars, and various other)	1,590 vehicles (buses, trucks, cars, and heavy machinery)
Oil testing	On site with CSI model 5100 Cost: $8,000	Off site by Titan Labs Cost: $6/sample; "Probilizer" sampling port available for fleets	On site with CSI model 5100; Cost: $8,000	Off site with Herguth Labs Cost: variable
Number of samples per month	40 to 60	50	45	32
Time to sample per analysis	1 hour to sample and analyze	5 minutes to collect one sample	30 minutes to sample and analyze	5 to 10 minutes to collect one sample
Parameters analysis	Silicas Iron Metals Water	Silicas Metals Water Viscosity Percent fuel Percent antifreeze	Silicas Ferrous materials Metals Water	Non-metallic contaminants Heavy metals Water Viscosity Percent fuel Percent antifreeze
Oil change interval	Average oil change interval tripled	Before: 4,000 miles After: 8,000 miles	Average oil change interval doubled	Interval increased by about 1,000 miles, and labor decreased
Used oil disposal per year	Before: 26,260 gallons After: 3,400 gallons Savings: $435	Reduced by 80 gallons Savings: $230	Before: 2,385 gallons After: 500 gallons	Before: 10,000 gallons After: 8,500 gallons Savings: $600
Engine oil purchased	Reduced by 13% Savings: $26,000	Decreased but not quantified	Before: 2,255 gallons After: 495 gallons	Decreased but not quantified
Engine wear and tear	No engines lost due to oil failure in 5 years of oil testing (this is also attributed to synthetic oil use)	Not tracked	Not tracked	Saves about 3 engines per year that cost $6,000 to $25,000 each. Saves the most on bus engines ($25,000 for a new engine and $12,000 to rebuild an old engine) Net savings: at least $40,000 per year
Estimated payback period	4 months	7 months	About 18 months	About 1 year

Your state or local government environmental agency has more information about compliance and pollution prevention for auto repair shops and fleet maintenance operations in your state or area. Additional fact sheets and information can be found at www.epa.gov/region09/p2/autofleet. This fact sheet is part of a package of fact sheets entitled either "The Pollution Prevention Tool Kit, Best Environmental Practices for Auto Repair" (publication number EPA-909-E-99-001) or "The Pollution Prevention Tool Kit, Best Environmental Practices for Fleet Maintenance" (publication number EPA-909-E-99-002). To obtain copies of either package, call (800) 490-9198. Accompanying videos, "Profit Through Prevention", are available at the same phone number for either auto repair (number EPA-909-V-99-001) or fleet maintenance (number EPA-909-V-99-002).