WEAR CHECK AFRICA
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ANALYSING USED OIL . . . WHAT ARE THE BENEFITS?

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In a recent meeting we were discussing what the topic for the next technical bulletin should be. After writing technical bulletins for fifteen years it suddenly dawned on me that we have never written a bulletin outlining the benefits of performing used oil analysis. I have written brochures and I can find at least two dozen PowerPoint presentations that address this question but the material has never ended up in this format. So, without further ado, what are the benefits of a well-run oil analysis programme?

This series of publications details how to run an oil analysis programme, how to calculate the effect on the bottom line and how oil analysis fits into maintenance management philosophies. However what, in technical terms, are the actual benefits?

Used oil analysis has three main functions: to monitor the health of the oil, to monitor the health of the machine being lubricated by the oil and to measure levels of contamination. It is both a predictive and proactive maintenance technique. It is predictive in that it can reduce the severity of failures and allows activities to be planned; it is proactive in that it permits the reduction of failure rates and operating costs.

That is the ultimate goal of oil analysis, to reduce operating costs and to save money. So, how does it do this? The main benefits are that it:

- Detects abnormal wear
- Detects oil degradation
- Detects oil/component contamination
- Detects impending failures
- Verifies the oil in use
- Optimises service intervals
- Avoids unnecessary overhauls
- Avoids loss of production
- And, ultimately, saves money

Each one of these points will now be discussed in detail.

DETECTING ABNORMAL WEAR

The metallurgy of a particular component is known or can be ascertained from the

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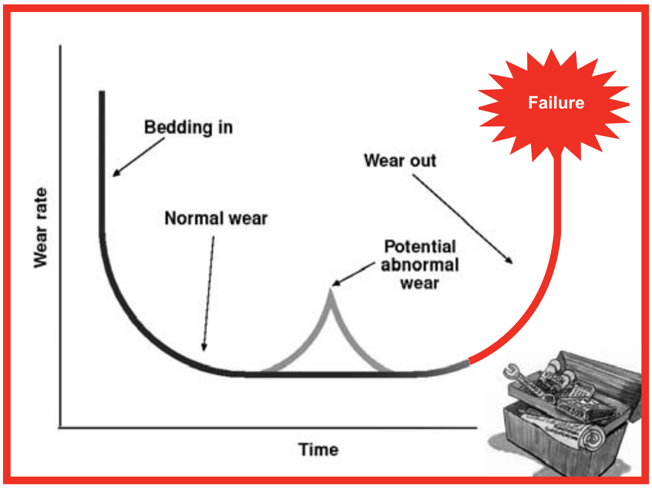
THROUGH OIL ANALYSIS

manufacturer. Pistons are made of aluminium; plain bearings contain lead; thrust washers and bushes usually contain copper; and shafts, gears and roller bearings consist of alloys of iron. Oil analysis has been around since the late 1940s and evolved on the railways in the United States. Of particular interest was the premature failure of plain bearings in locomotive engines which usually contain a lead/tin overlay. The original idea was to analyse the used engine oil to see if it contained any lead. Most of the samples analysed did contain lead so it was back to the drawing board. What was eventually discovered was that an increase in the lead level indicated the onset of bearing failure.

Generally, wearing components exhibit what is known as the 'bathtub' curve in terms of metal generation. Initially wear rates might be quite high as a unit beds in; these will settle down to a relatively constant generation rate until the end of the unit's life has been reached when wear rates will again increase. See graphic below:



The bathtub curve

Any deviation from the normal wearing portion of the graph may either indicate that the machine is working harder (accelerated wear) or that abnormal wear is taking place. The most important thing here is to detect and correct these problems early so that catastrophic failure can be avoided.

DETECTING OIL DEGRADATION (MONITORING OIL CONDITION)

Oil analysis also allows the condition of the oil to be monitored. Oil degrades over time due to its ability to react with oxygen in the atmosphere (oxidation). This process causes the viscosity to increase and acids to form. The rate at which this occurs can be increased by high temperature operation and the presence of contaminants. A variety of chemicals are blended into the oil in order for it to do its expected job. These additives are sacrificial in nature and are gradually used up over time and this process also leads to the degradation of the oil. What this means is that oil cannot last for ever and needs to be changed on a periodic basis.

The oil change period will depend on many factors such as machine type, application and environment but without an oil analysis programme it is impossible to know when to change the oil. A large variety of physical and chemical tests can be done to monitor the health of the base stock and the level of activity of the additives in the oil.

