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The Perils, Pitfalls and Perks of extending oil drain periods

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The extension of oil drain periods has long been an area of debate. There are many benefits to be obtained from extending oil drain periods and doing so is a legal requirement in certain countries around the world. These benefits are just as applicable to South Africa but it would be foolish to try to apply parameters recommended for European, Japanese or North American conditions (the source of most diesel engine technology) to this country.

This technical bulletin will examine the benefits of keeping oil in use for longer periods with specific reference to heavy-duty diesel engines, the perils and pitfalls of doing so in South Africa, and how some of these dangers can be overcome or minimised.

The equipment considered will be on-road (buses and trucks) and off-road (earthmoving) vehicles. Drivetrain (differentials and gearboxes) and clean oil (hydraulic) systems will not be looked at because they already apply fairly long oil drain periods.

BENEFITS

The most obvious benefit is that if the oil is kept in use for twice as long, then half the amount will be used. This is a valid assumption and does result in a cost saving to the fleet owner, although the savings are small.

Oil analysis, as a maintenance technique, has been around since the late 1940's but was considered a 'black art' for many years. It is only in the last 10 - 20 years that it has become a mainstream practice. In the early days, one of the selling points for oil analysis was the extension of oil drain periods and this financial justification could be seen in the bottom right hand corner immediately. It was a lot harder then to quantify the savings due to reduced downtime, labour and the cost of parts.

The cost of lubricants is actually very small when compared to the overall running cost of a fleet of

VARIABLE COSTS	% OF COST	% OF TOTAL COST
Fuel	60	22
Lubrication	1	0.5
Tyres	9	3
Planned maintenance	16	5.5
Unplanned maintenance	14	5
Total	100	
FIXED COSTS		
Finance charges	52	34
Licence	2	1
Insurance	22	14
Staff	24	15
Total	100	100

The biggest saving comes from reduced downtime.

buses or of trucks or bulldozers. Estimates vary but the chart above gives an approximate breakdown of the fixed and variable running costs of a typical 8 ton, double axled dropside truck.

This shows that the savings in lubrication are quite small and the real advantages come from other considerations, the most important of which is downtime. If the oil drain period and the service interval (the two are not necessarily the same) can be extended then the truck will spend less time in the workshop being serviced. This not only represents a labour saving but also increases the availability and utilisation of the unit; if the truck is in the shop, it is not earning money.

Another important consideration is the environmental impact and the cost of disposing of used diesel engine oil. The Rose (Recovery of Oil Saves the Environment) Foundation of South Africa estimates that in 1998, 321 million litres of oil were sold, of which 90 million litres were recoverable. Of the 52 million litres recovered, the foundation was responsible for collecting 37 million litres. Although the foundation makes it easier for people to dispose of used oil correctly and there are some companies that will even remove waste oil and pay a nominal fee for that oil (which is often turned into boiler fuel), legislation overseas can often mean that the cost of disposing of a litre of used oil is more than the cost of the new oil.

This type of legislation does not apply to South Africa but most of the engines that are brought into the country come from areas where such legislation does apply and are designed with such laws in mind.

FACTORS THAT CAN INFLUENCE OIL DRAIN PERIODS

If a management decision has been made to extend the oil drain periods of the fleet then these are some of the factors that need to be borne in mind:

1. ENGINE FEATURES

1.1 Sump capacity

The oil in the engine has a job to

Operating temperature has a direct effect on the lifetime of the oil.

do: to reduce friction and wear and to cool and control contaminants, amongst many other features. The ability of the oil to carry out these functions is determined by a combination of the properties of the base stock from which the oil has been blended and the additives that the oil company uses in the formulation of the final product. Many of these additives are sacrificial in nature and once they have done their job, they are used up and there is, for example, no more anti-oxidant left.

The longer the oil is in use, the more the additives will be used up. One way of avoiding additive depletion, is by ensuring that there are enough of them and this can be achieved by having a large sump capacity or by increasing the existing capacity. Sump capacity can be increased by the addition of a supplemental or by-pass filtration system.

1.2 Oil consumption

High oil consumption results in the continual topping up of the engine with fresh oil and, therefore, oil additives. Some modern engines are designed to have high oil consumption for precisely this reason; others are designed to have low oil consumption for environmental considerations.

