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When Oil Analysis Does Not Work

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WHY OIL ANALYSIS PROGRAMMES SOMETIMES FAIL AND WHAT CAN BE DONE TO PREVENT THIS

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Before looking at the effective management of oil analysis programmes it is salutary to look first at the reason why these programmes sometimes do not work. The service provider is frequently blamed for the failure of a doomed oil analysis programme when the fault almost always lies with the end user. This is generally not as a result of poor management but a lack of education and understanding.

The first thing that is important to understand is that oil analysis will not catch all failures before they occur. There are some failure modes that simply will not show up when the oil is analysed. For example: a failure mode that generates debris over a period of time but does not allow that debris to circulate in the oil. Problems with systems that have very large sump capacities are notoriously difficult to deal with as the evidence is often diluted below a reasonable detection level. Most common of all is the sudden death failure. With the fast onset of a catastrophic failure there will be no evidence in the last oil sample or even the failure sample.

Medical analogies are frequently used when talking about oil analysis because the oil is truly the life blood of machinery. If a man dies of AIDS or a heart attack then a blood sample will reveal some evidence of the cause of death; if he dies of a gunshot wound to the head there will be none.

Two areas which the end user has direct control over and can cause an oil analysis programme to fail are the taking of the oil sample and the information that accompanies the sample to the laboratory.

The first step in obtaining a meaningful report is ensuring that the oil sample is representative of the oil that is in the system. This may seem very obvious and frequently Wearcheck does a lot of on-site training with regards to the taking of a good oil sample, but it is surprising how often it is forgotten. What is preached time and time again in these courses is that the oil must be hot (at operating temperature) and well mixed.

If a truck is driven into the workshop and allowed to stand overnight then particulate debris, contaminants and wear metals will settle to the bottom of the sump. A sample scooped from the top of the sump will look abnormally clean whilst a sample taken from the bottom will look abnormally dirty. The truth of the matter will be somewhere in between the two

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extremes. This will also explain why a failure sample will not always show the cause of a failure. Failure samples, by definition, can never be representative as the machine is no longer working.

Not only does the sample need to be representative in nature, it also has to be taken from the right place. Samples taken before and after a filter will yield different results. If a 'good' sample cannot be taken then at least try to ensure that a 'bad' sample is taken in a consistent manner; in this event at least the information obtained will be consistently bad. Trend analysis is very important in oil analysis and has been dealt with in other Technical Bulletins.

The other area that is easy to control, but frequently is not, is the information that accompanies the sample to the laboratory. Often this is the result of the fact that the person taking the samples does not fill in the submission forms. A simple but vital piece of information that is required is how long the oil has been inside the machine. A certain wear reading might be normal after 20 000 km but critical after only 5 000 km. What is worse than missing information is **wrong** information. Oil analysis is a holistic process; all laboratory results as well as all information provided along with all the previous results and information are studied before a diagnosis is made.

It is quite easy to ‘catch out’ the diagnostic department. Customers sometimes like to 'test' Wearcheck by sending in duplicate samples. One sample will be submitted to the component history where it belongs, the other will be submitted to another similar or even fictitious component. The laboratory results will be identical but unless the results are very obviously normal, the diagnosis will almost inevitably be different as the results will be compared against different information and different histories.

Wrong or missing information is probably the most common reason for the failure of an oil analysis programme.

Sadly, another reason for the failure of oil analysis programmes is declining troubleshooting skills. The true artisan, craftsman if you will, of yesteryear is a dying breed. With the advancement in technology, many artisans have become parts replacement technicians. The sample may be perfectly taken from the right location and all the necessary and relevant information supplied. An incipient problem may be indicated and diagnosed but if the artisan cannot troubleshoot, find and correct the problem then obviously 'oil analysis doesn't work'.

The Wearcheck course on troubleshooting and report interpretation examines the cause of this in detail and uses an aircraft analogy to analyse what is happening in industry. To borrow from the course material:

The most frequent last words heard on cockpit voice recorder tapes are "Oh shit!". Frank McDermott, NTSB expert on 'black box' evaluations during an interview on BBC television.

Predictive maintenance practices grew out of the aircraft industry in the 1960s and were the origin of RCM or Reliability Centered Maintenance - machinery was attended to 'on-condition'. This and proactive maintenance relies on service crews responding to warnings generated from the equipment and taking appropriate corrective action.

