TECHNI/TIPS

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USE OF ANALYSIS IN MONITORING ENGINE CONDITION

Monitoring the condition of the engine through oil analysis will help operators get the most value from their equipment and their lubricant. This is just one part of an overall Preventive Maintenance (PM) Program.

Lubrication Engineers, Inc., is in the oil testing business as a service to our customers for Preventive Maintenance. LEAP (Lubrication Engineers [Oil] Analysis Program) has all testing performed by one of the largest independent laboratories in the U. S.

LE is always interested in investigating any question about the quality or performance of any product it sells. When and if a question is raised by a customer we want to do whatever is necessary to resolve the question by a determination of the condition of the oil at any time of use. By determining the condition of the oil, LE can make suggestions to help correct any mechanical, operating or environmental condition affecting the oil. There are two general types of oil analysis used in LEAP-spectrographic analysis and wet analvsis.

SPECTROGRAPHIC ANALYSIS

Periodic spectrographic oil analysis is a tool to help determine proper oil drain intervals. Every engine, gear mechanism or oil circulating system is unique in its construction, operation and its effect on the oil used. To get the maximum service life from any piece of equipment, the oil should be analyzed periodically to determine the degree of degradation and contamination. Analysis tells when additives have been depleted or when contaminants have reached a level which may prevent the oil from doing a proper job. With the ever increasing cost of oil, labor and equipment, getting the most from the oil dollar is more important than ever.

Periodic spectroanalysis of metal concentrations will tell an operator a lot about the condition of his equipment and alert him to impending problems allowing him to schedule mechanical procedures at the most practical time. Typically, used oil analysis can identify component wear, poor bearings, sticky valves, faulty air filtration, coolant leaks, improper timing, faulty carburetion or improper diesel engine rack settings and many other less significant equipment malfunctions.

The principle indicator of the condition of the components of a machine is the number and level of metallic elements which appear in the oil. Some of the elements determined by spectroanalysis are wear metals, airborne contaminants and those which indicate coolant (anti-freeze) leaks. To correlate an analysis of metallic elements in an oil, first establish a base line for the additive levels of new oil. Most periodic oil analysis programs have three basic parts-1) physical property testing, 2) spectroanalysis for determination of metal concentrations, and 3) the interpretation of data. Some analysis programs can also use the technique of ferrography where wear debris is taken from a sample and analyzed for size, shape, number, etc. This data can be used to determine wear metals and signal the onset of severe wear.

A. PHYSICAL PROPERTY TESTING MAY INCLUDE:

TOTAL SOLIDS-this test will indicate if the oil and air filters are functioning properly, if the oil is beginning to form sludge or deposits, or if there has been contamination from dirt, sand, etc. In an engine this is also an indication of fuel soot.

WATER-water present in a system is probably abnormal. High water content can indicate condensation, coolant leakage or contamination from an outside source. Other tests can help determine which of these is the probable cause.

VISCOSITY-this is a measurement of the degree of oxidation or contamination of the lubricant. As most oils oxidize, they tend to increase in viscosity, while some viscosity index improvers have a tendency to shear down in service, resulting in lower viscosity.

NEUTRALIZATION NUMBER: TAN or TBN

TAN (TOTAL ACID NUMBER)-lubricants can form acidic degradation products which are detected in this test. This is a measure of the degree of degradation and a high value indicates the potential for metal corrosion.

TBN (TOTAL BASE NUMBER)-A measurement of the alkalinity reserve of the lubricant. A low value often means that the additive package has been depleted, and that the dispersant characteristics of the oil have been reduced.

FUEL DILUTION-for crankcase applications, this is a measure of the unburned fuel in the lubricant. This can indicate problems with the fuel line, injectors, carburetor or fuel pump.

B. SPECTROANALYSIS TESTING may include detection of up to 16 different elements and the level in parts per million (ppm) present in the oil. These elements can be divided into the following categories:

WEAR METALS-including iron (Fe), lead (Pb), copper (Cu), chromium (Cr), molybdenum (Mo), aluminum (Al), nickel (Ni), silver (Ag), and tin (Sn). These elements represent the metallurgy of the equipment components. Gradual increases in element levels indicates wear is occurring. However, rapid increases in elements levels are a warning of impending component failure.

SILICON (Si-Silica) - sand, dirt, dust or similar type of abrasive is generally identified as silicon. An increase in the level is often an indication of air filter failure. Silicon can also be an oil additive.

