USED OIL ANALYSIS - ITS USE AS A MAINTENANCE TOOL.

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INTRODUCTION

This paper outlines the analysis of used lubricants, the availability of used oil analysis, and looks at decisions that can be made from the interpretation of oil analysis results in the planning of maintenance. Some examples of used oil analysis are included.

USED OIL ANALYSIS - DESCRIPTION

Used oil analysis is the physical, chemical and spectroscopic testing of used oil, and the interpretation of the results as an indication of equipment condition and performance.

For maximum effectiveness of used oil analysis however a history of the oil's condition must be established for any given piece of equipment, and it is trends in, or departures from, this analysis history that are used as maintenance or service indications for that piece of equipment.

One-off used oil analysis is of little use in the planning of equipment maintenance as there is no indication of how the results from this one-off test differ from normal used oil condition.

The analysis of used oil can be used for the planning of service or maintenance for a wide range of equipment such as internal combustion engines, transmissions, axles, hydraulic systems, heat transfer systems, compressors and lubricant circulation systems. In fact any equipment that depends upon a lubricant for it's operation may have it's service or maintenance planned and monitored by the use of used oil analysis.

The most common use of lubricant analysis is the monitoring of oil condition in heavy duty diesel engines, in both mobile and stationary applications. Used oil analysis is ideally suited to monitoring engine operation for a number of reasons. These are:

- Frequency of analysis. Engine oil is changed frequently in comparison with other applications. Samples are conveniently taken at this time, enabling an extensive history to be obtained in a reasonable period.

- Operating conditions. The lubricant in an internal combustion engine is degraded and contaminated in service. Engine operating condition, and therefore service and maintenance needs, is rapidly reflected in lubricant condition.

- Link between oil condition and engine operation. A rapid increase in oil degradation, or in contaminants, can be directly related to engine operation, ie, an increase in fuel dilution in the engine crankcase oil will usually indicate a fuel system or combustion problem.

Used oil analysis is also used in the monitoring of equipment components other than engines, but because these components usually have less frequent lubricant changes, and there is less likelihood of contamination of the lubricant, there is a tendency for infrequent oil sampling and therefore a less detailed analysis history of the lubricant. This applies particularly to hydraulic and gear systems.

USED OIL ANALYSIS - AVAILABILITY

Analysis of used oil is available from three main sources. These are the lubricant supplier, the equipment supplier and independant laboratories.

The Lubricant Supplier

The lubricant supplier offers this service to users of their products, by making use of the established laboratories used for quality control in the production of their lubricants. While having maximum involvement with the performance and formulation of their own products, the lubricant supplier probably has only a limited knowledge in the areas of equipment construction and application.

The Equipment Supplier

Some equipment suppliers offer used oil analysis as a service to users of their equipment. They have maximum knowledge of their equipment and its applications, but have to accommodate lubricants from a variety of suppliers, manufactured to different formulations in their analysis system.

Independant Laboratories

The independant laboratory offers used oil analysis as a saleable commodity, maximising the use of staff and equipment. They have neither the equipment supplier's knowledge of the equipment and its applications, nor the lubricant supplier's intimate knowledge of the lubricant.

USED OIL ANALYSIS - TESTING

Used oil analysis is performed using recognised, standard, laboratory procedures and test methods. These can range from the most basic qualitative methods to sophisticated spectroscopic analysis.

Some of the major used oil analysis tests, and their correlation to oil and equipment condition are:

Appearance and Odour

Can often confirm a later test result, ie, water or fuel contamination, or thermal degradation of the oil. The contamination of the product being analysed by another product, for example the contamination of an engine oil by an extreme pressure gear oil, can often be simply confirmed by odour.

Fuel Dilution

The presence of excessive fuel in an engine's crankcase oil will necessitate both an engine oil change and correction of the cause of the fuel dilution.

USED OIL ANALYSIS - SERVICE AND MAINTENANCE

From the indications of a lubricant's condition, and therefore a decision on the equipment's condition, a number of judgements concerning the servicing and maintenance requirements of the equipment can be made.

These can range from a simple confirmation that the current servicing frequency is correct, to a decision to bring plant down early for preventative maintenance.

Used oil analysis can be an early warning of equipment problems. Any decision to bring alter equipment maintenance schedules should be made in conjunction with information from other sources, such as:

Operator reports
Equipment noise or temperature
Equipment service history
Equipment operating conditions
Equipment performance

Areas of equipment maintenance, or service, where the analysis of used oil can most assist in decision making are:

Frequency of Regular Service

Used oil analysis can confirm that current service periods are satisfactory, whether the service life of the lubricant can be extended, or should be reduced. Decisions regarding the extension of lubricant service should take into account indications of the rate of oil contamination or degradation such as oxidation, viscosity change, wear metal levels such as silicon, base or acid number of the lubricant, and also, most importantly, the manufacturer's recommended lubricant service period.

Unscheduled Maintenance

The need for re-scheduling, or planning unscheduled, maintenance can be indicated by the analysis of used oil. The change in trends in the history of used oil condition can indicate increased wear rates or unexpected contamination of the lubricant. One-off used oil analysis is of little use in confirming the need for unscheduled maintenance, nor in the planning of maintenance, as there is no indication of the extent of change of the used oil analysis results from normal operating conditions.