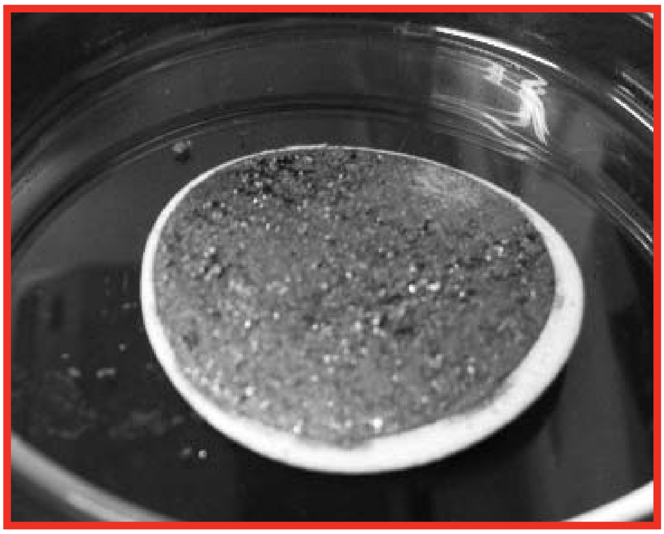
Often the degradation of the oil can be as a result of a vicious circle. A minor abnormality (slight overheating, for example) could cause the oil to degrade only to a small extent (a slight increase in viscosity may occur). The problem here is that an increase in viscosity will diminish the oil's ability to act as a coolant so that the overheating problem becomes more pronounced resulting in more degradation of the oil. Total mechanical failure can occur in a surprisingly short period of time. Below is an engine oil that has been subjected to severe overheating.

An engine oil subjected to severe overheating

MONITORING CONTAMINATION LEVELS

The third major function of oil analysis is to monitor levels of contamination. Contaminants can be either internal or external. Internal contaminants are generated within the mechanical system such as wear debris or combustion by-products. External contaminants are substances that exist in the environment that should not be in the oil. The most common ones are dirt and water.

Contaminants can be directly damaging to the machinery being lubricated. Dirt is abrasive and can cause components to wear abnormally, while water causes metals to rust. Contaminants can also cause the oil to degrade which in turn may have an adverse effect on a mechanical system. Combustion by-products such as soot cause the oil's viscosity to increase making it less effective as a coolant and lubricant. There is also a phenomenon known as secondary wear. Unfortunately wear can never be eliminated but it can be reduced. This means that small wear debris particles are always circulating in the oil. If these become excessive, they can become ground up between gear teeth and this means that they become work hardened which in turn can cause other components to wear at an accelerated rate.

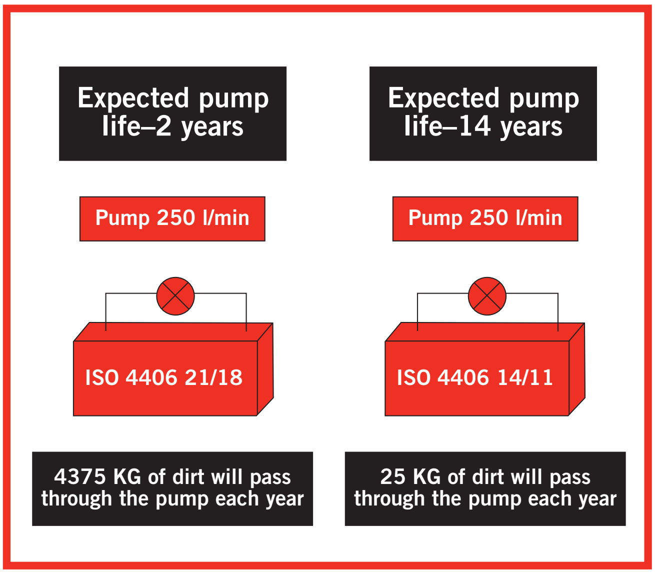


Large wear

Coarse dirt

Oil degradation by-products

The illustration below, courtesy of the Noria Corporation, shows how detrimental dirty oil can be to a hydraulic system.



The effect of dirty oil on the life of a hydraulic system

DETECTING IMPENDING FAILURES

Related to the monitoring of machine health, oil analysis can be used to detect impending failures. Sometimes the results of oil analysis can indicate that severe wear has started to take place over a very short period of time, as the previous sample may have been completely normal. This is important and represents a different benefit to that of detecting the onset of abnormal wear. In the case of failure, the majority of the damage is done at the point of failure so a repair bill can be dramatically reduced by taking action before the failure actually takes place.