BORON (B), SODIUM (Na) and POTASSIUM (K) - these elements are present in the additive packages of most engine coolants. They indicate a coolant leak into the oil, and may be present even though the water from the coolant has evaporated. Boron can also be an oil additive.

PHOSPHORUS (P), ZINC (ZN), CALCIUM (Ca), BARIUM (Ba), MAGNESIUM (Mg) -these elements are present in the additive packages of most commercial lubricants, and their levels may indicate the type of formulation being used. Phosphorus and zinc are part of the anti-wear additives; while calcium, barium and magnesium are often found in the detergent dispersant additives. Significant reductions in the levels of these additives may mean that they are no longer present in a sufficient concentration to do their job well. An oil change or the addition of makeup oil may be required to replenish the additive level.

C. THE INTERPRETATION OF THE DATA is probably the most important part of an oil analysis program. Only the technician, of the particular lab who ran the tests, would really be qualified to correctly appraise the findings of their tests. They know their test equipment and their general condemning limits. Those trained technicians can oils usually spot problem areas using their data. This requires years of experience in analyzing similar systems and situations. Proper sampling techniques, good labeling and careful following of sampling schedules are important for results to be meaningful.

Many capable laboratories around the country are set up to specifically do used oil analysis. Tests can be made on a one time basis or as a part of a sophisticated Preventive Maintenance Program. Results can be obtained quickly and at a reasonable cost. Such labs, close to the operators base, can provide rapid analysis and interpretations. Most operators (LE customers included) are interested primarily in routine spectrographic oil analysis. The LE analysis program, LEAP, which is conducted through one of the best independent laboratories, is illustrated in Figure 1.

