LUBRICANT ANALYSIS PROGRAMS

Revision: 5/99
Process Code: Navy and Marine Corps: SR-01, SR-02; Air Force: PM07, PM08; Army: VHM
Usage List: Navy: Medium; Marine Corps: Medium; Army: Medium; Air Force: Medium
Alternative for: Scheduled Oil Changes
Compliance Areas: Medium
Applicable EPCRA Targeted Constituents: 1,1,2-trichloro-1,2,2-trifluoroethane (CAS: 76-13-1), 1,1,1-trichloroethane (CAS: 71-55-6)

Overview:

Lubricant analysis programs are tests that are used to determine whether a lubricant remains effective. A lubricant analysis program may allow longer intervals between changing lubricants thereby reducing lubricant consumption and waste disposal. In this program, samples of lubricant are collected and either analyzed in the field (using test equipment) or sent to an analytical laboratory for analysis. Representative sample collection is critical to ensure that the sample being analyzed is indicative of the lubricant's overall condition. Four main types of lubricant testing procedures are discussed in this data sheet.

Physical/Chemical Analysis

The parameters that are typically evaluated include viscosity, total base number (a measure of the oil's ability to neutralize acids), and the concentration of some metal ions (e.g., calcium, magnesium, phosphorus, sodium, and zinc) which are components of many additives. Once the samples are analyzed, various factors depending on the history of the equipment must be considered in determining when the oil requires changing. For example, metal levels in engine oils can vary depending on numerous factors including:

- Engine metallurgy
- Oil/lubricant consumption and replacement
- Types of engine lubricants and additives
- Filtration efficiency
- Dispersion characteristics of the oil's additive package (which help hold metals in suspension)

These and other factors must be considered when evaluating whether an oil is acceptable for continued use. Rapid changes in contaminant metal concentrations or rapid fluctuation of other oil properties are much more important in determining whether an oil is failing rather than a strict adherence to published ranges of criteria. Rapid changes in oil properties can be indicative of

faulty equipment, severe operating conditions, or insufficient maintenance procedures.

Determining whether an additive package is depleted is difficult, because additive packages vary from one manufacturer to another, and most available analytical tools do not directly measure the concentration of the additive package. This process is particularly difficult when oils from different manufactures are mixed together. Using a single brand of oil will minimize this difficulty. Instrumentation for analyzing engine oil should be calibrated to the specific type and manufacturer of oil being used. Differences in oil additives between manufacturers can affect the accuracy of the tests.

Ferrographic Analysis

Ferrographic analysis is a predictive method for determining equipment condition long before signs of wear are detected. Ferrography detects particles of ferrous, non-ferrous, and nonmetallic materials that are generated at the contact surfaces of moving parts. These particles are analyzed, and changes from previous results indicate a developing mechanical problem. If sufficient information about the equipment's metallurgy is available, it may be possible to identify which gear, bearing, etc., is wearing. The size, number composition, and type of particles indicate the severity of the wear.

Dielectric Constant

A third form of analysis is a field test unit that measures the dielectric constant of lubricating oil, which is indicative of oxidation of the lubricant molecules. Dielectric constant is monitored as a function of time, and once the deterioration exceeds recommended limits, the oil should be changed. The test equipment can indicate if one of three following potential problems are present:

1) moderate dielectric increase indicative of contamination due to fuel soot, sludge, dirt, oxidation, or acid build-up (this condition is monitored over time until a predetermined point is reached at which time the oil should be changed);
2) severe dielectric increase indicative of water, antifreeze, or metal particles (immediate action is required to avoid potentially serious equipment damage); and
3) moderate dielectric decrease due to gasoline or diesel fuel dilution (this condition is also indicative of a potentially serious problem that needs immediate attention). Note that moderate dielectric decreases are sometimes difficult to detect.

Particle Counters

A fourth form of analysis is the particle counter, which measures the number and size of particles present in oils and hydraulic fluids. Use of an electronic particle counter offers a viable alternative to the patch test, which has traditionally been conducted with CFC-113 or methyl chloroform (both Class 1, ozone depleting substances). This equipment requires no hazardous solvents, and test results are accurate and non-subjective. Use of this technology is approved for Navy activities as specified in the NA 01-1A-17 Aviation Hydraulics Manual.

Compliance Benefit:

Instituting a lubricant analysis program may allow longer intervals between lubricant changes thereby reducing lubricant consumption and waste disposal. The decrease in the amount of used oil generated will decrease the labor necessary to manage the used oil under **40 CFR 279 or 40 CFR 262**. In addition, if used oil is not recycled the lubricant analysis program may help a facility meet the requirements of waste reduction under **RCRA, 40 CFR 262, Appendix**. A decrease in oil stored on site may also put a facility below threshold amounts for the requirement to develop and implement a Spill, Prevention, Control and Countermeasure Plan under **40 CFR 112**.

The compliance benefits listed here are only meant to be used as a general guideline and are not meant to be strictly interpreted. Actual compliance benefits will vary depending on the factors involved, e.g. the amount of workload involved.