1.3 Oil and air filtration

One very basic way of ensuring a long lifetime for an engine is to put clean oil, air and fuel into it. It is important that adequate filtration is available for extended periods; in terms of oil filtration the addition of a supplemental or bypass system is advisable. These systems usually divert about 10% of the oil flow to the supplemental filter and improve the cleanliness of the oil as well as having the added bonus of increasing the sump capacity. Some systems can provide very fine levels of filtration without removing active additives from the oil.

1.4 Engine operating temperatures

Operating temperature has a direct effect on the lifetime of the oil. The base oil reacts with oxygen in the atmosphere in a process called oxidation. This degrades the oil but the oil contains an antioxidant additive that retards this process. Unfortunately, like most of the other additives, the antioxidant is sacrificial. As a general rule of thumb, every 10°C increase in temperature will double the rate of oxidation and halve the lifetime of the oil. High temperature operation, which does not necessarily mean overheating, can put a severe strain on the oil. Even seasonal variation in oil lifetime has been noted, with oil lasting longer during the winter months due to cooler ambient temperatures.

2. OPERATING CONDITIONS

2.1 Long or short distance trips

In the case of on-road vehicles, the duty cycle can have a profound effect on the oil. Short distance (stop, start, idle) trips generally put a greater stress on the oil than long distance trips where optimum road and engine speeds can be maintained for long periods.

Most responsible road users would like to think that they do not drive their personal cars under severe conditions. However, starting the car in the morning, allowing it to warm up and then driving 25 km on a freeway would be considered severe by most automotive manufacturers.

2.2 Long idling periods

Long idling periods can cause

Key factors are wear, oxidation, acid content and soot contamination.

fuel dilution to occur. As the engine is not being operated under full load for long periods, an oversupply of fuel is possible which results in fuel mixing with the oil in the sump. This reduces the viscosity of the oil and hence its load bearing capacity. The additive level is also diluted because the fuel does not contain the same additives that the oil does.

2.3 Off-highway versus on-highway conditions

Off-highway (earthmoving and construction) vehicles are generally subjected to more dusty conditions, so the possibility of the oil being contaminated with dirt is that much greater. Oil contaminated with dirt is highly abrasive and will cause accelerated wear.

2.4 Fuel quality

This is probably the most important factor when considering the extension of oil drain periods. The quality of South African fuel is not good and this means that the combustion by-products that end up in the oil are very aggressive, much more so than in the countries where most of the diesel engines on our roads are manufactured.

The sulphur content of South African diesel is high by world standards. Coastal fuel has a sulphur content that is limited to 0.55% by mass, although fuel samples with sulphur contents higher than this have been noted. When fuel is burned in a diesel engine this sulphur reacts to form a variety of acids, one of which is sulphuric (battery) acid. This ends up in the oil, with disastrous effects on the engine.

Engine oils do contain additives that neutralise these acids but, like other additives, these are sacrificial and, once used up, can no longer provide protection against acid attack. The higher the sulphur content and the longer the oil is in use, the more acid will be produced. There is firm commitment to reduce the fuel sulphur to 0.3% by January 2002 but this is still nearly 10 times higher than the sulphur levels in Europe.

Sulphur is not the only problem, and diesel produced by Sasol and Mossgas is basically sulphur-free. Unlike many other countries, South Africa has huge coal reserves and much of the power generation comes from coal-fired power stations. This means that the heavier fractions of crude oil go into oil refining whereas, in Japan for example, these fractions would be used to generate power. This results in a higher density and boiling point range for South African diesel than would be encountered elsewhere in the world. The result is the production of more soot, which causes the oil's viscosity to increase (thicken).

The main lubricant factors that need to be controlled when extending oil drain periods are oxidation, wear, acid content and soot contamination; and it is often the soot content that is the limiting factor.

3. MAINTENANCE PROCEDURES

3.1 Frequency of the vehicles' availability to the workshop

If oil drain periods are to be extended then the margin of safety of a missed or late service is greatly decreased. If a truck has an oil drain period of 15 000 km and a service is late or missed, extending the oil drain (without any other considerations) to 30 000 km is not ideal but is probably tolerable. However, if all precautions have been taken and it has been shown to be viable to extend the oil drain period to 25 000 km then, in this case, a missed service could result in the oil running to 50 000 km which would probably not be acceptable.