The aftermath of an airline accident is normally a very public affair with highly charged emotions and high cost implications. This has led to a highly developed industry devoted to the investigation of airline maintenance, safety and accidents whose findings are regularly made public. There is no equivalent body for earthmoving, transport and fixed plant and this makes getting unbiased information on equipment failures extremely difficult. If the truck's engine fails you just park it up at the side of the road; you can't do that with an aeroplane.

Statistics from some airline safety boards make interesting reading and parallels to other industries may be drawn. The Flight Safety Foundation found that of the 439 final-approach-and-landing accidents (as with motor cars, the bulk of aircraft accidents occur within 2 km of the airport or 'home') investigated between 1959 and 1994, 383 or 78.1% showed the flight crew as the primary factor in the accident.

Put another way, nearly 80% of all accidents were generally due to the flight crew's failure to respond to warnings and follow correct procedures. Of 62 accidents investigated by the same body since 1992, 58 or 93.6% were found to be due to flight crew error. The problem appears to be getting worse.

If we replace flight crews with maintenance crews and accidents with failures, we have a reasonable approximation of what is going on in other industries. When analysing failures in these industries, maintenance personnel are often found to be at fault. Why is this?

One of the main reasons is that machines are becoming more reliable. Equipment manufacturers have done superb work in improving the reliability and performance of their machines. Unfortunately, the human factor has not improved at the same rate and has probably degraded over the same period. As machines now have far lower inherent failure rates, premature failures are more often due to maintenance crews not following correct procedures and ignoring early warning signs that a problem may be developing.

History is full of famous people that have ignored such warnings with dire consequences. On 14 and 15 April 1912 a certain Captain Smith ignored a warning of ice ahead. The standard procedure would have been to slow down and post lookouts; he didn't and 1513 lives were lost.

OEMs (Original Equipment Manufacturers) have recognised this problem and have fitted increasingly sophisticated warning devices to their machines with surprisingly little effect. Continuing with our airline analogy, aircraft manufacturers have installed a device that shakes the joystick when the aircraft is about to stall. This is over and above audible and visual alarms, yet there have been two instances where crashes have been caused by failure to heed a stall warning. This has led to a re-think regarding how flight crews respond to warnings. The solution to these problems will be addressed in the next section.

The final reason for oil analysis not working is lack of staff commitment and buy-in. If there is no top-down management commitment to making the system work, then the belief is not instilled in the work force. In these situations it is fairly easy to show that oil analysis does not work and this leads to an endless cycle of failure. At the same time, it is important that oil analysis is not seen as a policeman being used to check up on how well the maintenance staff are performing. Oil analysis should be used as a tool to measure quality, not achieve it. If problem areas are detected then they need to be addressed through best practices in maintenance and lubrication rather than how far we can spread the blame when things go wrong. In this case, best practice defines the meaning of quality in terms of machine reliability.

In the March/April 2001 issue of **Practising Oil Analysis**, Jim Fitch of the Noria Corporation in the United States published an editorial entitled 'The Six Most Expensive Oil Analysis Tests'. At that time Wearcheck considered this such a valuable lesson that it was copied in its entirety and sent out with all the month end reports. It is no less of a valuable lesson today so here are Jim's six most expensive oil analysis tests once again, as they all have a direct bearing on the failure of oil analysis programmes.

1. The Tardy Test

This test is expensive because it wastes time and opportunity. One common example is when lab data arrives 10-20 days after a sample is pulled. Perhaps this was due to procrastination in forwarding the sample to the lab or a lack of timely service from the lab. By then, responding is often a futile exercise since the data may bear little resemblance to the current conditions of the oil or machine. And, had the belated report flagged an impending failure condition, the consequence of the delay might be a more expensive repair and collateral damage to other machine components.

2. The Garbage Test

Often oil analysis is performed routinely over a period of years on samples that are not representative of machine or lubricant condition. This is typically due to lack of training and proper documentation of correct sampling procedures. As the name implies, the Garbage Test is oil analysis that is done on unrepresentative samples (you've heard of garbage in and garbage out). The practice frequently results in un-trendable data and nuisance alarms. No amount of laboratory wizardry can extract useful data from the smog of poorly sampled oil. And, the onward investment in oil analysis from such samples will yield no real return. The Garbage Test is indeed very expensive.