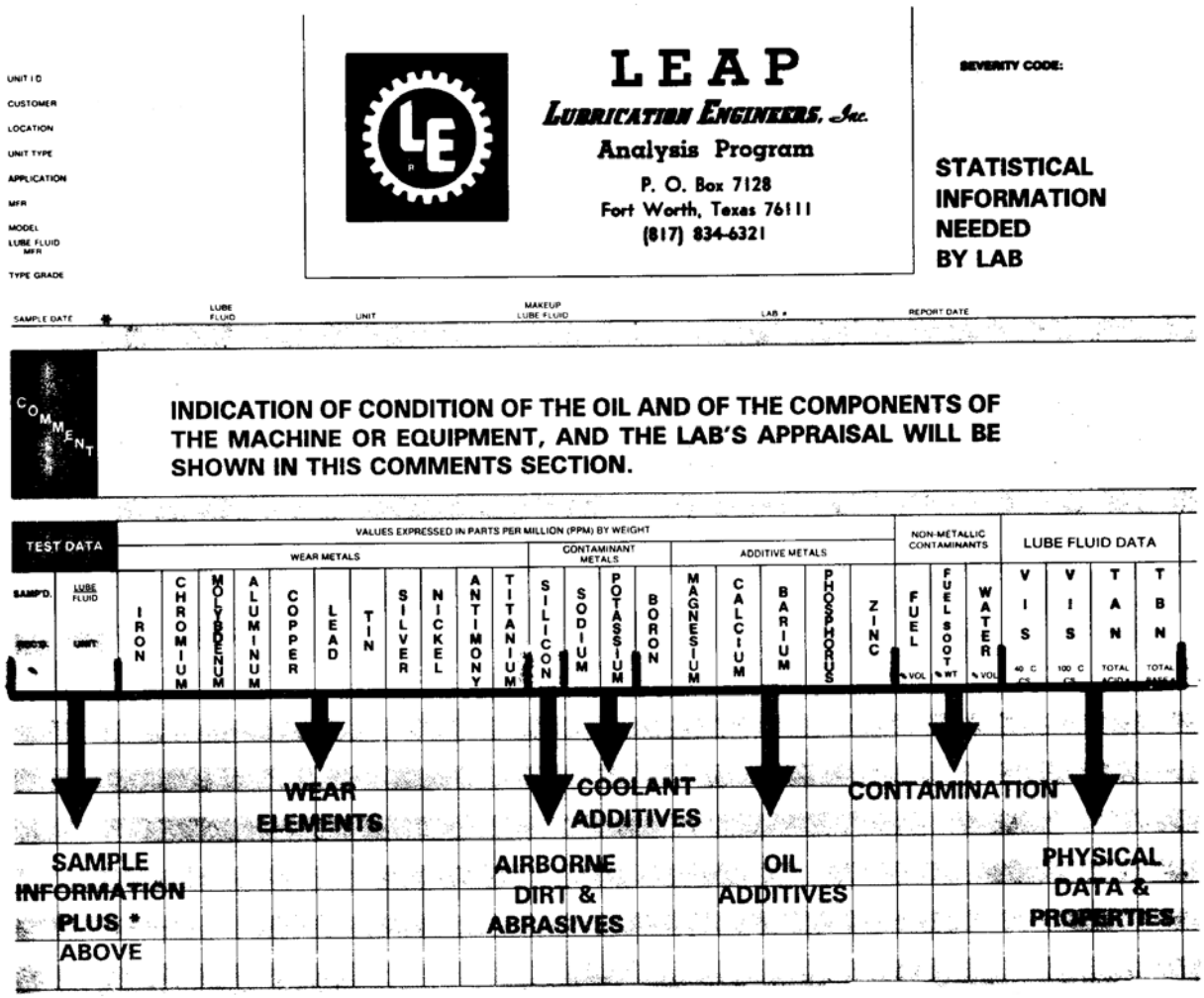

FIGURE 1.

As previously discussed and shown in Figure 1, the ppm of concentrations shown by spectroanalysis are (left to right) the wear metal elements-airborne abrasives, coolant additives-oil additives (the additives used in that particular oil formulation)-nonmetallic contaminates (such as water, dirt and carbonaceous solids and fuel dilution)-and physical data/properties of the sample.

Figure 1 also shows the comment section where the Lab will indicate its appraisal. Statistical information which would be supplied with the sample will be entered at the upper left of the form.

The condition of a used oil is an indicator of the environment in which the machine operates. High temperature, high moisture conditions, a dirty environment, abrasive contaminants, etc. all have an effect. Upon determining the condition of the oil, customers can establish oil life limits or modification of operating or maintenance procedures for their equipment.

WET ANALYSIS

There are too many variables to permit setting of test limits that apply to all oils and all machines. But through comprehensive testing we can gain important information about the condition of the oil. A series of physical/ chemical properties tests (called "wet" analysis) will indicate 1) whether the oil viscosity is within the proper range, 2) whether the oil is oxidized or has become degraded in any way, 3) whether the additive package is still effective, 4) the levels of particulate matter, and 5) whether or not the oil is contaminated with by-products of combustion, water, fuel, coolant (anti-freeze), etc.

LE will do what it can to help determine if a mechanical failure might have been lubricant-related. Such a comprehensive, time-consuming and expensive procedure takes much longer than the usual spectrographic "trend analysis" used for Preventive Maintenance Programs. And while spectrographic analysis requires only about 4 oz. of oil, physical-chemical (wet) analysis requires not less than one quart of oil.

Depending upon all the variables involved, we could use the following condemning limits as a very general guide for oil changes:

1 . Viscosity change of 10% to 12% (either up or down).
2. A Neutralization Number-
   TAN of 6.5 or above or an increase of 1.0 to 2.0
   TBN reading below 2.0 indicates additive protection level is low
3. A 0.5% Pentane (P E.) insolubles reading (Total carbonaceous solids, metals [by magnetic method], etc.)
4. A 0.25% Toluene insolubles reading (the difference between the RE. and Toluene readings indicate oxidized oil, gum, sludge, soot, etc.)
5. A 3.0% fuel dilution reading
6. A 1 % reading for water calls for attention-2% calls for change

When using the general guide above, you should remember that:

1 . A Neutralization Number alone is of no value-interpretation can be used only with the other test results and the many variables as outlined in the operating and environmental data submitted with the sample.
2. A trace of metal (magnetic method) is naturally a concern-a measurable amount requires prompt investigation.
3. Even a trace of glycol requires prompt investigation-a measurable amount means immediate inspection of the engine. In spectroanalysis, sodium, potassium or boron levels higher than normal would indicate glycol (coolant leak).

Spectrographic analysis reveals more about the condition of the engine, but less about the conditions of the oil than physical/chemical analysis. But, because of more economical cost and rapid availability of data, an operator should use spectrographic analysis in their ongoing Preventive Maintenance Program.

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