Trucking applications that involve vehicles going up into central Africa are particularly at risk of falling into this sort of situation.

3.2 Maintenance control

Maintenance (engineering) and operations (production) departments have been at loggerheads since time immemorial, although the old attitude of "we bend 'em, you mend 'em" is beginning to change. As mentioned in the point above, the margin of safety decreases with increasing oil drain periods and the maintenance department needs to keep a tight control on the servicing of the equipment. Servicing needs to be carried out timeously, accurately and comprehensively as most premature failures are due to poor or inadequate maintenance.

Oil drain periods should be extended gradually.

3.3 Accuracy of records

In any maintenance system, record keeping is of utmost importance so that trends and anomalies can be detected and investigated. These points become that much more important when oil drain periods are extended.

NB

There are two more critical points to consider. Firstly, make sure that the extension of an oil drain period in no way voids any warranties either from the OEM (Original Equipment Manufacturer) or from a third party such as the oil company. Secondly, if the decision has been made to extend the oil drain period, then monitoring the progress with oil analysis is essential.

PRACTICAL CONSIDERATIONS

The first step to take is to make sure that an oil analysis programme is established with a reputable company that provides a wide enough range of tests, quickly, accurately and at an affordable cost. Good technical backup should also be readily available.

Oil drain periods should be extended gradually, with oil samples being taken at regular intervals to monitor the progress of the exercise. Ideally a small section of the fleet should be tested first; preferably newer vehicles that have similar duty cycles, similar applications, and operate in similar environments. This must also be a section of the fleet that the maintenance department has tight control over and meticulous records must be kept in order to explain any anomalies that might arise.

Once the drain period for this section of the fleet has been optimised then the exercise can be repeated on other machines. It is important not to generalise; what applies to truck A might not apply to bus B. Application probably has the biggest influence on the lifetime of the oil and it is important to be aware that if the application changes then the acceptable oil drain period may also change.

It is also important to consider what impact all this will have on the servicing schedule of the workshop. In an earthmoving situation, an OEM may manufacture 20 different engines that could be fitted to any of a hundred different machines that could be used in hundreds of different applications. In the majority of these situations, the recommended oil drain period will be 250 hours.

Selection of the oil is important.

It is difficult to believe that in all these hundreds of different applications the oil drain period should be the same in each case, but this mystical figure of 250 hours is actually a very safe number that can be applied to both the worst and best of situations with a good margin of error. It also simplifies scheduling.

The service function that is carried out most frequently is the changing of the engine oil and this drives the primary service cycle, in this case 250 hours. At 250 hours an 'A' service is carried out, at 500 hours a 'B' service, another 'A' service at 750 hours and a 'C' service at 1000 hours and so on, with each service level becoming progressively more sophisticated. Everything works nice and neatly in multiples of 250 across nearly the whole fleet.

Unfortunately, extended oil drain periods do not behave in such a nice orderly fashion and it may not be feasible to exactly double an oil drain period. What may in fact happen is that some sections of the fleet will have their oil drain interval extended by 30%, some by 50% and others by 80%. This could result in part of the fleet operating on a 325, 650, 975, 1300 hour cycle, another part operating on a 375, 750, 1125, 1500 hour cycle and a third operating on a 450, 900, 1350, 1800 hour cycle.

Service scheduling would become a logistical nightmare, although there are certainly computerised maintenance packages that could handle this. The level of staffing to make it work would need to be considered very carefully. Again, it must be noted that the margin of safety (missed/late services) is that much less when oil drain periods are extended.

What this is all leading up to is the most important point in this bulletin. It was noted earlier that the actual cost of lubrication in the general scheme of things is very small and the real cost savings come from reduced downtime, labour and spares. However, all that has been done so far is to extend the ***oil drain period*** of the engine from 250 to 500 hours, for example. ***The 250 hour <u>service</u> has not been eliminated.*** All this means is that the 250 hour service job card no longer says 'change the oil'.

There are still important tasks that need to be carried out at the 'A' service interval, the most critical being to change the oil filter. Checking the brakes and grease points are other examples, and some of them directly related to safety.

