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The Lifetime Reliability Solutions
Certificate Course in Maintenance and Reliability
Module 3 – Other Condition Monitoring Techniques for Machinery

Sessions 12B
Condition Monitoring using Oil Analysis

1. An Introduction to Oil Analysis

For those machines that have circulating oil as the principal means of lubrication and cooling it is essential that the condition of the lubricating oil be routinely checked. This process is generally referred to as 'oil analysis' and is one of the important condition monitoring technologies.

Machines that are usually the subject of oil analysis are gearboxes, high speed machines with sleeve bearings, turbo-machinery, hydraulic systems and most mobile plant. For the purposes of this short introduction we will not refer to mobile plant (typically diesel engines, drive lines and final transmissions or electric wheels) because that represents a special category of oil analysis. We will consider oil analysis as applied to fixed plant only.

The process of oil analysis involves (a) routine sampling of the oil while the machine is in operation; (b) quality assessment of the oil for any change in its condition; (c) examination of the oil for contamination, and (d) reporting of the results.

2. Routine Sampling.

It is essential that the small amount of oil drawn off for analysis (typically 50 – 100 ml) represents a good sample of the oil in circulation. Therefore sampling must be done very carefully to procedures specified for each machine by a person thoroughly trained in the procedure. Usually sampling procedures are put in place by a person who is expert in the technology, and that service is offered by most oil analysis service laboratories.

Each sample is sealed in a sterile container and immediately marked with all the details required to properly identify the sample for the laboratory.

3. Oil Condition.

Some oil analysis programmes focus only on looking for contaminants in the oil sample. However, from a predictive and preventative perspective it is good value to check that the oil condition is still as was intended by the machine designer.

Therefore the first tests done in a good laboratory concern the quality of the oil. Most importantly viscosity is checked. If this is not found to be within the specified range then there may be reason to suspect that the wrong oil has been used and this could put the health of the machine at significant risk. An out-of-tolerance viscosity sample may lead to more sophisticated analysis to examine additive levels, the type of oil (mineral or synthetic) and the like. Speak to any oil analyst and they will be able to recount numerous cases of even new oils being way out of specification.

If the oil has lost its 'oilyness' it may well have reached the end oif its service life and must be replaced. However, most decisions to replace oil are made for other reasons than this and often oil is replaced that is fundamentally in good condition but perhaps only in need of filtration.

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4. Oil Contamination.

Common contaminates are water (from condensation), dust, dirt, wear particles (from the mating surfaces in the machine), other lubricants (eg grease), chemicals from process, particles from filter breakdown, and the like.

Generally for analysis purposes, contaminants break into two categories; (1) liquids and fine solids < 15 microns, and (2) particles >15 microns in size.

The test for moisture is a very simple 'sputter' test on a hot-plate. Low levels of water contamination may be permissible but need to be carefully monitored.

The analysis of the chemical composition of the oil and its small size contaminants is usually done by advanced oil spectroscopy and infra-red analysis procedures. These machines are very expensive to buy and maintain but they are essential to good quality analysis.

Analysis of the chemical composition of the oil and the elements that have caused the contamination can be very useful for early warning of fault condition. However, there are some who put a higher value on the analysis of the larger 'wear particles' as being more useful for condition monitoring purposes.

Wear particle analysis uses techniques that separate the wear particles from the oil. Common procedures are filtergrams and magnetic ferrography. Having separated the wear particles from the oil a process of inspection usually follows to identify the nature of the wear particle and its possible source.

Using a powerful microscope a skilled operator can identify the shape of the wear particle to help identify its source. This technique is known as morphology and has an increasing band of supporters in the world of diagnostic analysis and root cause investigations.

5. Reporting.

Because the technology of oil analysis has always been seen as a 'chemical' process it has often been conducted by people who were essentially trained as chemists but had little practical machinery knowledge. Therefore reports were often presented as a chemical analysis that didn't mean a lot to the hard-pressed maintenance planner who was looking for practical advice on what to do with the machine!

Integrated condition monitoring allows for people who understand the chemical analysis and have engineering training to produce recommendations for action that may also be influenced by the outcomes of other condition monitoring procedures.

6. Summary.

Oil Analysis has great potential to contribute to machinery availability and reliability. The concept of integrating the outcomes of oil analysis with vibration monitoring and other observations has the potential to realise even greater benefits.