VERIFYING THE OIL IN USE

Verification of the oil in use is an important benefit of oil analysis. When a sample is submitted to the laboratory the customer is asked to state what oil is being used. Often this is a case of 'what oil do you think is being used?' The answer to this question can sometimes be quite surprising. If the oil in use is not what the customer expected, then this can indicate a number of things. In its most severe case, the oil in use may not be recommended or even suitable for a particular application. Certain marine and locomotive engines have bearings that contain silver and these bearings react very badly with oils that contain zinc based anti-wear and anti-oxidant compounds. Oil companies produce engine oils that are zinc-free for these applications but it does mean that 'ordinary' engine oil would lead to catastrophic engine failure in a very short time.

Incorrect oil usage may show that there is a problem with maintenance practices in the plant. Mixed oils may indicate a need for training of personnel involved in the servicing of equipment. The oil mixture may not be life threatening and might possibly be perfectly acceptable but it does highlight other problem areas. Alternative brands and grades may be acceptable in one situation but not in an another and, in specialised applications, there is a chance of warranty being voided should a premature failure occur and the lubricant in use is not what the manufacturer recommends.

It is important to note that some mixtures of oils can be indistinguishable from a third product that may not even be present in the plant or workshop.

OPTIMISING SERVICE INTERVALS

Oil analysis can be used to optimise service intervals. Note the key word here is optimise, not the phrase, 'how far can I push this oil?' Let us use an earthmoving example. Going back about twenty years ago there was this magical oil drain period of 250 hours. Almost all equipment manufacturers subscribed to this and it did not matter which make and model of engine, what piece of equipment the engine was fitted to, what the application of the unit was or where it was working. A particular engine could be fitted to a bulldozer, a front end loader or a grader. The bulldozer, for example, could be dozing, ripping or even pushing a scraper. The unit could be doing final levels or building a dam and it could be working in KwaZulu-Natal, Gauteng or the middle of the Kalahari Desert. It was a case of 'one size fits all', a 250 hour oil drain period for the engine.

Obviously there is room for machines working in light applications and good environments to have their oil drain periods extended. However, this is an exercise that should never be undertaken without the aid of oil analysis. If you are going to extend your oil drain periods you need to know when the oil finally degrades to the point that it needs to be changed before it can do any harm.

Be aware that optimisation may mean that oil drain periods might need to be reduced in severe applications or hostile environments. This represents an increase in cost in terms of oil usage, labour and machine downtime. However, with an optimal oil drain period, hopefully the engine will last longer and the extra cost will be justified by the return on investment.

Just a note of caution. The most commonly encountered exercise is to try and extend engine oil drain intervals. This is logical as it is the maintenance activity that is carried out most often. Because of this it is often the activity that triggers the primary service cycle. If the oil drain can be extended from 250 to 500 hours, all well and good, but if 500 hours now becomes the time interval for carrying out an A service, make sure that all the other things that would normally have been carried out every 250 hours can now be carried out every 500 hours.

AVOIDING UNNECESSARY OVERHAULS

Equipment overhaul is often dictated by an empirical time interval, be it kilometres, hours or calendar based. These intervals are usually derived from averages and historical data. If the average time to transmission failure is 10 000 hours then it makes sense to schedule replacement at this time. The only problem is that averages are simply that – averages. The prescribed intervention interval will not cover premature failures and on the other side of the coin, some units will be overhauled or replaced when they still have useful remaining life.

Oil analysis can be used to help make these decisions based 'on-condition'. It makes sense to carry out as many non-destructive, non-invasive tests as possible then make the repair decision based upon the data obtained. If all the parameters appear to be within specification then there is no need to carry out the repair. Likewise, if the oil analysis results come back looking absolutely critical then early replacement might be recommended.

AVOIDING LOSS OF PRODUCTION

An oil analysis programme or for that matter, any maintenance activity, must be able to justify itself financially. The cost of labour and materials is fairly easy to calculate. Oil analysis detects a fault, a repair is scheduled, the parts are ordered and the manpower is made available to effect the repair. These are all easily quantifiable parameters and the cost of failure can also be calculated if the problem had not been highlighted by the oil analysis programme. But what would have been the impact on production if a production line had gone down for two days? What would the impact have been in a mining operation if a prime mover were in the workshop for a week? What would happen if a quarter of the buses were off the road over a holiday? What would be the repercussions for the company for not completing the job on time?

Although loss of production can often be very difficult to quantify accurately, it is the factor that usually has the biggest impact on cost savings and provides the biggest benefit of an oil analysis programme.

SAVING MONEY

At the end of the day, that is what it is all about: saving money, making the organisation more profitable. When all of the individual benefits of an oil analysis programme are added up they all serve to reduce operating costs and improve profitability. An efficiently run oil analysis programme should show a return on investment of at least 10:1. Now, where can you make an investment like that in this day and age?

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