In 1997 Cummins introduced their Centinel system for extending oil drain and service intervals. An electronic system monitors the duty cycle of the engine and periodically diverts small amounts of oil to the fuel tank. The fuel and used oil mix and are burned as fuel. A header tank of fresh oil tops up the engine to replace the used oil that has been removed. In the United States, oil drain intervals can be extended to an impressive 300 000 miles but there is still a 75 000 mile filter change interval.

INFLUENCE OF THE OIL

If the oil drain period is to be extended then the selection of the oil is important. All oil companies make a bottom of the range ('cheap') oil and a top of the range ('expensive') oil. The longer the oil is in use the more contaminated and degraded it will become, so it makes sense to use a high quality oil when drain periods are extended.

Soot is often the limiting factor.

Many high quality mineral oils are available from all reputable oil companies at a typical cost of R10 - 15 per litre. Bottom of the range products can cost less than R10 per litre and top of the range synthetic products can cost nearly R100 per litre.

The major factors contributing to the contamination and degradation of the oil are soot, oxidation, acidification and the related wear that they cause. Often it is the soot that is the limiting factor which determines when the oil needs to be changed in South Africa, and not the level of acidity. High soot levels cause the viscosity of the oil to increase and thereby decrease its ability to lubricate. Soot levels of 5% and higher have been seen, and although this may not sound like much, 5% soot by mass can occupy more than the original volume of oil, with severe effects on the viscosity.

Dispersants are additives that are blended with the oil to control soot but there is a limit to how much additive an oil can take. Most seal materials are incompatible with the dispersant chemicals, which also cause the oil to thicken at low temperatures. A solution to this problem would be to start with a lower viscosity base oil, although these oils are more volatile which could result in an increase in oil consumption.

Likewise, only certain levels of antioxidants and acid neutralising compounds can be added because they contain metallic-based additives which, in high concentration, can actually cause engine wear.

Synthetic oils can inherently tolerate high soot-loading without dramatic viscosity increase. Other properties include low volatility, natural resistance to oxidation and the ability to last for an extended period of time when blended with sufficient acid neutralising agents.

Unfortunately, all the benefits come at a price and it is up to the individual fleet owner to weigh up the increased cost against the increased benefits. Some fleet owners find the use of synthetic lubricants economically viable, others do not. Make, model, age, application and environment are some of the factors that will come into play. The fact is that a synthetic lubricant coupled with good maintenance practices will not only make the oil last longer, it will also extend the life of the engine.

Environmental protocols are putting increasing demands on engine design (see next section) and hence oil performance. Engine manufacturers can design new engines more quickly than the regulatory bodies can formulate new oils to cope with the new features. This has led to the engine manufacturers forming joint ventures with oil companies to produce oils that are tailor-made to specific engine designs. Both Cummins and Caterpillar have their own branded lubricants.

ENVIRONMENTAL FACTORS

Not only must the cost of disposing of used oil be considered from an environmental perspective, but also the changes that are taking place in engine design. In an effort to control pollution, engineers have made some design changes that have had important implications for the lubrication of these engines. The repositioning of the compression ring, the changes in combustion pressures and temperatures, and the advent of EGR (Exhaust Gas Recirculation) have all made heavy de-

Do not confuse oil drain periods with service interval.

mands on the lubricant, which will be exacerbated by poor fuel quality. All those pollutants that used to go into the atmosphere are now going into the oil.

These factors need to be considered seriously when imported engine technology is being combined with local fuel, environment, application and operating practices, all of which increase the soot loading of the oil.

PUTTING THEORY INTO PRACTICE WITHOUT PITFALLS

Oil drain periods can safely be extended as long as some basic rules are followed and common sense is applied. The most important question is: 'Will it save me money in the long run?' If the answer to this is 'no' or 'not much', then it is not worth taking a chance that something might go wrong and could result in engine failure.

The following are the important points to consider before making a decision:

- Engine make and model
- Age and general health of the engine
- Application
- Environment
- Fuel quality
- Oil quality and cost
- General maintenance practices
- Maintenance control

Once the decision has been made:

- Document everything
- Apply procedures correctly
- Apply them gradually after thorough investigation
- **Do not confuse oil drain period with service interval**
- Carry out safety checks as per OEM's recommendations
- Use oil analysis
- Do not void warranties

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