Planning of Maintenance

Should used oil analysis indicate the need for unscheduled maintenance, then it can also be used to determine whether the equipment would be able to be left in service until a suitable time for maintenance, or whether immediate maintenance is required to prevent extensive equipment failure. An indication that maintenance will be needed can be used to check that parts, workshop time, alternate equipment, and reserve production stocks are available.

USED OIL ANALYSIS IN ACTION

Example One

Analysis of used engine oil from a heavy duty diesel engine indicated high levels of sodium from the first sample, taken at 57000 km. Salt water and dirt contamination were discounted, the unit operated well away from the coast and the silicon level was satisfactory. Although a test for glycol was conducted this showed a negative indication.

Dispersancy

The ability of an engine oil to disperse contaminants, or even just a measure of the amount of solid contamination, can be an indication of the suitability of the engine oil for further service.

Water

The presence of water can indicate service or maintenance requirements. In an engine oil the presence of water may indicate a coolant leak or excessive low temperature operation.

Base Number

An engine oil's alkalinity, its Base Number, is an indication of its ability to neutralise acids of combustion that can build up in the crankcase. A drop in an engine oil's Base Number would indicate the need for an oil change, or a change to a higher performance lubricant may be considered.

Acid Number

An indication of an oil's oxidation, mainly applicable to gear oil, hydraulic oil, heat transfer oil and circulating oil.

Oxidation

The oil's oxidation can be detected spectroscopically. Viscosity increase due to an engine oil's oxidation can sometimes be masked by other used oil factors ie, fuel dilution.

Wear Metals

The presence of "Wear Metal" contamination of an oil can often be determined to single parts per million. By reviewing trends in individual "wear metal" levels, a relationship between these and the condition of the equipment can be established.

Some of the individual "wear metals" commonly analysed and their cause are:

Silicon:
Dirt. From faulty air intake or filtration systems in engines.

Aluminium:
Pistons, bearings.

Chromium:
Rings, cylinders, plated componentry.

Copper:
Bearings and bushings.

Lead:
Bearings, or contamination of diesel fuel with leaded petrol.

Iron:
Rings, cylinders, gears, valve train. May occur in association with silicon.

Sodium:
Dirt, sea water, engine coolant.

A very good indication of equipment condition may be obtained from the analysis of used oil and its comparison to an established used oil analysis history. This indication may be used in the planning of equipment service or maintenance.

However the unit operator was advised of a probable coolant contamination of the crankcase oil.

A low interval follow up sample, and a third normal service sample, confirmed the high sodium level. The unit was returned for a warranty check and a pinhole was found in the intercooler.

After repair used oil analysis results settled at an expected, acceptable level.

Example Two

A heavy duty diesel engine, converted to spark ignition CNG operation, had high copper results from its first used oil analysis. The initial analysis also indicated a high lead level, though this would have been expected during running in.

Subsequent analysis of used oil samples confirmed the high level of copper, but the lead dropped to normal levels.

Three possible causes of this high copper level in the used oil were discussed with the operator, these were:

- Contamination of the oil with another product which contained copper as part of its additive package. The level of copper reported, and checks on lubrication practice, discounted contamination as a likely cause.

- Bearing failure, due to "pounding" as a result of incorrect engine operation or due to nitration of the engine oil. The drop in the lead level after the first sample analysis indicated that the bearing as a whole was unlikely to be failing. Other tests on the used oil indicated no oil nitration so leaching of copper from the bearing was also unlikely.

- The use of a copper containing compound during modification of the engine. This was discounted by the operator after questioning staff concerned with the modification of the engine and its subsequent maintenance.

It was only after inspection of crankshaft and pinion bearings that it was in fact determined that an antiseize compound containing copper was being frequently used in the engine bay of the workshop. With the cessation of this practice oil analysis results settled at a normal level.

Example Three

The first used oil analysis of a light duty diesel engined service vehicle indicated an abnormally high level of lead. All other results were normal.

Contact with the operator elicited that a lead based supplementary oil additive had been added to the crankcase oil. The use of this proprietary additive was discontinued and oil analysis results returned to normal.

Two years later another result indicated an even higher (1100 parts per million) level of lead in the used oil, as well as a rise in the silicon level. It was determined that the same additive had again been added to the crankcase oil.

Not only did the use of this proprietary additive void any product warranty offered by the lubricant supplier, it would have masked any actual rise in the lead level in the used oil.

Example Four

A large, diesel marine engine was changed to a higher performance diesel engine oil.

Regular analysis of engine oil samples confirmed that the engine servicing regime being carried out was maintaining fuel soot, water and other oil analysis results at a satisfactory level. As well a gradual rise in engine crankcase oil base number due to top up with the high performance oil removed the concern of the vessel's operators that an oil drain and replacement (some thousands of litres of engine oil) would be necessary. The use of used oil analysis confirmed that the change to a higher performance oil had removed the need for unscheduled maintenance.