3. The Puzzling Test

This test is oil analysis that reveals a critical machine fault that an unskilled technician fails to identify (false negative), or a benign condition that is mistakenly alarmed (false positive). This could be caused by lack of training, lack of people resources or lack of emphasis on the importance of oil analysis. Effective interpretation of oil analysis data takes knowledge and focus. Sadly, many organizations place little importance on the development of oil analysis skills as a vital part of machine condition monitoring.

4. The Bloody Test

For want of a better term, the Bloody Test describes oil analysis performed post mortem, to find out what went wrong. Too often new maintenance policies and procedures are 'written in blood' because change occurs slowly and often only after machine mortality. This is classic 'reactive maintenance' when failure precedes analysis. Oil analysis can't breathe new life into a fatally maintained machine.

5. The Non-Test

This is the test not performed. Sometimes this test is thinly disguised as cost reduction. Common examples are samples taken too infrequently or tests not performed as a part of the test slate. Taking fewer samples or reducing the program test scope can reduce costs but often such practices have woeful consequences. The optimum selection of sampling frequency, routine oil analysis tests and exception tests can significantly enrich the quality and effectiveness of oil analysis.

6. The Get-No-Respect Test

This is lab data that is neglected by the maintenance staff. Common oil analysis exceptions that are sometimes ignored range from the use of a wrong lubricant, to a dirty hydraulic fluid, to a coolant leak. These are failure 'root causes' that can, and often do, lead to expensive machine upsets. Occasionally the non-conforming data points to an active degenerative condition in a critical component - accelerated bearing wear for instance. Yet, sometimes the correction itself risks lost production and downtime. Many people in charge of oil analysis fear 'eating crow' if they recommend a corrective repair that upon further inspection (after the bearing was removed for instance), it was found that no maintenance action was needed. The machine lubricant analyst who has mastered his craft and is skillful at troubleshooting and problem solving offers real value to maintenance organizations today.

The next section will look at how we can make oil analysis work for us and work well but we will close this section with a quote from management consultant and one time professor of management at the Graduate Business School of New York University, Peter Drucker:

So much of what we call management consists of making it difficult for people to work.

HOW TO MAKE OIL ANALYSIS WORK

For far too long now, maintenance departments have been seen as cost centres that simply appear to swallow resources without giving anything in return. Often this is as a result of the work carried out by the department reflecting in the bottom right hand corner of another department's balance sheet. Improved availability of equipment, through good maintenance, results in increased productivity and profit which is not directly linked back to the maintenance department.

The problems addressed here and some of the solutions can be applied to the bigger picture of the production versus engineering dichotomy. The old "we bend 'em, you mend 'em" argument has been around for years and needs to change. We certainly cannot have engineering departments running the mine or whatever but they do need to be considered on an equal footing with the production department. Organisations where production and engineering talk to each other and share equal partnerships and common goals function well.

But why is it that the engineering and particularly the maintenance departments are always seen as everybody else's poor brother? And by extension, the oil analysis programme.

One possible reason that has been cited is the lack of readily available metrics and Key

Performance Indicators or KPIs. As I look at the notice board in the diagnostics department at Wearcheck I can see graphs showing samples processed, samples sold, sample turnaround time, debtors days, actuals versus budgets and even the number of days sick leave each employee has taken. At a glance I can easily see how the company in general and my department in particular is doing. There are targets and I can see if they are being met - and so can everyone else.

The first step that needs to be taken in the implementation of a successful oil analysis programme is usually a change in management philosophy. People resist change not because they love the status quo but because they fear the uncertainty that accompanies change. Companies can behave in exactly the same way that humans do when dramatic change occurs: denial, anger, bargaining, depression and acceptance. Most people seemed to have coped with the anti-smoking legislation and the plastic shopping bag laws.

What needs to be accepted is that predictive and proactive maintenance philosophies are the way of the future.