Materials Compatibility:

No materials compatibility issues were identified.

Safety and Health:

Waste oil must be handled with care. The main concern is skin absorption. Proper personal protective equipment is, therefore, recommended. Consult your local industrial health specialist, your local health and safety personnel, and the appropriate MSDS prior to implementing this technology.

Benefits:

- Reduces the frequency of oil changes
- Decreases consumption and purchase of virgin oil
- Reduces the generation of waste oil
- Provides valuable diagnostic information

Disadvantages:

- Higher level of knowledge is required to perform the diagnostic tests or take representative samples
- Data must be collected over time and analyzed to determine trends
- Results are subject to interpretation

- Oil analyzers must be calibrated to the type and manufacturer of the oil being used

Economic Analysis:

The capital and operational costs will vary with each of the analytical techniques available for a lubricant analysis program and also with the equipment that is included in the program. The cost analysis presented reflects a lubricant analysis program using a dielectric constant monitoring program, which has a relatively low capital cost. The oil and filter disposal information was based on estimates from the San Antonio Air Logistics Center. The oil and filter prices were obtained through vendor information.

Assumptions:

- Dielectric constant sensor cost: $700
- Program involves monitoring 125 vehicles with average 6.5 quarts oil each
- Regular oil changes conducted at six month intervals
- Analysis program increases oil change interval to eight months
- Labor: 45 minutes per oil change, 15 minutes per test
- Average of three tests conducted per vehicle per year
- Labor rate: $30/hr
- New oil purchase cost: $4.42/gal or $1.11/quart
- New oil filters purchase cost: $6.00/each
- Oil Disposal: oils are recycled at no cost to the facility
- Filter Disposal: Estimated at $100 per drum, 100 filters per drum
- Filter Disposal cost: Estimated at $1.00 each

Annual Operating Cost Comparison for
Lubricant Analysis Program and Scheduled Oil Changes

	Lubricant Analysis Program	Scheduled Oil Changes
Operational Costs:		
Labor (oil change):	$4,200	$5,600
Labor (tests):	$2,800	$0
Filter Disposal	$190	$250
New Oil:	$1,350	$1,800
New Oil Filters:	$1,125	$1,500
Total Operational Costs:	$9,665	$9,150
Total Recovered Income:	$0	$0
Net Annual Cost/Benefit:	-$9,665	-$9,150

Economic Analysis Summary

Annual Savings for Lubricant Analysis Program:	-$515
Capital Cost for Diversion Equipment/Process:	$700
Payback Period for Investment in Equipment/Process:	N/A

Click Here to View an Active Spreadsheet for this Economic Analysis and Enter Your Own Values. To return from the Active Spreadsheet, click the ***reverse arrow*** in the Tool Bar.

NSN/MSDS:

Product	**NSN**	**Unit Size**	**Cost**
Duplex Ferrographic Analysis System	6630-01-178-0327	ea.	$26,055
Duplex Ferrographic Analysis System	6630-01-158-7638	ea.	$38,501
Particle Counter	6640-01-263-6618	ea.	$19,170
Oil Analyzer	6635-01-437-5614	ea.	$34,121
Oil Analyzer	6650-01-114-4663	ea.	$35,000

Approval Authority: Approval is controlled locally and should be implemented only after engineering approval has been granted. Major claimant approval is not required.

Points of Contact:

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Vendors:

Test Equipment

The following vendors have been identified as supplying test equipment for lubricants. This is not meant to be a complete list, as there may be other providers of this type of equipment.

Northern Technologies International Corp.
(Lubri-Sensor / Hydroil Sensor)
6680 N. Highway 49
Lino Lakes, MN 55014
Phone: (612) 784-1250, (800) 328-2433
www.ntic.com
Linda Petro, Marketing

Predict Technologies
9555 Rockside Road
Suite 350
Cleveland, OH 44125
Phone: (800) 543-8786
Russell Loede
Senior Machine Condition Analyst

High Yield Technology (HYT)
1178 Bordeaux Dr..
Sunnyvale, CA 94089
Phone: (408) 541-6450 Fax: (408) 541-6455

Analytical Testing Services

The following test services have been identified as providing analytical testing of lubricants. This is not meant to be a complete list, as there may be other providers of this service.

Predict Technologies
9555 Rockside Road, Suite 350
Cleveland, OH 44125
Phone: (800) 543-8786
Russell Loede
Senior Machine Condition Analyst

Source:

Mr. Michael Schleider, Robins Air Force Base, January 1999.
Mr. David Elliot, San Antonio Air Logistics Center, January 1999.
The U.S. Marine Corps Oil Analysis Program, TI-4731-14/1B, 14 Feb 1991.
Vandenberg Air Force Base Technical feasibility and Economic Analysis Report for Pollution Prevention Opportunity Assessment, September 1994
Air Force Manual 24-307, Procedures for Vehicle Maintenance, September, 1995
Oil Quality Analyzer, Project OV92-11, July 1992, Air Force Management and equipment Evaluation (MEEP), August, 1993