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THE ROLE OF LUBRICANT CONDITION MONITORING IN MAINTENANCE PROGRAMMES

The term Condition Monitoring (CM) is understood by most in the lubricants industry to refer to the periodic analysis of a lubricant in order to monitor both the levels of additive and also, more importantly, the levels of contaminants in the lubricant.
In fact, the scope of true CM is much wider, and can include e.g. vibration monitoring, thermography, ultrasonic analysis, filter wear debris analysis, ferrography, dye penetration, radiography, etc.
This article will concentrate on lubricant CM, but firstly it would be as well to briefly review the historical development of maintenance practices over the years, which will also help to establish the relevance of lubricant CM.

It should be stressed that each piece of equipment should be treated on its own merits with regard to the application of the most suitable type of maintenance philosophy.

BREAKDOWN MAINTENANCE

This involves rectification only after the failure of an item of equipment. Although no longer viable for large, costly and critical items of equipment, breakdown maintenance can still be appropriate for small, non-critical items, e.g. light bulbs.

PREVENTIVE MAINTENANCE

This involves the servicing, overhaul and replacement of items based on intervals of operating time or other unit, or on an elapsed time basis, the most familiar example is probably the servicing of your car. The downside to this philosophy is that units of equipment which are possibly operating completely satisfactorily can be unnecessarily disturbed, and there can be wastage involved when items are prematurely scrapped.

PREDICTIVE MAINTENANCE

This is where the use of CM first came into its own when maintenance was carried out on items based on predicted needs rather than on a regularised basis.

PROACTIVE MAINTENANCE

This system developed from the previous three philosophies and is concerned with the analysis of all maintenance and CM techniques to determine the causes of failures, and their prevention.
As could be expected, these differing maintenance philosophies result in differing failure modes.
These are summarised below in order of decreasing seriousness:

CATASTROPHIC FAILURE

As the name implies, this is the sudden and complete failure of a piece of equipment, and is associated with the 'Breakdown Maintenance' approach.

PREVENTIVE FAILURE

A state of deteriorating performance leading to a gradual loss of efficiency and/or a progressive shortening of working life of some, but not necessarily all, components.

PREDICTIVE FAILURE

The situation where loss of machine performance has not yet become apparent to the operator, but where detective measures such as lubricant CM begin to predict a deteriorating situation.

PROACTIVE FAILURE

The most 'early-warning' situation which can alert an operator to potential deteriorating performance or even complete failure even though no adverse effects are readily apparent.
It can be seen that CM has an important role to play both in the Proactive and the Predictive categories of failure mode.
There are also several differing levels of CM, i.e.

DETECTION

To determine whether a problem exists, and if so, the criticality of the situation

DIAGNOSIS

To determine the exact nature of the problem, and also to determine what, if any, additional CM techniques are required.

PROGNOSIS

To determine the overall seriousness of the problem and the use of the experience for future reference

LUBRICANT CONDITION MONITORING

Of the various approaches to CM outlined above, lubricant CM is one of the most useful, and can play an important complementary role in both Predictive and Proactive maintenance philosophies. However, it must be stressed at this point that lubricant CM should not be viewed as the complete answer to every potential failure situation. Even with a lubricant CM programme, catastrophic failures can still occur in a number of situations. These include:

EXTREME SHOCK LOADING

Examples are driver abuse and overloading in the case of vehicles

METAL FATIGUE

Lubricant CM will not identify the progressive breakdown in the crystalline structure of metal components, which could lead to their eventual breakdown.

SHORTAGE OF LUBRICANT

If a piece of equipment, such as an engine, runs short of oil, irreversible damage will occur, which will not be rectified by subsequently topping-up the oil level.
Failure to properly rectify a previous breakdown situation
An earlier failure can result in the generation of wear debris, which, if not completely removed, can result in further failures of other components in the same piece of equipment.
Also, generally speaking lubricant CM should not be used in isolation, but in conjunction with other monitoring programmes including filter debris inspection.
The lubricant CM programme should also be planned such that sampling frequency is adequate, and that sampling is carried out in such a way so as to ensure that samples are properly representative and free from contamination.

IDENTIFICATION OF AN APPROPRIATE LUBRICANT CM PROGRAMME

Lubricant CM programmes are developed according to the type of equipment using the lubricant.
Programmes generally fall into the following broad classes:

- Engines
- Gear Systems (including automotive manual gearboxes and differentials, also industrial gearboxes
- Automatic Transmissions
- Hydraulics
- Compressors and turbines

A number of further but more minor categories include e.g. aircraft engines, refrigeration compressors, etc.
A normal test programme would include

- Elemental analysis
- Particulate analysis (normally quantification only)
- Viscosity measurement
- Water content

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