To return to the medical analogy, we will often wait for the 'heart attack' to face harsh lifestyle realities. Critical motivation needs to be achieved, compelling ritual practice and dogged resistance to be put aside, heralding a new dawn of machine reliability. The other change in philosophy that is required is to accept the fact that oil is not a consumable but an asset that needs to be managed. Count the cost of lubrication not the cost of the lubricant.

This is not going to happen on its own. First of all a top-down management commitment is required; buy-in at the highest level is required and this must be carried through to the most junior apprentice on the shop floor. Much like a weak link in a chain, the programme will only be as good as the least committed member in the chain of command.

What is required next is a champion, a leader who will take ownership of the cause. Someone who will commit, publicly, time and effort to follow through with the oil analysis programme. The champion needs to get staff to see the reason for change, how each one will benefit, how the company will benefit overall and what the future will look like.

Most companies have or should have a corporate vision and mission statement; there may also be quality and environmental statements depending on adherence to such codes of practice as ISO 9001:2000 and 14001. There is no reason why major departments within a company cannot have their own mission statements, so why not a mission statement for the oil analysis programme?

There is no reason at all not to have one. The heirarchy might follow along these lines: corporate vision, corporate mission statement, departmental mission statement, reliability and maintenance mission statement, oil analysis mission statement. It is vital that the mission statement be aligned with the corporate vision or else the programme will be a sure target for cost cutting. The other key ingredient of the statement is that it must contain measurable objectives (KPIs); if you cannot measure your progress you will never know if your targets are being achieved.

The advantage of the mission statement is that it is written and this institutionalises it, which makes it difficult for people to pay lip service to it. It should also be dynamic so that it can be reviewed on a periodic basis. Even this may not be enough to start the ball rolling - money and authority are required by the people charged with implementing the programme. Do not make the mistake of giving staff responsibility without authority; oil analysis must have teeth to be effective.

The mission statement must reflect best practices so the first step is to identify those best practices. Next, the staff need to be educated about best practices - it cannot be stressed too strongly how important education, at all levels, is to the success of the programme. Maintenance staff cannot buy into the programme if they do not know what it is about or what to do - there must be confidence in a shared vision. External educators should be used to engender credibility. After a period of education, the best practices or mission statement needs to be implemented. Finally, best practice needs to be rewarded.

Once a mission statement has been created and has been implemented, the whole system needs metrics and KPIs that can be measured to gauge the effectiveness of the programme. The KPIs can be broken down into macro and micro metrics. Some simple yet very easily measured macro-metrics are listed below, the most important of which is equipment availability; a KPI that most organisations will monitor anyway.

- Machine availability
- Replacement frequency (machine and component level)
- Mean time between failures (MTBF)
- Oil and fuel consumption
- Planned versus breakdown maintenance
- % service carried out on time

The devil, however, is in the details. The macro-metrics are large, company-wide KPIs that are only tangentially related to the oil analysis programme which in turn needs to be micro-managed. What is ultimately trying to be achieved is the elimination of root causes of failure. 100% success is not a realistic target, even with the best company in the world and an unlimited budget. However, the 80/20 rule definitely applies. Attend to 20% of the causes and you will remove 80% of the problems. Examples of simple micro-metrics that are easy to monitor and to set goals for are:

- % samples that are normal, borderline, urgent or critical
- Average time to respond to an actionable report
- Average time taken to get the samples to the laboratory
- % feedback returned
- % samples with missing/wrong information
- % repeat problems

The first and last points are probably the most important.

Targets need to be set for these objectives and the progress monitored on a monthly basis. These must be graphical and very visible so that all staff that are involved know where they stand and where they are headed. Milestone achievements should be rewarded.

Most large organisations, and a lot of smaller ones too, employ a computerised maintenance management system (CMMS) but there is still a lot to be said for the old fashioned planning board in the workshop. This is also highly visible and allows all personnel to see what is going on at a glance. Two items that should be included are whether the oil analysis reports are normal or not and if the problems have been attended to.

Teamwork is important. The previous section used an aircraft analogy to show how flight (and maintenance) crews frequently miss signs that something is wrong. A re-think has shown that a team approach is far more effective in dealing with the problems. The team should include:

- The operator
- Maintenance personnel
- Production personnel
- Equipment suppliers
- Oil companies
- Technical support services

Finally, the importance of education needs to be stressed once again. The cost of an untrained workforce can be astronomical.

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